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SCIENTIFIC WORTHIES.

XXVI.—DMITRI IVANOWITSH MENDELEEFF.

DMITRI IVANOWITSH MENDELEEFF was born on February 7 (N.S.), 1834, at Tobolsk, in Siberia. He was the seventeenth and youngest child of Ivan Paolowitsh Mendeleeff, Director of the Gymnasium at that place. Soon after the birth of Dmitri his father became blind, and was obliged to resign his position, and the family became practically dependent upon the mother, Maria Dmitrievna Mendeleeva—a woman of great energy and remarkable force of character. She established a glass-works at Tobolsk, the management of which for many years devolved entirely upon her, and on the profits of which she brought up and educated her large family. The story of Mendeleeff's youth is given in the preface to his great work "On Solutions," which he dedicated to the memory of his mother in a passage of singular beauty and power. Having passed through the Gymnasium at Tobolsk, Mendeleeff, at the age of sixteen, was sent to St. Petersburg, with the intention that he should study chemistry at the University, under Zinin. He was, however, transferred to the Pedagogical Institute, the aim of which was to train teachers for the District or Governmental Gymnasiums throughout the Empire. The Institute (which was abolished in 1858) was established in the same building as the University, and was divided into two Faculties—Historico-philological and Physico-mathematical. Mendeleeff attached himself to the natural sciences, and thus came under the influence of Woskresenky in chemistry, of Emil Lenz in physics, of Ostrogradsky in mathematics, of Ruprecht in botany, of F. Brandt in zoology, of Kutorga in mineralogy, and of Sawitsh in astronomy, most of whom were Professors of the same sciences in the University. Whilst at the Institute he wrote his first paper on "Isomorphism," and on the termination of his course of instruction he was appointed to the Gymnasium at Simferopol, in the Crimea. During the Crimean war he was transferred to one of the Gymnasiums at Odessa, and in 1856 he was admitted to the degree of *Magister Chemiæ* of the Physico-mathematical Faculty of the University of St. Petersburg, and was made *Privat-Docent* in the University. Even at this early period of his career we find Mendeleeff speculating on the great problems with which his name is inseparably connected. The relations between the specific gravities of substances and their molecular weights had begun to attract increased attention. Kopp had just published the first instalment of that long and laborious series of experimental observations which constitutes the real foundation of all our knowledge concerning the specific volumes of liquids, when the young Siberian philosopher laid a number of theses on problems relating to specific volumes before the Physico-mathematical Faculty of the University. He pointed out that magnetic elements have smaller specific volumes than diamagnetic elements. He also showed that Avogadro's supposition, that electro-positive elements have larger specific volumes than electro-negative elements, was in accordance with the greater number of well-established facts. When we remember how slowly, in spite of the powerful advocacy of Williamson, the ideas of Laurent and Gerhardt and what came to be known as the modern French school, found favour in this country, it is remarkable, as indicating the radical and progressive character of his mind, and the keenness of his mental vision, to find Mendeleeff, as far back as 1856, insisting that to Gerhardt was due the best mode of determining the chemical molecule; that the molecule of oxygen was expressed by the symbol O_2; those of arsenic and phosphorus by As_4 and P_4 respectively; that of alcohol by $\left.\begin{matrix}C_2H_5\\H\end{matrix}\right\}O$; and that of ether by $\left.\begin{matrix}C_2H_5\\C_2H_5\end{matrix}\right\}O$.

Mendeleeff's researches on specific volumes were begun in 1855, and were continued, with intermissions, down to 1870; but part only of the work has been published. In 1859, Mendeleeff obtained permission from the Minister of Public Instruction to travel, and repaired to Heidelberg, where he established a small private laboratory, and occupied himself with the determination of the physical constants of chemical compounds. He returned home in 1861, and in 1863 was named Professor of Chemistry at the Technological Institute of St. Petersburg. In 1866 he became Professor of Chemistry at the University, and was made Doctor of Chemistry after a public defence of his dissertation "On the Combinations of Water with Alcohol." He is now Emeritus Professor, and delivers annually a course of lectures on general chemistry.

Mendeleeff is so prolific a writer that it is impossible within the limits of an article of this kind to do justice to his work. There is, in fact, no section of chemical science which he has not enriched by his contributions. Some of his earliest work related to questions of mineralogy and chemical geology; and at times, as in his papers on Œnanthol-Sulphurous Acid, on Fermentation Propyl Alcohol, and on the Nitriles, he cultivated the rapidly extending domain of organic chemistry. But his reputation mainly rests upon his contributions to physical chemistry and to chemical philosophy. In his papers on Specific Volumes he extends Kopp's generalizations, and traces the specific volumes of substances through various phases of chemical change. He shows that in the thermal expansion of homologous liquids the expansion-coefficient diminishes in a regular manner as the series is ascended, and he indicates the intimate connection which exists in the case of liquids between expansion and cohesion, and the *rôle* played by molecular cohesion in the determination of chemical activity. His paper on the thermal expansion of liquids above their boiling-points is noteworthy as demonstrating that the empirical expressions given by Kopp, Pierre, and others, for the expansion of liquids up to their boiling-points, are equally applicable to far higher temperatures, and that the expansion-coefficient gradually increases with the diminution in molecular cohesion of the liquid, until, in the case of certain liquids, *e.g.* ether at 133°, it becomes even greater than that of the gas. The expansion-coefficient of ether increases to 0·0054 at the temperature of its *absolute boiling-point*—that is, at about 190°. The absolute boiling-point is defined by Mendeleeff as that temperature at which the cohesion and latent heat of vaporization are *nil*, and at which the liquid becomes gaseous independently of pressure and volume. It is, in fact, that temperature which the researches of Andrews have made us familiar with as the "critical-point." In this paper Mendeleeff presents us for the first time with a number of determinations of the critical-temperatures of various substances, founded partly on his own determinations, and partly on those of Cagniard de la Tour, Wolff, and Drion.

Other papers on physical chemistry relate to Contact Action, to Fractional Distillation, and to the Heat of Combustion of Organic Substances. In 1883 Mendeleeff was made an honorary member of our Chemical Society, and in the following year he contributed a remarkable paper to the Journal of the Society (Transactions of the Chemical Society, xlv. 126), in which he developed an extremely simple general expression for the expansion of liquids under constant pressure between 0° and their boiling-points. This expression may be written $1/V_t = 1 - kt$, in which V_t is the volume at $t°$ (that at 0° being unity), and k is a quantity which varies with different substances, but which may for any one substance be considered invariable between 0° C. and the neighbourhood of the boiling-point. This formula is analogous to that which expresses Gay Lussac's law of the uniformity of expansion of gases. But just as Gay Lussac's formula, $V = 1 + kt$, applies only to a so-called ideal gas, Mendeleeff's expression is in like manner to be regarded only as a first approximation—that is, as applicable only to ideal liquids. The deviations are not large in either case; they are, as might be expected, especially remarkable near temperatures at which the states of the bodies change. In the case of actual liquids the deviations from the ideal form of expansion increase not only as the liquid approaches the point at which its state of aggregation is changed, but also with diminishing density, increasing cohesion, and diminishing molecular weight. This last cause is especially noteworthy since Mendeleeff showed, more than a dozen years ago (*vide supra*), that the deviations from Gay Lussac's law were related to the molecular weights of the gases. The well-known irregularities in the expansion of water are, according to Mendeleeff, connected with its small molecular weight, its high capillary constant (which expresses its cohesion), and the comparatively small temperature-interval within which its state of aggregation is unchanged. Subsequent observers, by applying Van der Waal's theory of the general relation between the pressure, volume, and temperature of bodies to Mendeleeff's expression for the thermal expansion of an ideal liquid, have shown that the reciprocal of the constant k is the number obtained by subtracting 273 from the product of the critical temperature into a quantity which should be the same for all substances. The value of this quantity is approximately 2, and since the range of its variation is apparently very small, the development of Mendeleeff's formula affords a simple and ready method of calculating the critical temperature of bodies from observations of their expansions as liquids.

Mendeleeff's skill in physical measurement is well illustrated by his determinations of the Specific Gravities of Aqueous Solutions of Alcohol. Such determinations have been frequently made the subject of the most rigorous experiment in this and other countries, inasmuch as they constitute the basis of the methods of assessing the duty on spirits, which is so important a factor in the national income of many States. Mendeleeff's work has served to confirm and extend that of Drinkwater, Fownes, and Squibb, and has been utilized by certain Continental Governments (*e.g.* that of Holland) for the purposes of revenue. But it was not the utilitarian aspect of this subject which alone attracted Mendeleeff. In a paper communicated a couple of years ago to our Chemical Society (Trans. Chem. Soc., li. 778), these determinations are applied towards the elucidation of a theory of solution in which it is sought to reconcile Dalton's doctrine of the atomic constitution of matter with modern views respecting dissociation and the dynamical equilibrium of molecules. According to Mendeleeff, solutions are to be regarded as strictly definite atomic chemical combinations at temperatures higher than their dissociation temperature, and just as definite chemical substances may be either formed or decomposed at temperatures which are higher than those at which dissociation commences, so we may have the same phenomenon in solutions; at ordinary temperatures they can be either formed or decomposed. In addition, the equilibrium between the quantity of the definite compound and of its products of dissociation is defined by the laws of chemical equilibrium, which require a relation between equal volumes, and their dependence on the mass of the active component parts (*loc. cit.* p. 779). It follows from this hypothesis that the specific gravities of solutions depend on the extent to which active substances are produced, or that the expression for the specific gravity, s, as a function of the percentage composition, p, may be represented by the general equation—

$$s = C + Ap + Bp^2.$$

Between two definite compounds which exist in solution, the differential coefficient $\frac{ds}{dp}$ is a linear function of p—

$$\frac{ds}{dp} = A + 2Bp.$$

By the application of this method to the case of aqueous solutions of ethyl alcohol, Mendeleeff infers the existence of three definite hydrates, viz. $EtHO.12H_2O$, $EtHO.3H_2O$, and $3EtHO.H_2O$, the first two of which he has isolated by subjecting the mixture to low temperatures. The hypothesis respecting the linear character of the differential coefficient $\frac{ds}{dp}$ has been proved to be correct for solutions of many salts, of acids, and of ammonia.

We have the consummation of this work on solution in the monograph published by Mendeleeff last year. This volume, the fruit of many years of labour, is unquestionably the most important contribution to the theory of solution yet given to science.

Much of Mendeleeff's scientific activity since 1871 has been absorbed in an extended work on the elasticity of the gases, which he has executed in conjunction with his pupils, Kirpitshoff, Hemilian, Bogusky, and Kajander. Part only of the results have as yet appeared. The first volume, published in Russian in 1875, contains details of the modes of measurement, which involved many forms of apparatus new to physical science. A summary of the principal results obtained was published in the form of a pamphlet in 1881. Regnault found that the product

$p.v$ = const.—*i.e.* Boyle's law—was true for ideal gases only. Between one atmosphere and thirty atmospheres the deviations were positive in the case of hydrogen, and negative in those of all other gases. Mendeleeff pointed out that the deviations must become positive for all gases at sufficiently high pressures, and the fact has since been confirmed by the observations of Amagat and Cailletet. Mendeleeff, more particularly, made observations at low pressures, *i.e.* below one atmosphere; and here the deviations were again found to be positive and relatively very large. It was found, in fact, that, at the limit of condensation, the gases seemed to behave like solid bodies—*i.e.* the molecules were incapable of being stretched or brought nearer together to any appreciable extent by varying pressure. Mendeleeff has further determined the *real* coefficients of thermal expansion of gases. This, for air between 0° and 100° under a standard atmosphere, was found to be 0·0036829. Determinations made in the case of other gases have shown that the coefficients of expansion increase with increasing molecular weight, gases of the same molecular weight giving the same coefficient.

	Molecular weight.	Coefficient of expansion.
Hydrogen	2	0·00367
Nitrogen / Carbon monoxide	28	0·00373
Nitrous oxide / Carbon dioxide	44	0·00373
Sulphur dioxide	64	0·00385
Hydrogen bromide	81	0·00386

The coefficient of expansion is found to decrease with increasing pressure in the case of hydrogen. Thus at

200 mm.	0·00369
760 ,,	0·00367
8 atmos.	0·00366

But with the so-called coercible gases the reverse is found to take place. Thus, in the case of carbon dioxide,

120 mm. pressure	0·00372
220 ,, ,,	0·00370
760 ,, ,,	0·00373
3 atmos. ,,	0·00389
8 ,, ,,	0·00413

The decrease of the coefficient of expansion with increasing pressure is a normal phenomenon of gases, the positive deviation observed in the case of hydrogen being found to hold equally good for all gases at very high and very low pressures. Hence the laws of Boyle and Charles are only valid at points of the curve when the deviation changes from positive to negative or *vice versâ*.

These experiments have also borne fruit in various meteorological papers on the physical nature of the highly rarefied air existing in the upper strata of the atmosphere. In this connection it may be stated that Mendeleeff has attempted to organize meteorological observations in the upper regions of the atmosphere by means of balloons, and hence he has been led to study aëronautics. His practical acquaintance with the subject induced him to make an ascent from Klin during the total solar eclipse of August 19, 1887, for the purpose of observing the extension and structure of the corona when seen through highly rarefied air.

Russia is indebted to Mendeleeff for the training of two generations of her chemists. His writings have largely modified the mode of teaching chemical science in that country. His treatise on Organic Chemistry was the standard work of its time, and exercised great influence in spreading abroad the conceptions which are associated with the development of modern chemistry. His "Principles of Chemistry," published in 1869, and repeatedly reprinted, is a veritable treasure-house of ideas, from which investigators have constantly borrowed suggestions of new lines of research. This book is one of the classics of chemistry; its place in the history of science is as well assured as the ever-memorable work of Dalton. Mendeleeff, indeed, might with equal fitness have styled his book a "New System of Chemical Philosophy." In it he has developed the great generalization which is known under the name of the "Periodic Law"—a generalization which is exerting a profound influence on the development of chemical science in all countries in which its study is actively prosecuted. Mendeleeff first drew attention to the principles upon which the Periodic Law is based in a paper read to the Russian Chemical Society in 1869, in the following series of propositions:—

(1) The elements, if arranged according to their atomic weights, exhibit an evident *periodicity* of properties.

(2) Elements which are similar as regards their chemical properties have atomic weights which are either of nearly the same value (*e.g.* platinum, iridium, osmium), or which increase regularly (*e.g.* potassium, rubidium, cæsium).

(3) The arrangement of the elements, or of groups of elements in the order of their atomic weights, corresponds to their so-called *valencies*, as well as, to some extent, to their distinctive chemical properties; as is apparent among other series in that of lithium, beryllium, barium, carbon, nitrogen, oxygen, and iron.

(4) The elements which are the most widely diffused have *small* atomic weights.

(5) The *magnitude* of the atomic weight determines the character of the element, just as the magnitude of the molecule determines the character of a compound body.

(6) We must expect the discovery of many yet *unknown* elements—for example, elements analogous to aluminium and silicon—whose atomic weight would be between 65 and 75.

(7) The atomic weight of an element may sometimes be amended by a knowledge of those of its contiguous elements. Thus the atomic weight of tellurium must lie between 123 and 126, and cannot be 128.

(8) Certain characteristic properties of elements can be foretold from their atomic weights.

In the Faraday Lecture recently delivered to the Chemical Society, and from which these words are taken, Mendeleeff has indicated for us the lines upon which the evolution of his theory proceeded. In the first place, it is to be noted that it is based wholly on experiment: it is as much the embodiment of fact as are the laws of chemical combination formulated by Dalton. Without the knowledge of certain data it could not possibly have been discovered; with this knowledge its appearance, says Mendeleeff, is natural and intelligible. Three series of data were necessary to pave the way for its enunciation:—

(1) The adoption of the definite numerical values of the atomic weights founded on the conceptions of Avogadro and Gerhardt, as insisted upon by Cannizzaro.

(2) The recognition that the relations between the atomic weights of analogous elements were governed by some general law. Many chemists, and more especially Dumas, Gladstone, and Strecker, had drawn attention to the numerical relationship existing between correlated groups of elements, but no one before Newlands in England, and De Chancourtois in France, had sought to generalize this conception, and to extend it to all the elements by considering their properties as functions of their atomic weights. (3) A more accurate knowledge of the relations and analogies of the rarer elements, such, for example, as that given to us by Roscoe in the case of vanadium, and by Marignac in that of niobium. The law of periodicity was the systematized expression of these data; it was, to use Mendeleeff's language, "the direct outcome of the stock of generalizations of established facts which had accumulated by the end of the decade 1860-70."

We can only very rapidly allude to some of the more striking services which Mendeleeff's generalization has rendered to science during the twenty years of its existence. By a more systematic arrangement and co-ordination of the known chemical elements, it has not only indicated the existence of new forms of elementary matter, but it has pointed out the probable sources of the undiscovered substances, and has enabled us to know their properties even before we have knowledge of their existence. It was this power of divination inherent in the law which, perhaps more than any other feature, first attracted attention to it, and quickened the interest with which its development was regarded by men of science. There are now three instances of elements of which the existence and properties were foretold by the periodic law: (1) that of *gallium*, discovered by Boisbaudran, which was found to correspond with the *eka-aluminium* of Mendeleeff; (2) that of *scandium*, corresponding to *eka-boron*, discovered by Nilson; and (3) that of *germanium*, which turns out to be *eka-silicium*, by Winckler. No one who was present on the occasion of the delivery of the Faraday Lecture will forget the enthusiasm which followed the reading of these words of Mendeleeff's: "When, in 1871, I described to the Russian Chemical Society the properties, clearly defined by the periodic law, which such elements ought to possess, I never hoped that I should live to mention their discovery to the Chemical Society of Great Britain as a confirmation of the exactitude and the generality of the periodic law."

Up to the time of the formulation of the law, the determination of the atomic value or valency of an element was a purely empirical matter, with no apparent necessary relation to the atomic value of other elements. But to-day this value is as much a matter of *a priori* knowledge as is the very existence of the element or any one of its properties. Striking examples of the aid which the law affords in determining the substituting value of an element are presented by the cases of *indium*, *cerium*, *yttrium*, *beryllium*, *scandium*, and *thorium*. In certain of these cases, the particular value demanded by the law, and the change in representation of the molecular composition of the compounds of these elements, have been confirmed by all those experimental criteria on which chemists are accustomed to depend. One of the most interesting instances of the kind is seen in the example of *uranium*, the atomic weight of which was formerly regarded as 120, then as 180, but which, on the authority of the periodic law, is now established as 240, a value completely confirmed by the independent experiments of Zimmermann and Rammelsberg. Uranium has a special interest in being the last term in the series: no element of higher atomic weight is at present known.

As examples of the value of the law in enabling us to correct the atomic weights of elements whose valencies and true position were well known, we may cite the cases of *gold*, *tellurium*, and *titanium*, the values of which were apparently higher than those demanded by it. In each of these cases a redetermination of the atomic weight has resulted in a value which is in conformity with the previsions of the periodic law.

The law has, moreover, enabled many of the physical properties of the elements to be referred to the same principle of periodicity. At the Moscow Congress of Russian physicists in August 1869, Mendeleeff pointed out the relations which existed between the density and the atomic weights of the elements; these were subsequently more fully examined by Lothar Meyer, and are embodied in the well-known curve in his "Modern Theories of Chemistry." Similar relations have been discovered in certain other properties, such as ductility, fusibility, hardness, volatility, crystalline form and thermal expansion; in the refraction equivalents of the elements, and in their conductivities for heat and electricity; in their magnetic properties and electro-chemical behaviour; in the heats of formation of their haloid compounds; and even in such properties as their elasticity, breaking stress, &c.

In the Faraday Lecture, Mendeleeff indicated the bearing of the law of periodicity upon the doctrine of constant valency, and especially on the conception of a primordial matter. The mind almost instinctively clings to the notion that the law can only find its rational interpretation in the idea of unity in the formative material, and it is not surprising that the promulgation of the law has been heralded by some as the most convincing proof of the validity of the Pythagorean conception that experiment has yet been able to adduce. But the author of the periodic law will not admit that his generalization has either sprung from this conception or has any relations towards it. "The periodic law, based as it is on the solid and wholesome ground of experimental research, has been evolved independently of any conception as to the nature of the elements; it does not in the least originate in the idea of an unique matter; and it has no historical connection with that relic of the torments of classical thought; and therefore it affords no more indication of the unity of matter or of the compound nature of the elements than do the laws of Avogadro and Gerhardt, or the law of specific heats, or even the conclusions of spectrum analysis. None of the advocates of an unique matter has ever tried to explain the law from the standpoint of ideas taken from a remote antiquity, when it was found convenient to admit the existence of many gods—and of an unique matter."

No record of Mendeleeff's intellectual activity would be complete without some reference to his influence on the development of the industrial resources of Russia. In 1863 he brought out the first encyclopædia of chemical technology of any magnitude which the literature of that country possessed, and he has been frequently commissioned to report on the progress of chemical industry as manifested at the various International Exhibitions. But it was on the petroleum industry of Baku, on the Caspian, that this influence has been most widely felt. Fifteen years ago the production of petroleum in Russia was a monopoly, and was accompanied by all the evils which usually spring from monopolies: the trade was exceedingly limited, and apparently incapable of development. Thanks largely to his action, both on the platform and in the press, the opening up of the boundless supplies of the peninsula of Apsheron was thrown open to the world, with the result that petroleum threatens to effect an industrial revolution in Eastern Europe and in Asia. Indeed, it is not too much to say that the oil industry of Baku is rapidly becoming, directly and indirectly, one of the most powerful factors in the Central Asian problem. Mendeleeff's interest in the development of the Baku industry has led to his being sent to the Caucasus and to Pennsylvania, to report upon the best modes of working the wells, and of separating and utilizing the products. Last year, during the coal crisis in Southern Russia, he was commissioned to study the economic condition of the industry in the rich coal-basin of Donetz.

No man in Russia has exercised a greater or more lasting influence on the development of physical science than Mendeleeff. His mode of work and of thought is so absolutely his own, the manner of his teaching and lecturing is so entirely original, and the success of the great generalization with which his name and fame are bound up is so strikingly complete, that to the outer world of Europe and America he has become to Russia what Berzelius was to Sweden, or Liebig to Germany, or Dumas to France. Nowhere has Mendeleeff's pre-eminence been more quickly or more fully recognized than in this country. English men of science and of learning have delighted to do him honour. In 1882 the Royal Society gave him the Davy Medal; and now, the Chemical Society, which is proud to number him among its Honorary Fellows, has conferred upon him the highest distinction in its power, by the award of the Faraday Medal. To the great regret of the large gathering of British chemists which had assembled to welcome him and to listen to the memorable address on the subject which he of all others is best fitted to expound, Mendeleeff was unable to receive the gift in person; but the circumstances of his absence awakened a deep feeling of commiseration and sympathy, and served to intensify the sentiment of respect and admiration with which he is regarded by all English men of science.[1]

T. E. THORPE.

[1] I have to express my grateful acknowledgments to Prof. Menshutkin and M. Gorboff, of St. Petersburg, and to Dr. B. Brauner, of the University of Prague, for much of the information on which this article is based.—T. E. T.

THE PREVENTION OF HYDROPHOBIA.

As was foretold three years ago, by those experienced in its behaviour, rabies is again making itself felt in this country by becoming epidemic. No disease probably has been more misunderstood in the past, none is more clearly known to-day. We are not therefore, as in 1885, caught napping. Since M. Pasteur showed us the whole story of rabies, we have acknowledged the brilliancy of his researches and the most gratifying discovery he made of the way in which the disease may be prevented from developing in any individual unfortunately bitten by a rabid dog. The manner too in which he gradually unfolded one secret of Nature after another, by his extraordinary insight into the phenomena of infectious disease, has been demonstrated with beautiful clearness in the recent Croonian Lecture delivered by Dr. Roux before the Royal Society.

The gradual evolution of the science of preventive inoculations by M. Pasteur has taught us how to obviate the appearance of rabies or hydrophobia when the virus has been introduced into the system; how, in fact, the virus may be hindered from exerting its frightful effects on the nervous centres of those unfortunately exposed to the danger. Consequently he enjoys the supreme pleasure of having saved hundreds, not only from a most painful and miserable death, but from what is actually far more painfully important—the most dreadful of apprehensions.

But this last point, the apprehension or dread of the disease, which is so appalling a feature of this malady, owing to the extraordinary length of its incubation period, has forced upon everyone save the anti-vivisectionists, the fact that it is far more necessary, in this of all troubles, to prevent the chances of the mischief occurring, than to try and shut the door after the evil has found admission. We have persistently urged that in islands like Great Britain the mere existence of rabies is a matter of the greatest reproach; that preventive legislation is to a very unusual degree able to cope with it and destroy it utterly. A brief repetition of the grounds of this belief will not be out of place. Of all acute specific diseases, rabies is evidently the one in which the virus survives removal from living tissues with the greatest difficulty. As retention of virulence and viability by the viruses of different acute specific diseases is a subject of the highest interest, as well to the practical hygienist as to the pathologist, we fortunately know enough from the work of recent years to speak with confidence on the point. Bacteriological experience has shown that the difficulty of artificially cultivating a zymotic virus in dead material, *e.g.* gelatine, increases, roughly speaking, in proportion to the length of the incubation period. In proof of our contention we may quote the extreme cases of tuberculosis and anthrax. In the former disease the virus is a slow-growing bacillus, growing in artificial cultures with the utmost difficulty, and destroying life only at the end of many weeks. In anthrax, on the contrary, we have a bacillus which develops with the utmost activity on artificial nutrient soils, and which kills in a few hours.

Duration of incubation period, however, is not necessarily an index to the viability of a bacillus. But while it was clear from what has just been said that we were *a priori* fully justified in prophesying that the rabic virus would probably not develop in the absence of a living pabulum, *i.e.* living tissue, we have actual evidence to show that fortunately this most terrible virus in all probability is not possessed of powers of active resistance to those injurious influences which act upon it when exposed to the air, &c. This evidence is simply the fact that no case bears investigation in which the poison was asserted to have been found infecting the ground, woodwork, &c., of places habited by rabid animals—that, in short, the rabic virus cannot survive the drying, changes of temperature, &c., it necessarily undergoes when scattered over the ground, as we often see happen by the slobbering of a rabid animal.

This is the first and a most important point, upon which our opinion was based. We pass now to the second, which is to a certain extent the corollary of the first. It is, that the disease is communicated only by one animal biting another. There is really no evidence to show that accidental inoculation with the blood, &c., has ever occurred, and we are now in possession of direct experimental evidence to show that the poison cannot be absorbed, by being combined with food, through the mucous membrane of the alimentary canal. The only practicable mode of transmission of the disease, therefore, is by one animal biting and lacerating another's tissues, or by licking a wound and so introducing the virus.

This point, coupled with the first, establishes irrefragably the proposition that, for the permanent extinction of rabies from a country into which its reintroduction can reasonably be prevented, it is only necessary to prevent rabid animals from biting healthy ones. In other words, it is only necessary to apply the muzzle. Usually the public does not listen to scientific men, unless the matter happens to be one where their own experience, favourable or unfavourable, serves to help them to a conclusion. On the present question the experience of London in 1885 and 1886 is sufficient; and from the recent memorial of the County Council addressed to the Privy Council, the knowledge gained by the last epidemic has been speedily utilized. But with particular wisdom the County Council have asked for the general adoption of the muzzle all over the country, so that we may have not merely a temporary extinction of the disease in one locality, but a riddance of it from the whole country. It might well be asked, Why have not the Privy Council, who hold in their hands the machinery of prophylactic legislation, brought this consummation to a perfect conclusion without waiting to be urged by the public outcry which it was well known would certainly be raised sooner or later, according as rabies rapidly or slowly increased? The answer is simple, being nothing more than the well-known cowardice of authorities to interfere with what they believe to be a popular interest, sentiment, or feeling, on any point, however contrary to reason or fact that sentiment may be. The Select Committee of the House of Lords, whose Report we reviewed two years ago, did yeoman service to the cause by collecting an immense amount of valuable evidence; but unfortunately, misled by the interests falsely stated to be interfered with, reported adversely to a general adoption of muzzling regulations all over the country, and advised leaving the whole matter in the hands of the local authorities.

Even those members of the Upper House who were most interested in the subject, both from philanthropic and agricultural reasons, hesitated to support any measure which might involve some trouble in application. We allude of course to the muzzling of sporting dogs more especially, and to the exemption of sheep and other dogs actually engaged in work. All these points were considered fully two years ago by the Society for the Prevention of Hydrophobia, a Society composed of dog owners and scientific men, and were treated by them in the provisional draft of a Bill which provided for each of the cases referred to. Fortunately this Bill will be introduced into the Lower House by Sir Henry Roscoe, so that the question will now be brought to a very definite head.

Nothing, however, in the way of philanthropic reform is said ever to succeed unless it is violently opposed. Violent opposition to the present proposals has assuredly not been wanting, nor will apparently be wanting. At the time of the last epidemic, and ever since, the anti-vivisectionists, turning from vilifying M. Pasteur's charitable efforts, maligned the police, and, to parody the celebrated dictum of Spinoza, first asserted that there was no such thing as rabies; secondly, that it was contrary to religion (of humanity); and thirdly (this only recently), that the disease was well known, but did not require preventing.

The diatribes of these people may be amusingly ridiculous, but naturally they are also mischievous. It is scarcely conceivable, in this present century of intelligence, that none of their subscribers should have seen that they are really opposing the only known means of counteracting rabies, and that their money is consequently being spent to perpetuate this terrible infliction among us. However, the infallible test of time is fortunately dispersing the mists of falsehood which have been so carefully spread around the subject.

M. Pasteur's splendid achievements have, as all scientific truth must, contributed greatly to the success of the movement for obliterating the curse from this country. For, attracted by the value of the work of the Pasteur Institute, and its single-mindedness, the Prince of Wales and the Lord Mayor of London have recently visited it, have seen the immense importance of the researches carried on in the laboratory there, and they are in consequence greatly desirous of providing similar blessings for this country. The Lord Mayor, in order to give effect to the opinions he has so strongly formed, has summoned a meeting at the Mansion House for July 1, at 3 p.m., and the Prince of Wales will write a letter in support of the same. At the last meeting of the Royal Society for the present session, held on Thursday, the 20th instant, the Society adopted a letter which had been drawn up by the President and Council, expressing sympathy with the Lord Mayor's attempt to obtain some public recognition in this country of the services rendered by M. Pasteur to science and humanity, and appointing the officers with Sir James Paget, Sir Joseph Lister, Sir Henry Roscoe, and Prof. Lankester, as their representatives at the meeting called by the Lord Mayor.

The whole business of the meeting will be devoted to, first, the providing of a sum of money to be paid to the funds of the Pasteur Institute as a slight acknowledgment of the great benefits which the Institute has gratuitously extended to over 200 of our fellow-countrymen threatened with rabies; secondly, the formation of a fund to cover the expenses of poor people travelling to Paris for inoculation and unable to support themselves; and thirdly, a strong resolution calling upon the Privy Council to instantly inaugurate such muzzling and other restrictive measures as shall definitely and finally exterminate rabies. The anti-vivisection agitators, whose object it is apparently to keep alive rabies in this country, have opposed the meeting, which we hope will be crowded by genuine lovers of men and animals. The form their opposition has taken is amusing to the last degree, since it consists of a petition, advertised in the daily papers, made of four or five headings, each of which may be called in question. In the very first paragraph it is stated that the Manager of the Dogs' Home in Battersea has passed a large number of dogs through his hands, and that he never saw a case of rabies among them. If this means that there has never been a case of rabies at the dogs' home, we believe evidence can be produced to the contrary.

The innate falsity of this agitation is always making itself felt, and it is nothing more than Nemesis that the statements made by agitators in the hope of deceiving the public, should be detected and exposed again and again. Such a statement as that asserted to have been made by the Manager, even if he did make it, has no value in view of the incontrovertible facts of the police records of the existence—nay, more, of the increase—of rabies in London. The Mansion House meeting will do much to blow away this miserable opposition, which attacks biological science alone, knowing full well that no false sentiment can be hashed up against physical science and its benefits to mankind. The object of the meeting is to honestly acknowledge our great indebtedness to M. Pasteur, to provide for our poorer fellow-countrymen gaining the benefits of the Pasteur Institute, and, finally, to stamp out rabies.

No scientific man who really has the interests—in fact, the honour—of his country at heart will refuse his support on this important occasion; and we may well hope that many will be found able to attend the meeting personally, to render the occasion worthy of the great chemist whose work has so essentially led to the successful performance of the hygienic measures now about to be executed.

STELLAR EVOLUTION.

Stellar Evolution and its Relation to Geological Time. By James Croll, LL.D., F.R.S. (London: Edward Stanford, 1889.)

DR. CROLL'S book, though chiefly dealing with the question of stellar evolution from the astronomer's point of view, calls in the evidence afforded by geology in favour of the theory which is set forth in its pages. The particulars of the theory are clearly stated, and the new facts which have been gathered since the theory was first published are fully considered.

Dr. Croll accepts the nebular hypothesis of Kant and Laplace, and deals mainly with the question of the pre-nebular condition. According to his theory, large cool dark bodies, moving with enormous velocities, were either created or were eternal; and these colliding with each other here and there, the evolution of the celestial bodies was accomplished. With regard to the origin of these bodies endowed with motion, Dr. Croll states:—"We are perfectly at liberty to begin by assuming the existence of stellar masses in motion; for we are not called upon to explain how the masses obtained their motion, any more than we have to explain how they came into existence. If the masses were created, they may as likely have been created in motion as at rest; and if they were eternal, they may as likely have been eternally in motion as eternally at rest" (p. 3). It is argued that the heat energy which would have been derived from gravitation alone could not possibly have been equal to that which the solar system originally possessed. But there is absolutely no limit to the amount of available energy from Dr. Croll's point of view. The most important argument against the gravitational theory is undoubtedly the geological and biological one. The whole question of geological time rests on an estimation of the time during which the sun has been radiating its heat, and on this point Dr. Croll remarks: "If gravitation be the only source from which the sun has derived its heat, then life on the globe cannot possibly date farther back than 20,000,000 years, for under no possible form could gravitation have afforded, at the present rate of radiation, sufficient heat for a longer period" (p. 35). The adoption of Langley's value (1·7 times that of Pouillet) for the rate of solar radiation reduces Helmholtz's estimate of 20,000,000 years to 12,000,000 years, and even this would not be available for plant and animal life, as millions of years must have undoubtedly elapsed before the earth was prepared for them. Prof. Tait ("Recent Advances in Physical Science," p. 175) has shown that, from the physical point of view, "10,000,000 years is about the utmost that can be allowed for all the changes that have taken place on the earth's surface since vegetable life of the lowest known form was capable of existing there." Sir William Thomson states his conclusions on this point thus: "In the circumstances, and taking fully into account all possibilities of greater density in the sun's interior, and of greater or less activity of radiation in past ages, it would, I think, be exceedingly rash to assume as probable anything more than 20,000,000 years of the sun's light in the past history of the earth, or to reckon on more than five or six million years of sunlight for time to come" ("Popular Lectures and Addresses," p. 390).

It is not necessary here to enter into details of the various methods by which geologists and biologists have attempted to estimate the length of time which must have elapsed since the earth first received the heat of the sun. On this point Dr. Croll says: "The grounds upon which the geologists and biologists found the conclusion that it is now more than twenty or thirty millions of years since life began on the earth are far more certain and reliable than the grounds upon which the physicist concludes that the period must be less" (p. 68). Here, again, it may be well to quote Sir William Thomson, who says:—"What then are we to think of such geological estimates as 300,000,000 years for the 'denudation of the Weald'? Whether is it more probable that the physical conditions of the sun's matter differ 1000 times more than dynamics compel us to suppose they differ from those of matter in our laboratories; or that a stormy sea, with possibly channel tides of extreme violence, should encroach on a chalk cliff 1000 times more rapidly than Mr. Darwin's estimate of one inch per century?"[1]

But granted that the geological evidence is against the gravitation theory, it remains for us to see how Dr. Croll's theory bears the strain put upon it when the details of the evolutionary processes are inquired into.

According to the impact theory of Dr. Croll, "meteorites are but the fragments of sidereal masses which have been shattered by collision" (p. 12). The result of such a collision would be mainly to produce a gaseous mass, but some of the exterior fragments would have velocities sufficient to carry them beyond the influence of the central mass. This view is obviously in direct contradiction to the opinion held by Mr. Lockyer, who looks upon meteorites as the parents, and not the children, of sidereal systems. The explanation of the thumb-marks and the heterogeneous structure of meteorites which has been given by Mr. Lockyer (Proc. Roy. Soc., vol. xliii. p. 151) would apply equally to Dr. Croll's view.

Comets, according to the impact theory, have a similar origin to meteorites, Dr. Croll apparently agreeing that they are nothing more than swarms of meteorites. Those with elliptic orbits probably had their origin in the collision which produced the nebula out of which the solar system has been evolved, whilst those with parabolic and hyperbolic orbits are probably the outcasts of other systems.

The first condition of a nebula, according to Dr. Croll, is that in which it consists of broken fragments scattered through a gaseous mass of excessively high temperature. Mr. Lockyer's recent researches are consistent with this view, as far as meteorites and interspaces are concerned, but they point to the opposite conclusion with regard to temperature. Mr. Lockyer's spectroscopic work has shown that the highest temperature is in all probability only reached by a nebulous mass after the complete volatilization of all the meteorites composing it, and he has shown that the intermediate stages which should occur on this supposition are actually represented amongst the stars, the stars of Group II. being amongst these. This therefore furnishes a strong argument against the high-temperature theory of nebulæ.

According to the impact theory of Dr. Croll, the meteorites scattered through the gaseous mass have nothing whatever to do with the luminosity; whereas, from Mr. Locker's point of view, the luminosity is in great part, if not entirely, due to collisions between the meteorites. Dr. Croll objects to this latter view because it "does not appear to afford any rational explanation of this banging about of the stones to and fro in all directions; for, according to it, the only force available is gravitation, and this can only produce merely a motion of the materials towards the centre of the mass" (p. 20). Dr. Croll has evidently given but little thought to this theory, originally advanced by Prof. Tait, for it is obvious that all the meteorites would not lose all their momentum by collisions during their first movements towards the common centre of gravity. Those which escaped collision would move on beyond the centre of gravity with considerable velocities, and would continue to oscillate to and fro until all their momentum was converted into heat by collisions. The banging about might therefore go on for a very long time, and the observations made by Dunér, and classified by Mr. Lockyer, show that this is probably the case. The increase of temperature would accordingly take place gradually, and not suddenly, as Dr. Croll supposes; and further, the highest temperature would be associated with a certain class of stars, and not with the nebulæ themselves.

The subject of new stars is dismissed with very few words. The general view adopted by Dr. Croll seems to be that in such a case as Nova Cygni the outburst was due to the collision of a star with a swarm of meteorites. The spectroscopic evidence in favour of Mr. Lockyer's view, that such an outburst is due to the collision between *two* swarms of meteorites, is not even referred to. The case of Nova Cygni, indeed, has an important bearing on theories of cosmogony. Its spectrum, as observed by Copeland when it was just fading from our view, was that of a planetary nebula. If, therefore, a nebula is at a higher temperature than a star, Nova Cygni must have got hotter as it got dimmer!

Dr. Croll shows that his theory explains other details of the structure of our universe, including the proper motions of stars and the origin of binary systems, but these need not be more than mentioned.

Assuming that Dr. Croll has established that gravitation alone would have been incompetent to produce the heat originally possessed by the solar nebula, it is only necessary to reconcile this with the low-temperature theory of nebulæ, as the high-temperature theory has been shown to be inconsistent with the facts.

It may be suggested that instead of the dark stellar masses endowed with motion which Dr. Croll supposes to have been the pre-nebular condition, meteorites at great distances apart were endowed with similar velocities. In the first groupings, the collisions would only occur very rarely, and there would be more grazes than anything else, so that the average temperature might still be low in the earlier stages. Prof. G. H. Darwin[1] has recently shown that the conception of fluid pressure which is demanded by Laplace's nebular hypothesis is not difficult to reconcile with the meteoritic hypothesis. If we substitute meteorites in collision for the molecules of a gas impinging against each other, there would be a quasi-fluid pressure as the average result of the impacts of the meteorites, and the separation of the planets from the meteor-swarm would take place exactly as in a gaseous mass.

A. FOWLER.

[1] *Macmillan's Magazine*, March 1862; reprinted in "Popular Lectures and Addresses," p. 361 (Macmillan, 1889).

[1] Phil. Trans., vol. cclxxx. pp. 1–69.

THE TELEPHONE.

The Telephone. By William Henry Preece, F.R.S., and Julius Maier, Ph.D. Pp. i–xvi., and 1–498. (London: Whittaker and Co., 1889.)

THIS book is one of the "Specialists' Series" of technical manuals now being issued by Messrs. Whittaker and Co. Its aim is to give as full an account as possible of telephony as a practical art, and the authors have certainly succeeded in inclosing within the compass of a handy octavo volume a vast amount of well-arranged information on a subject hitherto unrepresented in English by any systematic treatise. After two chapters, comprising about twenty pages, on sound and speech, and on such parts of electrical theory as are more immediately connected with the action of the telephone, the authors proceed to deal with the construction of the telephone, and treat in detail the subject of transmitters and receivers of all kinds. This part of the book is very interesting, giving as it does an account of the principal forms of telephone receivers and transmitters which were the outcome of the marvellous activity of telephonic research aroused by the publication of the inventions of Bell, Edison, and Hughes. In chapter x. come telephone lines and cables, and modes of installing them; then chapters on auxiliary apparatus, and on terminal and intermediate stations, lead up to the important subject of telephone exchanges, and appliances connected with their working, to which chapters xiv. to xx. are devoted. Long-distance telephony is introduced in chapter xxi., and systems of translation between the terminal networks, and the return wire or other induction avoiding circuit between the two places, are fully described. Various problems of practical telephony are then discussed, such as multiplex telephony, and the numerous devices for enabling several subscribers to work in one circuit. Chapters on the telephone as applied to the telegraph service, its military uses in camp and in the field, and finally some miscellaneous although important scientific applications of the instrument, conclude the work.

Of the main body of the work the contents of which are briefly analyzed above, we have no remark to make that is not commendatory. As has been already indicated, the work is full of most valuable practical details of actual working systems of telephony. The descriptions of complicated apparatus and appliances are full and clear, and bear everywhere the stamp of the work of men accustomed to exposition, and professionally acquainted with the subjects of which they treat.

In our examination of the work, we have noted a few points in which perhaps improvement might be effected in a second edition. Most of these occur in the preliminary chapters on the theory of the telephone, a part of the subject in some ways much more difficult to treat successfully than that which follows. For example, such a phrase as that on p. 14—that in a current following the simple harmonic law of variation with the time the electricity flowing is, "so to speak, thrown into undulatory motion"—is very apt to create an erroneous impression on the mind of a learner, and in no way describes what actually takes place. What is thrown into undulatory motion is not the electricity conveyed but the medium which forms its vehicle.

On p. 16 the phenomena of induction of currents are hardly "described with due precision." It is stated that "if there be a magnetic field, and a conductor in that field, any change in that field will produce the conditions that determine a current in that conductor." No doubt it is stated immediately afterwards that, "if a conductor forming part of a closed circuit be moved *across* a magnetic field in a direction at right angles to the lines of force in that field, a current will be induced whose strength is proportional to the strength of the field and to the rate at which the conductor cuts across the lines of force," but it nowhere appears that a change of the magnetic induction through the circuit is the one determining condition of an induced current. The authors, indeed, as if to sum the matter up, conclude this passage with the unqualified statement, which, as it stands, is not true except under certain conditions which are not stated: "In fact, currents are produced in a closed circuit placed in a magnetic field, whenever any change whatever occurs in the intensity of that field." If the circuit be so placed in the field that there is zero magnetic induction through it, the field may be absolutely annulled without producing any current whatever.

Again, on p. 18 it is stated that "the energy of the current in a coil at any moment is expressed by the product of the electromotive force (E) at the terminals of the coil producing the current, and the current itself (C), that is, $W = E C$." Now, what is here called the "energy of the current" is in reality the *activity* or time-rate of working of the current. The energy of the current at any instant is the energy which would be evolved in the form of a spark, or otherwise, if the current in the circuit were at that instant annulled. It is just this kind of misuse of the word energy that has led to the popular confusion (very common among the so-called "practical" (!) men who have applauded the Quixotic crusade against theory and "theoreticians") between work and rate of working, and to the astounding proposition, not yet exploded in all quarters, that the efficiency of a motor is a maximum when half the whole energy spent is wasted.

There are various other points and some omissions in the introductory and theoretical portions which we had noted. The remarks on self-induction might be improved, and it would have been well to point out here that conductors carrying rapidly-alternating currents (and telephone wires certainly do this) have, as Lord Rayleigh has shown, a virtually increased resistance due to the concentration of the current in the outer part of the wire. Another point is the apparently unguarded application, made at pp. 123, 124, of the results of the theory of a slowly worked submarine cable to the transmission of the rapidly alternating currents of telephones. The state of the case is much less simple than the authors here make it appear. Also, it is not possible, with any approach to accuracy, to regard copper wires, in this connection, as "virtually free from electro-magnetic inertia." But we have said enough as to these blemishes. They can be removed by careful extension and rewriting of the introduction. After all, it ought to be recognized that it is impossible to give in a book on a branch of electrotechnics any statement of theory which can supersede that full and detailed treatment which is indispensable, and which must be sought in systematic treatises on electrodynamics.

As to the more purely technical portion of the work, we have only to repeat that it is full and trustworthy, and, moreover, remarkably well illustrated. There are several statements made by the authors which might be questioned, but as these are in many cases matters of opinion rather than of actual fact, we need not enter into them.

In conclusion, we have to say that this book is a striking testimony to the rapid development of telephony. Thirteen years ago the first rude model of a telephone was brought from America by Sir William Thomson. One year later, Graham Bell himself brought to Scotland and exhibited first in Glasgow, and Mr. Preece brought to England, the telephone receiver (then also used as transmitter), almost exactly as it is now constructed. But a vast amount of practical work of a most important kind remained to be done before telephony could be made a commercial success. Without, however, waiting for this to be accomplished, a telephone line was immediately installed by Sir William Thomson between his house at the University and his laboratory, and between both and the workshop of his instrument-maker, Mr. White, in Sauchiehall Street, and this (now merged in the Telephone Exchange) has been in daily use ever since. From this very appropriate first practical beginning has developed the present immense and continually extending system, whose wires form a network above all our great cities, which plays so great a part in the transaction of business, and even of ordinary domestic affairs, and which now enables men in different cities at great distances apart to converse with one another by the living voice. All this has taken place in little more than ten years. Who knows what scientific wonders we may not see before A.D. 1900? But it is mournful to reflect that, as the applications of a scientific principle or invention become more and more wonderful, the thing itself excites so little interest among the people at large who continually use it. This is, no doubt, in part due to our curiosity- and admiration-stifling systems of education, and in part to other causes, about which it is useless to speculate. But true it is, "Familiarity breeds contempt," and, by the ordinary member of the British public, the telephone will soon be as much used, quite as little understood, and regarded with just as little curiosity, as the wonderful machine which he carries in his pocket from his boyhood to the end of his life.

A. GRAY.

OUR BOOK SHELF.

Morocco. By H. M. P. de la Martinière, F.R.G.S. (London: Whittaker and Co., 1889.)

IN this book, which has been translated directly from the author's manuscript, M. de la Martinière records the impressions produced upon him during journeys in the kingdom of Fez, and to the Court of Mulai Hassan. He had exceptional opportunities of making himself acquainted with the facts of social life in Morocco; and in a simple, graphic, and clever narrative he describes exactly what he saw, and the inferences that may be reasonably drawn from his observations. Upon the whole, his account of the condition of the people is most unfavourable, and everyone who studies the evidence he brings forward will admit that the regeneration of Morocco, by whomsoever or in whatever way it may be undertaken, will be no easy task. One of the few bright spots in the author's picture is a passage in which he praises what he calls the refined taste of the Arabs of Morocco. This reveals itself in the industrial products of the country, in the decoration of the pavements and ceilings of their houses, and in the skill with which they match colours in dress. They by no means display the same aptitude for science, which is generally regarded, from a religious point of view, as a forbidden subject. On the other hand, alchemy flourishes, and M. de la Martinière says there are many rogues who trade upon the credulity of the public. Some good route-maps and plans illustrate the text, and a preface is contributed by Colonel Trotter.

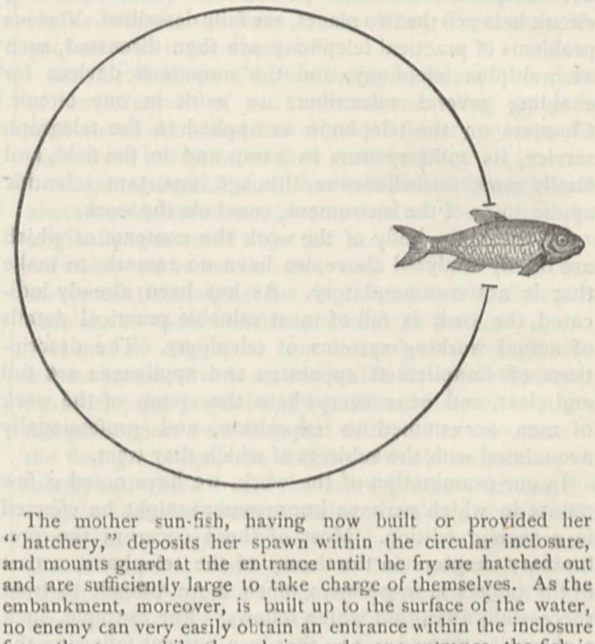
LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The "Hatchery" of the Sun-fish.

I HAVE thought that an example of the intelligence (instinct?) of a class of fish which has come under my observation during my excursions into the Adirondack region of New York State, might possibly be of interest to your readers, especially as I am not aware that anyone except myself has noticed it, or, at least, has given it publicity.

The female sun-fish (called, I believe, in England, the roach or bream) makes a "hatchery" for her eggs in this wise. Selecting a spot near the banks of the numerous lakes in which this region abounds, and where the water is about 4 inches deep, and still, she builds, with her tail and snout, a circular embankment 3 inches in height and 2 thick. The circle, which is as perfect a one as could be formed with mathematical instruments, is usually a foot and a half in diameter; and at one side of this circular wall an opening is left by the fish of just sufficient width to admit her body, thus:—



The mother sun-fish, having now built or provided her "hatchery," deposits her spawn within the circular inclosure, and mounts guard at the entrance until the fry are hatched out and are sufficiently large to take charge of themselves. As the embankment, moreover, is built up to the surface of the water, no enemy can very easily obtain an entrance within the inclosure from the top; while there being only one entrance, the fish is able, with comparative ease, to keep out all intruders.

I have, as I say, noticed this beautiful instinct of the sun-fish for the perpetuity of her species more particularly in the lakes of this region; but doubtless the same habit is common to these fish in other waters.

WILLIAM L. STONE.

Jersey City Heights, N.J., U.S.A., May 30.

Black Rain.

ON Friday, April 12 last, the rain is stated to have come down black during a thunderstorm at places distributed over a considerable area in the County of Galway, King's County, and County of Tipperary.

I was in England at the time, and after my return to Ireland, on hearing of the rain-water being black in the tanks at a friend's house, I was at first sceptical as to its origin, as a heavy shower after a spell of tolerably dry weather might have brought down much dirt from the roofs, and hence I missed several opportunities of obtaining samples at once.

Finding, however, that other neighbours had noticed the same thing, and that at Golden Grove, near Roscrea, the workmen had observed that not only the water in the barrels was black, and was even next morning "like ink," but also that there was a decided blackness and scum in the pools on the carriage drive, at some distance from any chimney, I was convinced that the blackness had come from the thunder-cloud.

At so great a distance (about 200 miles) from any large smoke-producing town this was somewhat remarkable.

I was able to procure from one place, from near Eyrecourt, Co. Galway, through the kindness of the Rev. C. Lawrence, of Lisreaghan, Eyrecourt, a sample of the water. It is stated to have been of a dark blue colour, but when it reached my hands it had become pale reddish brown, with a considerable amount of solid matter in suspension.

Dr. W. J. Russell, F.R.S., has been good enough to examine the sample, which appears to behave in all respects much as London rain water, except in being free from acid reaction (this may be due to previous impurity in the collecting vessel). The amount of sulphates is represented by 0·074 gramme of H_2SO_4, and of chlorides by 0·066 gramme of HCl, in a litre. The solid matter is devoid of structure or of crystalline form, and appears to be soot. The specimen is, however, the less satisfactory from having been taken from near a house where coal has been burnt.

I understand that the rain was black near Shinrone, King's County, and that a few blackish drops were noticed at Dundrum, near Cashel. From Ballymore Castle, near Eyrecourt, where the sample was obtained, to Golden Grove, the distance is about 23 statute miles, and Shinrone is between them. From Eyrecourt to Dundrum is about 48 miles. Mr. Lawrence tells me that the blackness of the rain was noticed by several of his neighbours, and that a laundress kept the water three weeks in the barrels, and had then to reject it, as it was still too much discoloured.

Possibly it may be worth noting that two days before (April 10) there was an intense blackness like that of a moonless night in London, between 12.30 and 1.30 p.m., but I have at present no evidence to connect it with the phenomenon above described.

Athenæum Club, S.W., June 18. ROSSE.

On the Theory of Hail.

IN last week's NATURE (p. 151) Prof. Robinson gives an account of a hailstone that fell at Liverpool on the 2nd instant, consisting of an opaque nucleus, surrounded by almost clear ice, and this by opaque ice.

Hailstones formed of concentric layers, like the coats of an onion, are by no means uncommon. The number of layers has been known to amount to as many as thirteen (*American Journal of Science*, l., 403); but the statement that such a structure is formed, as Prof. Robinson supposes, "during electric oscillation from cloud to cloud," belongs to a theory that has often been disproved. Nor would it probably have excited much attention, but that it originated with no less a man than Volta, who, seeing how pith balls and other light objects oscillated between two metal plates in opposite electrical states, imagined that the hailstone acquired its successive coatings by oscillating between two clouds in opposite states, until its weight became too great for the electric force to sustain it against the gravitating force.

The two most distinguished writers who have examined this theory, and have shown its futility are Kämtz (*Lehrbuch der Meteorologie*, ii. 525) and Becquerel ("Traité de l'Electricité," iv. 151).

The theory of hail which scientific meteorologists now accept, originated with Prof. Olmsted, of Yale College (I have not the reference at hand to the *American Journal of Science*, but see *Edin. New Phil. Journ.*, ix. 244). This theory has received its finishing touches in the papers of the United States Coasts Survey ("Meteorological Researches for the use of the Coast Pilot," Part ii., p. 85, Washington, 1880). The writer is Mr. William Ferrel.

Limiting our notice to such compound hailstones as the one described by Prof. Robinson, which from their size and velocity are the most destructive, and are produced during a tornado or a violent thunderstorm, the following is in few words the theory of their formation. When the wind gyrates rapidly round an axis, more or less inclined to the earth, the space at and about the axis is rarefied. When air charged with vapour is drawn into this rarefied space, it may be condensed into cloud or rain, but at a greater elevation into snow. Now, supposing the rain formed in the lower region to be drawn up by the ascending current into the snowy region, and so held for a short space, the drops will be frozen, and then if propelled beyond the gyrations it will fall to the ground as a shower of ordinary hail. But if in the descent they are again drawn in by the inflowing current, they will be again carried up into the cold region, and so acquire another coating of snow, or, if wetted in the previous descent, the water will freeze into a coat of transparent ice. In this way the globule may make a number of ascents and descents, and acquire a fresh coating each time.

From the date of Franklin's experiments even to our own day, the formation of hail has been attributed to electricity. Even so good an observer as Peltier ("Météorologie," p. 116), while rejecting Volta's theory, offers an electrical theory of his own, with the complacent remark that "Volta a placé des suppositions où je place des faits;" but De la Rive, in noticing Olmsted's theory, very properly remarks that although electricity always accompanies the formation and fall of hail, these two phenomena are not connected as cause and effect.

Highgate, N., June 20. C. TOMLINSON.

Curious Effects of Lightning on a Tree.

DURING the recent thunderstorms a large elm-tree was struck by lightning in a private park at Dulwich, but the only visible effects were linear interrupted grooves about ¾ inch deep, extending down one side of the tree to the ground, where two or three depressions some 3 inches deep were found. The bark is scooped out as clearly as if done with a gouge, and the intervals are from 1 to 2 feet in length, while the grooves themselves are from 1 to 3 feet in length. The grooves are now filled with mildew, which, I take it, indicates the death of the adjacent bark. I have often seen trees which have been struck by lightning, but none in which the effects have at all resembled those I have described. ALFRED S. GUBB.

Gower Street, W.C.

The Formation of Cumuli.

A VERY perfect illustration of the method of formation of cumuli was noted by the writer recently. A perpendicular column of smoke was seen capped at a vast height by a rounded mass of cumulus cloud having a flattened under surface. The ascending warm current being traceable by the smoke, and the cloud-cap very distinct and persistent, the appearance was very striking, the sky in the vicinity being intensely blue and otherwise cloudless. M. A. VEEDER.

Lyons, N.Y., June 10.

Coral Reefs.

THE business of the surveyor abroad is not with theories. It is to collect facts; to apply the resources under his command to the delineation of the earth's surface; and to examine the bottom of the ocean. When he begins to theorize, he may be suspected with some reason of bias, and of insensibly colouring his reports with preconceived notions of what he expected to find, instead of carefully storing up evidence. He is, however, at liberty to study the writings of our great naturalists, and to him Darwin is, at present, the great authority: not so much the young naturalist of the *Beagle*, as the matured thinker who, after forty years of deep research into various problems of Nature, published that edition of "Coral Reefs" which has been before the world for the last fifteen years.

With your permission, I desire to ask two or three questions of those gentlemen who are unable to reconcile their views with Mr. Darwin's theory of subsidence.

The Fiji Islands present the most complete collection of coral reefs in the world. We have there the fringe reef, the barrier, and the atoll; islands which have a barrier all around them, others where it is sunken on one side; the island, such as Lakemba, where there is a fringe on one side and a barrier on the other; as Thithia, which is surrounded by fringe only. There are extinct craters, such as Fulanga, and islands with exterior rim and depression in the centre, the formation of which is apparently not due to the volcanic action; islets on the edge of atolls like Ngele Levu which are wholly coral, others of coral in the centre of lagoons. In the same locality may be found islands which have a fringe to windward and barrier to leeward, and those which have a fringe to leeward and a barrier to windward. One island which is about the size of Jamaica, has a fringe on one side and an extensive barrier on the other. Shells and coral have been found at great heights, and there are many evidences of upheaval. One small island, called Vatu Leile, appears to be raised on one side and depressed on the other; the raised coast is lined with a fringe-reef, the submerged by a barrier.

In the Lau group, there are two fine barrier reefs—those of the Exploring Isles and the Bukatatanoa. Inside the lagoons of these and other reefs, there are an infinity of coral banks with various depths of water over them, many being mushroom-headed.

The prevailing wind throughout the Fiji group is east-south-east. Unquestionably the coral is in most vigorous growth where there is the most violent surf; and no matter what the current, it is in least vigorous growth on the lee or north-west side.

I believe that it is not inconsistent with the theory put forward by Mr. Darwin that, in the same group, some islands should be rising and some falling at the same time; nor that an island should have fallen to a certain level and have then undergone a movement of upheaval. If this be so, there is nothing, as far as one can see, in the Fiji group which disproves subsidence as the origin of barrier reefs. The questions which I desire to ask are these:—

How does Dr. Guppy account for the remarkable similarity in many instances in this group, between the shape of the barrier reef and that of the coast of the island within it? As examples, I would point to the islands of Nairai and Ngau, and to the correspondence in form between the north-east horn of the barrier of the Exploring Isles and the nearest cape of Vanua Mbalavu with its off-lying islets.

In the case of the Bukatatanoa reefs, how does he account for this great rim being all much on the same level; except by the supposition that it commenced its growth on the same contour? or for the cleanly-cut ship channels which occur on the *weather* side of some of the barriers, except by the supposition that the growth was originally checked by the streams from the land?

It is, I believe, universally admitted that there are large areas of elevation—such, for instance, as the New Hebrides—and corresponding areas of depression. What form, does Dr. Guppy suppose, is assumed by the growing coral on the coasts of the descending islands?

Let me draw attention to Kandavu. To the north of this island there is a barrier reef inclosing a chain of islands of volcanic origin, and gradually decreasing height. The most northerly islet, which is a mere rock (now surmounted by a lighthouse), stands in the centre of a circular barrier of great symmetry. The highest part of Kandavu is over the western end, and here there is comparatively little coral. Has not this group every appearance of a range of mountains, the northern half of which is sinking beneath the ocean? There are many strings of islands in Fiji and eleswhere the position and coral surroundings of which seem to be accounted for only by the theory of subsidence.

Mr. Darwin did not visit Fiji; but it is worthy of note that Mr. Dana spent five months there, and enjoyed peculiar advantages of examination, and that he left it convinced of the general truth of Mr. Darwin's theory.

8 Ashburton Road, Southsea. W. USBORNE MOORE.

Hydrophobia.

I THINK it cannot fail to interest some of the readers of NATURE to know what is written "in the Talmud of old—in the legends the Rabbins have told" about this baneful malady. I have therefore translated a fragment preserved in this ancient work, which, read through the mist of ages and wrapped in the garb of expressions and ideas of a long-ago past, may be of value to the antiquarian, and perhaps not wholly uninteresting to the man of science. A. D.

June 11.

"It is not permissible to give to a person bitten by a mad dog from the lobe of the mad dog's liver, but Rabbi Matya, the son of Hheresh, considers it permissible"[1] ("Mishna," "Tractate Yoma," p. 83).

[1] The subject of hydrophobia is introduced quite incidentally, the question in dispute between the "Mishna" and R. Matya being whether the patient might eat of the mad dog's liver upon the fast of the Day of Atonement, and the difference of opinion is in consequence of the prescribed remedy being held to be only imaginary on the one side, and a real one on the part of R. Matya.

"He who is bitten by a mad dog, &c." The Rabannan have learnt that there are five indications of rabies, viz. open mouth, dripping saliva, elongation of ears, tail resting on buttocks, and wandering along the sides of the streets. There are some who add barking without sound. How does this come about? Rav says that witches have practised their sorceries upon them, and Samuel says an evil spirit has rested upon them.

What deduction may be made from this difference of opinion? That the mad dog should be killed by means of a weapon hurled from a distance, for in accordance with the view held by Samuel we learn that the dog, when killed, should be despatched from a distance. He who has come into contact with a mad dog by the animal brushing against him is in danger, and he who has been bitten by a mad dog is in peril of his life.

"He who has come into contact, &c." What precaution should he take? He should divest himself of his robes and *run*. Rav Huna, the son of Rav Joshua, came into collision with a mad dog in the street. He threw off his robes and ran, exclaiming, "I illustrate in my own person the Scriptural verse, 'And wisdom is a source of life to those who possess her.'"

"He who is bitten, &c." What precaution should he adopt? Abaya says he should obtain the skin of a male ape and write thereon, "I, so and so, the son of so and so, write upon thee, 'Kanti, Kanti, Kiloroth,'"[1] and those present should respond "Kandi, Kandi, Kiloroth,[1] the Lord, the Lord, the Lord of Hosts, Amen, Amen, Selah." He should then throw off his clothes and bury them in the burial-place for twelve months, after which he should recover them and burn them in a furnace, scattering the ashes across the roads.

During these twelve months, if he should drink water he should do so only through a copper tube, otherwise he might see the reflection of the demon in the water held in the vessel, and suffer dangerous consequences.

It is said of Aba, the son of Matya (he is Aba, the son of Menimah), that his mother made for him a tube of gold ("Gemara," "Tractate Yoma," p. 84).

SIR LYON PLAYFAIR ON UNIVERSITIES.

WE congratulate Sir Lyon Playfair on the admirable speech he delivered last week in the House of Commons on the Scottish University Bill. It was a powerful and luminous exposition of the true functions of Universities, and of the duty of the State with regard to the highest departments of education.

Speaking of the fact that the adaptation of degrees in Scotland had not followed the steady improvement in the education of the people, Sir Lyon Playfair said:—

"Degrees remained much as they were two or three centuries ago. The University was not a technical school, but a school to introduce culture into the professions. Unless that culture were introduced there was no justification for professional schools in the Universities. The *via antiqua* ought to be replaced by a *via moderna*. The Commission of 1878 proposed to open five gateways of knowledge—the gateways of literature and philology, of philosophy, of law and history, of mathematical sciences, and of the natural sciences. Now there was a great difference between the Universities of rich and of poor countries. The Universities of poor countries must rest on the professions. The rich men of Scotland went to Oxford and Cambridge, whereas those who attended the Scotch Universities had to earn their bread by a profession. Unhappily those professions were now being taught without culture; that was, with the exception of theology, the men went through the technical part of their education without taking a degree in arts, though there was a sort of matriculation examination, which did not represent a very high degree of culture. In that way the great medical schools were technical schools which gave length but not breadth of education. One of the greatest reforms to be attained was to carry out the recommendations of 1878 so that, by proper courses in arts, culture might be restored to the professions."

Sir Lyon Playfair spoke as follows about the provision

[1] The meaning of these words is lost.

made in the Bill for an increase in the vote for the Scottish Universities:—

"The increase of £13,000 in the vote was no striking example of Parliamentary generosity when measured by the efforts of other countries. Reference had been made to what had been done in Holland, a country with a revenue of nine millions, and a population about the same as that of Scotland. Holland gave £136,000 to her Universities. The case of France was equally striking. The French Institute discussed for a whole week why it was that the great crisis in her history produced no men of ability in France. The decision they came to was that the reason was to be found in the decay of the provincial Universities. Since that time the French Government had spent £3,280,000 on the provincial Universities, and voted half a million a year for their support. Then Germany had spent £711,000 in order to build and equip the University of Strasburg, which they endowed with £46,000 a year. This country must be prepared to spend more money on higher education not only in Scotland, but in England. Modest, however, as was the proposal of the Government, he was rejoiced at the disappearance of the abominable finality clause. There was no finality in knowledge or the progress of science. Notwithstanding the stern aspect of the Chancellor of the Exchequer, we could not help ourselves. We must be prepared to adequately support our Universities, and to make sufficient provision for higher teaching in all our great towns. Though he thought the provision inadequate for what the Bill proposed, he had perfect confidence in the generosity of Parliament that, having begun the reform of the Scotch Universities, they would take care that the reform was thoroughgoing. In the Scotch Universities, while the number of students was very large relatively to the number of teachers as compared with, say, the German Universities, they had one Professor for one single subject. For the Chair of Chemistry in Edinburgh, for example—a chair which he had had the honour to hold—there was but one Professor, whereas in any moderate-sized German University there were four or five. They must add largely to the teaching staff of the Universities in Scotland if they expected them to become prosperous. . . . The teaching Universities in England had one student to 3500 of the population; in Ireland there was one student to 2040 of the population; while in Scotland there was one University student to 580 of the population. Therefore, the roots of University education had gone seven times wider and broader among the people of Scotland than they had done either in England or in Ireland. The object had always been to try and evolve brain power from all capable citizens, and it was this which had made Scotland what it was. Nevertheless, it was his deliberate opinion that Scotland was decidedly behind England in education. The English Universities had been adapting themselves to the changing conditions of the world very largely, and the Scottish Universities had been remaining behind in modern wants altogether. The lion rampant in Scotland had been standing on its hind legs pawing the air, while the lion passant with its fore-feet on the ground had been going ahead; and it was because of that consideration that he was extremely anxious to see this Bill pass into law."

THE OXFORD UNIVERSITY OBSERVATORY.

THE Savilian Professor of Astronomy, in his Annual Report, read on June 5, thus refers to the work done:—

In addition to the statutable lectures, four others were given on the recent speculations concerning the construction of the sidereal universe, in relation to possible meteoric collisions.

The renovation of the macro-micrometer, mentioned in the last Report, has been completed by Mr. Simms, who originally constructed it; and it has since been in constant use. The mounting of the De la Rue instrument has been provided with a slow motion in right ascension, of a peculiar and delicate construction, and set in motion by electro-magnets; the driving-clock also has been thoroughly renovated in the parts which exhibited the effects of wear. The object of all these extensive improvements is to make it possible to expose photographic plates during those lengthened periods of several hours, rendered necessary for the purposes of the recent modifications of astronomical inquiries. These improvements have been so recently effected, and the twilight is at present so protracted, that it has not yet been possible to fully test their practical efficiency on the skies.

The mounting of the Grubb equatorial has been completed. It is now furnished with automatic driving apparatus of the most modern and efficient construction, well worthy of the high reputation of its eminent constructor. The visual object-glass has been refigured, and is now in a greatly improved condition. The tube of the photographic telescope is *in situ*, but the object-glass of 13 inches' aperture, meeting the conditions required by the International Congress, has not yet been supplied by the maker. Two experimental object-glasses have, however, been already examined, but their performance did not prove satisfactory. Prof. Pritchard is now expecting the speedy arrival of a third, which, he is assured by Sir Howard Grubb, will relieve him from further anxiety, and place him in a position to prosecute the essential preliminary operations necessary for the International scheme.

All these important renovations and additions, so necessary to practical astronomy in its present phase, have been provided by the unsolicited generosity of the late Dr. De la Rue. Prof. Pritchard expresses deep regret —which he has no doubt is shared by the Board of Visitors—that their lamented and munificent friend did not live, as he had hoped, to see the fulfilment of his anticipations in connection with this judicious expenditure.

The first extensive series of the observations connected with the new application of the photographic method to stellar parallax, as applied to stars of the second magnitude in the northern hemisphere, has been brought to a conclusion, and is now, through the liberality of the Delegates of the University Press, in course of printing. The volume, it is hoped, will be distributed among astronomers in the course of a few weeks. It comprises no less than thirty distinct determinations of stellar parallax: these are applied to eight stars, referred in most cases to four faint stars of comparison. Progress also has been made in the continuation of the like observations to other stars connected with the general scheme. Prof. Pritchard has had the gratification of finding that this method of parallactic determination, which was originally devised at Oxford, is in process of adoption at other well-known Observatories.

At the request of Dr. Gill, he proposes to assist in a scheme of photographic observation of the minor planet Victoria, for the determination of solar parallax during the present summer; efficient assistance, however, can be rendered in this direction only on the condition of the arrival of a satisfactory object-glass from Dublin.

He has been engaged in the examination of a Wedge photometer for the Observatory of Pulkova at the instance of its eminent Director. It is not without some satisfaction that he finds that this method of photometry is likely to be employed in other Observatories.

The Director states that the various operations mentioned above could not have been thus efficiently completed without the continuous and intelligent co-operation of the two able assistants, Mr. W. E. Plummer and Mr. C. A. Jenkins. It has been a source of great gratification to him that Mr. Plummer's ability has been recognized by the Royal Astronomical Society in their selection of him for a seat on their Council.

JOHN PERCY, M.D., F.R.S.

BY the death of Dr. Percy, on the 19th inst., this country has lost a distinguished man, who has greatly influenced its metallurgical progress.

He was born in 1817, and at an early age entered the Medical School of the University of Edinburgh, where, at twenty-one, he took the degree of M.D. He subsequently became Physician to the Queen's Hospital at Birmingham, and the few papers he published on medical subjects show that he would probably have risen to eminence in medicine had it not been for the fact that in the great metallurgical centre of the Midlands his studies were soon diverted to the particular line of work to which his life was ultimately devoted. This is not perhaps surprising when it is remembered that the connection between therapeutics and metallurgy has been traditional since the days of Paracelsus and Agricola.

When we look back at Dr. Percy's career, the remarkable fact stands out that notwithstanding the great importance of metallurgy to this country, with its vast industrial interests, there was no metallurgical treatise worthy of the name until he wrote one; and, what is stranger still, up to the time when he accepted the chair in the Royal School of Mines, in 1851, there was no systematic teaching of metallurgy. Dr. Percy found it practised mainly as an empirical art. Sir Henry de la Beche indicated the direction the teaching had to take, and in his inaugural discourse as Director of the School of Mines, he said, "We still too frequently hear of practical knowledge as if, in a certain sense, it were opposed to a scientific method of accounting for it, and as if experience without scientific knowledge were more trustworthy than the like experience with it." Reference to the pages of the Journal of the Iron and Steel Institute will show that this, the most practical body of men in the world, not only thoroughly recognizes that mere empiricism would be fatal to industrial success, but constantly appeals to science for guidance. This is in great measure owing to Dr. Percy's teaching, and is not the least important of its results.

Ten years after he began to teach, he published the first volume of his treatise on "Metallurgy," which he dedicated with "sincere respect and affectionate regard" to Faraday. This work, which he calls the "task of his life," has developed into a series of volumes containing 3500 octavo pages. One remarkable feature of these books is that almost every woodcut may be regarded as an accurate, though small, mechanical drawing, and it is only measurable drawings of this kind which are of real utility in practice. Treatises such as his naturally embody descriptions of processes furnished by those actually engaged in conducting the operations—aid which was always most fully acknowledged. The thoroughness of his own research is well shown by the careful digests of monographs, which were gathered from all kinds of sources; and it is evident that immense pains were bestowed upon the work. Some years ago a foreign friend, himself a laborious and conscientious author, forcibly expressed to the writer his appreciation of Dr. Percy's labours, looking up from one of the volumes and exclaiming, "*C'est énorme ce qu'il a compilé.*"

It may perhaps be admitted that his intolerance of inaccuracy at times led him to magnify points which now seem to be somewhat trivial, and he sometimes withholds the expression of his own opinion when the reader has fairly a right to expect it, and would be grateful for the support of his authority.

With the notable exception of a process for the extraction of silver from argentiferous ores and residues, he can hardly be said to have originated any important metallurgical process; but his works teem with suggestions, and many improvements in metallurgical practice can be directly traced to his teaching. Such is the case with the practical application of the basic process for eliminating phosphorus in the Bessemer converter—a process of truly national importance, and one which has been widely adopted in other countries. It may fairly be claimed that during the thirty years he held his chair he trained a body of scientific workers in whose hands the immediate future of metallurgy to a great extent rests.

Remarkable evidence as to the strength of his individuality is afforded by the fact that those who were admitted to his friendship, and even his students who only saw him in the lecture-room or laboratory, were all singularly attracted to him, notwithstanding the occasional ruggedness of his manner. The purity of his style and the quaintness of his illustration recall the writings of another doctor, Sir Thomas Browne, making, of course, due allowance for the difference of the periods at which they wrote. The subjects he dealt with were very diverse, and it would be interesting to collect his trenchant letters, which appeared in the *Times*, usually over the signature Y. One especially occurs to the writer. Dr. Percy was charged with the superintendence of the ventilation of the Houses of Parliament, and amusingly describes his difficulties in meeting the varied and often contradictory requirements of the members, as to the temperature best suited to their work. He was an honorary member of the Institution of Civil Engineers, and held the office of President of the Iron and Steel Institute in 1885, having received the Bessemer Medal of that Institute in 1877. His artistic skill was considerable, and he possessed a fine collection of water-colour drawings.

Two days before his death the Prince of Wales awarded him, on the nomination of the Council, the Albert Medal of the Society of Arts. Dr. Percy was still able to appreciate the honour which had been done him, and received the intimation with the characteristic words, almost his last, "My work is done."

W. C. ROBERTS-AUSTEN.

HENRY WILLIAM BRISTOW, F.R.S.

MR. BRISTOW'S death, which we briefly chronicled last week, requires a fuller notice. With him passes away one of the gentlest and most courteous of English geologists—one whose associations connected him with the magnates of geology in the early decades of this century, and whose death breaks another of the links that unite us personally with that heroic time. Born in 1817, he was the only son of Major-General H. Bristow, a distinguished officer, who devoted himself to the cause of Spain, where he died, and received the honours of a public funeral. Mr. Bristow suffered from an inveterate deafness. An old school-fellow, speaking of his boyish days not long ago, remarked that he was as deaf then as he was even late in life. This ailment was undoubtedly a life-long hindrance to him, for it kept him from mingling as freely among his associates, and taking so public a part, as his tastes and abilities would have prompted and fitted him to do.

When twenty-five years of age, he joined the Geological Survey under Sir Henry De la Beche, and he remained in that department of the public service for the long space of forty-six years. Most of his scientific work was done for the Survey, and is to be found in the official maps, sections, and memoirs. It is thus, perhaps, less generally known than that of some of his colleagues who have published communications in the more widely circulated scientific journals. To those, however, who can appreciate accurate and artistic mapping, the work which he did, more particularly among the Secondary rocks of

Dorsetshire and the Isle of Wight, will always possess a special value and charm. It was among the earliest work of its kind, and to this day may be taken as a model of admirable geological cartography. His memoirs, too, are remarkable for their lucidity of statement and clear presentation of fact; also for a certain literary and antiquarian flavour thoroughly characteristic of the author.

In the last fifteen or twenty years of his official life Mr. Bristow's time and thought were mainly given to the duties of administration required by the high appointments to which he was promoted. Under Sir Roderick Murchison he became one of the two district-surveyors charged with the immediate supervision of the field-work in England and Wales, and on the death of that chief and the promotion of Sir Andrew C. Ramsay to succeed him, Mr. Bristow was appointed Senior Director, an office which he held until his retirement last summer.

Yet in spite of the pressure of his official duties, which grew greater as years advanced, Mr. Bristow contrived to find leisure for various pieces of literary work. Perhaps the best known and most useful of them was his "Glossary of Mineralogy,"—a volume which has long been out of print, and in the preparation of a new edition of which he looked forward to employ himself during the present year. He also edited translations of Figuier's "La Terre avant le Déluge" and Simonin's "La Vie souterraine," besides furnishing mineralogical and geological articles to Brande's "Dictionary of Science, Literature, and Art," to Ure's "Dictionary of Arts, Manufactures, and Mines," and to the geological journals. But it is on his contributions to the Geological Survey that his scientific reputation will mainly rest. His last work was the revision of the proof-sheets of a new edition of his classic memoir on the "Geology of the Isle of Wight"—a volume which is now in the press. He did not live to see its publication, and to receive the congratulations of his friends on its appearance as the crowning work of his scientific career. Mr. Bristow has carried with him to the grave the affectionate regrets of his colleagues and of all who ever came in contact with his genial kindly nature.

NOTES.

Dr. Archibald Geikie has been elected a corresponding member of the Physical and Mathematical Section of the Royal Academy of Science, Berlin.

On Thursday last, the 20th inst., a dinner was given in Paris to Prof. Francis Darwin, by the members of Scientia, a group of French men of science, who are accustomed to meet once a month at a friendly dinner, and to invite a distinguished guest of scientific renown. This dinner was the fourteenth since the foundation of the Society, and among the guests have been MM. Pasteur, de Lesseps, Eiffel, Renan, Janssen, Berthelot, and Chevreul. Mr. F. Darwin was the first foreign guest of the Society. The dinner was attended by many eminent scientific men, among whom were MM. Marey, the physiologist, acting President, Eiffel, de Brazza, Richet, de Lesseps, Giard, and some fifty others. Prof. Marey, in very appropriate terms, recalled the great achievements of Charles Darwin, and spoke enthusiastically of the doctrine of evolution—a fact worthy of note, when it is remembered that Prof. Marey is a member of the Institute. Mr. Darwin expressed cordial thanks for the honour conferred upon him, but, in the opinion of most of the members, adopted too modest a tone. His "Life and Correspondence of Charles Darwin" has won for him high rank in the esteem of the French scientific public.

This year the summer meeting of the Institution of Mechanical Engineers will be held in Paris. It will begin on Tuesday, July 2. The following papers have been offered for reading and discussion:—Description of the lifts in the Eiffel Tower, by M. A. Ansaloni, of Paris (this paper will be supplemented by results of working to date, communicated verbally by M. Gustave Eiffel, President of the Société des Ingénieurs Civils); the rationalization of Regnault's experiments on steam, by Mr. J. Macfarlane Gray, of London; on warp weaving and knitting without weft, by Mr. Arthur Paget, Vice-President, of Loughborough; on gas-engines, with description of the Simplex engine, by M. Edouard Delamare-Deboutteville, of Rouen; on the compounding of locomotives burning petroleum refuse in Russia, by Mr. Thomas Urquhart, Locomotive Superintendent, Grazi and Tsaritsin Railway, South-East Russia; description of a machine for making paper bags, by Mr. Job Duerden, of Burnley, communicated through Mr. Henry Chapman, honorary local secretary.

With reference to the proposed visit of geologists to the volcanic regions of Italy next October—a scheme to which we referred last week—Dr. J. Foulerton, Secretary of the Geologists' Association, writes to us that the excursion will be under the direction of Dr. H. J. Johnston-Lavis, of Naples, assisted by eminent Italian geologists. Anyone desiring further information on this subject should communicate as early as possible with Dr. Foulerton, at 44 Pembridge Villas, Bayswater, W., sending a stamped and addressed envelope for reply.

At a meeting on Friday last of the Council of the University College of North Wales, it was decided to open an Agricultural Department at the College in October, and steps were taken with a view to the appointment of a Lecturer in Agriculture. It was stated that the proposal for the formation of dairy schools in connection with the College had met with much support.

From the Annual Report of the Principal of the Owens College, Manchester, read on Friday last, at the meeting for the distribution of honours and prizes, it appears that the total number of students has increased during the year from 1269 to 1297, and of these no fewer than 380 are in the Medical School. The number of associates elected during the year was 33: the associates, of whom there are now more than 300 on the roll, are *alumni* of the College, and are only elected after taking a degree at a University. It appears also that during the last year 104 Owens College students passed in arts, science, and law, and 57 in medicine, at the Victoria University. In the London University 51 Owens College students passed in arts, science, and law, and 24 in medicine. Reference was naturally made to the liberal gifts to the College by Sir Joseph Whitworth's legatees. A considerable portion of the most recent extension of the College buildings is devoted to the housing of the old Manchester Natural History and Geological Museums, and the additions made to them since they were handed over to the College. In addition to the sum of £3000 previously given, the Whitworth legatees extended their gift by the further benefactions of £25,000 to the Museum Building Fund, and of £10,000 in augmentation of the Museum Trust Fund.

Prizes will be distributed at the Medical School, St. Thomas's Hospital, on Tuesday, July 2, at 4 o'clock in the afternoon, by Sir Henry Doulton, almoner of the hospital.

A meeting of the National Health Society is to be held on Saturday, June 29, in the Town Hall, Westminster, when the Society's certificates gained during the year for proficiency in "domestic hygiene," "sick nursing," and "first aid to the injured," will be presented to the candidates by the Duchess of Westminster.

The large herbarium of Fungi, transferred by Dr. M. C. Cooke to the Herbarium of the Royal Gardens, Kew, is now for the most part incorporated with the previous collection. The total number of specimens reaches to 46,000, being nearly double that of the Berkeley Herbarium; and these, approximately, represent—

Hymenomycetes	11,000
Gasteromycetes and Myxogastres	2,000
Ustilagines and Uredines	6,000
Discomycetes	6,000
Pyrenomycetes	12,000
Incompletæ	9,000

The number of species has not been calculated. A large number of these are types, and others as important as types; such, for instance, are the individual specimens used in the illustration of "Mycographia." The entire collection is a most valuable addition to the national collection at Kew, containing as it does contributions from most of the mycologists of the past forty years—Berkeley, Broome, Bloxam, Cesati, Currey, Curtis, De Notaris, Duby, Ellis, Fries, Kalchbrenner, Leveillé, Montagne, Peck, Ravenal, Rabenhorst, Westendorp, Winter, &c., &c.

IN a British official Report on Brazil, which has just been laid before Parliament, reference is made to the Pasteur Institute founded at Rio de Janeiro on February 9, 1888. Out of 106 persons treated between then and January 8, 1889, only one died, viz. a child who only attended ten times out of twenty-three attendances ordered. In sixty-two instances the dog biting the people treated at Rio was recognized as undoubtedly mad. Besides the 106 cases, 130 other persons were sent away as having nothing the matter with them.

THE National Association for the Promotion of Technical Education has reprinted the excellent series of "Opinions of Practical Men" on the industrial value of technical training, which lately appeared in the *Contemporary Review*. A prefatory note is contributed by Lord Hartington.

WE regret to announce the death of Signor G. Cacciatore, Director of the Palermo Observatory. He died on June 16, in his seventy-sixth year.

PROF. OSCAR HOWARD MITCHELL, of Marietta College, U.S.A., died at Marietta on March 29, in his thirty-eighth year. Prof. Mitchell did some mathematical work which excited the warm admiration of Prof. Sylvester, whose pupil he had been. Of two papers by him in the *American Journal of Mathematics*, Prof. Sylvester wrote: "I should have been very glad, not to say proud, to have been the author of them."

EARLY on Saturday morning an earthquake occurred at Watts Town, in the valley of the Little Rhondda. A shock, which was accompanied by a rumbling noise, shook the walls of houses, and caused the inhabitants to run into the streets in alarm. Crockery was broken, and in one instance children were thrown from their beds. At Pontygwaith the shock was severely felt. Mr. Davis, of Penrhys Cottage, says he was alarmed by the noise, and thought it a more than usually violent explosion in one of the collieries which abound in the valley. The walls of his house shook so that he thought the place was coming down, and he ran into the street. The scene in Llewellyn Street was one of the wildest confusion, women and children partly undressed running hither and thither, the greater number of them being of Mr. Davis's opinion that an explosion had occurred. A considerable time elapsed before the people were induced to go back to bed. The weather had been exceedingly sultry for some days.

WE learn from the *American Meteorological Journal* that the Chief Signal Officer, Washington, has issued the following instructions relating to weather predictions for two or three days:—"In view of the great importance of long-time weather predictions to the business interests of the country, it is hereby directed that, on and after May 1, 1889, the Indications Official shall make, whenever practicable, a general prediction, showing the condition of the weather two or three days in advance. This class of long-time predictions will be confined to such occasions and such sections of the country as from peculiar and persistent meteorological conditions seem to urge successful forecasts. These predictions will not be too much in detail, but will clearly set forth the section of the country for which they are intended, and the days of the week which they will cover. . . . In making these long-time forecasts, the language should be varied according to the necessities of the occasion, but should always be in such form as to convey clearly to the general public the opinions of the Indications Official, and also the degree of positiveness that attaches to his opinions."

KRÜSS AND SCHMIDT'S statement that both nickel and cobalt contain a small percentage of a hitherto unknown element—gnomium—amounting in the case of one specimen of nickel to as much as 2 per cent. (*Ber. der deut. chem. Gesellsch.*, xxii. 11; NATURE, vol. xxxix. p. 325), has not been permitted to pass unchallenged, and quite recently two papers have appeared which tend to show that the supposed new element is non-existent. At the time when they were led to recognize the presence of this common impurity, Krüss and Schmidt were engaged in repeating Winkler's old determination of the atomic weights of nickel and cobalt, in which the ratio Au : Ni or Au : Co was arrived at from the amount of gold precipitated by these metals from neutral solutions of gold chloride. Winkler, in the meantime, has repeated this work with carefully purified materials (*Ber. der deut. chem. Gesellsch.*, xxii. 890), and has not only failed to obtain any evidence of the existence of gnomium, but moreover calls in question the purity of the metallic specimens employed by Krüss and Schmidt. A communication from Dr. Fleitmann to the *Chemiker Zeitung* (xiii. 757) lends considerable support to this view. Adopting the method patented by Krüss and Schmidt for separating this common impurity from nickel and cobalt by extracting the hydroxides of these metals with sodium hydroxide, Fleitmann has examined a number of specimens of commercially pure nickel and cobalt, and, so far from obtaining 2 per cent. of gnomium oxide, has failed to isolate from 50 grammes of material a weighable amount of any impurity which would serve to justify the view that a hitherto unknown element was associated with these metals. Fleitmann points out that when the hydroxides of commercially pure nickel and cobalt are treated with large quantities of sodium hydroxide, impurities go into solution which vary in composition and amount with the source and degree of purity of the metals; these impurities consist of small quantities of the oxides of lead, zinc, arsenic, manganese, molybdenum, silicium, aluminium, cerium, chromium, &c., together with an amount of nickel or cobalt oxide not exceeding 1/20 per cent. of the hydroxide extracted, and when separated from the alkaline solution by the addition of an acid and subsequent precipitation with ammonium carbonate give rise to a highly complex mixture of oxides and acids which can only be separated and identified with considerable difficulty. It is not improbable, therefore, that Krüss and Schmidt have been dealing with some of the constituents of this mixture, and that on further examination gnomium oxide will prove to be a mixture of the oxides of elements already known.

WE learn from the *Daily Inter-Ocean*, of Chicago, that Lieutenant Schwatka has reported the discovery of a large tribe of cave-dwellers in the unexplored regions of Northern Mexico. Their abodes are exactly like the old, abandoned cliff-dwellings of Arizona and New Mexico. So wild and timid were the inmates that it was hardly possible to get near them. Upon the approach of white people they usually fly to their caves or cliffs by means of notched sticks placed against the face of the cliffs. They can also ascend perpendicular cliffs without the use of these sticks if there are the slightest crevices for their fingers and toes. A number of children, playing in a deep cañon, were interrupted, and immediately fled to the low brush and rocks and could not be found, hiding as completely as young quail. These cliff-dwellers are usually tall, lean, and well formed, their skin being very blackish-red, much nearer the colour of the negro than the copper-coloured Indian of the United States. They are said to be sun-worshippers.

IN response to demand, a new edition of Prof. A. Gray's small work on "Absolute Measurements in Electricity and Magnetism" will be issued immediately by Messrs. Macmillan and Co. The whole work has been very carefully revised, and several alterations and additions made, which it is hoped will bring it into accordance with the present state of practical electricity, and render it still more useful to students and electrical engineers. The preparation of the second volume of the same author's larger treatise on the same subject is being pushed on at the same time as quickly as possible.

PART VI. of the "Catalogue of the Moths of India," by Colonel Swinhoe and Mr. E. C. Cotes, has just been issued. It deals with *Crambites* and *Tortrices*, and there is also a list of "addenda."

THE Elizabeth Thompson Science Fund, established by Mrs. Elizabeth Thompson, of Stamford, Connecticut, "for the advancement and prosecution of scientific research in its broadest sense," now amounts to \$25,000. The trustees of the Fund have issued a circular, stating that, as accumulated income is again available, they desire to receive applications for "appropriations" in aid of scientific work. This endowment is not for the benefit of any one department of science, but it is the intention of the trustees to give the preference to those investigations which cannot otherwise be provided for, which have for their object the advancement of human knowledge or the benefit of mankind in general, rather than to researches directed to the solution of questions of merely local importance. Applications for assistance from the Fund, in order to receive consideration, must be accompanied by full information, especially in regard to the following points: (1) precise amount required; (2) exact nature of the investigation proposed; (3) conditions under which the research is to be prosecuted; (4) manner in which the appropriation asked for is to be expended. All applications should be forwarded to the Secretary of the Board of Trustees, Dr. C. S. Minot, Harvard Medical School, Boston, Mass., U.S.A. It is intended to make new grants at the end of 1889. The trustees are disinclined, for the present, to make any grant exceeding \$500; preference will be given to applications for smaller amounts. The following is a list of the grants hitherto made:—(1) \$200 to the New England Meteorological Society, for the investigation of cyclonic movements in New England (results published in the *American Meteorological Journal* for 1887 and May 1888); (2) \$150 to Mr. Samuel Rideal, of University College, London, England, for investigations on the absorption of heat by odorous gases; (3) \$75 to Mr. H. M. Howe, of Boston, Mass., for the investigation of fusible slags of copper and lead smelting; (4) \$500 to Prof. J. Rosenthal, of Erlangen, Germany, for investigations on animal heat in health and disease (results published in the *Sitzungsber. k. Akad. Wiss.*, 1888, 1309–19; 1889, 245–254; *Arch. Anat. u. Physiol. Suppl.*, 1888, 1–53); (5) \$50 to Mr. Joseph Jastrow, of the Johns Hopkins University, Baltimore, Md., for investigations on the laws of psycho-physics; (6) \$200 to the Natural History Society of Montreal, for the investigation of underground temperatures; (7) \$210 to Messrs. T. Elster and H. Geitel, of Wolfenbüttel, Germany, for researches on the electrization of gases by glowing bodies (results published in the *Sitzungsber. k. Akad. Wiss. Wien.*, xcvii., Abth. 2, 1175–1264, 1889); (8) \$500 to Prof. E. D. Cope, of Philadelphia, Penn., to assist in the preparation of his monograph on American fossil Vertebrates; (10) \$125 to Mr. Edw. E. Prince, of St. Andrews, Scotland, for researches on the development and morphology of the limbs of Teleosts; (11) \$250 to Mr. Herbert Tomlinson, of University College, England, for researches on the effects of stress and strain on the physical properties of matter; (12) \$200 to Prof. Luigi Palmieri, of Naples, Italy, for the construction of an apparatus to be used in researches on atmospheric electricity; (13) \$200 to Mr. Wm. H. Edwards, of Coalburg, W. Va., to assist the publication of his work on the butterflies of North America (results published in the "Butterflies of North America," third series, Part 5); (14) \$150 to the New England Meteorological Society, for the investigation of cyclonic phenomena in New England; (15) \$25 to Prof. A. F. Marion, for researches on the fauna of brackish waters; (16) \$300 to Prof. Carl Ludwig, for researches on muscular contraction, to be carried on under his direction by Dr. Paul Starke; (17) \$200 to Dr. Paul C. Freer, for the investigation of the chemical constitution of graphitic acid; (18) \$300 to Dr. G. Müller, for experiments on the resorption of light by the earth's atmosphere; (19) \$300 to Prof. Gerhard Krüss, for the investigation of the elementary constitution of erbium and didymium; (20) \$50 to Dr. F. L. Hoorweg, for the investigation of the manner and velocity with which magnetism is propagated along an iron bar; (21) \$150 to Mr. W. H. Edwards, to assist the publication of his work on North American butterflies.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Captain M. S. Riach, 79th Highlanders; a Macaque Monkey (*Macacus cynomolgus*) from the Nicobar Islands, presented by Mr. W. J. McCausland; a —— Wild Dog (*Canis* ——) from Bangay, Bornean Group, presented by Mr. C. T. Kettlewell; a Grey Parrot (*Psittacus erithacus*) from West Africa, presented by Miss L. Davy; a Redwing (*Turdus illacus*), British, a Red-legged Partridge (*Caccabis rufa*), European, presented by Mr. J. C. Clayton; a Purple-crested Touracou (*Corythaix porphyreolophus*) from East Africa, presented by Miss Dolly Kirk; two Canary Finches (*Serinus canarius*), three Teneriffe Chaffinches (*Fringilla tintillon*) from Teneriffe, presented by Mr. E. G. Meade Waldo; a Solitary Thrush (*Monticola cyanus*) from Italy, presented by the Rev. H. A. Macpherson; a Common Trumpeter (*Psophia crepitans*) from Demerara, presented by Mr. C. T. Tudway; four Violaceous Night Herons (*Nycticorax violaceus*) from the West Indies, presented by Dr. A. Boon, C.M.Z.S.; an Alexandrine Parrakeet (*Palæornis alexandri*) from India, presented by Miss J. Wilson; two Bolle's Pigeons (*Columba bollii*) from Teneriffe, a Pallas's Sand Grouse (*Syrrhaptes paradoxus*) from Scotland, deposited; a Specious Pigeon (*Columba speciosa*) from Brazil, a Black Francolin (*Francolinus vulgaris*) from India, a Hawk's-billed Turtle (*Chelone imbricata*) from the West Indies, purchased; two Burrhel Wild Sheep (*Ovis burrhel*), a Yak (*Poephagus grunniens*) a Bolle's Pigeon (*Columba bollii*), a Triangular-spotted Pigeon (*Columba guinea*), a Herring Gull (*Larus argentatus*), a Yellow-legged Herring Gull (*Larus cachinnans*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

RECENT DETERMINATIONS OF THE AMOUNT OF LUNAR RADIATION.—Prof. C. C. Hutchins, formerly of the Johns Hopkins University, now at Bowdoin College, Brunswick, Maine, has recently made some researches in the same field in which Prof. Langley has already worked, viz. the subject of lunar radiation. Prof. Hutchins's first step was the construction of a new form of thermograph, in which a single thermal junction was employed instead of many, the heat rays being condensed upon this one by means of a concave mirror. This combination proved in his hands very successful, though his galvanometer was not the most sensitive possible, since it was a matter of importance that the needle should quickly come to rest. As actually adjusted, the galvanometer gave a deflection of one scale division for 0·00000007 ampere, the period being 10 seconds.

The two principal points to which attention was directed were the comparative intensity of radiation of the sun and moon and the coefficient of transmission of our atmosphere for lunar radiations. The first point was determined by two methods: in one, but a very small fraction of the sun's rays were suffered to fall on the thermograph; whilst in the second method a resistance was interposed in the galvanometer. The two methods gave very fairly accordant results, the mean giving the solar radiation as 184,560 times the lunar. The experiments on the transmission of the lunar rays through our atmosphere gave a remarkably high value: for the deduced result showed that 89¼ per cent. of the rays of the moon when vertical are transmitted by the air at standard pressure.

Observations on the lunar eclipse of January 28, 1888, agreed with those of Langley and Lord Rosse in their testimony as to the suddenness with which the heat received from the moon is cut off at totality.

As to the quality of the lunar rays, it was found that but 31 per cent. were transmitted through a plate of quartz which allowed 93 per cent. of the sun's rays to pass. The radiations from a platinum coil placed in a Bunsen flame turned down as low as possible, suffered to about the same extent as the rays from the moon. From experiments upon the radiating powers of different rocks, a table of which has been formed, Prof. Hutchins concludes that a very considerable portion, about half indeed, of the incident rays are absorbed. The surface of the moon should therefore become strongly heated, but the evidence afforded by total lunar eclipses appears to show that scarcely any of this surface heat succeeds in passing through our atmosphere.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 *JUNE* 30—*JULY* 6.

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on June 30

Sun rises, 3h. 49m.; souths, 12h. 3m. 24·6s.; daily increase of southing, 11·8s.; sets, 20h. 18m.: right asc. on meridian, 6h. 38·4m.; decl. 23° 10′ N. Sidereal Time at Sunset, 14h. 54m.

Moon (at First Quarter on July 6, 6h.) rises, 5h. 35m.; souths, 13h. 48m.; sets, 21h. 54m.: right asc. on meridian, 8h. 22·9m.; decl. 21° 21′ N.

Planet.	Rises.	Souths.	Sets.	Right asc. and declination on meridian.	
	h. m.	h. m.	h. m.	h. m.	° ′
Mercury..	3 14 ...	11 0 ..	18 46 ...	5 35·2 ..	18 47 N.
Venus ...	1 28 ..	8 53 ..	16 18 ..	3 27·8 ...	15 19 N.
Mars ...	3 26 ...	11 48 ...	20 10 ...	6 23·2 ...	24 8 N.
Jupiter ...	19 40 ...	23 34 ...	3 28* ..	18 11·3 ...	23 16 S.
Saturn ...	7 17 ...	14 48 ...	22 19 ...	9 23·8 ...	16 29 N.
Uranus...	13 0 ...	18 31 ...	0 2*...	13 6·9 ...	6 27 S.
Neptune..	1 43 ..	9 32 ...	17 21 ...	4 6·7 ...	19 16 N.

* Indicates that the setting is that of the following morning.

Variable Stars.

Star.	R.A.	Decl.			
	h. m.	° ′		h. m.	
U Cephei ...	... 0 52·5 ...	81 17 N. ...	July 4,	21 46	*m*
U Virginis ...	... 12 45·5 ...	6 10 N. ...	June 30,		*m*
Z Virginis ...	... 14 4·4 ...	12 47 S. ...	July 6,		*M*
U Boötis ...	... 14 49·2 ...	18 9 N. ...	,, 1,		*m*
S Ophiuchi...	... 16 27·9 ...	16 56 S. ...	,, 1,		*M*
U Ophiuchi...	... 17 10·9 ...	1 20 N. ...	,, 2,	3 11	*m*
			,,	23 19	*m*
X Sagittarii...	... 17 40·6 ..	27 47 S. ...	June 30,	22 0	*M*
			July 5,	2 0	*m*
W Sagittarii	... 17 57·9 ...	29 35 S. ...	,, 1,	0 0	*m*
U Sagittarii...	... 18 25·6 ...	19 12 S. ...	,, 2,	0 0	*M*
R Lyræ ...	... 18 52·0 ...	43 48 N. ...	,, 6,		*m*
η Aquilæ ...	... 19 46·8 ...	0 43 N. ...	,, 3,	1 0	*m*
X Cygni ...	... 20 39·1 ...	35 11 N. ...	,, 2,	22 0	*m*
T Vulpeculæ	... 20 46·8 ...	27 50 N. ...	June 30,	21 0	*M*
δ Cephei ...	... 22 25·1 ...	57 51 N. ...	July 6,	22 0	*m*

M signifies maximum; *m* minimum.

July.	h.	
1 ...	1 ...	Mercury stationary.
1 ...	19 ...	Saturn in conjunction with and 2° 3′ south of the Moon.
1 ...	21 ...	Sun at greatest distance from the Earth.

GEOGRAPHICAL NOTES.

To an unusually crowded meeting of the Royal Geographical Society on Monday night Dr. Frithjof Nansen told in detail the story of his journey across Greenland last summer. We have already given the main incidents of this remarkable journey, and need only refer here to some of the scientific results. These cannot be fully given as yet, as the meteorological and other data collected by Dr. Nansen have not been fully worked out. It should be borne in mind that the main purpose of Dr. Nansen's expedition was to prove that it is quite possible to cross Greenland: in this respect the expedition has been completely successful. Dr. Nansen repudiates as untenable the idea that somewhere in the interior of Greenland an oasis of greenery must exist. The conditions there are quite different from those of Grinnell Land, where the winter's snow is annually melted away over a certain extent of the surface. Greenland, on the contrary, Dr. Nansen maintains, is so thickly covered with the ice-accumulations of ages, that no part of the interior is ever laid bare. He surmises that there is a sort of wind-pole about the high centre of the interior, from which, as a rule, the cold winds radiate in all directions to the warmer coasts. The cold experienced by the expedition reached as low as 90° F. below freezing, and as Dr. Nansen's thermometers were not adapted for a lower temperature he believes that the temperature was at times much under that. He compares the configuration of the inland ice to a shield, curving upwards from the edges to a sort of plateau, reaching in parts at least 10,000 feet above sea-level. As to the configuration of the ground underneath, Dr. Nansen maintains that it must be similar to Norway and Scotland, with the same rugged mountain masses, high ridges, valleys, and fjords; and that the shape of the ice-covering has nothing to do with the shape of the land underneath. The immense accumulation of snow has levelled up everything; in places the ice must be 6000 feet deep, and even the tops of the mountains must be covered with hundreds of feet of glacier. He believes the wind has much to do with maintaining the ice-level, and does not believe that the quantity of snow varies much from year to year. The enormous pressure exercised by this vast mass of ice causes it to send off icebergs, and, in Dr. Nansen's opinion, running water helps to maintain the uniform level. Even in winter, he maintains, there are running streams underneath, due to the action of this pressure, and which help to prevent the growth of the mass. From a meteorological point of view the scientific exploration of Greenland is in Dr. Nansen's estimation of immense importance. He therefore means to return to the country, probably in the autumn of next year. He will land on the east coast, much further north than his last year's starting-point. He will endeavour to explore the east and north coasts, and will attempt to cross the continent at its broadest part.

In illustration of Dr. Nansen's paper a large collection of oil paintings of Greenland scenery was exhibited, by a Danish artist, Mr. Carstensen, who spent two summers and autumns travelling up and down the west coast. They show, better than any photographs, the wonderful colour of the Greenland landscapes, the extent and nature of the ice, and the beauty and richness of the vegetation during the short summer of this ice-bound land.

THE LADIES' CONVERSAZIONE OF THE ROYAL SOCIETY.

The Ladies' *Conversazione* of the Royal Society, given on June 19, was a great success. The following were among the objects exhibited:—

Exhibited by Miss Constance F. Gordon Cumming:—Sketches near the active volcano of Mauna Loa, on the Island of Hawaii, and the extinct crater of Haleakala, on Isle Maui, described in "Fire Fountains of Hawaii."

Exhibited by Prof. Silvanus P. Thompson:—(1) Acoustic apparatus illustrating polarization of light. (2) Magnetic rotation of plane of polarization shown by projecting a polarized beam through a bar of heavy glass, and analyzing by a 24-ray disk of mica, or by a fish-lens. (3) Expansion and contraction, by transverse electrification, of the rings seen in quartz by convergent polarized light. (4) Objects electro-plated with the metal cobalt (new process).

Exhibited by the Hon. Ralph Abercromby:—Photographs and specimen, and map, illustrative of the nitrate of soda industry, and of the nitrate country.—Sun distilling apparatus, on the Atacama desert. This apparatus is situated at Sierra Gorda, near Caracoles, and is the property of Signor Oliveira. It consists of 1875 square feet of glass, something like a row of cucumber frames. A thin layer of salt water is led under the glass, when the heat of the sun vaporizes some of the water, which condenses as a sweat on the under surface of the glass top. The drops gradually coalesce, trickle down into the narrow groove on which the panes of glass rest, and are then led by pipes into a reservoir of fresh water. The bars along the outside of the glass are to save the apparatus from being wrecked by whirlwinds. Rather more water distils by night than by day, owing to the better condensation when the outer air is cool. At the time of my visit the outer air was 97°, the air inside the frames 120°, and that of the salt water inside only 117°, while that of the glass frame itself could not be determined. The apparatus is extremely inefficient, owing to the absence of a proper condenser, and the details are bad; still, from 150 to 175 litres of fresh water are distilled every day, which is sold at a profit for 1½*d*. a gallon. Twenty years ago a similar apparatus, with 50,000 square feet of glass, was erected at Carmen Alto on the same desert, and worked very profitably, as 10*s*. a gallon could then be obtained for fresh water. This apparatus was afterwards wrecked by a whirlwind, and is now replaced by a steam condenser.

Exhibited by Mr. Streeter:—Rubies from the Burmah Mines, English cut and mounted, and in the rough as found.

Exhibited and invented by Mr. Ludwig Mond and Dr. Carl Langer:—New form of gas battery. This battery is an improvement on the well-known gas battery invented by Grove fifty years ago, which produces electricity from hydrogen and oxygen gas by the intervention of platinum. The distinguishing feature of the new battery, which has been designed to obtain large currents of electricity by means of these gases, is that the electrolyte is not employed as a mobile liquid, but in a quasi-solid form, and it is therefore named "dry gas battery." Each element of the battery consists of a porous diaphragm of a non-conducting material—for instance, plaster of Paris—which is impregnated with dilute sulphuric acid. Both sides of this diaphragm are covered with very fine platinum leaf, perforated with very numerous small holes, and over this with a thin film of platinum black. Both these coatings are in contact with frame-works of lead and antimony, insulated one from the other, which conduct the electricity to the poles of each element. A number of these elements are placed side by side, or one above the other, with non-conducting frames intervening, so as to form chambers through which hydrogen gas is passed along one side of the element, and air along the other. One element, with a total effective surface of 774 square centimetres = 120 square inches, which is covered by 1 gramme of platinum black and 0·35 gramme of platinum-leaf, shows an electromotive force of very nearly 1 volt when open, and produces a current of 2 amperes and 0·7 volt or 1·4 watt, when the outer resistance is properly adjusted. This current is equal to nearly 50 per cent. of the total energy obtainable from the hydrogen absorbed in the battery. The electromotive force decreases, however, slowly, in consequence of the transport of the sulphuric acid from one side of the diaphragm to the other. In order to counteract this disturbing influence the gases are from time to time interchanged. The battery works equally well with gases containing 30 to 40 per cent. of hydrogen, such as can be obtained by the action of steam or steam and air on coal or coke, if the gases have been sufficiently purified from carbonic oxide and hydrocarbons. The water produced in the battery by the combination of hydrogen and oxygen is carried off by the unconsumed nitrogen and an excess of air carried through it for this purpose.

Exhibited by Messrs. Woodhouse and Rawson, Ltd.:—Samples of copper produced by the Elmore depositing process. Sketches of the appearance under the microscope of ordinary deposited copper, and copper made by the Elmore process. By the Rev. F. Howlett, F.R.A.S.

Exhibited by Prof. J. A. Fleming, D.Sc.:—Edison Swan incandescence lamps, showing the "Edison effect." If a carbon incandescence lamp has a platinum plate, carried on a wire sealed through the glass, placed between the loop or horse-shoe, it is found that when the lamp is in action a galvanometer connected between the middle plate and the *positive* side of the carbon loop shows a current passing. If the galvanometer is placed between the middle plate and the *negative* side of the loop no current is found. The lamps exhibited show this effect very well. It was first pointed out by Mr. Edison, in 1884. It has been found that shielding the negative leg by a glass or metal tube entirely stops the production of the effect.

Exhibited by the Director of the Royal Gardens, Kew:—Photographs of Ceylon vegetation.

Exhibited by Mr. J. Young:—(1) A cluster of nests of a species of swift (Collocalia) taken in one of the Society Islands. (2) A specimen of *Pluvianellus sociabilis*, a plover obtained in South America, of which only two specimens (obtained fifty years ago) were previously known in Europe. (3) The tail of a Japanese barndoor cock, 11 feet long. (4) Bearded-tits' nest, built in Pampas grass heads, stuck in a flower-pot in an aviary.

Exhibited by Mr. P. L. Sclater, F.R.S.:—(1) Head of Thomson's gazelle (*Gazella thomsoni*), from a specimen shot by Mr. H. C. V. Hunter, in Masai Land, Eastern Africa. This gazelle was discovered by Mr. Joseph Thomson during his expedition through Masai Land in 1883–84, and named after its discoverer by Dr. Günther (*Ann. Nat. Hist.*, ser. 5, vol. xiv. p. 427). (2) Head of Grant's gazelle (*Gazella granti*), from a specimen shot by Mr. Frederick Holmwood, C.B., in the Kilimanjaro district of Eastern Africa. This gazelle was discovered by Colonel Grant, C.B., F.R.S., in Ugogo, in 1860, and named after him by Sir Victor Brooke (P.Z.S., 1872, p. 601). (3) Mummy of a small falcon (probably the kestrel, *Tinnunculus alaudarius*) from the tombs at Thebes in Egypt, obtained from the natives by Mr. A. G. Scott. (4) Tray of birdskins, from St. Lucia, West Indies, collected by Mr. Ramage, the naturalist employed by the joint Committee of the Royal Society and British Association for the exploration of the Lesser Antilles.

Exhibited by Profs. Liveing and Dewar, F.R.S.:—Absorption spectrum of oxygen. The oxygen, compressed to 150 atmospheres, is contained in a steel tube fitted with quartz ends. In the red part of the spectrum are seen the absorptions corresponding to the Fraunhofer groups A and B. Less sharply defined absorption bands are seen in the orange, citron, and blue, and faint bands in the green and indigo. These band absorptions have a totally different character from the great line absorptions of A and B. Beyond the visible spectrum, photographs show some absorptions in the ultra-violet, and the extreme ultra-violet rays are wholly absorbed. This complete absorption extends nearly to the limit of the solar spectrum. This proves that the earth's atmosphere limits the rays which can reach us from the outside. Ozone has even a more powerful absorptive action, and oxygen, ozonized and unozonized, put a limit to our observations of stellar spectra. Profs. Liveing and Dewar have experimented with a steel tube 60 feet in length, and easily capable of holding a mass of oxygen equal to that contained in a vertical column of the earth's atmosphere of equal section.

Exhibited by Mr. Francis Galton, F.R.S:—Reaction-time instrument (working model). The time is measured by a half-second pendulum. The signal is the sharp sound made by a small hammer (noiselessly set free) on its striking a detent, and thereby releasing the pendulum. The response is made by touching a key that releases an arrangement (worked very quickly by a spring) whereby an elastic thread, which is secured above and below to the pendulum, parallel to its rod, but not touching it, is nipped and held fast against a horizontal bar. The bar is graduated to hundredths of a second, so that the graduation opposite to the thread shows the elapsed time between the signal and the response. The pendulum receives no jar, and continues to vibrate.

Exhibited by the Hon. A. Holland-Hibbert:—(1) Old telescope, with parchment tubes. (2) Old microscope, of stamped leather. Both formerly the property of King Charles I.

Exhibited by Mr. Fred. Enock:—Microscopical preparations illustrating the life-history of the Hessian fly (*Cecidomyia destructor*, Say).

Exhibited by Mr. Percy E. Newberry, by kind permission of the Director of the Royal Gardens, Kew:—A series of ancient funeral wreaths and plant remains, discovered last year by Mr. W. M. Flinders Petrie, in the cemetery of Hawara, Egypt. (I.) The wreaths, which are of Egyptian and Greek manufacture, were all made in the first century B.C., and were found in wooden coffins, either resting on the heads or surrounding the bodies of the mummies. Among them the following are of special interest:—(1) A very perfect wreath composed of the flowerheads of a species of Immortelle (*Gnaphalium luteo-album*, L.), called by the ancients "helichrysos," and much used by them in making garlands. Helichrysos wreaths are mentioned by Pliny ("Hist. Nat.," xxi. 96) as having been used in Egypt in Ptolemaic times, also by Theophrastus, Athenæus, Cratinus, &c. (2) Portion of a curious garland made of cones of papyrus pith, lychnis and rose flowers, rose petals, and scarlet berries of the woody nightshade. These latter are mentioned by Pliny as having been employed in garland-making by the Egyptians. (3) Portion of a wreath (of Greek manufacture) made of flowers of the Polyanthus Narcissus (*N. Tazetta*, L.). Wreaths made of this flower, the "clustered Narcissus" of the ancients, are often mentioned by early Greek poets. Sophocles thus alludes to them:—

> θάλλει δ' οὐρανίας ὑπ' ἄχνας
> ὁ καλλίβοτρος κατ' ἦμαρ ἀεὶ
> νάρκισσος, μεγάλαιν θεαῖν
> ἀρχαῖον στεφάνωμα.—*Œdipus Coloneus.*

(4) Portion of a wreath made of the flowers of a species of rose (*Rosa sancta*, Richards). (5) A perfect wreath composed of rose petals threaded by a needle on to strips of twine. "Recently," writes Pliny in his history of garlands, "the rose chaplet has been adopted, and luxury has now arisen to such a pitch that rose garlands are held in no esteem at all if they do not consist entirely of petals sewn together with the needle" ("Hist. Nat.," xxi. 8). There are also exhibited: (6) a portion of a wreath composed of twigs of sweet marjoram (*Origanum Majorana*, L.), lychnis flowers, coils of papyrus pith, and pieces of copper tinsel; (7) a portion of a wreath composed of chrysanthemum flowers and leaves, purple cornflowers, and petals of the flower of a species of *Hibiscus*; (8) a portion of a wreath made of flowers of *Matthiola Librator*, L., flowers of the polyanthus, narcissus, and *Hibiscus* petals; (9) portions of two necklaces made of flowers of the date palm threaded on strips of twine; and (10) a fragment of a necklace made of fruits of the date palm. (II.) Among the plant remains are peach stones, dates, and date stones, walnut shells, currants, pomegranates, plums, figs, chick peas, common garden beans and peas, lentils, wheat, barley, and oats. These are probably the remains of the ancient funeral feasts which were held in the Hawara Cemetery by the relatives of the deceased people who were buried there. The whole collection (of which the series here exhibited is only the third part) is fully described by Mr. Percy E. Newberry in Mr. Flinders Petrie's "Hawara, Biahmu, and Arsinoe."

Exhibited by Dr. H. H. Hoffert:—Photograph of lightning flashes taken at Ealing, on June 6, 1889.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Harkness Scholarship, for Geology and Palæontology, has been awarded to T. T. Groom, Scholar of St. John's College.

Mr. J. T. Nicolson, B.Sc. of Edinburgh University, has been appointed Demonstrator in Mechanism and Applied Mechanics.

The Mechanical Workshops Syndicate reports that the practical instruction in engineering and mechanism is producing excellent results in the training of engineers, but that the subject suffers by the lack of a higher technical examination analogous to a tripos, while the workshops do not get all the work they might do, owing to the withdrawal of the University Museums' work.

An examination for Scholarships in mathematics and in chemistry and physics will be held at Peterhouse on October 15. A syllabus of subjects may be obtained from the tutor.

The local lectures in science have been largely attended during the past year; the largest audiences being at Kettering, where astronomy was the subject, and Mr. J. D. McClure the lecturer, and at Lancaster, where Mr. E. A. Parkyn lectured on human physiology.

The Students' Associations have made good progress in many localities, and in Surrey a student, Mr. Broderick, of Guildford, was found sufficiently qualified to repeat the courses in several villages with much success.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 6.—"Notes on the Absorption-Spectra of Oxygen and some of its Compounds." By Profs. Liveing and Dewar.

The authors give a diagram representing the absorption, both in the visible and in the ultra-violet parts of the spectrum, of 18 metres of ordinary oxygen gas at a pressure of about 97 atmospheres—that is, of a mass of oxygen rather greater than is contained in a vertical column of equal section of the earth's atmosphere. Under the circumstances of the experiment the absorptions A and B are very black, and the lines of which they are composed appear much broader than in the ordinary solar spectrum. The other bands are all diffuse at their edges, and, so far as observed, unresolvable into lines. The complete absorption of the ultra-violet rays does not extend quite so far down as the limit of the solar spectrum, though it approaches that limit. There is a diffuse edge of gradually diminishing absorption succeeding the complete absorption, and this fact, together with the rapid diminution of the extent of the complete absorption with decrease of pressure, lead the authors to class this absorption of the extreme rays with the diffuse bands, which, according to Janssen, increase in intensity as the square of the density of the gas. If that be so, it is unlikely that the limit of the solar spectrum is due to the absorption of ordinary oxygen. For though we may suppose interplanetary space to be pervaded by materials similar to our atmosphere, yet they must be in such a state of tenuity that, although they may to some extent reinforce A and B, they will not add sensibly to the strength of the diffuse bands. Moreover, these bands, though identical in position, so far as the blue and less refrangible part of the spectrum is concerned, with bands observed by Brewster and others in the solar spectrum, are seen much more strongly through tubes of compressed oxygen than they appear in the solar spectrum with a low sun. The ultra-violet bands, of which the one near N appears in photographs nearly as strong as the band just above F, and that in the indigo, have not, so far as the authors are aware, been noticed in the solar spectrum. Probably they would appear if photographs were taken with small dispersion when the sun was low.

As the pressure in the tube diminished, the bands rapidly faded; that in the indigo, with an oscillation-frequency or wave number about 2240, was the first to disappear, then those near L and O and that near E. At the same time the limit of the transmitted ultra-violet light advanced from an oscillation-frequency of about 3575 at 97 atmospheres, to 3710 at 50 atmospheres and 3848 at 23 atmospheres. At 20 atmospheres the three bands above C, D, and F, respectively, were still visible, though faint. B remained visible until the pressure was reduced to 2 atmospheres, and A could still be seen, but with difficulty, when the pressure of the 18 metres of oxygen was reduced to 1 atmosphere.

When atmospheric air was substituted for oxygen the authors found that 7 atmospheres was the limit of pressure at which they could certainly distinguish A, and 18 atmospheres the limit at which they could see B. It is a difficult matter to say exactly when an absorption becomes invisible, but the observations on air were made under the same circumstances as those on oxygen, and the two sets of observations were fairly comparable. With air at 75 atmospheres the three bands above C, D, and F, respectively, could all be seen, but that near C only with difficulty. The mass of oxygen and its *partial* pressure in the tube was in this case less by about one-quarter than that which was required to bring out the bands when oxygen alone was used. The cause of this may be that the development of the diffuse bands depends in some degree on the total pressure of the air, and not only on the partial pressure of the oxygen in it.

The mass of oxygen which when unmixed with nitrogen made A visible would correspond to that in the tube filled with air at 5 atmospheres, and that which made B visible would correspond to air at 10 atmospheres. The differences between these pressures and those which are actually needed to render A and B visible seem too great to be ascribed to errors of observation, and seem to indicate that the addition of the nitrogen has some effect on the absorptive action of the oxygen. On the other hand, Egoroff found that he could still distinguish A when the thickness of air at ordinary pressure was reduced to 80 metres (*Compt. Rend.*, vol. ci. p. 1144). This amount of air corresponds to rather less oxygen than the 18-metre tube would hold at a pressure of 1 atmosphere. Differences in the sources of light, in the spectroscope, and the observers, would, however, count for a good deal in observations of this kind.

In order to try the influence of temperature on the absorption, the shorter of the experimental tubes, 165 cm. long, was surrounded by a jacket filled with a mixture of solid carbonic anhydride and ether, which was rapidly evaporated by means of a large air-pump. By this means the temperature would be reduced to -100°. The absorption of oxygen at several different pressures up to 104 atmospheres was observed through the cooled tube. The authors were not, however, able to detect any increase of intensity, or other change, in the absorptions which could be ascribed to the cooling. To try the effect of an increase of temperature, the 18-metre tube was surrounded by a jacket and heated up to 100° by steam. Heating appeared to render the diffuse bands rather more diffuse and less distinct. On the whole the influence of a change of temperature of 100° either way is slight.

The authors have observed repeatedly the absorption of liquid oxygen in thicknesses of 8 and 12 mm. Their observations confirm those of Olszewski. 8 mm. of liquid oxygen gives plainly the three diffuse bands above C, D, and F, respectively. With a thickness of 12 mm. the authors were not able to detect any more.

The authors observed the absorption produced by liquid oxygen on the one hand when it was cooled by its own evaporation until the tension of its vapour was only equal to that of the atmosphere—that is, to a temperature of -181°, according to Olszewski—and also when the temperature of the liquid was allowed to rise under pressure up to nearly the critical temperature. There appeared to be no appreciable difference in the absorption under these different circumstances when the oxygen was completely liquid, when it was near its critical temperature, and when it was completely gaseous; so far at least as concerns the three principal bands, which were all that could be seen in the light transmitted by the liquid in a thickness of 12 mm.

It will be observed that taking the density of oxygen at $-181^{\circ}\cdot4$ to be 1·124, as given by Olszewski, 12 mm. of the liquid would be equivalent to 9·37 metres of the gas at atmospheric pressure—hardly more than half the thickness required to make A visible. The experiments, therefore, point to the conclusion that gaseous and liquid oxygen have the same absorption-spectrum. This is a very noteworthy conclusion. For, considering that no compound of oxygen, so far as is known, gives the absorptions of oxygen, the persistency of the absorptions of oxygen through the stages of condensation to the state of complete liquidity implies a persistency of molecular constitution which we should hardly have expected.

In order to compare the absorption of ozone with that of oxygen, the authors employed a tube 12 feet long, made of tin-plate fitted with glass ends and coated with paraffin on the inside. Ozonized oxygen was passed into the tin tube for some time, while the ozonizer and the tube itself were cooled with ice and salt. The lime-light, viewed through the tube, looked very blue, and also the spot of light thrown from the tube on to a sheet of white paper was equally blue, indicating a considerable absorption of the less refrangible part of the spectrum. The absorption, so far as the visible rays are concerned, appeared to be of a general character, for the spectroscope revealed only four extremely faint absorption-bands. The centres of these bands were at about the wave-numbers 1662, 1752, 1880, and 1990, and their positions with reference to the bands of oxygen are indicated in the diagram. They were so faint as to be seen only with difficulty. When the hot carbon of an arc lamp was substituted for the lime-light they were rather more distinct, but the positions of the edges were undefinable. The light of a gas lamp was insufficient to show them, and they were no better seen with a single-prism spectroscope of low dispersive power than with the spectroscope employed for observing the oxygen. Only one of these bands is nearly coincident with an oxygen-band—namely, that near E, the faintest of the oxygen-bands. That at wave-number 1752 overlaps the strongest oxygen-band, but not at its strongest part, and has none of the peculiar character of its shading, abruptly increasing on the less refrangible side and slowly decreasing on the other side. Photographs of the spectrum (taken through a tube with quartz ends) showed that the ozone absorbed all the rays above the wave-number 3086—a point between Q and R—while partial absorption extended below Q. It may be said, therefore, that no identity can be traced between the absorptions of ozone and those of ordinary oxygen. There is no mere displacement of the bands, such as sometimes occurs when a coloured substance is dissolved in different menstrua, nor any such resemblance as subsists between the absorption-bands of the different cobaltous salts derived from different acids.

The four bands which are seen to be produced by ozonized oxygen correspond fairly with the second, third, fifth, and sixth of the bands described by Chappuis as due to ozone (*Annales de l'École Normale*, 2nd ser., vol. xi., May 1882). These four bands, he says, are the first to be seen. The authors have failed to perceive any others with the 3·66 m. tube, though the oxygen was highly ozonized, and maintained at a low temperature. None of the bands were of sufficient intensity to make themselves visible on photographic plates.

It will be noted that the absorption by ozone extends far below the limit of the solar spectrum. By diminishing the proportion of ozone to oxygen in the tube the limit of the transmitted light was continually advanced, as already described by Hartley. The limit of the solar spectrum may, therefore, very well be determined by the average amount of ozone in the atmosphere, as Hartley supposes. The known variations in the limit of the solar spectrum may be taken as confirmatory of this hypothesis, although the comparatively small amount of those variations is certainly less than we should have expected if they measure the changes in the proportion of ozone in the atmosphere.

The absorptions of the class to which A and B belong must be those which are most easily assumed by the diatomic molecules (O_2) of ordinary oxygen. Whether oxygen in more complex molecules, as in ozone (O_3), may be capable of taking up the corresponding vibrations cannot easily be determined, because we cannot isolate ozone; but since none of the compounds of oxygen with nitrogen, hydrogen, or carbon, or, so far as known, with any other element, exhibit these absorptions, it is very probable that they are peculiar to the molecule O_2. From this point of view it will be interesting to determine whether liquefied oxygen, which we suppose to have more complex molecules, produces these absorptions The corresponding spectrum of emission has not as yet been observed, probably because the agency employed to render the gas luminous breaks up the molecules into single atoms of oxygen.

As for the other class of absorption, the diffuse bands, since they appear to have intensities proportional to the square of the density of the gas, they must depend on a change produced by compression. This may either be the formation of more complex molecules, as for example O_4, corresponding to the deviation from Boyle's law exhibited by oxygen gas, or it may be the constraint to which the molecules are subject during their encounters with one another. Increase of temperature would affect the former, tending to diminish the number of complex molecules formed at a given pressure, but would have no effect on the latter, for though the number of encounters of the molecules in a given interval of time would be greater the higher the temperature, yet so long as the volume was unaltered the ratio of the duration of an encounter to that of free motion would be sensibly unaltered. So far as any change due to temperature has been observed, it is that a rise of temperature slightly weakens the diffuse absorptions.

Reverting to the compounds of oxygen, none of them show the absorptions of oxygen, not even the general absorption of the ultra-violet rays. Some of them, such as water and carbon dioxide, appear quite transparent to ultra-violet rays, while in others, such as nitrous oxide, which show a general absorption of the ultra-violet rays, the limit of transparency is different from that of oxygen. In other respects we may say that there is no resemblance between the absorptions of the compounds of oxygen and those due to oxygen itself. Some of the former have very definite and characteristic absorptions, such as the well-known spectra of the peroxides of nitrogen and chlorine, and we must regard these as indicating the rates of vibration which the molecules NO_2 and ClO_2 respectively are capable of easily taking up. The absence of the absorptions due to oxygen from all compounds of oxygen seems to indicate either that chemical combination is not, as has been supposed by some chemists, a temporary relation in which the molecular groupings are continually breaking up, to be formed anew with ever-changing elementary atoms; or, that the periods of dissociation are very small compared with the periods of association. For otherwise we should expect that such compounds of oxygen as CO_2 and NO_2 must always have amongst their molecules some molecules identical with those of oxygen and capable of taking up vibrations of the same period. At least we must conclude that little, if any, of the oxygen of these and other compounds is ever out of the influence of the other components.

The authors have re-examined the absorption-spectrum of N_2O_4 at various temperatures, and agree with the conclusions of Bell (*Amer. Chem. Journ.*, vol. vii. p. 32), that N_2O_4, whether liquid or gaseous, effects only a general absorption at either end of the spectrum, and that the selective absorptions observed with it are due to the presence of NO_2.

In order to obtain pure N_2O_4, the tube in which the liquid was sealed was placed in a freezing mixture, and a large part of the liquid frozen; the remaining liquid was then drained as completely as possible into the other end of the tube, and sealed off.

It should be observed that the crystals of N_2O_4 appear colourless, and that when they are melted the liquid and superincumbent vapour are of a very pale yellow colour. As the temperature rises, both liquid and vapour become, as is well known, of a deep orange, and finally of a dark, reddish-brown colour. The authors examined the spectra produced by two thicknesses of liquid and vapour—(1) by that contained in a narrow tube about 1 mm. in diameter, and (2) by that in a tube about 1 cm. in diameter. At 15° to 20° the vapour in the narrow as well as in the wider tube showed the well-known absorption-spectrum of fine, dark lines; no absorption by the liquid in the narrow tube could be detected, and the liquid in the wide tube showed no fine lines, but several faint, very diffuse bands, unresolvable into lines with a spectroscope of three prisms. These bands had their maxima in places where the fine lines of the vapour were most intense and most closely set, so that it might be inferred that they were due to similar molecules in both cases, but that in the liquid the vibrations of these molecules were no longer sharply defined, but modified by the constraint arising from the liquid state. Some parts, however, of the spectrum of the vapour, where the lines were closely set, did not appear to be represented by any definite bands in the liquid. The liquid absorbed a good deal of blue light in a continuous manner, while the vapour only absorbed it selectively. At the red end the limit of the visible spectrum was lower for the liquid than for the gas—that is, there was more absorption of red light by the vapour than by the liquid, so much so that below a certain point the absorption by the vapour appeared continuous.

The narrow tube was next immersed in a wider tube full of glycerine, which was gradually heated. As the temperature rose, the colour of both liquid and vapour deepened, the absorptions of the vapour were stronger, and the liquid gave the same bands as had been before observed with the greater thickness. At still higher temperature the absorption of blue light, both by liquid and vapour, diminished sensibly, until at 85° the groups of lines in the blue had pretty well disappeared from the spectrum of the vapour. In fact, at 85° there was no sensible difference between the actions of liquid and vapour on blue light, it seemed only some continuous absorption. At the red end the difference between the liquid and vapour remained quite as strongly marked as at lower temperatures—if anything, more so; and the absorptions in the orange, yellow, and green were unaltered. At 90° the lines of the vapour in the green began to fade, and at 100° they were very faint; but those in the orange, as well as the corresponding diffuse bands in the liquid, were as strong as before. There was still considerably more absorption of red light by the vapour than by the liquid, as if there were a strong absorption-band in the red of the vapour which was absent in the liquid.

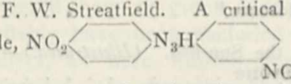
As the temperature rose to 110° all the lines in the vapour had become faint, and at 115° they were no longer discernible, and there was no difference between the spectra of liquid and vapour except in the red, and even here the difference was less marked than at lower temperatures. At 130° no distinction was observable between the spectra of liquid and vapour; there were no lines or bands in either, but a good deal of general absorption. Liquid and vapour were dark, and appeared much of a colour, but the meniscus at the junction was quite evident. The tube was further heated to 155°, but no further change was noticed in the spectrum. On gradually cooling the tube, at 112° the least refrangible band in the orange was seen coming in both in vapour and liquid, diffuse in both. At 100° the usual lines were well seen in the orange, yellow, and citron of the vapour, faint lines in the green, and none in the blue; and subsequently the appearances presented on heating followed in the reverse order.

A solution of N_2O_4 in carbon bisulphide gave, in a thickness of 7 or 8 cm., diffuse absorption-bands in the green and citron, ill-defined as in liquid N_2O_4 and in corresponding positions. In a thickness of 1 cm. these bands were no longer visible.

These observations bear out the supposition that pure N_2O_4 is without selective absorption of the visible rays, and that the absorption observed is due to NO_2, both in the vapour and liquid, this absorption being modified in the liquid by the state of solution in which the molecules have much less freedom. As the temperature rises, the proportion of NO_2 increases, and at the same time the density of the vapour increases and the freedom of motion of the molecules is diminished, they are less able to assume the more rapid vibrations, and those which they do assume become less sharply defined, so that the lines fade into bands and ultimately into a general absorption.

Chemical Society, June 4.—Dr. W. J. Russell, F.R.S., President, in the chair.—Prof. Mendeleeff's Faraday Lecture on the periodic law of the chemical elements, was read by the Secretary, owing to the enforced absence of the lecturer. At the conclusion of the lecture, a vote of thanks to Prof. Mendeleeff was moved by Prof. Frankland, and seconded by Sir F. A. Abel. The Faraday Medal and a purse were then presented by the President to Mr. Anderson, by whom it was received on behalf of Prof. Mendeleeff.

June 6.—Dr. W. J. Russell, President, in the chair.—The following papers were read:—Experimental researches on the periodic law, Part I., by Dr. B. Brauner. The author gives a detailed account of his attempts to determine the atomic weight of tellurium by as many different methods as possible; in all, eleven were adopted, but each gave a different result, varying from 125-140. He eventually succeeded, but with great difficulty, in preparing what appeared to be pure tellurium tetrabromide, and on most carefully analyzing this, obtained the value Te = 127·64 (O = 16). This number, however, is incompatible with the position of tellurium in the periodic system, and having satisfied himself that there were no experimental errors which could account for the discrepancy, the author was forced to conclude that what had hitherto been regarded as pure tellurium contained foreign elements. By submitting tellurium solutions to a systematic fractional precipitation, he has, in fact, succeeded in obtaining a variety of substances, some of which are undoubtedly novel elements. One of these it is proposed to call *Austriacum* (*Austrium*). In all probability this is the *Dvi-tellurium* (212), the probable existence of which was pointed out for the first time by Mendeleeff in his recent Faraday Lecture. From analyses made with material the uniformity of which is not yet quite established, the author is satisfied that the atomic weight of the element in question approaches very closely to that indicated by Mendeleeff. In addition, there is at least one other novel constituent, and this appears to be more or less closely allied to arsenic and antimony. It follows that true tellurium has yet to be discovered, and that its atomic weight and properties remain to be determined.—The amylo-dextrin of W. Nägeli, and its relation to soluble starch, by Mr. H. T. Brown and Dr. G. H. Morris. Amylo-dextrin, described by W. Nägeli in 1874, is prepared by the long-continued action of cold dilute acids on intact starch granules; when purified by dissolution in water and precipitation with alcohol, it forms crystalline spherules, closely resembling those of inulin. The authors consider amylo-dextrin to be analogous in composition to the malto-dextrin previously described by them (Chem. Soc. Trans., 1885, 528), and assign to it the formula $C_{12}H_{22}O_{11} + (C_{12}H_{20}O_{10})_6$; *i.e.* it may be regarded as constituted of one amylon or maltose group in combination with six amylin or dextrin groups. Soluble starch, with which amylo-dextrin has frequently been confused, is converted into a mixture of maltose and dextrin on treatment with diastase, whilst amylo-dextrin yields maltose exclusively; moreover it is shown that soluble starch is the first product of the action of cold dilute acids on starch, and that this is slowly hydrolyzed to amylo-dextrin, a portion of the starch substance at the same time going into solution as dextrose.—The determination of the molecular weights of the carbohydrates Part II., by the same. As determined by Raoult's method, galactose and malto-dextrin are found to have molecular weights corresponding with the formulæ $C_6H_{12}O_6$ and $C_{12}H_{22}O_{11} . (C_{12}H_{20}O_{10})_2$ respectively. For inulin the formula $2(C_{36}H_{62}O_{31})$ is deduced, and in view of the great similarity in physical properties between inulin and amylo-dextrin the authors are inclined to regard the two substances as closely analogous in composition, representing inulin by the formula $(C_{12}H_{22}O_{11})_2$ +

$(C_{12}H_{20}O_{10})_4$, although the amylon and amylin groups in each possess very different optical and other properties, and the products of the hydrolysis with dilute acid are very different. It was found impossible to apply Raoult's method to starch-paste; solutions of soluble starch produced so slight a depression that no reliable results can be obtained; a number of fairly concordant results, however, pointed to a molecular weight of 20,000 to 30,000. In order to ascertain whether the failure in this case was due to a high molecular weight, and not to the fact that the method was inapplicable to colloid substances, an arabinic acid, having a rotatory power $[\alpha]_j = + 61°{\cdot}16$, was examined; this gave a molecular weight of 717, thus rendering it probable that the small influence exercised by soluble starch was due to its high molecular weight. Indirect evidence was then sought for by an examination of the dextrins. The authors have previously shown that when starch is broken down by diastase, a resting stage in the reaction is reached when the amount of dextrin produced corresponds with one-fifth by weight of the starch taken, and that the molecule of this stable dextrin is one-fifth of the size of the starch-molecule from which it has been derived. Determinations of the molecular weight of this low dextrin pointed to the formula $20C_{12}H_{20}O_{11}$, and consequently the formula of soluble starch would be $5(C_{12}H_{20}O_{10})_{20}$, and its molecular weight 32,400. The endeavour was also made to apply Raoult's method to the determination of the question whether the dextrins are a series of polymers or whether they are simply metameric. For this purpose a number of the higher dextrins were prepared from starch-transformations which had been stopped at an early stage of hydrolysis. All the numbers obtained show that the freezing method affords no evidence of there being any difference in molecular weight between the high and low dextrins, the numbers being, in fact, almost identical. From a consideration of the results obtained with soluble starch, and with dextrins of varying position in the series, the authors conclude that the evidence points to the conclusion that the dextrins are metameric and not polymeric compounds. They therefore abandon their former working hypothesis of the hydrolysis of starch, and now suppose the starch-molecule to consist of four complex amylin-groups, arranged round a fifth similar group constituting a molecular nucleus. When hydrolysis takes place this complex is broken up, four amylin-groups being liberated, which in turn are capable of undergoing complete hydrolysis into malto-dextrins, and ultimately into maltose, whilst the fifth amylin-group which constituted the nucleus of the original molecule resists the action of hydrolyzing agents, and forms the stable dextrin of the No. 8 equation of the authors' previous papers (Chem. Soc. Trans., 1879, 634; 1885, 539). Each amylin group of the five has the formula $(C_{12}H_{20}O_{10})_{20}$, corresponding with a molecular weight of 6480; the molecule of soluble starch being represented by $5(C_{12}H_{20}O_{10})_{20}$, corresponding with a molecular weight of 32,400.—Researches on silicon compounds, Part V., by Prof. J. E. Reynolds.—The isomerism of the alkyl-derivatives of mixed diazoamido compounds, by Prof. R. Meldola and Mr. F. W. Streatfield. A critical study of the mixed diazoamide,  , has served to confirm the conclusion arrived at by the authors in their previous communications (Chem. Soc. Trans., 1886, 624; 1887, 102, 434; 1888, 664), that this compound and its alkyl-derivatives are perfectly definite, and that they cannot be formed by crystallizing together mixtures of the corresponding symmetrical di-meta- and di-para compounds. The authors restate their original proposition, viz. that every pair of amines, $X.NH_2$ and $Y.NH_2$, can give rise to three isomeric alkyl-derivatives—(1) by the action of diazotized $X.NH_2$ on $Y.NHR'$; (2) by the action of diazotized $Y.NH_2$ on $X.NHR'$; (3) by the direct alkylation of $X.N_3H.Y$. In support of the general truth of this proposition a large number of triplets have been prepared, all of which conform to the rule laid down. The isomerism of these triplets is shown not only by their melting points, but also by their products of decomposition by cold hydrochloric acid. These products have in all cases been examined quantitatively, and the general results are shown by the equations—(1) $X.N_2.NR'.Y + HCl = X.N_2.Cl + Y.NHR'$; (2) $Y.N_2.NR'.X + HCl = Y.N_2.Cl + X.NHR'$; (3) $2X.N_3R'.Y + 2HCl = X.N_2.Cl + Y.N_2.Cl + X.NHR' + Y.NH.R'$. From this it appears that the alkyl-derivatives of the mixed diazo-amides always split up like the unalkylated products into a mixture of the two diazo-chlorides and two alkylamines. The most feasible interpretation of these facts is that the mixed diazoamides have double the molecular weight usually assigned to them, and in support of this conclusion the authors have discovered that the mixed alkyl-diazoamides can be synthesized by simply boiling the alcoholic solutions of the other two isomerides of the triplet, thus—$X.N_2.NR'.Y + Y.N_2.NR'.X = (X.N_3R'.Y)_2$.—The atomic weight of zinc, by Dr. J. H. Gladstone and Mr. W. Hibbert. The authors have observed that when amalgamated zinc is used as anode in a zinc sulphate voltameter, the metal dissolved appears to be free from impurity. Results obtained in different voltameters with the same current showed a very close agreement, and the authors therefore determined the atomic weight of zinc by applying Faraday's law of electrolysis. For this purpose a series of copper, silver, and zinc voltameters were arranged in a simple circuit, and the quantity of zinc dissolved was compared with the weights of deposited silver and copper. The silver and copper voltameters were arranged according to the conditions shown to be best by Lord Rayleigh, Gray, and others. The zinc voltameters were almost of the same form as the silver voltameter of Lord Rayleigh. The anode was a sheet of amalgamated zinc supported so as to rest horizontally on the surface of the zinc sulphate solution, which had a specific gravity varying from 1·18 to 1·21. The mean ratio of the equivalents of silver and zinc is 3·298 ± 0·0008. Taking the atomic weight of silver as 107·93, this ratio gives 65·44 as the atomic weight of zinc. If silver is taken as 107·66, zinc = 65·29. The copper sulphate voltameter is not so accurate as the silver one, owing to the solvent action of the solution on the copper, and the ratio Zn : Cu given by the experiments (1·0322) is probably rather too high. Adopting Shaw's value for the atomic weight of copper (63·33), this ratio gives 65·37 as the atomic weight of zinc.—The amount of nitric acid in the rain-water at Rothamsted, with notes on the analysis of rain water, by Mr. R. Warrington. The rain of twenty months, analyzed by the copper-zinc method, contained an average of 0·138 of nitrogen as nitric acid per million of water; this is a little higher than that found by Way in 1855–56—namely, 0·12 per million—but is almost identical with that found by Frankland as a mean of his analyses of Rothamsted rain in 1869–70. In a whole year, 1888–89, with a rainfall of 29·27 inches, the quantity of nitric nitrogen in the rain was 0·917 lb. per acre, and the nitrogen as ammonia 2·823 lbs., or a total of 3·74 lbs.—The product of the action of sulphur on resin, by Dr. G. H. Morris.—The vapour-pressures and specific volumes of similar compounds of elements in relation to the position of those elements in the periodic system, by Prof. S. Young. Determinations have been made of the vapour-pressures and specific volumes of the four haloid derivatives of benzene and also of benzene itself, within very wide limits of temperature; benzene, fluobenzene, and chlorobenzene having been heated to their critical points, 288°·5 and 286°·55 and 360°·8 respectively. It is shown that if the four haloid derivatives are compared at such temperatures that their vapour-pressures are equal, the (absolute) temperatures and also the specific volumes bear a constant ratio to each other, whatever the common pressure. But on comparing benzene with one of its haloid derivatives it is found that these simple relations do not hold. The ratios of the absolute temperatures of benzene and fluobenzene corresponding to equal pressures are very exactly expressed by the equation $R' = R + ct$, where R' is the ratio at a pressure for which the corresponding Centigrade temperature of fluobenzene is t, $R = 0{\cdot}0838$, and $c = 0{\cdot}0000313$.—The vapour-pressures of uqinoline, by the same.

Anthropological Institute, May 28.—Mr. F. Galton, F.R.S., Vice-President, in the chair.—Lieut.-General Pitt-Rivers, F.R.S., exhibited some crania found during some recent excavations at Hunsbury Camp, and the Roman villa at Llantwit.—The Rev. H. G. Tomkins read a paper on the Hyksôs, or Shepherd-Kings, of Egypt.—In a paper on the proprietorship of trees on the ground of others, Mr. Hyde Clarke (Vice-President), showed that this was the case in Asia Minor, Melanesia, Borneo (honey-trees), India, Choto Nagpore (moura), and was supposed to be so in parts of China. He proposed the ownership of trees as a more probable origin in jurisprudence of the rights of property than ownership of land, which has no primitive value.

PARIS.

Academy of Sciences, June 17.—M. Des Cloizeaux, President, in the chair.—Numerical results obtained in the study of the vitreous and metallic reflection of the visible and ultra-violet rays, by M. A. Cornu. The tables here communicated contain the values of the following elements: the wave-length, λ, of the reflected radiation; the principal incidence, $\mathfrak{I}$, which corresponds to a difference of phase, ϕ, equal to ¼ between the two reflected vibratory components; the coefficient H, calculated on the empirical relation between ϕ and i—

$$H = \sin(\mathfrak{I} - i) \cot 2\pi (\phi - \tfrac{1}{4}),$$

in the neighbourhood of the principal incidence; the coefficient k; Cauchy's coefficient of ellipticity, ϵ, calculated by the formula $H = \epsilon \sin^3 \mathfrak{I}$; the product $2k \cos \mathfrak{I}$, which should be equal to ϵ when ϵ is very small before unity. The substances studied are selenium, realgar (sulphide of arsenic), senarmontite (crystallized antimony oxide), blende, diamond, fluor-spar, and silver. In general, these numerical data confirm the conclusions already announced, especially as regards the constant increase of the positive and negative coefficient of ellipticity with the refrangibility of the reflected radiations.—On the heats of combustion and formation of the nitriles, by MM. Berthelot and Petit. The nitriles of monobasic acids (acetonitrile, propionitrile, benzonitrile, orthotolunitrile, benzyl cyanide), and those of bibasic acids (oxalic, malonic, succinic, and glutaric nitriles) have been investigated.—A short summary of the thermo-chemical method in its principles and results, as applied to anatomical studies, by M. Sappey. Attention is called to a new method of research, which has for its object the study of the intimate structure of the tissues and organs. The advantages, importance, and absolute necessity of this thermo-chemical method are insisted upon, not as superseding, but as supplementing, older processes. M. Sappey has practised it since 1860, but has hitherto refrained from publishing anything on the subject through his desire to thoroughly verify all the facts before proclaiming the new doctrine. The method itself is based on the fundamental principle of the association of calorific with chemical action in the animal organism; and in its application to the study of the tissues, cuticle, secreting glands, the stomach, ovary, &c., yields highly satisfactory, and in some instances quite startling, results, which cannot fail to challenge the attention of all physiologists.—On the prophylactic method as applied to patients after being bitten, by M. L. Pasteur. In his brief report for the year ending May 1, 1889, the Director of the Pasteur Institute announces the treatment of 1673 subjects, of whom 6 were seized with rabies during, and 4 within a fortnight after, the process. But 3 only succumbed after the treatment had been completely carried out, making one death in 554, or, including all the cases, one in 128.—On the photographic spectrum of Uranus, by Dr. W. Huggins.—Improvements in the graphophone, by Prof. C. V. Riley. Several defects inherent in Mr. Tainter's instrument are stated to have been at last completely removed by Mr. John H. White, of Washington, who has greatly improved the graphophone by employing certain appliances which have been constructed by Prof. Riley on acoustic principles.—Observations of the planet Eucharis (181), made at the west equatorial in the garden of the Paris Observatory, by M. D. Eginitis. The observations are for February 7 and 9, 1889.—On the enlargement of the spectral rays of metals, by M. Gouy. These investigations show that the so-called *narrow* metallic rays present two distinct structures. Some are widened in a uniform manner on both sides (symmetric rays), while others are enlarged almost exclusively on one side (dissymmetric rays). The difference is very marked, and the author has failed to detect any intermediate phase. Nearly all the metallic rays are symmetric, the only exceptions hitherto observed by him being those of sodium and potassium, which belong to the dissymmetric group.—On the limit between polarization and electrolysis, by M. H. Pellat. These researches lead to the establishment of a general law thus announced: Electrolysis begins the moment the double electric layer has been neutralized by polarization.—On actino-electric phenomena, by M. A. Stoletow. Owing to some improvements in the conditions of the investigation, the author has succeeded in determining more accurately the laws of the actino-electric currents in the atmosphere at ordinary pressure. He now thinks that the hypothesis attributing the actino-electric phenomena to the condensed gaseous layers which cover the metallic surfaces, must be rejected.—On the duration of lightning, by M. E. L. Trouvelot. Aided in his observations by photography, the author infers that the flash is not instantaneous, as is generally supposed, but has a perceptible duration beyond the thousandth part of a second, denied to it by Wheatstone.—Researches on the phenomenon of dispersion in organic compounds, by MM. P. Barbier and L. Roux. The first results of the researches undertaken by the authors on the dispersive power of fluid organic compounds are here communicated. The present note is confined to the monosubstituted derivatives of benzine.—M. G. A. Le Roy describes a new method of preparing nitrites of the alkaline metals; and M. Alphonse Combes contributes a paper on the action of the diamines on the diketones.

AMSTERDAM.

Royal Academy of Sciences, May 25.—Dr. H. G. van de Sande Bakhuysen in the chair.—M. Lorentz read a paper on the molecular motion of dissolved substances. The values of the osmotic pressure, which M. van't Hoff has deduced from various data, seem to indicate that this pressure is due to the molecular motion of the dissolved body, the mean kinetic energy of a molecule being equal to that of the molecule of a gas at the same temperature. These views were tested by a discussion of molecular equilibrium in a solution under the influence of external forces.—M. van de Sande Bakhuysen exhibited an instrument for determining, by means of rectangular co-ordinates, the right ascensions and declinations of stars on photographs, and the results obtained by measuring, after this method, a photograph by M. Henry. The probable error of each co-ordinate is ± 0″·043. He pointed to the great interest of photographs in the determination of the sun's parallax, and stated that during the coming opposition of Victoria, M. Henry at Paris will make photographs which are to be measured at Leyden.—M. Bierens de Haan announced that the second volume of Huyghens's correspondence will soon be published.—M. Forster treated of the influence of our common salt on the life of pathogenetic bacteria, and stated that, from many and various experiments, he had come to the conviction that, whereas cholera bacilli are very sensible to that salt, and when brought into contact with it very soon die, the typhoid and pyogenetic bacteria, the bacilli of tuberculosis, and the cattle-distemper bacilli may remain for months buried in common salt without losing their powers of growth and reproduction. The salting of butchers' meat may, therefore, in some cases prove ineffectual. M. Forster further exhibited some preparations, obtained in the hygienic laboratory, which went to prove that neither the bacilli of tuberculosis nor cholera bacilli can develop under the influence of iodoform vapour.

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