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JOURNAL OF
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ORDINARY MEETING, MARCH 5, 1883.

H. CADMAN JONES, ESQ., IN THE CHAIR.

The Minutes of the last Meeting were read and confirmed, and the following elections were announced :—

MEMBER :—T. Morris, Esq., Warrington.

ASSOCIATES :—The Right Rev. E. Harold Browne, D.D., Lord Bishop of Winchester, Winchester ; Captain E. K. Calver, R.N., F.R.S., Cannes ; J. Hague, Esq., Canada ; H. C. Lawrence, Esq., London ; Rev. J. L. Uhl, India ; Rev. J. H. Usill, Eastbourne.

HON. CORRESPONDENT MEMBER :—Rev. G. R. Badenoch, LL.D., London.

Also lately, the presentation of the following Works for the Library :

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| “Transactions of the Royal Dublin Society.” | <i>From the same.</i> |
| “Transactions of the American Geographical Society.” | ” |
| “Transactions of the American Numismatic and Antiquarian Society.” | ” |
| “Transactions of the American Institute of Christian Philosophy.” | ” |
| “Transactions of the Society Biblical Archæology.” | ” |
| “Australian Stalk-eyed Crustacea, Sydney Museum.” | ” |
| “On the Modification of Clouds,” by L. Howard, F.R.S. | <i>J. E. Howard, F.R.S.</i> |
| “Positivism,” by Rev. G. Blencowe. | <i>From the same.</i> |

The following Paper was then read by the Author :—

ON CERTAIN DEFINITIONS OF MATTER. By JOHN ELIOT HOWARD, F.R.S., &c.

ἀλλὰ πάντα μέτρῳ καὶ ἀριθμῷ καὶ σταθμῷ διάταξας.*

1. SIR FRANCIS BACON, in his *Novum Organum*, dwells upon the “*idols*† and false notions,” which occupy the human mind, and inhere so strongly therein that they make the access of truth difficult.

2. Whilst dwelling upon the special illusions which beset

* “Thou [Wisdom] didst dispose all things by number, and weight, and measure.”—Wisdom of Solomon xi. 20.

† Lib. i., xxxviii., “Sunt quidem idola *profundissime mentis humanæ fallaciæ*.”—See Appendix.

those who affect particular sciences and modes of contemplation he bears rather hardly on the chemists, who, "from a few experiments conducted in the furnace, construct a phantastic philosophy of little account."*

3. This was true enough in his day, but it has been well shown by our illustrious colleague, M. Wurtz, what an alteration has taken place in the science, through the discoveries of Lavoisier.† He was at once the author of a new theory and the creator of the true method in chemistry. He first established the elementary nature of the metals, and fixed in general the notions of simple bodies. He recognised as such those bodies which yield only one kind of matter, and when subjected to the action of all available forces remain constantly the same,‡ indestructible, undecomposable. Having thus impressed on a large number of primordial substances the seal of a peculiar individuality, he finally recast the ancient notions on the nature of elements, and put an end to the hope of *effecting transmutations*.

4. The elementary bodies thus defined are represented by Lavoisier as endowed with the power of uniting together, so as to form compound bodies, this union taking place without loss of substance, and in such a manner that all the ponderable matter of the constituent bodies is found in the compound. These great principles form the basis of chemistry. Now that they are universally adopted they appear to us so simple and indisputable that we feel compelled, as it were, to admit them as maxims. But they were not so at the time in question.

"And if anything could vie in importance with the discoveries of the great master, it would be his method,—that method which consists in *applying the balance to all chemical phenomena*."

5. Thus the "fantastic theory" of "*phlogiston*"§ vanished before the light of real science; just as the notion of the "transmutation of species" would disappear if we could but

* *Novum Organum*, lib. i., liv.

† *Hist. of Chem. Theory*, by A. Wurtz, Membre de l'Institut (Aca. des Sciences).

‡ So also Lucretius :—

"Sunt igitur solidâ primordia simplicitate,
Nec ratione queunt aliâ, servata per ævom,
Ex infinito jam tempore res reparare."

Lib. i., lines 549, &c,

§ "The principle of inflammability."

ascertain in what the *formative power* of a single species or of a single individual consists.*

6. We have thus advanced in our knowledge of the *properties* of matter to some presumably correct appreciation of its nature. By spectrum analysis we appear to recognise this ponderable matter as the same throughout the universe. We may have to recast our list of simple substances, or in other ways to modify our present views; but we are conscious that we are now walking in the light of truth, and consequently cast the dreams of the past to the moles and to the bats.

7. This may seem presumptuous, but will not appear so if it is considered that on every hand our present chemistry is confirmed by fact; and that the health, comfort, and well-being (in a material sense) of the whole community are connected with continual recurrence to the principles of atomic proportions and dependence upon the unchangeable atomicity of atoms.

8. The brilliant illumination of our streets, the cleanliness of the population, their succour through pharmaceutical aid, the colours of the dresses worn, and of the furniture decorating our houses, are a few out of the familiar instances in which chemical art is essential to our civilisation.

9. Such being the progress of the science it has been necessary to co-ordinate our language with the use of phrases in the past; and also to modify words, *e. g.* metals, metalloids, salts, &c., giving a certain definite meaning to that which was before unfixed. This has not been easy to effect.

I do not even think that it has been effected, for, though we have quite a right to invent new words, or even a new language to express new facts that we discover, it is a different matter when we invade the common privilege of mankind to express themselves as they will,

“Si volet usus

Quem penes arbitrium est, et jus, et norma loquendi.”†

10. Whilst it is not to be supposed that the common language

* “Nec tamen omnimodis connecti posse putandum est

Omnia : nam vulgo fieri portenta videres ;

Semiferas hominum species existere, et altos

Interdum ramos e gigni corpore vivo

Multaque connecti terrestria membra marinis,

* * * * *

Quorum nihil fieri manifestum est ; omnia quando

Seminibus certis certâ genitrice creata,

Conseruare genus crescentia posse videmus.”

Lucretius, *De Rerum Natura*, lib. ii., lines 690, &c.

† Horace, *De Arte Poetica*, l. 71.

of mankind could be affected by chemical theory ; it is otherwise with "scientists" who have learned to dress up their thoughts in chemical language ; to talk, for instance, of mind being connected with *molecular changes* * and of "*molecular force becoming structural*," in the brain, whilst at the same time disbelieving in the existence of molecules themselves, and sceptical as to the very existence of matter itself. "It seems to be the natural desire of the chemist to see with his mind's eye the atoms and molecules which can no more be seen by the microscope than by the unaided eye. While endeavouring, then, to see the constitution of matter, we are told, on the one hand, that we may relieve ourselves from the idea of matter altogether, and be content with resolving all things into Force [e.g., Sir W. G. Armstrong, British Association Address, 1863] ; and, on the other hand, we are told that Force, in all its many manifestations, may be resolved into Matter and Motion." †

11. The popular mind would not have been influenced so easily by this pseudo-philosophy were it not for this illegitimate and misleading use of chemical language ; but even now there may be an advantage in insisting that two schools of thought should not use the same words in different meanings.

12. I plead for the common-sense views of Matter, and considerate the retention of the meaning of the word as given us in the standard old-fashioned English of Johnson's *Dictionary* : "Body, substance extended."

13. This he illustrates by the following quotations :—

From Watts's *Logic*:—"Some have dimensions of length, breadth, and depth, and have also a power of resistance ; or, exclude everything of the same kind from being in the same place. This is the proper character of matter or body."

Further, from Newton :—"It seems probable to me that God in the beginning formed Matter in solid, massy, hard, impenetrable, movable particles, of such sizes and figures, and with such other properties, and in such proportion to space, as most conduced to the end for which he formed them ; and that those primitive particles, being solids, are incomparably harder than any porous bodies compounded of them ; even so very hard as never to wear or break in pieces, no ordinary power being able to divide what God himself made one in the first creation."

14. The first of these extracts is the language of common

* See *Examination of Tyndall's Belfast Address, Trans.*, vol. x. p. 115.

† Presidential Address, delivered before the Newcastle Chemical Society by B. S. Proctor.

sense; or, in other words, that of the condensed experience of mankind. The second is that of the profoundest philosophy.

15. It was reserved for another deep thinker to bring the admirable *speculations* of Newton within the domain of *facts*. It is by weight and measure that we realise our conceptions of *body*, about which sight unaided does not always give us accurate information. What we think we see is not always really seen; and much as we owe to spectrum analysis in assisting in the investigation of the properties of matter, we are yet not able to obtain the amount of certainty which attends the following research.

16. It was Dalton, then, who first gave the idea of atomic weights:—"It was by a careful mechanical juxtaposition of parts that Dalton arrived at the idea: it is eminently mechanical, and it is remarkable that all progressive views on the subject have been so. He *introduced proportional weights into the theory, and found it to agree with facts*. His is, therefore, the quantitative atomic theory."*

17. Taking advantage of the already ascertained property of a mass of matter, called the attraction of gravitation, indicated by the weights in the balance, he thus enabled us to understand correctly something more about the intimate properties of body or substance, giving a solid basis to that which was previously theory.

18. The notion of the atomic constitution of matter formed part of the philosophy of the Hindoos, Phœnicians, and Egyptians, and must, in all probability, have descended to them from a very early antiquity, when those nations could share in common ideas.

19. Amongst the Greeks it afforded the basis of the cosmogony of Democritus; and, subsequently, Epicurus and the Epicureans generally supported the atomic hypothesis; and in a most admirable poem, Lucretius discourses on the nature of things in a sense hostile to religion, or, rather, to the abominable superstition which alone was to him "Religio,"—

"Tantum Religio potuit suadere malorum."†

20. Hence, I suppose, arose the prevalent opinion of the atheistic tendency of the doctrine which he inculcated. But if any person can read the poet's description of the sacrificed Iphigenia without partaking in his indignation, he must be destitute of humanity. We must needs, in so far, sympathise

* Ure's *Dictionary*, vol. iii. p. 270.

† Lucretius, lib. i., l. 90.

with the irreligion of Lucretius, whilst we have no excuse for copying his atheism.

21. It is, however, to be most accurately noted that the refuge of Agnosticism is, at the present day, rather in the opposing doctrines of Boscovitch and of Spinoza, and in the "everlasting haze" in which they involve us.*

22. Dr. Priestley was a champion of such *mystical materialism*. Everything with him was *matter* that was not space. There was no third or different substance; consequently the soul of man is material.† But what is matter? or, rather, what is its definition? "Matter is a solid and extended substance, endowed with powers of attraction and repulsion." With this definition he enters into controversy with his friend, Dr. Price. "Can matter think?" is the grand question proposed by the latter. Matter, observes Priestley in his reply, may think, for matter is not inert; it is not impenetrable; it is not, logically speaking, solid. We can form no conception of the beginning of perfect solidity, and it is not an improbable conjecture that all the elementary matter employed in the formation of the solar system might be comprised in the capacity of a nut-shell. It is, indeed, most probable that there is no such thing as solidity in nature; and that matter, consistently with the theory of Boscovitch, is nothing more than a *compages of centres of various attractions and repulsions extending indefinitely in all possible directions* (!) Hence, then, it was replied, the only powers or properties of matter are attraction and repulsion. But powers must be the powers of *something*; yet if *matter* have nothing but these powers, and be nothing but these powers, then is it a *nonentity*, or rather becomes altogether *immaterial*. Towards the termination, therefore, of this literary contest, it seems to have been agreed that materialism and immaterialism were the same thing; and, on the part of Dr. Priestley, that, provided there were but one essence admitted in the formation of man, he was totally unconcerned about the term, and was equally ready to denominate it a *material* or an *immaterial* substance.

23. Happily there is a large (though perhaps diminishing) fund of common sense in the composition of the English character, and neither Priestley's transcendentalism nor the theories of mystical materialists vegetate freely in our

* See *An Examination of Philosophy as advanced by Prof. Tyndall in his Belfast Address*, by J. E. Howard, F.R.S., *Trans.* vol. x. p. 126.

† Dr. Good's *Lucretius*, vol. i. p. 90.

soil. Nevertheless, it is highly desirable that our common experience should be treasured up in common English words, and that we should abolish entirely the "idols" which shield themselves under the misuse of terms in so-called "philosophy."

24. Let our word *matter* be, then, agreed upon as the same as the Latin *materia*, from which it is derived. What does this express but the "*wood*"* which the carpenter employs for the erection of his building; or the created substance out of which the Creator forms and fashions the Cosmos.

25. We will not, then, confound the carpenter with the wood that he uses, nor the Creator with His handiwork. We will not for a moment admit that Matter and Mind are the same.

26. But it is to the more accurate philosophic genius of the Greeks that we must turn for a more perfect definition. So we find "Υλη to mean "wood," or, "like the Latin *materia*, the stuff or matter of which a thing is made," or "matter as a principle of being,—mostly as opposed to the intelligent principle νοϋς"; and when I turn to this word (*Nous*) in the lexicon, I find that it implies *purpose*, *will*, and *design*, and that "Anaxagoras gave this name to the *Principle* which acted on the elementary particles of matter." †

27. We have, then, in the word *Nous* brought before us a *Divine Being*, full of will, purpose, and personality, acting on the subject-matter of the universe. Well might St. Paul say, "Whom, therefore, ye agnostically (ἀγνωστῶντες) *worship*, Him *declare* I unto you,"—and reason with them on the folly of idolatry, since we are the offspring of God, and possess something of His likeness.

28. Part of this likeness consists in our possessing Personality and Will. We begin from our infancy to learn that we are ourselves "Centres of Force,"—of force not only independent of our surroundings, but in opposition to that of other individualities, whom we must either dominate, or fall under subjection to them. Hence the knowledge of personality, and of force as the expression of this personality, becomes a part of our educated nature. The idea of *all*

* See Latin Dictionary, *sub voce*. This meaning is kept up in some of the languages derived from the Latin, e.g., the Rio Madera S.A., from the number of trees brought down by the stream. Appendix A.

† Liddell and Scott's *Gr. Lex.*, *sub voce*.

force as resulting from personality is, if I mistake not, most correct, but what that Personality is, whose will alone is force, is not so easily comprehended.

29. If the man would preserve in its freshness the knowledge which he has acquired in his youth, he must continually be adding to the store. It is necessary that he should keep himself *au courant* with the age, in its continual additions to the accumulated experience of mankind. He must be ever at school and advancing, *whilst never forgetting the grounding at his entrance.*

30. When a boy is sent to school he finds that some force is needed to overcome the difficulties that bestrew the path of learning. If he has a will to learn, the force needed is found in himself; and perhaps he may find supplementary help in the force of example, that is, in mind acting upon mind; but if thoroughly idle, he must be forced to learn. But whilst he complains of the force employed to subject his will to the will of another, he is never so stupid as to *personify* force, and to call the cane that corrects him, or the hand that wields it, *force.*

31. But our so-called "thinkers" continually make this mistake, and *personify Force.* *Nature* also, and *Natural Selection* and *Law** are so many gods or goddesses, the *idola tribus* whom our wise men agnostically worship; losing sight of the *Causa causarum* in the search after the intermediate causes, as if *they* were the all-important realities.

32. It is needful, then, to be quite sure that we attach definite meanings to the terms we employ, and that we do not mistake *words* for *things*, nor yet transform nouns-substantive into substantial realities. In many metaphysical treatises there is not even so much of substance as to fill a nut-shell, but then unfortunately it is substance capable of almost infinite expansion.

33. If I were to write a work on "Harmonics"; seeking to illustrate analogous properties in sound and in light, whilst myself totally ignorant of the science of music, I should justly expose myself to the reproach of conceit. But I find continu-

* No word is more misused than "Law." "Law, in the Aristotelian system, implies a consciousness of obligation which exists whether realised or not in practice. Law, in the Baconian system, means a uniform sequence, which exists only as it is realised in practice" (Mansell's *Int. to Aldrich*). And elsewhere:—"The laws of Nature are simply general statements concerning the powers and properties which have come under our observation" (Soisset, *Modern Pantheism*, vol. i. p. 169; see also Argyll's *Reign of Law*).

ally that writers and speakers, who manifest that they have no acquaintance with the atomic theory,—as now a matter of proven science,—still *use its language* without danger of detection; because so few of their hearers are at all competent to discover their presumption, or to prick the inflated bladder of their speculation.

34. Locke, as quoted by Huxley, expressed himself as follows:—“And thus here, as in all other cases when we use words without having clear and distinct ideas, we *talk like children*, who, being questioned what such a thing is, readily give this satisfactory answer, that it is *something*, which in truth signifies no more when so used either by children or men but that they know not what, and that the thing they pretend to talk and know of is what they have no distinct idea of at all, and are so perfectly ignorant of it and in the dark. The idea, then, we have to which we give the general name *substance* being nothing but the supposed but unknown support of those qualities we find existing which we imagine cannot exist, *sine re substante*, without something to support them, we call that support *substantia*, which, according to the true import of the word is, in plain English, standing under or upholding.”

35. I generally admire the clearness of thought and the appropriateness of diction with which this learned Professor (Huxley) sets forth his views on all subjects that are within his ken, but I fail to follow him in “the metaphysics of sensation” from which I quote. He says that he cannot but believe that “the judgment of Locke is that which Philosophy will accept as her final decision.”* He concludes that “*whether either mind or matter has a substance or not* is a problem which we are incompetent to discuss, and it is just as likely that the common notions upon the subject should be correct as any others.”

36. I cannot think we *are* incompetent to discuss either, in the *light of common sense*, and taking care that our language deals with facts, and not with the mere fictions of the imagination.

37. I contend for *atoms* as being literally *realities*,—*things* not only knowable, but ponderable. So Lucretius,—

“Non ex illorum conventu conciliata
Sed magis *æternâ potentia simplicitate*
Unde neque avelli quidquam nec diminui jam
Concedit natura, reservans semina rebus.”—Lib. i., line 603, &c.

* *Critiques and Addresses*, by T. R. Huxley, LL.D., F.R.S., p. 349, &c.

38. The size of these atoms must be considered as almost inconceivably, but not immeasurably, minute. M. Gaudin, who was rather specially adapted to abstract calculations,* published in 1873 this approximation. I must premise (for though every scholar in Professor Huxley's *new* Sunday school will be familiar with the fact, I have myself to resort to books for the exact figures) that a mètre† is equal to 39·37079 inches, and we try to think in French and translate our ideas into English in order to grasp the following calculation. I have before me the mètre on one side, and the yard on the other, of a certain whalebone scale which is always on my table; but nevertheless I confess that I think in English, and cannot help an effort of thought to realise the relation which a millimètre bears to the English conception. It is 0·003280825 of a foot. I look at the scale, to which I again refer, to fix my idea; for I have next to divide the millimètre into a thousand parts, which has been perfectly done by mechanical means, and a scale formed in proportion. This being placed under the microscope, and covered with a drop of water containing infusoria, has enabled observers to compare the small infusory animalcules which dart about and sometimes rest on the surface of the scale. It has been ascertained that they are not larger than one of these divisions.

39. At this degree of enlargement no detail can be perceived. The infusoria resemble small globules, but the nature of their movements, jerking, angular, and frequently retrograde, shows that we have before us small creatures endowed with spontaneous movement, and consequently provided with means of locomotion such as muscles and cilia, or other appendages.

40. M. Gaudin imagines one of these little entities enlarged to the diameter of one mètre, and then gives us a fancy sketch of the creature, and also of a small portion of one of its cilia, enlarged to about 45 millimètres in length, in which he shows the imaginary building up of the structure by molecules of an organic nature represented as one millimètre in diameter. These molecules would be of the nature of albumen, and would bear about the same relation to the ultimate atoms as a basketful of grapes would to a single grape.‡ Chemical considerations too abstract to enter into in this paper make it probable that

* As Calculateur du Bureau des Longitudes and Lauréat de l'Académie des Sciences.

† "The ten-millionth part of the distance from the equator to the pole, as ascertained (?) by actual measurement of an arc of the meridian."

‡ Appendix B.

the number of atoms in a cube of metal the size of a pin's head would be expressed by the following (or by the cube of 20 millions), 8,000,000,000,000,000,000,000.*

41. I will not follow further the deductions of this author, whose calculations may seem to some persons fanciful; but his beautiful work *L'Architecture du Monde des Atomes* commends itself at once to those who have sufficient mental training to follow his deductions. His merit has been appreciated in the highest scientific quarters in France.

42. I may, then, safely draw my own inference, which is this: We have in the body of the small infusorial animalcule we have been considering a certain number of atoms, and these combined into molecules in conformity with certain well-known chemical affinities; but we have also the evidence of another wholly different power acting upon the whole of these molecules, and not resulting from any properties in the molecules themselves. We may call this power (for argument's sake) *life*, and see that in virtue of this we have *one* individuality, *one* will, *one* centre of action, and *one* centre of reproduction, whether fissile or otherwise. We have, doubtless, *growth*, *maturity*, and *decay*, characteristics of *organisation*, but *contrary* to all that is known of chemical combination.

43. Moreover, we must bear in mind that we have in our small animalcule a Protozoon rather than a Protophyte, and that its movements are connected with seeking its food amidst the inconceivably more minute Protophyta who, like all plants, have the power of feeding upon and decomposing the molecules of inert matter. We have then, in their movements, the exercise of a will wholly opposed to the chemical actions we have been contemplating. No atom has ever the choice whether to

* Dr. Thomson has shown that an atom of lead cannot exceed in weight the $\frac{1}{310,000,000,000}$ of a grain, and that the sulphur united with it in the form of sulphuret could be no more than $\frac{1}{2,015,000,000,000}$ of the same. It may also be proved that a square inch of gold is divisible into a million of parts visible through a common microscope: so that when the metal is reduced to the thinness of leaf of $\frac{1}{50,700,000}$ of a grain, it may be distinguished. Nor is this all, for a grain of gold of the thinness which it is on gilt silver wire will cover an area of 1,400 square miles; it follows that $\frac{1}{1,400,000,000}$ of a grain may be seen through a common glass. Yet it is probable that even such a minute quantity comprehends a considerable number of atoms.—
DAUBENY, *Atomic Theory*, p. 272.

advance or to retrograde, to go to the right hand or to the left, nor what place it shall take in the compound molecule. Whence, then, comes the free will which characterises this organised matter?

44. Certainly *not* from molecular combination!

45. I do not propose to myself the task of enabling my readers to keep pace with the progress of the science; but having grown up with the atomic theory of Dalton, and from early youth followed with delight its further development, I find that I think *chemically*. I have constantly acted upon the certified details of chemical combinations with the same confidence that a traveller feels in consulting *Bradshaw*. He may complain of the bad type, or the arrangement of the contents, but the familiar book is his guide after all.

46. I thus find myself in altogether a different country, and speaking a different language from others differently circumstanced. It may seem very presumptuous to say that a writer who attempts to enlighten us in reference to "the *physical basis of life*," does not travel by the *Bradshaw* of science, and in fact proposes to lead us along the old high road. In proof of this I must refer to what I have already written, but the result of fuller study of his mind shows me that the difference between our views is much more fundamental (*substantial*) than I at first apprehended.*

47. When, according to the Professor's wish, we have "a scientific Sunday school in every parish," † I hope *the atomic theory* will hold a prominent place in the instruction. No well-educated Sunday scholar would then think of listening to disquisitions on the Origin of things, such as we find in Huxley's *Lay Sermons*, p. 128.

48. At the risk of exacting an unreasonable amount of attention, I will now recall some of the elementary lessons in this science, and seek to show that we not only imagine, but *know* "that matter has a substance"; and that Newton's views about the constitution of ultimate atoms are now as much the subject of proof as those about the falling of an apple.

49. It was from the results of an examination of two gases (olefiant gas and marsh gas) that Dalton was first led to the conception of his theory. He ascertained that both gases consist of carbon and hydrogen only; and set out the centesimal composition of each in the customary manner. But he observed

* Compare Dr. Huxley's *Lay Sermons*, p. 73, &c. Appendix C.

† *Ibid.*, p. 71.

further, that the ratio of hydrogen to carbon is exactly twice as great in the one case as in the other; that in olefiant gas, for instance, the carbon is to the hydrogen as six to one, whereas, in marsh gas it is as six to two. Or, in other words, a given quantity of carbon unites with either *one* or *two* proportions of hydrogen to form the above compounds. Dalton, whose turn of mind might be described as the expression of common sense in its mechanical aspect, explained the constitution of these two compounds by supposing that the first consisted of one *atom* of carbon united with one atom of hydrogen ● ○, while the second consisted of one *atom* of carbon united with two atoms of hydrogen ○ ● ○, the atom of carbon being considered to have six times the weight of the atom of hydrogen. He then calculated the composition of other bodies on the same plan; and found, for instance, that the quantity of hydrogen which unites with six parts of carbon to form olefiant gas unites with eight parts of oxygen to form water. Hence water was represented by the symbol ○ ○, the atom of oxygen being considered to have eight times the weight of the atom of hydrogen.* The crowning point of Dalton's theory was reached when he discovered that the numbers which expressed the respective combining proportions of carbon and oxygen with one part of hydrogen, also expressed the proportions in which they unite with each other. Thus the ratio of carbon to oxygen in carbonic oxide gas was found to be as six to eight; whereas in carbonic anhydride gas it was as six to twice eight. The former compound he considered to result from the union of one atom of carbon with one atom of oxygen ● ○, and the latter to result from the union of one atom of carbon with two atoms of oxygen ○ ● ○. Dalton extended the same views to the compounds of nitrogen.

50. Dalton thus established that general principle in chemistry known as the law of *combination in definite and multiple proportions*. He showed that a particular number might be selected for every element in such a manner that the proportions by weight in which any two or more elements combined together should be always in the ratios of their respective numbers, or of different multiples of those numbers. And he accounted for this law by supposing that the elements unite with one another, *atom to atom*, and that the proportionate number accorded to each particular demand expresses the relative weight of its atom. Hydrogen, being

* Watt's *Dictionary of Chemistry*: "Atomic Weights."
Longmans & Co.

the lightest substance in nature, was at once chosen by Dalton as the unit in his scale of atomic weights, and the weights in the atoms of other elements were established by ascertaining directly or indirectly the respective quantities of those elements which unite either with one part of hydrogen or with the quantity of some other element which unites with one part of hydrogen.

51. The founder of the doctrine which I have sought to explain might, if he had lived to this day, have boasted, with more probable truth than the Roman poet, that he had erected a monument which even the ravages of time could not destroy.* But his was the simplicity of the true philosopher, as was specially appreciated by the French *savants* when they welcomed him to their capital. I am struck, in reading over my notes of an early meeting of the British Association (in 1834), with the absence of self-assertion shown by Dalton. I do not find that he took any notice of the *half atoms* talked about by some inferior men.

52. As a disciple of Dalton, I claim (on his behalf) that his views of matter are consistent with common sense and with revealed religion. On the other hand, I have proved, beyond contradiction, that Professor Tyndall's views are consistent with neither.

53. On recurring to these notes, I find that a certain chemist of less note contended for *one-third atoms* against Dalton. This seemed to me at the time so absurd that I kept no record of the discussion, except that of "*ultimate atoms minimised*,"—the word atom being derived from two Greek words which imply that which *cannot be divided or cut asunder* (ἀ, not; τέμνω, I cut).† I do not say there are not even now some worthy successors to the individual alluded to above, who dislike the atomic theory because it interferes with their mystical notions; but to show that modern chemistry has been built up altogether in connexion with the theory of atoms,‡ I will refer to the appropriately-coined word, *Atomicity*.

54. This term is invented to express the combining capacity of an element. The atomicity of hydrogen, as exhibited in

* "Exegi monumentum ære perennius," &c.—Horace, Ode xxx.

† Ure's *Dict.*, *sub voce*.

‡ Foreshadowed by Lucretius :—

"Nam si primordia rerum
Commutari aliquâ possent ratione revicta
Incertum quoque jam constet, quid possit oriri
Quid nequeat."

the single compound which it forms with chlorine, is assumed as the standard of this *force* (I was about to say). I do not like the term "force," however, as it scarcely seems to describe accurately a power acting *ab intra* and not *ab extra*; but this former power is what very specially characterises the *properties* of matter, as seen from a chemical point of view.

55. We must, in fact, regard atoms as "substantial" *centres of force* (if this term be used), and as combining with mathematical certainty on the lines of their affinities, or separating, as the result of superior attraction on the one hand, or of force (*ab extra*) on the other.

56. I may be pardoned for explaining my meaning by reference to familiar use of words. When two young persons have a liking for each other, we do not call this *force*; and yet their caring for each other may have very important influence on their future destinies. Now we are compelled to speak of the affinities of atoms as very important indeed, and these "affinities" if "unsatisfied" may lead to the dismemberment of the molecule; or, shall we say, to the breaking up of the household. In some cases two individual atoms are quite taken up with each other, as chlorine and hydrogen; and are consequently termed monatomic, monadic, or univalent. But oxygen unites with two atoms of hydrogen, and is diatomic, dyadic, or bivalent. Nitrogen combines with three atoms of hydrogen, carbon combines with four atoms of hydrogen, and so forth.

57. It is fortunate that we are able to calculate with perfect certainty on the basis of the permanent likings or dislikings of these small bodies. Though violence may sever, they always retain the same measure of affection.* It is equally fortunate that when a molecule is established by means of these affinities, there is no *law* to render the alliance stable. Chemical change mostly depends on our being able to entice away an atom from its molecule, or to present to a molecule that has taken possession of more atoms than it can well keep a more tempting object which replaces another in the magic ring. This is called, in chemical language, *substitution*.

58. Thus chlorine and bromine may in many instances be introduced into hydrogen compounds by direct substitution;

* Of course, I use the language of *metaphor*. I have not the least approach to a conception of the *how* or the *why* of these affinities. The suggested "harmony of molecular movements" are to me like the Mediaeval explanations of the movements of the heavenly bodies,—“Cycle on cycle, orb in orb,” nor is “the impact of atoms of luminiferous ether on opposite sides” more explanatory.

one atom of hydrogen being removed and entering into combination with one atom of chlorine or bromine, while another atom of the haloid element takes the place of the hydrogen removed. Thus, when chlorine acts upon marsh gas (methylic hydride) the products are hydrochloric acid and methylic chloride.*



and by the continued action of the chlorine the latter may be converted successively into CH^2Cl^2 and CHCl^3 , the last being the compound usually called *chloroform*. Behold the transformation!

59. Now, I trust I may be pardoned, in consideration of the importance of the result, for dwelling on these technicalities. Every one knows the soothing properties of *chloroform*, which exists nowhere in nature, but is the product of the chemist's art. Its twin sister, *iodoform*, was recently the means of saving a young life threatened by the result of a dreadful accident, and now full of hope and promise.

60. The views which were attempted to be established, founded on the electrical relations of the elements, are diametrically opposed to what we now know of substitution.† Thus, atoms like chlorine, bromine, and iodine, are capable of replacing hydrogen atom for atom, and discharging functions similar to those of hydrogen in the primary compound.

61. It must be remembered that we are speaking of bodies of almost inconceivable but *not infinite* minuteness; not absolutely in contact, nor, on the other hand, capable of exercising these affinities at any distance that we can define. The action is what we call instantaneous, and frequently most marked and pleasing. I have often been delighted with beholding the production of colour from colourless liquids, and of crystallisation on the mixture of two uncrystallizable fluids.

62. *Such, then, is matter*, or, as we may say, *ponderable matter*,—subjected to destiny, acting according to implanted impulses, and that with unerring certainty,—so that when we understand the nature of these impulses we can avail ourselves of our knowledge to alter to an unknown extent the resulting combinations; producing continually things which have never existed from the beginning of time.

* *Watts's Dict. Sub.*, vol. v. pp. 450, 452.

† See further my *Exam. of Tyndall's Belfast Address*, *Trans.* vol. x. p. 121.

63. But all this knowledge of matter is, as I have shown, the result of our knowledge of another property of matter, which we call *gravitation of mass*; that which causes the apple to fall from the tree, that which has enabled mankind to construct the balance and the weights.

64. But in all this we find not the slightest approach to what we call "mind," nor to the exercise of any power of organisation or of combination to serve one common purpose.*

65. What, then, are we to say to *force*? This, at all events as an abstract conception, can neither be weighed nor measured; and the *proper* idea of force is surely destructive and not constructive. The common experience of mankind has ever looked upon the flash of lightning as the embodiment of force, and thus the thunderbolts were of old put into the hands of *Jupiter Tonans*. It is somewhat arrogantly said that the great achievement of the age is to have taken these weapons out of the hand of the Thunderer, and adapted them to our every-day purposes.

66. Moreover, we are to teach all the young scholars in the proposed new Sunday schools that we know all about the lightning now, and that it is simply a display of *electricity*. But if any junior of inquiring mind asks, What, then, *is* electricity? he will probably be told that it is "a name given to a series of phenomena," and that "it derives its name from the Greek word *electron*, amber, which, when well rubbed, has the power of attracting bodies." He might be further told about "an extremely subtle fluid"; but if the *enfant terrible* pursued his inquiries to the point whether this fluid was *matter* or *no matter*, he would surely be told that such subjects were beyond the grasp, at all events, of a Sunday scholar!

67. But if I put this inquiry to Modern Science, I shall doubtless receive a satisfactory answer, since whatever is capable of being measured, whether by *Ells* or by *Ohms*,† must certainly be ranked amongst phenomena of matter, though it be not ponderable.

68. I put to myself the question Matter or *no Matter*? whilst gazing on the crimson glories of the recently observed Aurora. I looked on it *all* as a display of terrestrial magnetism. I turn to my books for an answer to the question, What *is* magnetism? and I find that it is specially an

* *Exam. of Belfast Address, Trans.* vol. x. p. 126.—See *ante*.

† The unit of resistance of electricity is thus called after Ohm, a German electrician.—See Prescott, *The Speaking Telephone* p. 103.

attractive *power* residing in the magnet. But then what is that extraordinary white beam which I saw traversing the heavens at the same time? Was that material?*

69. So that I must tell the boys that, in the lightning we behold embodied *force*, in the Aurora embodied *power*; but if I ask after embodied *mind* in man, I shall, like the troublesome boy, be driven on to the question of embodied *not mind* in the birds which, before my eyes, are feasting on provision hung up for them during the frost. I watch their ways with much amusement, and, if I were a Greek, should say they display much *nous* (*vous*), though I grant no *mind* (*mens*).

70. My object in this paper is to show that, contrary to Professor Huxley's theory, the constitution of *matter* is a *legitimate subject of inquiry*; and that, pursuing the research on the lines of common sense, we arrive at some certain knowledge of its properties, and attain to a strong presumption of accuracy as to our conception of its constitution. The resulting knowledge that we obtain shows us matter as subordinated in all things to the disposal of an Infinite Mind,—in its orderly arrangement affording scope for devout admiration; but as regards any possibility of deducing the properties of mind from those of matter, everything shows that the attempt must fail. Instead of Will and Choice we encounter Destiny; instead of power of combination and organisation, we meet with an all but infinite individuality,—every atom acts on its neighbours according to fixed properties and laws.

71. Ponderable matter, then, stands in the same relation to us that it does to its Creator,—the subject *materia* which we (as formed in the image of God) may, in proportion to our knowledge of its properties, mould at our will.

72. I assert nothing, because we know nothing distinctly, about *imponderable matter*. In this direction there lies a whole world open to our inquiry, concerning which our present acquaintance is like that of children, deriving their knowledge of the ocean by wading fearfully amongst its tiny waves.† On

* I suppose so, though the discussion in the pages of *Nature* has not led to a very definite result; but I find a definition in Ganot's *Eléments des Physiques*, translated by Dr. Atkinson, 1879, which would, at all events, apply. It is this:—"That which possesses the properties whose existence is revealed to us by our senses, we call matter or substance"; but what, then, is it that proceeds from the end of the fingers, as represented at p. 825 of this work, and attracts the electric (magnetic) stream within a Geissler's tube? The repulsion by the flat hand, as I have seen it, is, if possible, even more curious.

† In *Nature*, pp. 304-6 and 328-30, of the present year (1883), is a report

these I shall not enter. But in the meantime I challenge the popular philosophers above mentioned to the disproof of that which I have sought to establish.

APPENDIX.

DR. HUXLEY'S "IDOLA."

I FULLY appreciate Dr. Huxley's talent, but cannot submit to his guidance, when I know that he is wrong. His greatest admirers must concede that he is human, and that he shares the common lot, *humanum est errare*.

Take as an illustration his paper on "Yeast," in the *Contemporary Review*, 1871, reprinted in his *Critiques and Addresses*, 1873.

of a lecture at the London Institution on "The Ether," summing up very well what we do *not* know, but infer, about this difficult subject of investigation. "Ether is often called a fluid or a liquid, and again it has been called a solid, and has been likened to a jelly because of its rigidity; but *none of these names are very much good*. All these are molecular groupings, and, therefore, not like ether. Let us think simply and solely of a continuous frictionless medium possessing inertia, and the vagueness of the notion will be nothing more than is proper in the present state of our knowledge." But it is characteristic of the present age of dreamy speculation that to this "vague notion" of an unknown "something" is to be sacrificed all the knowledge of substantial reality that mankind has accumulated. "One continuous substance filling all space, which can vibrate as light, which can be sheared into positive and negative electricity, which in whirls constitutes matter; and which transmits by continuity, and not by impact, every action and reaction of which matter is capable." This is the Thomsonian or mystical theory of matter; which is thus resolved into an everlasting dance of the vortices of Something of which "we have no distinct idea at all" (see No. 34 above). Is not this absurdity worthy to be placed side by side with that other piece of folly which made life to descend upon this planet on the back of a meteorite, like the image which fell down from Jupiter?

He gives us in this a well-written account of fermentation, and of the *modus operandi* of the yeast plant, to which I have nothing to object, till he gets to the description of the yeast plant as a mere sac or cell, and follows Schwann in his assertion that "fermentation is the most fully and exactly known operation of cells, and represents, in the simplest fashion, the process which is repeated by every cell of the living body."

Those who like the analogy may take it for what it is worth, —not much, I think,—but mark what follows!

"A wonderfully suggestive thought, opening up views of the nature of the chemical processes of the living body, which have hardly yet received all the development of which they are capable.*

"Kant defined the special peculiarity of the living body to be that 'the parts exist for the sake of the whole, and the whole for the sake of the parts.' But when Turpin and Schwann resolved the living body into an aggregation of quasi-independent cells, each, like a *torula*,† leading its own life, and having its own laws of growth and development, the aggregation being dominated and kept working towards a definite end only by a certain harmony amongst these units, or by the superaddition of a controlling apparatus, such as a nervous system, *this conception ceased to be tenable.*"

I have published my adhesion to the above view of Kant in a work which I have placed in the library of the Institute.‡ I have minutely described the trees I had under examination as to (1) the heart wood, (2) the leaves, (3) the course of the ascending sap, (4) the alkaloids formed in the bark, (5) the influence of respiration, and, in conclusion, "*the plant as an organised whole,*" and I remarked that this last definition is the conclusion to which I have been brought,—indeed, I might almost say *compelled* to come, so that I place no faith in any of the theories of vegetation which *isolate the different parts of the plant*, but I agree with Kant in what seems to me a clear definition that "the cause of the particular mode of existence of a living body resides *in the whole,*" and with Müller, from whose *Physiology* I quote, "that there is in living or organic matter a principle *constantly in action*, the operations of which are in accordance with a *rational plan*, so that the individual parts which it creates in the body are *adapted to the design of the whole*, and THIS IT IS WHICH DISTINGUISHES ORGANISM."

* *Critiques and Addresses*, p. 86.

† Yeast plant.

‡ *Quinology of the E. I. Plantations*, p. 19.

Now, Kant was a profound thinker, and Müller no mean physiologist; but all the truth they enunciated is to be set aside for the sake of an ill-conceived and weakly-supported cell *theory*, which is even now in its decadence.* It is virtually given up even by Huxley himself in this *his* explanation, for his millions of "quasi-independent cells" would not form themselves even into the body of a flea unless "dominated"—by what? "A certain harmony"! But does not this explanation range very closely on NONSENSE? Is it not, at the best, according to the old adage, *obscurum per obscurius*? But I proceed, "or by the superaddition of a controlling apparatus such as a nervous system." But, in the first place, *who* superadds? This is work for Divine prescience to foresee and for an Almighty hand to execute; all which supposition is impossible to Agnosticism. Perhaps he means "to *develope*," but this will not do; for it would imply that these *quasi* entities united themselves by some kind of inconceivable *Caucus* to devise means of "dominating" themselves, and then to execute (O most admirable cells!) the creation of a *nervous system!* and that as a *controlling apparatus!*

I do not, for a moment, think that Dr. Huxley would have written this for the Royal Society; but he no doubt appreciates correctly the mental calibre of his numerous readers among the public at large.

It is with a salutary dread of the application of the proverb *ne sutor ultra crepidam*, that I continue my criticism on the remaining medical statement,—"*The cell lives for its own sake, as well as for the sake of the whole organism; and the cells which float in the blood, live at its expense, and profoundly modify it, are almost as much independent organisms as the torulæ which float in beer wort.*"

Now, it so happens that an eminent physician and F.R.S. showed me, under the microscope, these said corpuscles in unusual abundance in the blood of a relative suffering probably from suppressed ague. This state of things clearly enough pre-indicated the fatal termination.

Further, I turn to a work sent me by the author,† who has made special researches on the subject, in which he shows, as

* Huxley is obliged to say that "Schwann burdened his enunciation of the cell theory with two false suppositions," &c.—See p. 86.

† *Experimente Untersuchungen über das Wesen der Chininwirkung.* Von D. C. Binz, Berlin.

drawn under the microscope, these bodies *killed,* to the great advantage of the whole organisation*, by the application of quinine.

Is it not something like throwing dust in the eyes of the reader to lead him to infer that this is *how cells live* for the sake of the whole organisation ?

Place before me a Stilton cheese, and tell me that these quasi-independent organisms are created *for the sake of the cheese*, and are really *part* of the cheese, since the cheese would not be worthy of its name without them, and I will listen, for there would be *vraisemblance* at least in your assertion ; if not *true*, it were at least *amusing* ; but do not *fatigue* me with the real NO-MEANING which, as Pope tells us, “ puzzles more than wit.”

From BACON'S WORKS, vol. vii., 272, ed. 1803.

“ Nam mens humana (corpore obducta et obfuscata) tantum abest ut speculo plano æquali et claro similis sit (quod rerum radios sincere excipiat et reflectat) ut potius sit instar speculi alicujus incantati, pleni superstitionibus et spectris. Imponuntur autem intellectui idola, aut per naturam ipsam generis humani generalem, aut per naturam cujusque individualem, aut per verba, sive naturam communicativam. Primum genus, *idola tribus* ; secundum, *idola specus* ; tertium, *idola fori*, vocare consuevimus. Est et quartum genus, quod idola theatri appellamus, atque superinductum est a *pravis theoriis*, sive *philosophiis*,” &c., &c.

The italics are mine.—J. E. H.

A discussion of a general character took place upon the paper, in which the Chairman (Mr. H. Cadman Jones), Mr. R. C. Shettle, M.D., the Rev. W. B. Galloway, and Mr. W. Griffith took part.

* *Die farblosen Blutkörperchen liegen abgestorben dicht an der Aussenwand der Vene.*