Three important points, however, do exist in common between de Chancourtois's system and that of Mendeleeff:—

Firstly, all the known elements are arranged in the order of their combining weights.

Secondly, the combining weights chosen as best suited to bring out clearly the numerical relations existing between them are those adopted by Cannizzaro in 1858, a striking fact when we recollect that de Chancourtois wrote only in 1862, at a date long before these numbers had gained anything like general acceptance.

Lastly, an attempt is made to show that simple numerical relations exist, not only between the combining weights, but between all the measurable properties (*toutes les capacités physiques et chimiques*) of allied elements.

The reasons for the neglect of de Chancourtois's researches and the oblivion into which they have fallen are not far to seek. His style was heavy and at times obscure, and, moreover, his ideas were presented in a way most unattractive to chemists.

A geologist by profession, de Chancourtois had been powerfully impressed by the facts of isomorphism in the case of the feldspars and pyroxenes, which form such important constituents of the volcanic rocks he was studying; and he was thus led to seek for a system of classification which should bring out some simple relationship between the elements they contained.

To quote from his paper (*Comptes rendus*, vol. liv. p. 969): "The parallelism of the groups of manganese (7 + 3 . 16) and iron (8 + 3 . 16), of potassium (7 + 2 . 16) and calcium (8 + 2 . 16), of sodium (7 + 16) and magnesium (8 + 16), is the origin of my system"; and again, suggesting the expediency of adopting 55 (= 7 + 3 . 16) as a *characteristic* for aluminium, which would bring the element on the sodium and potassium generating line, "this would render perfect the parallelism between the elements of the feldspars and the pyroxenes, the starting-point of my system" (*Comptes rendus*, lvi. p. 1479).

Thus the correct idea of seeking for a relationship between the combining weights of isomorphous elements was marred by a somewhat imperfect comprehension of the facts of isomorphism. No chemist would certainly have tried to show any close relationship between aluminium on the one hand and the group of the alkalies on the other, notwithstanding their union in the feldspars and pyroxenes; and a suggestion of this kind served to cast discredit on de Chancourtois's really important views.

Notwithstanding his frequently eccentric ideas, de Chancourtois had the merit, so rare in an inventor of this stamp, of not considering his system as final. We cannot do better than let him speak for himself; and quote the conclusion of his last paper on the subject (*Comptes rendus*, lvi. p. 481):—"In presence of the rapid increase in the list of elements which engage the attention of chemists and physicists, it has become urgent to unite in one synthesis all the notions of chemical and physical capacities, of which the exposition would otherwise become an impossible task.

"It is, therefore, perhaps not unnecessary to recall the ideas of Pythagoras, or what I may better term the *Biblical truth* which dominates all the sciences, and of which I propose to make practical use by the following concrete example,[1] the first general conclusion of my essay:—

"THE PROPERTIES OF BODIES ARE THE PROPERTIES OF NUMBERS.

"It is easily perceived, that a helicoidal system of some kind or another, which is necessarily a graphic table of divisibility, offers the most convenient means for rendering manifest the relations between the two orders of ideas. It is evident, also, that the particular system which I have adopted brings into relief the relations of the most important and usual of the properties of matter, because the case of divisibility by 4, which is the basis of my plan, is the first which presents itself in arithmetical speculation after the case of divisibility by 2, to which there corresponds directly, as one perceives by a first glance at my table, the existence of the natural couples of elements, with consecutive odd and even characteristics.

"I hope, therefore, that the *telluric helix* will offer, until it is replaced by some more perfect invention, a practical framework, a convenient scale, on which to set down and compare all measurements of capacities, whatever the point of view which may be taken, whatever elasticity or variation, whatever interpretation may be given to the *numerical characteristics*, by which these capacities must always be represented.

[1] The French is *vulgarisation*, literally *popularization*.

"The development in a plane of the cylinder ruled into squares, with the circumference at the base divided into 16 equal parts, seems to me, in a word, to be a *stave* on which men of science, after the fashion of musicians, will note down the results of their experimental or speculative studies, either to co-ordinate their work, or to give a summary of it in the most concise and clear form to their colleagues and the public."

Lothar Meyer has noted down his classification in the form of a helix,[1] and Dr. Johnstone Stoney, F.R.S., has shown that the numerical values of the atomic weights may be expressed geometrically as functions of a series of integral numbers by points all lying approximately on a logarithmic spiral.

But no simple mathematical formula has so far been discovered to express the relationships of the atomic weights accurately—*i.e.* within the limits of experimental error, and de Chancourtois's predictions still remain but incompletely fulfilled.

I need not comment further on the remarkable breadth and originality of our author's views, taken as a whole. Strange to say, it was only a year or two before his death that he heard, through a colleague, of the immense development they had undergone; nor did he ever set up any claims to priority. But when we speak of the greatest generalization of modern chemistry, and recall the names of Newlands and Mendeleeff, it is only just that we should no longer forget their distinguished precursor, de Chancourtois.

P. J. HARTOG.

SCIENTIFIC SERIALS.

American Journal of Science, December.—The temperature of the moon, by S. P. Langley, with the assistance of F. W. Bery. With this memoir the authors complete the researches begun at the Allegheny Observatory in 1883 and continued during the next four years. The main outcome is that the mean temperature of the sunlit lunar surface is much lower than has been supposed, most probably not being greatly above 0° C.—The Lower Cretaceous of the South-West, and its relation to the underlying and overlying formations, by Charles A. White. The chalk formations constituting the so-called "Texas Section" are here referred to two natural divisions, which may be designated the Upper and Lower Cretaceous respectively, although not necessarily the exact equivalents of the corresponding European strata. Their fossil contents show that each represents an unbroken portion of Cretaceous time, while the palæontological contrast between the two indicates that there is a time hiatus between them. But this hiatus is no greater than exhibited in others of the mountain uplifts in the same region, and not so great as it is in some cases.—On the hinge of Pelecypods and its development, with an attempt toward a better subdivision of the group, by William H. Dall. Three fundamental types of hinges are described, and on these is based a new classification comprising the three orders of Anomalodesmacea with five sub-orders, Prionodesmacea with eight sub-orders, and Teleodesmacea with eleven or more sub-orders.—The magnetism of nickel and tungsten alloys, by John Trowbridge and Samuel Sheldon. The question is here discussed whether nickel and tungsten alloys magnetized to saturation increase in specific magnetism as different kinds of steel alloyed in small proportions with tungsten or wolfram are known to do. The tabulated results show that tungsten greatly increases the magnetic moment of nickel, if the alloy be forged and rolled, but has small influence if simply cast; nor do changes in the amount of tungsten appear to cause corresponding changes in the magnetic properties of the alloy.—Note on the measurement of the internal resistance of batteries, by B. O. Peirce and R. W. Willson. The authors' researches show that the value of the resistance of a cell obtained by the use of alternate currents is always smaller than that obtained by other methods, but the application of the method of alternate currents "fatigues" all but the so-called constant cells. In most cases there is a tendency in the internal resistance to *decrease* as the strength of the current which the cell is delivering increases.—Papers were contributed by Robert T. Hill and R. A. F. Penrose, Jun., on the relation of the uppermost Cretaceous beds of the Eastern and Southern United States, and on the Tertiary Cretaceous parting of Arkansas and Texas; by W. E. Hidden and

[1] "Die modernen Theorien der Chemie," iv. Auflage, p. 137; English translation, p. 118.

J. B. Mackintosh, on sundry yttria and thoria minerals from Llano County, Texas; and by O. C. Marsh, on the skull of the gigantic Ceratopsidæ.

THE *American Meteorological Journal* for November contains the first part of an article on "Theories of Storms, based on Redfield's Laws," by M. H. Faye, member of the French Institute. In support of his "whirlpool" theory, he urges that meteorologists have constructed a theory of storms on the basis of a single fact, viz. that storms which burst over a region cause a fall of the barometer there, and he points out that starting with the idea of an ascending column, exercising an aspiration below, a thing is invariably produced which neither turns nor progresses. Mr. A. L. Rotch contributes the first part of an article on "Meteorology at the Paris Exposition," dealing with the instruments exhibited in the French Section. Among the most interesting are (1) the actinometers exhibited by the Montsouris Observatory; (2) the Richard actinometer, which has bright and black bulbs *in vacuo*, connected with two thermometers, by which curves are traced giving at each instant the radiation from the sky, both at night and day; (3) the Richard anemographs, which have, instead of the usual Robinson cups, a fan wheel formed of six blades inclined at 45°, and fastened to a very light axis, one revolution of the wheel corresponding to one metre of wind. Parrigou-Lagrange's anemometer (NATURE, vol. xxxvii. p. 18), giving the vertical component of the wind, was also exhibited. M. Baudin showed some very fine standard thermometers, and Mr. Rotch describes various other instruments, such as hygrometers, aneroids, &c. Dr. F. Waldo continues his discussion of the "Distribution of Average Wind-velocities in the United States." The present article deals with the comparison of average wind-velocities with other elements, *e.g.* with barometric minima. Lieutenant Finley contributes State tornado charts for Arkansas, North Carolina, and Dakota.

THE numbers of the *Journal of Botany* for November and December are chiefly occupied with articles of special interest to students of British botany. Mr. Thiselton Dyer gives a very interesting biography of the late Mr. John Ball, F.R.S., first President of the Alpine Club, Under-Secretary of State for the Colonies under Lord Palmerston, an ardent explorer in all the four quarters of the globe, and a botanist of wide and varied knowledge. In the December number is a remarkable article on the disappearance of British plants, mainly through the depredations of collectors.

Rendiconti del Reale Istituto Lombardo, November 1.—Physical researches on the lakes of North Italy, by Prof. F. A. Forel. During a visit to this lacustrine region, last autumn, the author studied the waters of Lakes Maggiore, Como, Piano, and Lugano, with a view to determining their temperature, colour, and transparency, as compared with the analogous properties of Lakes Lucerne and Geneva. The results, which are here tabulated, show that the temperature is generally higher, and the colour deeper in the Italian than in the Swiss lakes, while the transparency is about the same, except in the shallow Lake Piano, where the temperature is lower and the transparency less than in any of these basins.—Meteorological observations made at the Brera Observatory during the month of September. These observations include records of temperature, barometric pressure, atmospheric moisture, rainfall, direction of the winds, and cloudiness.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 12.—"The Relation of Physiological Action to Atomic Weight." By Miss E. J. Johnston, University College, Dundee, and Thos. Carnelley, Professor of Chemistry in the University of Aberdeen. Communicated by Sir Henry Roscoe, F.R.S.

A. *As deduced from the Character of the Elements occurring naturally in Living Organisms.*—It is shown (*a*) that life is associated with a low atomic weight, so that elements with an atomic weight of 40 and under are required by the living organism, whereas those of an atomic weight greater than 40 are more or less inimical to life (compare Sestini, *Gazz. Chim. Ital.*, vol. 15, p. 107). (*b*) That the eight elements which enter most largely into the composition of the earth's crust, and which, therefore, are the most easily accessible to the living organism, are all included, with the exception of aluminium, in the fourteen elements which are required by the living organism.

A consideration of the exceptions (viz. Li, Be, B, Al, and Fe) to the first rule and of all the known facts bearing on the question leads to the conclusion that, "*The degree of necessity of an element to the living organism is a function of, first, its atomic weight, and, second, its accessibility to the organism.*" An element may be inaccessible to living organisms either because it is rare (*e.g.* Li and Be); or because, though moderately common, it has a very limited distribution (*e.g.* B); or because, though plentiful and widely distributed, it does not occur in nature in a form in which it can be assimilated (*e.g.* Al, on account of the insolubility of its native compounds).

That elements which are necessary to life must be readily accessible is self-evident, but that living organisms should require elements with low atomic weights, while elements with high atomic weights are inimical to life, is not so evident. This, however, may be due, in part at least, to the fact that the elements with low atomic weights are on the whole the most common elements (as shown by Gladstone, *Phil. Mag.* [5], vol. 4, p. 379; compare also Mendeljeff, *Zeit. f. Chem.* vol. 5, 1869, p. 405), and therefore the most accessible, so that *from the first the elements utilized in vital processes have been those which have been the most accessible, and therefore those with the lowest atomic weights.*

B. *As deduced from the Toxic Action of Compounds administered artificially.*—In view of the somewhat discordant results obtained by previous observers as to the relation between atomic weight and physiological action, the authors have reinvestigated the subject as carefully as possible. Their experiments have been made partly with fish (sticklebacks) and partly with aërial micro-organisms, the salt being administered by solution in the medium (water or Koch's jelly) in which the organism lived. the following conclusions are drawn from the results of about 800 experiments which the authors have made during the two years they have worked on this subject:—

1. *With corresponding compounds of elements belonging to the same sub-group, the toxic action*[1] *alters regularly* (i.e. *increases or diminishes*) *with the atomic weight.*

2. *In almost all cases this alteration takes place in such a way that the toxic power increases with the atomic weight.* (This is analogous to increase in toxic action in homologous series of carbon compounds.)

3. *Elements belonging to odd series* (Mendeljeff's classification) *are much more toxic than the corresponding elements of even series.*

4. *Other things being the same, the greater the ease of reducibility of an element from a state of combination to the free state the greater its toxic action.* (Applicable to compounds of odd as compared with those of elements of even series, and also to compounds of the elements of odd series belonging to the same group when compared with one another.)

5. *Other things being the same and the compounds comparable, the greater the heat of formation of a compound from its elements the smaller is its toxic power;* or, in other words, the greater the stability of a compound the smaller its toxic power. (Applicable to elements belonging to odd series; data for those belonging to even series are wanting or are too incomplete.)

There is a close connection between rules 3, 4, and 5.

6. *Lithium forms a very marked exception to all the above rules*, for notwithstanding its very low atomic weight, its difficult reducibility to the free state, the fact that it belongs to an even series, and the great stability of its compounds, as indicated by their relatively great heat of formation, its toxic power is, nevertheless comparatively very great. This exceptional character of lithium, however, is not limited to its physiological action only, but applies likewise to many of its purely chemical and physical properties. So much so, indeed, is this the case that its exceptional physiological character might have been foreseen.

7. *The toxic action of a series of comparable salts runs parallel with the solubility in such a way that as the solubility increases the toxic action either increases likewise or else diminishes.*

8. *When the quantity of salt present in Koch's jelly is less than the minimum dose required to prevent the development of micro-organisms, the number of colonies which develops increases as the amount of salt diminishes, but as a rule much more rapidly.*

[1] As represented in terms of either the minimum toxic weight of metal or of the minimum molecular toxic dose. The minimum molecular toxic dose = minimum toxic weight of salt ÷ molecular weight of the salt.