THURSDAY, MARCH 12, 1914.

CHEMISTRY FOR ADVANCED STUDENTS.

(1) *A Treatise on Chemistry.* By H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S. Vol., ii., The Metals. New edition completely revised by the Rt. Hon. Sir Henry Roscoe and others. Pp. xvi+1470. (London: Macmillan and Co., Ltd., 1913.) Price 30*s*. net.

(2) *A Dictionary of Applied Chemistry.* By Sir Edward Thorpe, C.B., F.R.S. Assisted by Eminent Contributors. Revised and enlarged edition. In five volumes. Vol. v., Pp. viii+830. (London: Longmans, Green and Co., 1913.) Price 45*s*. net.

JUST as the leaves of our deciduous plants fade away in autumn, and in winter perish, so do our science books have their autumn and their winter. They cannot live long under a *régime* which changes with the fleeting years. The publisher's spring-time brings forth an array of fresh books, but none are more welcome than some of the older and familiar forms revitalised and newly adapted to the change of environment. The reviewer has therefore a pleasing task in introducing the new editions of the above-named books to readers of NATURE, and this the more because each book is a familiar friend to chemists the world over.

(1) The new edition of "Roscoe and Schorlemmer"—as it is colloquially called—merits a hearty welcome. This book stands on the most convenient shelf in the libraries of thousands of chemists, and its well-thumbed pages bear eloquent testimony to its utility and value. This has continued, edition after edition, since 1878, when vol. i. was published. The first edition was thus born before many of us, in this generation, took up the test-tube and the wash-bottle; and we have grown up using "Roscoe and Schorlemmer" as a kind of alkoran. The book, in consequence, must have exercised a deep influence on the present generation, and it is a book of which British chemists have been proud.

It is interesting to see how the concepts of physical chemistry gradually permeate, modify, and illume even so conservative a subject as the "Systematic Description of the Metals and their Derivatives." True enough, there are no very marked changes in the descriptive matter ranging from pages 224 to 1406, yet the first 223 pages are largely occupied by physical chemistry, and the last 42 pages have a clear succinct account of the present state of our knowledge of that fascinating subject, "The Radioactive Elements." In the chapter on specific heats, a page or two might perhaps have been spared for Einstein's work on the atomic heats of solids to show how theory has at last given a reasoned explanation of the "constancy" of the number 6. The chapters on crystallography and on spectrum analysis are specially good. The new edition has all the strong points of former editions, and it can therefore be confidently recommended to advanced students as the best text-book extant on descriptive inorganic chemistry.

(2) The fifth volume of "Thorpe's Applied" completes the work. The concluding volume maintains the high standard of those which precede, and the observations on the fourth volume in NATURE, August 14, 1913, are of equal weight here. This volume covers subjects ranging from "Sodium to Z." The longer articles deal with sodium, soils, solutions and solubility, specific gravity, spectrum analysis, starch, sugar, sulphide dyes, sulphur and sulphuric acid, synthetic drugs or medical products, tannins, tartaric acid, tea, terpenes, thermometers, thermostats, thorium, tin, titanium, tobacco, toluene and toluidines, toxins and antitoxins, triphenylmethane colouring matters, tungsten, ultramarine, uranium, urea, uric acid, urine, vanadium, varnish, vat dyes, vegetable alkaloids, water, waxes, whisky, wine, destructive distillation of wood, wool, zinc, zirconium, etc. This list is quite inadequate, and gives but a feeble idea of the immense range of the subjects discussed in this volume. I am informed that the whole set of volumes contains some six thousand articles—short or long. The work is therefore *ganz deutsch* in its thoroughness.

As a rough imperfect test, in order to find how the fifth volume happens to fit the subjects in which I personally am interested, I wrote a list containing twenty items, and then consulted the "dictionary." I did not succeed in finding any mention of a thermostat for high temperatures (say 500°–1100°) for electrically heated muffles; or of μ- and λ-sulphur and their effect on the melting-point of the so-called "pure" sulphur. In the remaining eighteen cases the dictionary emerged triumphant. This result is very good, and illustrates the high probability that the work will not be found wanting when occasion demands. The dictionary, as a whole, reflects great credit on the wisdom and acumen of the editor, on the skilful and accurate condensations by the contributors, and on the enterprise and good taste of the publishers.

J. W. MELLOR.

DYNAMICS: OLD AND NEW.

(1) *Leçons sur la Dynamique des Systèmes matériels.* By Prof. E. Delassus. Pp. xii+421. (Paris: A. Hermann et Fils, 1913.) Price 14 francs.

(2) *The Theory of Relativity.* By Prof. R. D. Carmichael. Pp. 74. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1913.) Price 4*s.* 6*d.* net.

(1) THIS volume is the result of an experiment made by the author to improve on the usual methods of introducing students to the study of dynamics. The first respect in which this has been essayed is in presenting the subject from the beginning in a general form, instead of beginning with those problems which are geometrically most simple. Thus the volume has rather the appearance of a treatise on what is usually known as analytical dynamics. But the object which the author has in view is not so much the development of the advanced analytical theory, which becomes largely a study of differential equations, as a unification of method which shall obviate the feeding of the student on a multiplicity of isolated problems in which the dynamical properties are essentially of the same type.

Special attention is paid to the class of systems the equations of motion of which can be integrated by quadratures. An elaborate study is made of two special questions in respect of which the author considers wrong notions to be prevalent. The first of these is the assumption usually made in respect of a unilateral constraint, such as that which occurs when a body rolls or slides on another body, that the constraint will cease to be conformed to at the moment when the force required to maintain it vanishes and changes sign; examples are given in which the assumption that this is true where there is more than one point of contact between two bodies leads to wrong conclusions.

The other point which is called in question is the assumption, which the author considers to be often tacitly made, that if the constraint imposed on a system is realised by means of auxiliary bodies of negligible mass, these auxiliary bodies have no influence on the motion of the system. An example given is that of a heavy particle constrained to move in a horizontal plane by attachment to an axis bearing two weightless wheels which roll and slide respectively on a fixed horizontal plane. It is clear that if the wheels and axis have ever so little inertia and are set in motion with a rotation about the vertical, the particle cannot describe a straight line, but the example points to such an obvious objection to the assumption referred to that it is difficult to believe that as a general rule it has really been commonly asserted.

(2) After reading this careful course on classical dynamics, it is an abrupt transition to the first book published in English on the principle of relativity, and to read of a revision of the fundamental concepts, not only of space and time, but also of mass. Prof. Carmichael sets out to give a popular account of the way in which these magnitudes are regarded by the exponents of this most up-to-date of generalisations, without going into the details of its origin in electrical theory.

The project is well carried through, but it seems doubtful whether even yet the public mind is prepared to face the shock of the postulate (p. 20): "The velocity of light in free space, measured on an unaccelerated system of reference S, is independent of the velocity of S." But less objection seems to be taken to one of the consequences of the assumption of the complete relativity of all physical phenomena, namely, the dependence of the mass of a body upon its velocity, in spite of its reducing the status of Newtonian mechanics to that of an approximate theory.

The reason for this is probably that experiment seems to have demonstrated without doubt that the mass of the electron must be admitted to be variable, and we can find no reason for denying the possibility of the mass of any body varying within the limits of error admitted by astronomical theory.

The real obstacle to the acceptance of the theory of relativity is the carrying over of a conception of space and time, which is based on, or rather part of, Newton's dynamical theory into regions where that theory is certainly no longer tenable in its entirety. Prof. Carmichael's book deals entirely with these fundamental matters and will help to make more familiar a more logical and less metaphysical view of space and time in their physical bearing.

NEW ZEALAND: THEN AND NOW.

(1) *Camp Fire Yarns of the Lost Legion.* By Col. G. Hamilton-Browne. Pp. xiii+301. (London: T. Werner Laurie, n.d.) Price 12*s.* 6*d.* net.

(2) *Social Welfare in New Zealand.* By Hugh H. Lusk. Pp. viii+287. (London: William Heinemann, 1913.) Price 6*s.* net.

THESE two books present a most vivid picture of the progress which has occurred in New Zealand during the last fifty years. The first is essentially personal, the account of strange and curious adventures of individuals; the second is largely impersonal, the account of the development of a system of State Socialism. Both works tell the story of the reaction between outsiders from overseas and the environment which they found awaiting them in these distant islands.

(1) The gallant colonel, typically a frontiersman, presents a picture of the Maori wars, and demonstrates the dangers of the trackless bush. The Maori regarded war as essentially the work for men; their curious outlook caused them to regard the shot which landed in their "pah" during a bombardment and failed to explode as the enemy's method of supplying them with powder with which to continue fighting. Mr. Lusk, formerly a member of the New Zealand Parliament, states that Maoris nowadays receive old-age pensions on the same terms as the white men.

The camp-fire yarns are racy, redolent of the soldier's vocabulary, and make excellent reading; the parliamentarian account (2) of organised attention to the well-being of the community as a whole community, and not as a congeries of classes of society, is calm, dispassionate, careful, and on this account eminently readable.

Steadily, step by step, the State interfered with manifestations of private enterprise, prevented the permanent establishment of a landed gentry, or of a body of yeomen tenant farmers; established systems of communication by rail, by telegraph, and by telephone, which have contributed greatly to a feeling of national unity; freed the country from outside influences as regards fluctuations in coal prices; secured loans of capital for all the people at advantageous rates, so preventing the exploitation of the farmers because they were necessitous; and, by controlling the development of the country, secured a high average of prosperity to all members of the State, without causing the growth of either a wealthy or a poverty-stricken caste.

Mr. Lusk is of opinion that New Zealanders grew, without definite intention, or without definite leadership, to regard the welfare of all as paramount, and he is further of the opinion that New Zealand sets an object-lesson to the whole world in its regard for all members of the body politic; he pays more attention to the principle which underlies these progressive movements than to the fact that New Zealand is a special case. Regarded as a contribution to the knowledge of the world, New Zealand's progress is a striking illustration of the unique reaction to its own local environment, which occurs in a more or less isolated community. More than a thousand miles from its nearest neighbour, with a small population of a million souls, with a large area of cultivable land, in the happy position of having one market only, and that a certain one for its surplus of food-stuffs and raw material, almost outside the stress and strain of international competition, New Zealand has developed along lines which were only possible in such comparative isolation. But it is hazardous to generalise from so specific an example; while, on one hand, it is possible to note the fact of New Zealand's prosperity, it is incorrect, on the other, to infer from New Zealand's experience principles of State activity which shall be regarded as of general application.

It does not necessarily follow that what is good for one million people on the edge of the modern business world and mainly occupied and dependent upon the cultivation of the soil is equally good both in method and in result for more than forty millions of people, with an industrial population in ratio to that employed on the land of roughly four to one, situated at the hub of world commerce and the centre of concentration of a world-wide competition.

B. C. W.

OUR BOOKSHELF.

Camping in Crete: With Notes upon the Animal and Plant Life of the Island. By Aubyn Trevor-Battye. Including a Description of Certain Caves and their Ancient Deposits. By Dorothea M. A. Bate. Pp. xxi + 308 + plates. (London: Witherby and Co., 1913.) Price 10*s*. 6*d*. net.

THIS pleasant record of camping experiences in Crete falls into two parts. In the body of his book Mr. Trevor-Battye, who declines to discuss questions of politics and excavations, describes a series of tours through the island. With Canea as his headquarters, he made trips by steamer along parts of the coast, journeyed so far as Sitia on the east, traversed the island to Sphakia, and again to Retimo, with a long and arduous march from Sphakia, *viâ* Mt. Ida, to Candia. The main object of these excursions was the collection of zoological and botanical specimens, many of which have been valuable additions to the South Kensington Museum. He succeeded in bringing home two ibex kids to the Zoological Society, one of which, the male, died from an accident, but the female is now at Regent's Park, and has given birth to twins. He gives a delightful account of these charming animals.

He finds that a narrow waist, which appears in the Minoan frescoes, is quite characteristic of the islanders. He gives useful accounts of the geology, describing the curious high-level plains of Homalo and Nidha, Mt. Ida, and Kurnás, the only lake in the island. He was kindly received by the Turkish officials, the monks, and the villagers. But it is only the most enthusiastic traveller who will risk the privations and difficulties of journeys over breakneck passes.

The appendix is one of much scientific interest. Miss D. M. A. Bate, one of the best authorities on the island, describes the caves, many containing animal remains, and gives a list of the mammals. The birds are catalogued by Mr. Trevor-Battye, who also deals with geology, harbours, agriculture, industries, and ethnology. The book is well illustrated, and is supplied with a good index. This account of the island forms a supplement to the standard authorities—Pashley in 1834 and Spratt in 1865, both of which, with due acknowledgment, are frequently quoted.

The State Provision of Sanatoriums. By Dr. S. V. Pearson. Pp. viii+80+iv plans. (London: Cambridge University Press, 1913.) Price 3*s*. net.

THIS book deals in a practical manner with a subject of considerable interest and importance at the present time. In the earlier chapters the author discusses what is meant by sanatorium treatment, the reasons why the State should provide this, and what other countries are doing in this direction. "Sanatorium" is defined as "an institution in the country for the treatment of resident patients suffering from any form of tuberculosis," and such institutions as farm colonies are excluded. Valuable suggestions are given on the financing, construction (with diagrams), and management of sanatoriums, and the advantages of sanatorium over domiciliary treatment are emphasised.

The author is a strong advocate for the provision of sanatoriums by the State, largely to the exclusion of other forms of treatment. We do not find, however, any estimate given of the number of beds that would be required for the necessary sanatorium treatment of tuberculosis in this country. The State is the trustee of the funds entrusted to it by the taxpayers, and it is the duty of the State to expend those funds to the best advantage of the *community* as a whole. Whether the erection of a number of substantial and costly buildings (the author estimates the cost as at least 170*l*. a bed) all over the country, with their medical and nursing staffs, is really the most efficient and economical way of dealing with the tuberculosis question is a debatable point, and one on which we probably have not sufficient data at present to guide us. It behoves us, therefore, to move warily, and not to launch out into the erection of numbers of sanatoriums, a large proportion of which might hereafter have to be scrapped, and in the meanwhile to improve our domiciliary and dispensary treatment with the adjunct of a certain number of farm colonies and sanatoriums. It must be recognised that tuberculosis is now decreasing, and it is not always remembered that this decline commenced before the institution of any administrative measures against the disease!

Stanford's Geological Atlas of Great Britain and Ireland, with Plates of Characteristic Fossils. By Horace B. Woodward. Third edition. Pp. xii+214. 50 plates. (London: Edward Stanford, Ltd., 1914.) Price 12*s*. 6*d*. net.

THE first edition of this invaluable atlas was reviewed in the issue of NATURE for February 2, 1905 (vol. lxxi., p. 315), and readers may be referred to that notice for particulars of the general characteristics of the volume. The late Mr. Woodward amplified the present edition by an account of the geological features of the Channel Islands and by further descriptions of facts observable along railways in England and Wales. Small corrections have been made, and the maps have been revised.

Bill's School and Mine: a Collection of Essays on Education. By W. S. Franklin. Pp. vii+98. (South Bethlehem, Pennsylvania: Franklin, Macnutt and Charles, 1913.) Price 50 cents, cloth.

MR. FRANKLIN is known on both sides of the Atlantic as the author of useful scientific text-books, and it is not surprising to find him insisting in his very readable essays upon the value and importance of a training in scientific method in a complete system of education. He quotes Nietzsche as saying: "The time will come when men will think of nothing but education"; it may be hoped that the time will soon be reached when in this country, in addition to thinking about it, people come to believe in it enough to pay sufficient for it to secure competent educators for the next generation.

Heaton's Annual. Tenth Year, 1914. Edited by E. Heaton and J. B. Robinson. (Pp. 590. (Toronto: Heaton's Agency. London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd.) Price, British edition, 5*s*.

ATTENTION has been directed on previous occasions to former issues of this useful work of reference, which is described in its sub-title as the "Commercial Handbook of Canada and Boards of Trade Register." The first half of the volume brings together facts about Canada which business men are wanting to refer to continually, and the second contains, among other useful material, up-to-date descriptions of all Canadian towns of any importance.

A Handbook of Wireless Telegraphy: Its Theory and Practice. For the Use of Electrical Engineers, Students, and Operators. By Dr. J. Erskine-Murray. Fifth edition. Revised and enlarged. Pp. xvi+442. (London: Crosby Lockwood and Son, 1914.) Price 10*s*. 6*d*. net.

THE general characters of this valuable handbook were described in the review of the third edition which appeared in the issue of NATURE for August 24, 1911 (vol. lxxxvii., p. 239). The most important additions to the present edition are those concerned with the uniform alternating current and shock excitation systems. Recent measurements of transmitted power have been added also.

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.*]

Alexander Agassiz and the Funafuti Boring.

PROF. POULTON has directed attention (NATURE, February 26, p. 712) to the fact that "very little has been said" concerning the evidence on coral-reef formation obtained by the boring at Funafuti, and he also refers to the views upon the subject held by the late Prof. Alexander Agassiz.

It will be remembered that the very successful borings at Funafuti were carried out by Profs. Sollas and Edgeworth David, and their assistants, under the auspices of the Royal Society, with valuable aid from the Admiralty and the Government of New South Wales. The place for the experiment was selected by a committee of the Royal Society, on which every shade of theoretical opinion was represented, this committee having the invaluable assistance of the late Admiral Wharton, who recommended Funafuti as perhaps the most typical atoll that could be found on the globe.

The very complete set of cores, with all the other materials obtained during these borings, were, by the permission of the Board of Education, received in the geological laboratories of the Royal College of Science at South Kensington, where they were studied by the members of the staff, with the invaluable assistance of Dr. G. J. Hinde, much aid being also given by the officials of the British Museum (Natural History) and of the Geological Survey.

Those who were responsible for the preparation of the report on the undertaking, published by the Royal Society in 1904, felt it to be outside their duty to advocate any particular theory of the origin of coral-reefs; their aim was simply to place on record the evidence obtained; and it may be added that this evidence is always open to examination and criticism from the circumstance that the halves of all the cores are now deposited in the British Museum, with the sections and other specimens, while duplicate halves of the cores have been sent to Sydney University.

During the eight years that the work of studying the materials from Funafuti was in progress, I received many visits from my friend, Prof. Alexander Agassiz, and gladly profited by his advice and suggestions. He showed his confidence in the manner in which the work was being carried on by entrusting to me the materials he collected from the upraised coral-reefs of the Pacific, with the request to have them examined side by side with the Funafuti cores, the result being published at his own expense.

I should not be justified in trying to reproduce the views of Agassiz as communicated to me in our frequent friendly discussions—everyone who knew him will accept my statement that they were always candidly and fairly expressed. But, fortunately, in the work published since his death, his position in the controversy is very clearly indicated. His own researches had demonstrated that, over very considerable areas in the Pacific, elevation, often to the extent of 1000 ft. or more, had taken place. Agassiz maintained that the masses of coral-limestone in the upraised islands—which were much altered, like the limestones in the lower part of the Funafuti boring—were Tertiary rocks, and that the lower cores of Funafuti were of the same age. His views are very clearly illustrated in a diagram reproduced in the "Letters and Recollections," p. 343, together with their relation to the views of others, as understood by himself.

I may add that the most careful study of the Funafuti limestones did not supply any evidence of such a change in the fauna as would justify their being assigned to any of the Tertiary periods. But even if such evidence had been found, the geologist would have been justified in arguing that this would only prove that subsidence had taken place with extreme slowness, or had been subjected to long interruptions. On the other hand, the fact, which Agassiz so fully demonstrated, that certain areas in the Pacific have undergone elevation in recent times, would suggest to every geologist, taking into account what we know of "the warping of the earth's crust," that other areas must simultaneously have been undergoing subsidence, and this was the view maintained by Darwin.

We are entitled then to say that a boring, initiated and carried out under the direction of representatives of all the rival theories on coral-reef formation, was attended with brilliant success. In an island selected as a very typical atoll, the main boring was carried down more than 900 ft. below the lowest depth at which, as all naturalists agree, reef-forming corals can flourish. The materials from top to bottom yielded only those organisms that thrive near the surface of the ocean, often in the position of growth. In opposition to the view that the boring may have penetrated only a talus on the side of the reef, it must be pointed out that two additional borings were made *in the very centre of the lagoon,* which revealed, down to the depth of 100 ft. below their limit of growth, the same reef-forming corals. Finally, in this very typical atoll, all idea of solution going on at the bottom of the lagoon was negatived by the luxuriant masses of the delicate calcareous alga, Halimeda, which, with the thinnest shelled Foraminifera, everywhere abounded in a perfectly uncorroded state.

With Prof. Poulton, then, we may fairly say that while the theory of subsidence is not of "universal application"—and Darwin in all his later writings candidly admitted that such was the case—yet the "validity" of this theory of subsidence is fully established in the case of the only atoll in which the test by boring has been carried out.

JOHN W. JUDD.

Kew, February 28.

An X-Ray Absorption Band.

FOR some time past I have been trying to make accurate comparisons of the intensities of the various orders of X-ray spectra reflected by crystals. The purpose of the inquiry is to make experimental tests of the theoretical discussions by Debye and Sommerfeld in relation to the influence of molecular motions upon reflecting power. Of some of their predictions I have found it easy to obtain confirmation which is at least roughly quantitative. For instance, the intensities of the higher order spectra are much more affected by rise of temperature than the lower, and the amount of the change is of the right order of magnitude; also rock salt and sylvine show greater changes than fluorspar.

In one case, however, the results have been puzzling. The relative intensities of the spectra of the diamond at ordinary temperatures are quantities of much importance. Now the diamond which I use is a thin flake which intercepts only a fraction of the incident primary ray, a fraction which diminishes as the diamond is set at a greater angle to the primary beam in order to obtain the higher order reflections. It would appear, therefore, to be necessary to make allowance for this waste of reflection opportunities, a correction which would not be necessary in the case of the other crystals, which are thick enough to intercept all the primary rays. Yet the intensity ratios are, to all appearances, nearly correct before the allowance is made, and become quite wrong afterwards. The diamond behaves as if, like the other crystals, it were quite thick.

I have therefore renewed a search for an effect which I have more than once failed to find, a special absorption of rays which are undergoing reflection. Since the earlier attempts the apparatus has gained in sensitiveness and accuracy, and I now find that the effect is easily visible. That is to say, when the pencil of rays strikes the diamond at the proper angle for reflection there is a diminution in the amount transmitted.

In the experiment as arranged at present a pencil of X-rays from a rhodium bulb passes through a slit one-tenth of a millimetre wide, and falls upon the diamond, which is mounted on the revolving table of the spectrometer. The rays that pass through the diamond fall afterwards upon a crystal of rock salt so placed as to reflect a pencil into the ionisation chamber. When the diamond is turned, a minute of arc at a time, through the angle (about 9°) at which the diamond itself reflects the principal rhodium ray, the intensity of the ray reflected by the rock salt drops in the ratio 100 to 70. No doubt this ratio could be increased by more accurate arrangement.

The principal rhodium ray is really a doublet, the two constituents of which are separated by an angle of four minutes under these arrangements. The doublet is resolved not only in the pencil reflected by the diamond, but also in the absorption band occurring in the reflection from the rock salt.

The effect is no doubt analogous to the selective absorption shown by crystals of chlorate of potash (R. W. Wood, *Phil. Mag.*, July, 1906).

W. H. BRAGG.

The University, Leeds.

Experiments Bearing upon the Origin of Spectra.

IT has been known for some years that a stream of luminous vapour can be distilled away from the mercury arc *in vacuo*, the vapour still remaining luminous when it has passed far beyond the limits of the electric field. It is known also that this luminosity is quenched when the stream passes near a negatively electrified metal surface.

I have from time to time attempted to extend these results to other less volatile metals, and have now succeeded in a large number of cases.

A preliminary account of some of the more significant observations will be given, without dwelling on experimental details.

In the case of sodium under favourable conditions, a very curious behaviour is observed. Where the distilled luminous vapour leaves the lamp, and where, of course, it is most brilliant, the light is yellow, and is dominated by the D lines. Further on, it becomes green, and the lines of the two subordinate series outshine the D lines. Finally, further still, the D lines again predominate. It would seem that if we represent the intensity of each series as dependent on time by a curve, the curve for the principal series will cut that for the subordinate series at two points. It is not, however, easy to find a law of decay which seems physically probable, and will satisfy this condition.

Another interesting effect is seen when the luminous stream is made to pass through a negatively electrified wire net. As in the case of mercury, the glow is partially extinguished. But, if the glow is watched through a spectroscope while the negative potential is applied to the gauze, it is seen that the lines of the subordinate series are far more affected than the D lines.

We may regard the distilled glow as due either to persistent vibration of the luminous centres originally excited in the arc, or to some subsequent interaction occurring in the gas, such as molecular association, or the neutralisation of ions. Whichever view is taken (and neither view is free from difficulty, as I shall show in a more complete publication) we must attribute the action of the electrified gauze to its power of attracting and neutralising positively charged ions. On either view the experiment cited shows that *the systems which gave rise to the subordinate series are not the same as those which give rise to the principal series.*

In the case of potassium, the development of the subordinate series in the distilled glow is very striking, and the existence of a series relation between the lines is visible at a glance, since the series are not confused by extraneous lines. The photography of this spectrum will be undertaken, and it is hoped will lead to an improvement in existing knowledge of the series and their convergence point.

Lastly, I will refer to the behaviour of the glow from magnesium vapour. Initially, the colour is green, dominated by the triplet *b*, and the green band of the "magnesium hydride" spectrum, upon which as a background *b* lies. As the vapour moves on these die out, but the blue flame line at $\lambda 4571$ survives much longer. The vapour was passed through a wire gauze screen. On electrifying this to -40 volts, all the features of the spectrum which have been mentioned were seen to diminish in intensity, but the effect on the blue line and on the bands of magnesium hydride was much stronger than the effect on *b*. The extinction of the band spectrum of magnesium hydride is specially significant.

R. J. STRUTT.

Imperial College of Science, March 9.

Unidirectional Currents within a Carbon Filament Lamp.

THE following experiments are good illustrations of the thermionic current, or Edison effect, in a carbon filament lamp, and require only such apparatus as is usually found in a laboratory.

The type of lamp used is that having two large loops in the filament, with the middle of the loop fixed by a short wire fused in glass at the top of the lamp. If the terminals are earthed and a charged body, either positive or negative, is brought near the lamp, then the two leaves diverge like two leaves of a simple electroscope. The loops may touch the glass bulb, and, if so, they spring back discharged.

But if the lamp is lighted and a pointed rod, connected to a Wimshurst, gives a powerful positive discharge, the loops are not displaced, even if the point is close to the bulb. On the other hand, with a negative discharge, even a foot or two away, the two loops of the filament rapidly and repeatedly strike the glass and spring back. Apparently this action will go on for a long period, if the point of discharge is continued.

The action may be explained from the fact that the lamp acts like a valve, and that the current can pass in one direction only, between the hot filament and the interior of the bulb. There can only be a thermionic current of electrons from the filament to the sides, and when there is an equilibrium distribution the carbon is at a relatively high positive potential compared with the inner wall. If this equilibrium is disturbed, it is adjusted by a thermionic current only, in one direction, or by movement of the loops only, in the other direction.

Thus if the negatively charged plate of an electrophorus is brought towards the lamp, the loops will diverge and strike the sides. Or if the displacement is only partial, the loops will swing back to their original place of rest directly the charged plate is removed to a distance. If, however, the metal disc of the electrophorus, positively charged, is brought towards the still lighted lamp, there is no movement of the loops. Equilibrium of potential is attained by emission of electrons from the filament. But as the disc with its positive charge is being moved away the loops diverge and may strike the glass.

What is most remarkable is this, that if the displacement of the loops is only partial, and not up to the glass, then when the disc is removed, the loops retain their displaced position and very slowly creep back to their original place of rest. It is this last phenomenon which clearly indicates the great difficulty of negative electricity returning to the glowing filament, or of positive ions leaving it.

The Beta rays from a few milligrams of radium near the lamp produce in it an ionisation current which accelerates the creep into a rapid motion, to the natural position of the filament.

These experiments with the electrophorus can all be carried out through a dry wooden drawing-board more than half an inch thick. When projected by a lens on a screen the motions of the filament afford interesting lecture-room illustrations of the thermionic current.

The valve action inside high vacuum lamps was explained by Fleming (Proc. Roy. Soc., 1890, vol. xlvii., p. 122). An account of his work is given in his well-known book on "Electric Wave Telegraphy" (second edition, p. 478).

So far as I know, the experiments described in this letter, with an electric force, produced outside the lamp, have not been previously published.

A. S. EVE.

McGill University, Montreal, January 29.

The Densities of the Planets.

THE prominence you give to M. F. Ollive's note in *Comptes rendus*, tome 157, No. 26, induces me to point out that M. Ollive's so-called empirical formula is really a simple statement about the densities of the planets. The formula is $r^3=kRR'v'^2$, where r is the mean radius of any planet, R its mean distance from the Sun, R′ the mean distance of any satellite from its primary, and v' the mean orbital velocity of the satellite. v'^2R' for any satellite can be replaced by γM, where γ is the gravitation constant, and M is the mass of its primary, since we can ignore the mass of the planet as compared with its primary. We get then $r^3=k'RM$, where k' is a new constant. But $M=\frac{4}{3}\pi\rho r^3$ where ρ is the mean density of a planet. Thus we get $R\rho=$constant. This is what M. Ollive's formula amounts to. In other words, his formula does not derive any generality by the introduction of the satellites. The fact that his results for the various satellites of any given primary agree *inter se* is merely Kepler's third law.

The value of M. Ollive's "empirical" formula is thus to be measured by the extent to which the formula $\rho R=$constant is true of the planets of the solar system. As it happens, this is at all approximately correct only for Earth, Mars, Jupiter, and Saturn. The densities as generally accepted are, taking the planets from Mercury outwards, 0·85, 0·89, 1·00, 0·71, 0·24, 0·13, 0·22, 0·20. The density of the earth is taken as the standard. M. Ollive's formula gives 2·58, 1·39, 1·00, 0·66, 0·19, 0·10, 0·05, 0·03. It is evident that M. Ollive's "empirical" formula is quite wrong for all but the four planets mentioned, and even for these the agreement is by no means encouraging.

It may be urged that the densities are not observed directly, but are inferred from the masses and the radii of the planets, so that a small inaccuracy in the observed radius of any planet may well account for a considerable error in the inferred density. But I very much doubt whether astronomers will be ready to admit possible errors of 50 per cent. in the radius of Uranus and 100 per cent. for Neptune. They will certainly decline to concede an error of 50 per cent. in the radius of Mercury and of 12 per cent. in the radius of Venus.

SELIG BRODETSKY.

University of Bristol, March 3.

An Optical Representation of Non-Euclidean Geometry.

LET us suppose Euclidean space to be filled with a medium of variable refractive index. Then to an observer in that medium the curved path of a ray of light will present all the appearances of a straight line, and, further, if the observer estimates the distance between two points by the time light takes to pass between them, this path will appear to be the shortest distance between the two points.

Suppose now that one or more such observers conduct an Ordnance Survey of the region occupied by the medium, using theodolites to measure angles, and imagine them to be equipped with instruments capable of measuring the time interval occupied by optical signals in transmission from one station to another, this interval being used as a measure of the distances between the stations. It is clear that these observers will obtain what to them must be a convincing proof that the sum of the three angles of a triangle cannot possibly be always equal to two right angles. And it would not be easy for an individual whose methods of observation of the geometrical properties of such a region were limited to those here assumed to believe that the space in which he lived could contain a Euclidean geometry.

G. H. BRYAN.

NATURE RESERVES.

IT is only too true that man is slowly but surely destroying the beautiful wild animals and plants of the world, and is substituting for them queer domesticated races which suit his convenience and his greed, or else is blasting whole territories with the dirt and deadly refuse of his industries, and converting well-watered forest lands into lifeless deserts by the ravages of his axe. It is not too late to rescue here and there larger and smaller areas from this awful and ceaselessly spreading devastation. In remote lands there are large tracts which may be taken in charge by the local government and rescued from destruction, and to some extent this has been done. Even in our over-crowded European states there are still lovely bits of forest, marsh-land, and down which man has not yet irretrievably befouled, and from which he has not yet driven by assault nor removed by slaughter the beautiful living things which nature has guided and nurtured in their seclusion. There is yet time! Some of these little scattered fragments of our great mother's handiwork can still be preserved even in England, Wales, Scotland, and Ireland, so that future Britons may not utterly curse us, but enjoy, with gratitude to those who saved them, the precious living relics of the world as it was before man destroyed it.

There must be many who have in these days learnt to know the difference between "the country" and the "wilderness," and have discovered the rare and over-powering charm of the latter. The "country," with its manured fields, its well-trimmed hedges, and artificial barriers, its parks planted with foreign trees and shrubs, its roadways stinking of tar and petrol, and its streams converted into chemical drains or else into over-stocked fish-stews, is only rendered less repulsive than the town by the survival here and there of a pond or a copse or a bit of ancient moor-land (happily too swampy for golfers) where nature is still allowed to pursue her own way without the arrogant interference of that prodigiously shameless barbarian, the "civilised" man.

Who does not know the charm of the real wilderness—far from the madding crowd—still accessible, even in southern England, to those in the secret? It is perhaps most directly to be found on a sea-shore bounded by sand dunes and marsh lands, or overhung by rocky cliffs on the untamed summits of which strange plants and legendary birds still linger. It is the real and effective absence of the marplot man which gives its vast beauty and fascination to that world protected by the great sea which is exposed as the tides withdraw from the rocks and pools. Here the passionate lover of nature seeks the unparalleled joy of contact with her, unsullied by human trail. And he finds it, too, in the desolate marshes, the remote sand-wastes of our coasts and estuaries, as well as in the still-surviving moorlands of the north. Plants of many kinds, the insects which depend on them, and timid birds—all of which perish in the presence of civilised man—are still to be seen in these precious and adorable sanctuaries. Even an old-time pond, undisturbed by man's improvements, is for the naturalist who can use the microscope a real "nature-reserve" full of the mystery and beauty of isolation.

It is proposed to secure by purchase or gift the right to preserve from destruction in this country as much and as many as possible of the invaluable surviving haunts of nature. A society has been formed for the promotion of nature reserves. It is in cooperation with societies and individuals having a like purpose in other European countries and in other continents, and has already sent representatives to an international conference recently held at Berne, which was attended by delegates from eighteen countries, and was the means of effecting an important exchange of views as to purposes and methods. The Speaker of the House of Commons is the president of the Society, Mr. Ogilvie Grant and the Hon. F. R. Henley are its secretaries. Its official address is "The Natural History Museum, Cromwell Road," and on its council we find such influential public men as Sir Edward Grey, and Mr. L. V. Harcourt, the two Secretaries of State, and many of our leading naturalists such as Profs. Bayley Balfour, J. B. Farmer, Edward Poulton, Sir David Prain, Sir Francis Darwin, and the Hon. Charles Rothschild.

The main objects of the Society for the Promotion of Nature Reserves, more explicitly stated, are "to collect and collate information as to areas of land in the United Kingdom which retain their primitive conditions; to obtain these areas, and to hand them over to the National Trust, and thus to preserve for posterity as a national possession some part, at least, of our native land, its fauna, flora, and geological features." It is hoped that naturalists and lovers of wild life in every district will keep a watchful eye on primitive and unspoilt tracts, and bring them to the notice of the society by writing to the secretary at Cromwell Road. Often such areas, if sought in good time, may be purchased at a low rate per acre; often local interest and public spirit as well as individual generosity, will facilitate the acquirement of the purchase-money, whilst "the National Trust" has proved itself a capable guardian, and will accept the trusteeship of such "reserves" with the necessary conditions imposed by the Society as to the absolute preservation of their natural conditions. No doubt there may be some care needed in arranging for the occasional admission of visitors to these reserved lands so as to avoid the access to them of too large a concourse, or of persons who are merely bent on holiday frolics—no less than of those who, actuated by the cupidity of the collector, would root out and destroy, under the false pretence of being naturalists and nature-lovers, all the rarer living things, as they have done in so many unprotected spots.

Already a beginning has been made in England. A part of Wicken Fen in Cambridgeshire has been acquired for the nation; also the shingle and salt-marshes of Blakeney in Norfolk. Near Oxford, too, there is a "Ruskin Reserve."

In foreign countries the government has long been active in the way of establishing "reserves," especially where, as in the United States, there are large tracts of uninhabited country. In Germany there is a department of State to control and assist in the preservation of nature, having a very large annual budget. There are already 100 reserves in that country. The yew and the holly are protected in the Government forests, and none may be cut: whilst the service tree is also protected. In this country we have no department of forestry, no knowledge or practice of forestry, and we shall very soon have no forests. The incapacity and want of authority in this subject which has been allowed to grow up in the British official world is lamentable, and was characteristically exhibited in the proceedings of the recent commission on Coast Erosion.

In Germany military exercising grounds and rifle ranges are made into nature reserves so far as is possible and consistent with their military use. The same thing might be, and should be, done in this country. There is no Government department in this country which can either advise or control in such matters. Commons, when taken over by public authority for preservation, should not be utterly drained of water and converted into

London parks, as has been the case at Hampstead, where the small bog above the Leg of Mutton Pond, in which grew the Sun-Dew (Drosera) and the Bog-bean (I used to visit them there!) might well have been left as a bog for the delighted contemplation of London naturalists. There was plenty of dry ground on Hampstead Heath without destroying the bog. There is danger of all such open spaces being converted into a common-place garden or a football field or a golf course unless the new society can extend its protection to them.

The purpose of this article is to invite all lovers of the wilderness, all worshippers of uncontaminated nature, to enter into communication with the Society for the Promotion of Nature Reserves, and see how far they can help in promoting its most worthy national objects.

E. RAY LANKESTER.

P.S.—The following series of inquiries issued by the Society for the Promotion of Nature Reserves will enable the reader to appreciate its purposes and mode of going to work.

Answers will be treated as strictly confidential, and will be at the disposal of the executive committee only. Name of Place. District and county where area is situated. Name and address of society or person giving information. (A) Is the suggested area worthy of permanent preservation as:—(1) A piece of typical primeval country? (2) A breeding-place of one or more scarce creatures? (3) A locality for one or more scarce plants? (4) Showing some section or feature of special geological interest? (B) Is the place recommended primarily for birds, insects, or plants? (1) To whom does it belong? (2) Would the owner be willing to sell, or could the area be leased? (3) Could you get local financial aid should it be considered desirable to acquire the area? (4) Is the place or site locally popular as a pleasure resort? This form should be filled up and returned to the secretary, Society for Promotion of Nature Reserves, c/o Natural History Museum, Cromwell Road, London, S.W.

GOVERNMENT LABORATORY REPORT.[1]

FROM the report of the Government Chemist,[1] issued a short time ago, it appears that the work of the Department increased considerably during the year 1912–13. The total number of samples examined was 209,502, as compared with 195,170 in the previous year.

It is noted that many questions of a consultative and advisory nature, apart from those connected with the examination of samples, are referred to the laboratory by various Government departments. Above 600 such references were dealt with during the year. They included such diverse matters as the causes of the deficiency in the non-fatty solids of milk; the relation between the citric acid solubility and the availability of the phosphates in slags; the selection of suitable denaturants for growing tobacco; stamps for National Health Insurance; and the supply of lime juice to the mercantile marine.

In connection with the attempts to cultivate tobacco and sugar in this country, it is interesting to note that 224 samples of home-grown leaf tobacco were examined, and also specimens of beet-juice, sugar, and molasses from the recently erected beet sugar factory at North Cantley.

Imported dairy produce was generally satisfactory as regards freedom from adulteration. Thus fresh (pasteurised) milk was not below the statutory regulations for quality, and contained no preservatives or artificial colouring substances. Imported butter, of which 1223 specimens were analysed, occasionally contained a small excess of water, but gave no evidence of the presence of fat other than butter fat.

In connection with the supervision of dangerous trades, a large number of lead glazes, dust, and other articles were analysed. From works where lead poisoning had occurred, fifty-eight specimens of lead glaze were taken; in most of these nearly the whole of the lead was in a soluble form, and therefore readily dissolved by the acids of the gastric juice. The principal chemist notes also that important investigations were conducted during the year for the Home Office Committees appointed to consider questions concerning (1) celluloid, and (2) the use of lead compounds in the painting of buildings and coaches.

A large part of the report is devoted to an account of the work done by the laboratory in exercising chemical control over the production and sale of dutiable articles. The account is accompanied by brief outlines of the reasons for this control, and shows how it is exercised. For example, it is explained that the duty on beer brewed in this country is charged on the wort or unfermented saccharine liquid from which the beer is brewed; that the basis of the charge is a statement made by the brewer as to the quantity of materials used and unfermented wort produced, and that the accuracy of this statement can be checked at any time subsequently by analysing the fermented wort. That there is some need for such control is shown by the fact that out of 11,641 samples examined, 1628 were found to have been "declared" at less than their true value. In this and numerous similar ways the laboratory has become an indispensable ancillary of the fiscal departments.

The report shows steady progress of the laboratory, and records a useful year's work.

[1] The Report of the Government Chemist upon the work of the Government Laboratory for the year ended March 31, 1913. (Cd. 7001). Price 3*d*.

NOTES.

THE meeting of the Royal Society on March 19 will be a meeting for discussion, the subject being "The Constitution of the Atom." The discussion will be opened by Sir Ernest Rutherford.

MR. LAURENCE BINYON, assistant-keeper in the British Museum in charge of the sub-department of Oriental Prints and Drawings; Dr. R. M. Burrows, principal of King's College, London; and Mr. A. G. Lyster, president of the Institution of Civil Engineers, have been elected members of the Athenæum Club under the provisions of the rule which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public services."

THE death is announced of Mr. John Gott, widely known among telegraph engineers and electricians by his pioneer work in electrical testing and practical telegraphy.

THE death is reported, in his forty-seventh year, of Dr. A. H. Pierce, professor of psychology since 1900 at Smith College, Massachusetts. He was editor of the Psychological Bulletin, and author of "Studies in Space Perception."

DR. W. W. BAILEY, professor of botany at Brown University, Rhode Island, from 1881 to 1906, has died at the age of seventy-one. His publications included "Botanical Collector's Handbook," "Among Rhode Island Wild Flowers," "Botanical Note-book," "New England Wild Flowers," and "Botanizing," as well as a volume of poems.

IT is announced that the Government will ask the House of Commons to sanction a grant of 13,000*l*. for special investigation into the movements of ice in the North Atlantic. The grant is provided for in the Estimates for Mercantile Marine Services for 1914–15, and represents an increase of 11,000*l*. on the sum voted for this purpose last year.

IN the Civil Service Estimates for the year 1914–15, issued a few days ago, it is announced under the head of "Grants in Aid of Scientific Investigation," that the sum of 5000*l*. is to be voted this year towards the expenses of the British Transantarctic Expedition, which Sir Ernest Shackleton is to conduct across the south polar continent. Another 5000*l*. is to be voted next year. This grant of 10,000*l*. forms part of the sum of 50,000*l*., which was already guaranteed before the public announcement of the expedition.

A NEW magnetic observatory is being established in Swider, near Warsaw, in connection with the magnetic researches now being carried on in Poland by Dr. St. Kalinowski. The observatory will be provided with registering instruments (Adolf Schmidt's system), and for the absolute determinations a large Sartorius magnetic theodolite and an earth inductor will be used. Dr. Kalinowski hopes that the new observatory will be in active operation in the present year.

IN accordance with the resolution adopted by the eighteenth International Congress of Americanists, held in London in 1912, the Smithsonian Institution have made arrangements for holding the nineteenth congress in Washington on October 5–10. The organising committee, of which the chairman is Prof. W. H. Holmes, head of the department of anthropology, United States National Museum, has already drawn up a provisional programme. This includes an archæological excursion to the aboriginal quarries and workshops at Piney Branch. A feature of the congress will be an exhibition of rare Americana and other objects and a special exhibition in the museum of the daughters of the American Revolution.

ON Tuesday, March 24, Mr. A. H. Smith, keeper of Greek and Roman antiquities in the British Museum, will begin a course of two lectures at the Royal Institution on landscape and natural objects in classical art, and on Thursday, March 26, Dr. C. W. Saleeby will deliver the first of two lectures on the progress of eugenics: (1) "The First Decade, 1904–14," (2) "Eugenics of To-day: its Counterfeits, Powers, and Problems." The Friday evening discourse on March 27 will be delivered bv Prof. J. A. Fleming on improvements in long-distance telephony, and on April 3 by Sir J. J. Thomson on further researches on positive rays.

PROF. E. NAVILLE, in the *Times* of March 6, describes a remarkable discovery in the course of excavation at Abydos. Strabo, in his account of what he calls the "Fountain of Abydos," speaks of a labyrinth with covered ways roofed with enormous slabs resting on pillars. Two gigantic colonnades have now been discovered not far from Seti's temple, leading into a great hall, now empty, as it has been a quarry for centuries. The texts, however, which survive on the walls, copies of the Book of the Underworld, show that this was the famous tomb of Osiris. Like the pyramids in the case of the monarchs of Egypt, this splendid building was a fitting tomb for a god. What has become of his body, whether only his head was preserved, whether the remains were enclosed in a sarcophagus—we shall probably never know.

THE Army Estimates for 1914–15 provide a million pounds sterling for the air service, of which nearly 200,000*l*. is for buildings. Colonel Seely's memorandum on the Estimates points out that good progress has been made during the past year with the development of the Military Wing of the Royal Flying Corps. By the end of this month the number of officer fliers will have grown to about two hundred. During the past year an Inspection Department for Aviation has been formed and is finding much scope for its activities in inspecting new supplies of all kinds, and also in overhauling periodically the aeroplanes, engines, and so on of the flying squadrons. A special section of the Army Ordnance Department is also about to be formed to deal with the storage and supply of the highly technical and complicated *matériel* used in this branch of the service. As a general indication of the progress made in the past year, it may be said that, as compared with 100 aeroplanes in existence on March 20, 1913, there were on February 25 last 161 on hand, and between those dates 87 had been struck off as unserviceable and replaced.

SOME of the recent work at Rothamsted in connection with the partial sterilisation of soils has found application in the Lea Valley district just north of London, where a great market garden and glasshouse industry flourishes. So much interest has been aroused among the growers that they have banded themselves together to form an Experiment Station where the various problems arising out of the industry can be investigated in a scientific manner, and where advice may be obtained as to plant diseases, pests, and so on. The growers have raised a large sum of money among themselves for the erection and maintenance of the station, and, in addition, a substantial Government grant has been made, and the county councils have also contributed; the financial success of the scheme therefore seems assured. The problems to be investigated are of great technical importance and high scientific interest. A strong committee of management has been formed, one-half being practical growers, and the other half men of science nominated by the committee of the Rothamsted Experimental Station. The scientific side of the work will, therefore, be amply represented, and there is every prospect that a sound programme of work will be drawn up.

MR. G. MARCONI delivered a lecture in Rome on March 3 before the King and Queen of Italy, members of the Italian Government, both Houses of Parliament, and the Diplomatic Corps. He described the progress which had been made in wireless telegraphy, and the difficulties which had been overcome since his previous lecture in Rome in 1903. His voyage to South America on board the *Principessa Mefalda* had illustrated that communication in a north and south direction was easier than communication in an east and west direction. Mr. Marconi described his new system for generating continuous waves, and its use in wireless telephony. He then described the apparatus for producing waves, divided into regular groups, and dealt with the improvements effected in receivers, giving a practical demonstration of the reception of messages in the lecture hall from Poldhu, in Cornwall, and Tripoli. Mr. Marconi finally described the practical applications of radio-telegraphy to all types of vessels, including submarines, as well as its uses in war and peace. He concluded with an acknowledgment of the help which he had received from the King and Queen of Italy.

AN appeal on behalf of the Alfred Russel Wallace Memorial Fund, signed by the executive officers, Prof. R. Meldola, Prof. E. B. Poulton, and Mr. James Marchant, was published in the issue of NATURE for December 11 last (vol. xcii., p. 425). If a sufficient sum can be raised, the following memorials are proposed:—(1) A memorial medallion for Westminster Abbey, to which the Dean and Chapter have given their consent; (2) a portrait; (3) a copy of the portrait for presentation to the nation; and (4) a statue to be offered to the trustees of the British Museum for erection in the Natural History Museum. It is estimated that the complete scheme can be carried out for 1100*l.* The subscriptions received or promised amount to 200*l.* The medallion for Westminster Abbey will, it is estimated, necessitate the expenditure of at least 300*l.*, and the executive committee is anxious to complete this part of the work as soon as possible. The second part of the scheme, the portrait, will be proceeded with as soon as an additional sum of 350*l.* is subscribed. The most convenient course for intending subscribers to adopt is to send cheques made payable to the "Alfred Russel Wallace Memorial Fund," to the manager, Union of London and Smith's Bank, Holborn Circus, London, E.C. It is earnestly to be hoped that a sufficient response to the appeal will be speedily forthcoming to enable the executive officers to complete what will be worthy memorials of a great naturalist.

THE report of the council of the Physical Society (adopted at the annual general meeting on February 13) states that owing to the improved financial position it is felt that the society's field of activity should be increased; careful consideration has, therefore, been given, during the past year, to the possibility of introducing new features, such as the issue, from time to time, of reports upon certain subjects of general interest. The first subject selected for the purpose is radiation. Mr. J. H. Jeans, F.R.S., has expressed his willingness to write the report upon this subject, and to have it complete during the summer. An occasional or annual lecture by some eminent physicist will also be arranged. This series of lectures, the first of which will be found summarised elsewhere in this issue, will be known as the Guthrie Lectures, in memory of the late Prof. F. Guthrie, through whose efforts the society was founded. A committee has been appointed by the council to consider questions in regard to nomenclature and symbols and allied matters, and consists of Prof. H. L. Callendar, Mr. A. Campbell, Dr. C. Chree, Dr. W. Eccles, Prof. G. Carey Foster, Sir George Greenhill, Dr. A. Russell, Prof. the Hon. R. J. Strutt, Prof. S. P. Thompson, and Prof. W. Watson, with Dr. Eccles as secretary and convener. At present the committee is discussing electric and magnetic quantities; but reports on mathematical and mechanical nomenclature and symbols, so far as these concern physicists, and on heat are also projected.

A SUMMARY of the weather for the past winter in the several districts of the United Kingdom, as shown by the results for the thirteen weeks ended February 28, has been issued by the Meteorological Office. The mean temperature for the whole period was above the average over the whole of the British Isles, the excess being greatest in the English districts. The highest temperature in any district was 61° in the midland counties, and the lowest reading 5° in the east of Scotland. In the north-east of England the lowest winter temperature fell to 9°, and in all other districts it fell below 20°, except in the English Channel district, where the lowest reading was 25°. The summary shows the rainfall to be less than the average except in the north of Scotland and the north of Ireland; the greatest deficiency was 2·15 in. in the midland counties, where the total rainfall was only 67 per cent. of the average. In the north-east of England the rainfall was 70 per cent. of the average, in the east of England 75 per cent., and in the south-west of England 86 per cent. of the average. The greatest aggregate measurement for the winter was 19·16 in. in the north of Scotland, and the least measurement 3·83 in. in the north-east of England. There was a deficiency in the number of rainy days in all the English districts. The duration of bright sunshine was deficient over the entire kingdom, except in the south-east of England, where, however, the excess was very slight.

IN the Annals of the South African Museum, vol. xiii., part i., Mr. L. Péringuey, the director, gives an interesting list of inscriptions left by early European navigators to the East in South Africa. The earliest inscribed stone is that of Diego Cão, A.D. 1484. This was found in German territory in 1893. By orders of the German Emperor, the original has been removed to Germany; one replica has been erected on the spot where the original stood, and a second has been promised by the German authorities to the South African Museum. The first English record is that of Antony Hippon, mate or master of the *Hector*, dated in 1605. The next is that of the *Thomas* in 1618. The paper throws new and interesting light on the early history of European discoveries in the East, and the evidence now provided will be useful for comparison with the early records in the India Office.

THE University Museum of Philadelphia has started an interesting experiment for the study of some Indian tribes. Mr. L. Shotridge, a full-blood Tlinget, from the Chilkat river in south-eastern Alaska, has been appointed an assistant on the museum staff. He has made for the museum a model of a section of his native village, and in this article, in the issue of the journal of the museum for September, 1913, he gives a detailed account, with plans, of the methods of house-construction. Those of chiefs are sometimes elaborately decorated, and are looked on with respect, because in them are kept the old relics—ceremonial costumes, helmets, batons, carved and painted screens and posts—which have come down from the family ancestor. The house drawings are interesting as showing the methods of native architecture and carpentry.

No. 6 of the fourth volume of the Journal of the College of Agriculture of Tokyo is devoted to an account by Mr. Tsunekata Miyaké of the Japanese insects of the neuropterous group Mecoptera, a group of which Japan is already known to possess more than forty species, while Europe and America collectively do not own more than twenty. It was at one time supposed that these insects, as typified by Panorpa, were of value to agriculturists on account of their destroying other insects, but their importance in this respect appears to have been overrated.

THE receipt of a copy of the February issue affords a welcome opportunity of bearing testimony to the high standard of excellence attained, both from the zoological and the artistic point of view, of Mr. Douglas English's illustrated monthly journal, *Wild Life*, which has now entered its third volume. Among the contents of the present issue an article by Mr. C. J. King on the grey seal in the Scilly Isles, illustrated by photographs showing the wonderful difference between the coat of the new-born young and half-grown individuals, is one of the most interesting. Attention may also be directed to the photograph by Mr. Seth Smith of the male pigmy hippopotamus recently presented to the Zoological Society by the Duke of Bedford, which, although taken when the animal was too much in the shade, serves to show the small head, slender limbs, and widely separated toes distinctive of the species. The society now possesses a pair of these rare animals.

THE Transactions of the Royal Scottish Arboricultural Society, vol. xxviii., part 1 (January, 1914), contain the concluding part of Mr. A. D. Hopkinson's account of the State forests of Saxony, which are perhaps the best managed in Europe, being worked upon a strictly commercial basis. These forests, with an area of 426,105 acres, yielded in 1910 a gross return of 790,753*l*., from which, if the working expenses, 327,869*l*., are deducted, there remains a net annual revenue of 462,885*l*., or 1*l*. 1*s*. 9*d*. an acre. The expenses comprise cost of administration, maintenance of roads and buildings, cost of felling and planting, etc., and include also such items as 1044*l*. for research work, and 8035*l*. for insurance of workmen. The main species in cultivation is spruce, which is felled at an age of eighty years. Of special interest to plant ecologists is Mr. G. P. Gordon's article on the different associations constituting the beautiful natural forest of the Zernez district in the Engadine, which has lately been made a nature reserve by the Swiss Government. Continental forestry is further dealt with in the official account of the visit of the society to Switzerland in July, 1913, and by numerous notes on the forests of France and southern Germany. The main article on home forestry deals in a practical way with the successful planting of a considerable tract of high-lying peat at Corrour, in Inverness-shire. The method adopted is a Belgian one, which was introduced by Sir John Stirling-Maxwell in 1908.

THERE seems to be some probability of more unfavourable ice conditions in the North Atlantic this year than existed during 1913. Although bergs were sighted throughout the whole of that year, they were comparatively few in number, and of small dimensions on the Transatlantic routes. The meteorological charts of that ocean for the present month published by the Meteorological Office and by the Deutsche Seewarte contain useful notes upon the subject. Bergs were seen at Belleisle early in January last, and also several about 46° N., between 46° and 49° W. On January 30, in 48·2° N. and 48·7° W., the steamer *Czar* had to alter her course considerably to get clear of field ice, and some ships bound for Canada have had, owing to unfavourable ice conditions, to take to the more southerly route before the usual time agreed upon. There was much ice on the west coast of Iceland in the early part of January, and several trawlers are reported to have received damage.

A BIBLIOGRAPHY of the Antarctic, from the earliest works to 1913, by J. Denucé, forms a bulky appendix to the thin report of the International Polar Commission held at Rome in April, 1913 (Bruxelles: Hayez, 1913). The first outcome of the ambitious projects of this scheme was the "Liste des Expéditions Polaires depuis 1800," compiled in 1908 by the same author, and republished in a revised form in 1911. The present bibliography is excellently arranged under various subjects, and in cases where the entries are numerous, a regional subdivision has been adopted. The entries under each heading are in chronological order, and classified with an index number on the decimal system. The division of the Antarctic into four equal quadrants is a mistake, as it results in the partition of the Ross Sea, but any scheme of division must have its drawbacks, especially as the isolated known areas become linked by further exploration. M. Denucé has founded his work on the polar library which the commission is trying to form in Brussels, but he has gone far beyond the scope of that collection, and has spread his net wide enough to include various important reviews of Antarctic works, many newspaper articles, and notes in geographical publications, some of which inevitably would be lost sight of but for a careful compilation of this kind. On the other hand, there is room for revision and additions. We have noted a few omissions, and some slight errors in references, besides the premature inclusion of some papers announced, but not yet published. However, M. Denucé's work is a welcome supplement to Dr. H. R. Mill's bibliography in the "Antarctic Manual" of 1901.

THE symbol $|x|$ as applied to real quantities denotes the numerical value of x irrespective of algebraic sign. In a recent paper (Moscow: I. N. Kouchnéreff and Co., 1913), Dr. D. Riabouchinsky, director of the aerodynamic institute of Koutchino, treats this quantity as a function of the variable x, and shows how this method leads to interesting formulæ involving the solution of equations, differentiation, and integration. A number of elegant geometrical applications are also given, such as equations of broken lines, and equations of limited portions of planes, such as a square area.

THE first number of the *Washington University Studies* contains an interesting paper by Mr. Benjamin M. Duggar on Lycopersicin, the red pigment of the tomato, and the effects of conditions on its development. This red pigment is partially or completely suppressed when green fruits are ripened at a temperature of 30° C. or above, the inhibition of reddening being proportional to the temperature above this point. The factors for reddening are not destroyed by high temperatures, and a return of the fruit to normal conditions causes rapid pigmentation. The presence of oxygen is necessary to bring about reddening, and fruits maintained in an oxygen-free atmosphere fail to redden at the normal ripening temperature. The colouring matter of the red peppers and of the arils of Momordica exhibit the absorption bands of Lycopersicin.

THE *Photographic Journal* for February contains a condensed account prepared by Mr. F. F. Renwick of Dr. H. Ewest's thesis on quantitative spectrophotography. After giving a short account of most of the methods used previously, the author gives a description of his own apparatus, and the tests he has made in order to see that it is capable of giving trustworthy results. The light from a Nernst lamp is condensed on the slit of a direct-vision spectroscope, and the spectrum is produced on the photographic plate to be tested. Immediately in front of the plate is a neutral Goldberg absorbing wedge which covers the whole plate, and is raised with the plate at a uniform rate. The curve separating the opaque from the transparent portion of the negative then allows the character of the plate to be determined, and the relations between the time of exposure, the intensity of the light, and the density of the negative in all parts of the spectrum to be investigated. The method seems convenient and trustworthy, and should lead to an extension of our knowledge in this field.

AN important paper on the nature of enzyme action by Mr. Hendrik S. Barendrecht appears in the *Biochemical Journal* (vol. vii., part 6). In this paper, which bears the title, "Enzyme Action, Facts and Theory," it is pointed out that the researches of the past few years on the kinetics of enzyme action have brought more confusion than clearness into this field. An attempt is made by Mr. Barendrecht to clear up some of the contradictory statements regarding the kinetics of some of the most simple enzyme actions. As a working hypothesis it is assumed that enzyme action spreads like a radiation from an enzyme particle as centre; this conception is developed mathematically for the cases of more or less concentrated solution of the substrate, and the effect is considered of the products of the action exercising an absorption on the active radiations, and hence on the velocity of the change. In this way velocity equations are derived, which explain certain cases which have appeared to be abnormal. In particular the special cases of the action of invertase on cane sugar, of lactase on milk sugar, and of maltase on maltose are considered, with especial reference to the effect of the resulting sugars on the velocity constants.

IN the course of an interesting and suggestive paper on the calculations and details for steel-frame buildings, read at the Concrete Institute on February 26, Mr. W. Cyril Cocking urged that all constructional engineers and draughtsmen should support the London Building Acts 1909 Amendment. It may be thought by some that certain amendments to the Act would be desirable, but no concessions can be expected unless all concerned with its working combine to make the best of it as at present framed. Time has shown already that the Act has been the means of improving considerably the general design of steelwork. The 1909 amendment is an Engineer's Act essentially, and the reinforced concrete regulations will be more so, and it seems within the possibilities of the near future that, provided the engineer takes advantage of his opportunities, he might assume the more important position—the architect then confining his attention solely to the architectural treatment. Whole-hearted cooperation between engineer and architect will tend to provide London with buildings in which the architecture is more fully developed, and combined with sound construction in such a manner that the demands of economy and scientific utility are satisfied fully.

A GENERAL discussion on every aspect of the passivity of metals was held at the meeting of the Faraday Society on November 12 last, and was reported in the issue of NATURE for November 20, 1913 (vol. xcii., p. 356). The eight papers read on that occasion, together with the discussion upon them, have now been reprinted from the Transactions of the Faraday Society in book form, and can be obtained at the price of 7*s*. 6*d*.

THE following books relating to science are announced, in addition to those referred to in our issue of March 5:—In *Anthropology*—The Ban of the Bori: an Account of Demons and Demon-Dancing in West and North Africa, Major A. J. N. Tremearne, illustrated (Heath, Cranton, and Ouseley); in *Biology*—The Wonder of Life, Prof. J. A. Thomson, illustrated (A. Melrose, Ltd.); In Nature's Ways, M. Woodward, illustrated (C. A. Pearson, Ltd.); British Flowering Plants, illustrated by Mrs. H. Perrin, with descriptive notes and an introduction by Prof. Boulger, 4 vols. (B. Quaritch); in *Chemistry*—Chemical Lecture Diagrams, Dr. G. Martin; The Wonderland of Modern Chemistry, Dr. G. Martin, illustrated (Sampson Low and Co., Ltd.); Elements of Physical Chemistry, J. L. R. Morgan, new edition (New York: J. Wiley and Sons, Inc.); in *Engineering*—Modern Practice in Tunnelling, D. W. Brunton and J. A. Davis; Subaqueous Foundations, C. E. Fowler; Influence Lines for the Determination of Maximum Moments in Beams and Trusses, M. A. Howe (New York: J. Wiley and Sons, Inc.); in *Geography and Travel*—Sport and Science on the Sino-Mongolian Frontier, A. de C. Sowerby (A. Melrose, Ltd.); Hunting and Hunted in the Belgian Congo, R. D. Cooper, illustrated; South Polar Times, reproduced in facsimile, new volume (Smith, Elder and Co.); in *Geology*—A.B.C. of the Useful Minerals, A. McLeod; Engineering Geology, H. Ries and T. L. Watson (New York: J. Wiley and Sons, Inc.); in *Mathematical and Physical Science*—Science and Method, H. Poincaré, translated by F. Maitland (T. Nelson and Sons); The Stars Night by Night, J. H. Elgie, illustrated (C. A. Pearson, Ltd.); Meteorological Treatise, F. H. Bigelow; Theory of Numbers, R. D. Carmichael; Elementary Theory of Equations, L. E. Dickson; Invariants, L. E. Dickson (New York: J. Wiley and Sons, Inc.); in *Medical Science*—Industrial Gas Poisoning, Prof. Glaister and Dr. D. D. Logan (E. and S. Livingstone).

OUR ASTRONOMICAL COLUMN.

COMET 1913*f* (DELAVAN).—In this column for February 12 we gave the ephemeris of comet 1913*f*, discovered by Delavan, which was computed by Dr. G. van Biesbroeck. This ephemeris is now continued here for the rest of the month so far as it is published:—

0h. M.T. Berlin.

	R.A. (true) h. m. s.	Dec. (true) ° ′	Mag.
March 13	2 47 21	+5 53·6	10·7
17	49 27	6 38·5	10·7
21	51 44	7 23·7	10·7
25	2 54 12	+8 9·2	10·6

The magnitudes are based on the assumption that the comet was of magnitude 11·0 on December 17. The current number of the Lick Observatory Bulletin (No. 250) contains another computation of the parabolic elements of this comet undertaken by Messrs. S. Einarsson and S. B. Nicholson, and an ephemeris based on those elements by Miss Julia I. Mackay and Mr. C. D. Shane, of the same institution. The elements are very closely similar to those calculated by Dr. Biesbroeck, and the ephemeris differs only slightly. According to the last-mentioned computers, it is stated that assuming the brightness of the comet to have been 1·00 on December 29 of last year the comet may become visible to the naked eye.

On the other hand, M. R. Goudey contributes to the *Astronomische Nachrichten* (No. 4717) elliptic elements of the above comet based on observations extending between December 18, 1913, and January 15 of the present year. The position he gives in his ephemeris for March 21 is almost identical with that stated in the foregoing table.

A LARGE REFLECTOR FOR CANADA.—It is very satisfactory to be able to record that Canada will soon be equipped with a fine large reflecting telescope, contracts having been given for its construction. When it is mentioned that Messrs. J. A. Brashear and Co. will be responsible for the optical parts, and Messrs. Warner and Swasey Co. for the mounting, the well-known capabilities of these firms should certainly secure a fine instrument. Prof. J. S. Plaskett is to be congratulated on the successful issue of his endeavour to secure an instrument of large aperture for Canada, and his account of the proposed form of mounting, programme of work, etc., contributed to the current number of the Journal of the Royal Astronomical Society of Canada will be read with interest. The telescope will have a parabolic mirror of 72 in. clear aperture, with a central hole of 10 in., the focal length being 30 ft.; it is to be mounted similarly to the Melbourne reflector. It will be primarily used for spectrographic observations of stellar radial velocities, but it is planned to have the telescope available for the direct photography of nebulæ, clusters, etc. One of the principal considerations in the design is to enable work "to be done in the most efficient and convenient way possible with the simplest possible mechanical design." The communication in question describes in detail the simplifications with which it is intended the instrument shall be equipped.

THE SMITHSONIAN ASTROPHYSICAL OBSERVATORY.—The report of the Astrophysical Observatory for 1913, under the direction of the Smithsonian Institution, contains a good account of progress made; in fact, the director, Mr. Abbot, refers to the work of the observatory as "uncommonly successful." We notice that for the solar work at Mount Wilson there has just been erected a Tower telescope, 40 ft. high, for use with the spectrobolometer, for the study of the distribution of radiation over the sun's disc. The report states many results of the year's work. Thus the mean value of the solar constant of radiation at the earth's mean distance from the sun, from about 700 observations made at high and low stations between 1902 and 1912 is 1·932 calories per square centimetre per minute. The fluctuation of the "solar constant" values is attributed to the variability of the sun, and in addition to the periodicity due to sun-spots, there is another "irregular, non-periodic variation, sometimes running its course in a week or ten days, at other times in longer periods and varying over irregular fluctuations of from 2 to 10 per cent. of the total radiation in magnitude." Further, a combination of the effects of sun-spots and volcanic haze is put forward as explaining the principal outstanding irregularities in the temperature of the earth for the last thirty years. Finally, in the Californian expedition, in which sounding balloons were employed, the solar radiation values at very high altitudes indicate that the direct pyrohelion metric observations gave results of the same order of magnitude as the solar constant work of 1902–12 by high and low sun observations on homogeneous rays, according to Langley's methods.

THE IMPORTATION OF BIRDS' PLUMAGE.

TO the *Fortnightly Review* for March Miss L. Gardiner contributes, under the title, "The Fight for the Birds," a timely article apropos of Mr. Hobhouse's Plumage Bill now down for second reading. She gives a history of the rise and progress of the contest against the slaughter and extermination of so many of the most useful and ornate birds of the world for the plumassier trade, which has never been more in evidence than in the past season or two, during which women have "so gaily worn the brand of Cain in the street." Miss Gardiner quotes statistics from brokers' catalogues, mainly of 1911, 1912, 1913, which show that, besides others, 132,000 "ospreys" were killed, 8700 birds of paradise, 22,000 crowned pigeons, 24,000 humming-birds, 23,000 terns, 162,000 kingfishers, 1200 emeus, and 4500 condors. It is significant that, as the author remarks, "reports on the quantities now sold are no longer published in the *Public Ledger* since the House of Lords inquiry."

The outcry against this wholesale slaughter is not confined to the lovers of nature and the humanitarians as such, but is loud from the agriculturists of the Himalayas, of Madras, and other parts of India, of Georgia, Florida, and Carolina, and of Egypt, whose crops are devastated by reason of the scarcity of the birds that heretofore destroyed the insect pests now ruining them. Strong official support has been given by the Zoological Society to Mr. Hobhouse's Bill, and also by the British Ornithologists' Union, although the trade journals claim both societies, as well as quote the names of numerous distinguished scientific men, many of whose names were authorised under the impression that they were supporting the principle of the Bill—as in favour, not of the Bill, but as supporters of the Committee for the Economic Preservation of Birds. Unfortunately, the Zoological Society has been made to appear to the general public to support the Economic Committee—to which it is absolutely hostile—through the secretary of the society having accepted, in his private capacity, the chairmanship of the committee. The corresponding Economic Committee in Paris, as recorded recently in NATURE (January 29, p. 617), was entirely defeated on its very strenuous attempts to check the growing force of opinion in France in favour of the protection of birds, fostered by the Acclimatisation Society.

Miss Gardiner's article should be widely studied by all who desire to know the rights and wrongs of the plumage traffic. In a letter "On the Need for Protection of Rare Birds," in the *Times* for March 3, the Hon. Charles Rothschild says he is impelled to write "as there is a danger of the [Plumage (Prohibition)] Bill being defeated through the efforts of those opposed to the measure, who have formed themselves into . . . the Committee for the Economic Preservation of Birds." His observations fully corroborate what Miss Gardiner has stated about the objects of this committee in the *Fortnightly Review*. "One thing is certain," as Mr. Rothschild remarks, "that many of the most beautiful birds have never been in greater need of protection than at the present time. In the *Times* of March 6 Mr. C. F. Downham, replying to Mr. Rothschild, trails once more the red-herring of the "dead" egret feathers across the question. It has been abundantly proved that the plumes offered as "dead" were wrongly so described to quieten public opinion; and if, indeed, any "dead" feathers now come to the market, they are brought with the same object, and for the reason that the supply from slaughtered birds has decreased below the demand, not "because the area of protection is increasing," but because the heronries themselves have been so depopulated. It is amusing to read Mr. Downham's statement that "the nuptial plumes of the egret are borne by the birds long after the nesting time, and that the birds carry their feathers for seven or eight months of the year."

In the March issue of *Pearson's Magazine* Mr. Hesketh-Pritchard describes the almost incredible cruelties perpetrated by the professional plume-hunters, the sworn testimony of one of whom he quotes, which is directly contradictory of the plume-traders' reiterated declarations that the "egrets" are moulted feathers. The *Spectator* of March 7 has also a powerful article on the need for the Plumage Bill, from which the following sentences are extracted:—"... the activities of the [economic] committee appear at present to be centred hardly so much on the protection of birds which are being harassed, as upon definite opposition to the Bill which prohibits the importation of their plumage. . . . The plumage of all birds is at its brightest in the breeding season, and it is at this season, therefore, that the bird is killed. No 'economic preservation' will alter that fact. The plain issue, in short, is . . . whether traffic in feathers which admittedly involves cruelty and which leads inevitably towards the extinction of species shall be permitted at all. So far as Great Britain is concerned, we hope that a Plumage Act will be the answer."

A public meeting will be held at Caxton Hall, on Thursday, March 19, at 5.30, under the patronage of the Royal Society for the Protection of Birds, the Zoological Society, the Avicultural Society, the British Ornithologists' Union, the Society for the Promotion of Nature Reserves, the Society for the Preservation of the Wild Fauna of the Empire, and other bodies, in support of the Plumage Bill. When the Bill is passed it will be illegal to import the feathers or skins except for scientific purposes, for which purpose a licence will be obtainable from the Board of Trade. It is confidently believed that such legislation will have far-reaching effects towards the preservation of rare and beautiful wild birds. The trade in ostrich feathers is specially exempted from the provisions of the Bill. Tickets (free) for the meeting may be obtained through the secretaries of the patron societies, or from the hon sec., Plumage Meeting, 34 Denison House, Westminster.

THE VITAMINES OF FOOD.[1]

FLEURENT, in his "Le pain de Froment," shows that the grain of wheat consists, by weight, of the protective coat (15·6 per cent.), the embryo or germ of millers (1·4 per cent.), and the white flour (83 per cent.). The coat includes, in addition to the pericarp and testa, the aleurone layer of the endosperm, the remainder of which forms white flour. The bran of the miller, as removed by the metallic roller, includes the aleurone layer, which is not only a starchless layer, rich in fats, but contains the newly discovered bodies to which C. Funk has given the name of vitamines, and of which the first detailed authoritative account has appeared this year ("Die Vitamine," von Casimir Funk, J. F. Bergman, Wiesbaden, 1914).

A discussion of their chemical nature would be out of place now, and must be left to organic chemists. It may be mentioned, however, that they do not contain phosphorus, they are not fatty bodies, and are distinct from lipoids. They are nitrogenous and of highly complex structure (*e.g.* the formula of one is $C_{26}H_{20}O_9N_4$); they are indispensable for

[1] Summary of a lecture entitled a "Grain of Wheat," delivered in the National Museum, Dublin, on February 24, by Prof. T. Johnson.

life, and no diet is complete without them. If the brain, "one of the three legs of the tripod of life," is starved by a vitamineless diet troubles of all kinds—called by Funk *deficiency diseases*—arise, and these may end in death. The muscles dwindle away, the nerves degenerate, and heart and bone troubles result. Their absence is a predisposing cause of tuberculosis. Vitamines are found in plants, and especially in their seeds. So far as is known at present, animals are incapable of making them. Animals, however, obtain them by feeding on plants. Thus vitamines occur normally in meat, fresh milk, and yolk of egg. They are soluble in water, and insoluble, mostly, in ether. They are thermolabile, and are destroyed by exposure for 10–20 minutes to a temperature of 120°–130° C., as well as by extreme dryness. Thus cattle may, following on a long drought, suffer from a vitamineless fodder.

Funk regards vitamines as the mother-substance of ferments and hormones, and of vital importance to the thyroid and other ductless glands. It is thus evident that the diet standards of the text-books must be revised in the light of their discovery, which throws a flood of light on the milk and other food problems. White flours and corn flours are deficient foods because the vitamines have been removed in the milling process.

Wherever any cereal, robbed of its aleurone or vitamine layer, forms the chief food of a people, there a deficiency disease appears. Rice is eaten by more people than any other grain, in the tropical regions of both hemispheres. The marked increase of beri-beri caused by eating *polished* rice, claiming thousands of victims yearly in Japan, etc., coincides with the replacement of the primitive whole-grain stone-milling by the modern steel roller. The United States Government has already made the polishing of rice in the Philippines illegal. Indian corn (*Zea mais*) is largely eaten in north Italy, the Balkan provinces, the southern part of the United States, Brazil, etc. In all these countries pellagra, which affects the skin, digestive organs, and mental powers, is prevalent. The disease could be stamped out by adding to the diet potatoes, one of the cheapest and most practical sources of vitamines. Though the tax of 32*s*. 6*d*. a ton on potatoes has been removed, the U.S. Government has at the same time closed its ports to European potatoes, as a precaution against the introduction of potato diseases, such as Spongospora, though pellagra is on the increase, and American potatoes are becoming dearer.

Rickets, scurvy, osteomalazia, etc., are also deficiency diseases caused by the use, as the main articles of diet, of such vitamineless foods as sterilised milk, condensed milk, cornflours, starch, and sugar. The mixed diet of most people protects them from deficiency diseases.

Vitaminous foods are fresh milk and (though less rich in them) pasteurised milk, whole grains, potatoes, carrots, and other fresh vegetables, lime and other fruit juices, beans, peas, lentils, and the like, meat, beef-tea, barley-water, yeast, and apparently cod liver oil The discovery of vitamines leaves the vexed question of the relative values of white bread, standard bread, etc., where it was, as the heat of the oven, far above that of the autoclave in milk sterilisation, probably destroys the vitamines of the wholemeal bread.

Phaseolus mungo. L. (*P. radiatus*, L.), added to polished rice effectively supplies the removed vitamines, prevents beri-beri, and has long been regarded by the Chinese as a delicacy in the form of vermicelli. A yeast extract is already available for a similar purpose in this climate.

ATMOSPHERIC REFRACTION AND GEODETIC MEASUREMENTS.[1]

AMONGST the many perplexing problems with which geographical surveyors have to deal those which concern the determination of altitude are not the least. For purposes of practical ability, such as the levelling of roads or the laying out of contours and gradients where differential altitude is comparatively small and progressive, existing methods are quite sufficiently scientific and accurate. It is in the determination of the relative altitudes of large geographical features, where angular measurements become necessary, that there arises a series of complications due to variations in the amount and effect of refraction, or in that of the plumb-line deflection, which have been by no means exhaustively investigated, and which introduce errors of an appreciable quantity. These errors are seldom of large practical importance, so that an investigation into their origin and the scientific methods of their dispersion is more or less matter of academic interest to that limited public which concerns itself with mountain altitudes and is generally content to accept the reading of a cheap aneroid as sufficient proof of the correctness of a value determined by triangulation.

By the scientific geodesist, however, Mr. Hunter's investigations will be warmly appreciated. The book before us is No. 14 of the Professional Papers of the Survey of India, and it contains a careful analysis of the chief sources of error which beset the ordinary estimates of the amount and effect of terrestrial refraction. The error due to refraction is usually disposed of by the assumption that the angle of refraction bears a constant ratio to the angle contained by the ray of observation at the centre of the earth. When reciprocal observations can be taken (*i.e.* from A to B, and from B to A) this ratio can be determined, and it is then recorded as the "coefficient of refraction," and is applied to other observations which, not being reciprocal, require to be corrected for the effect of refraction. This method Mr. Hunter calls a "makeshift," and it is with the object of putting the consideration of "angular measurements affected by terrestrial refraction on a more accurate and scientific basis," that he has deduced formulæ from his investigation which, in the concrete form of tabulated corrections, may assist in dispersing the errors arising from variations in the density, temperature, and atmospheric pressure of the air between the station of observation and the point observed. The only assumption which he makes is the natural one that "layers of equal density in the air are concentric with the (circular) section of the earth in the azimuth of the ray," an assumption which includes that of thermal equilibrium. The formulæ derived in chap. i. show that refraction depends very largely on the rate at which temperature changes with the height, and with the change of this rate, as well as on the differential height to which the ray extends. Mr. Hunter confirms the accepted rule that refraction is least in the middle hours of the day, but he further regards its variations as seasonal, *i.e.* it is least in the springtime of the year.

But when all is said and done, it is the errors arising from the deflection of the plumb-line (not always ascertainable at the point of observation), and the possible variation in the actual height of the point observed (common enough in the case of snow-capped peaks), which chiefly affect the accuracy of angular determinations of altitude, and it is probably to these rather than to the unequal conditions affecting the

[1] "Formulæ for Atmospheric Refraction and their Application to Terrestrial Refraction and Geodesy." By J. de Graaff Hunter.

intermediate stratum of air that we must ascribe (*exempli gratia*) the doubt whether Kinchinjunga or K_2 is to hold the honourable position of second in altitude to Everest amongst the world's highest peaks.

T. H. H.

REPORTS OF MUSEUMS.

THE report of the Bristol Museum for the year ending September 30, 1913, records praiseworthy activity, especially in the department of vertebrate zoology. Three plates show how attractively some of the more important specimens are displayed. A tiger shot by the King in Nepal, and presented by his Majesty, has been set up by Messrs. Rowland Ward, in a crouching attitude among bamboo stems, while the background, painted by Mr. Stanley Lloyd, shows the shooting-party approaching on elephants in the distance. Three springboks are placed near the margin of a veldt, on which other animals are browsing; this background was painted by Mr. G. E. Butler. The picturesque group in which pheasants are feeding (harmlessly) in the stubble, is backed by a view of Ashton Park, with the Clifton Suspension Bridge in the distance, composed by Mr. A. Wilde Parsons. This utilisation of really competent artists is an example to be followed. The geological department has not shared in the general progress, and considering the recent work of Vaughan and others in the west of England, this fact is rightly deplored by the committee.

With the aid of local naturalists, the small staff of the Hancock Museum at Newcastle-upon-Tyne has during the past two years accomplished some excellent work. From a 45-ft. Rorqual (*Balaenoptera borealis*) cast ashore near Amble, the complete skeleton, including ear-bones, hyoids, and rudimentary hip-bones, was obtained. The larger bones have been satisfactorily prepared in a sand-pit; but the smaller bones which were macerated as usual in water made so little progress that they have now been transferred to sand. A promising beginning was made with classes from the elementary schools, each of which went through a definite course of six lessons, given by the teachers, who were first rehearsed in the lesson by the curator, Mr. E. L. Gill. Unfortunately this regular system could not be followed in the second year, owing to the overcrowded curriculum of the schools, and the visits are now of small educational value. Perhaps the committee recently appointed by the British Association may devise some scheme that will overcome this difficulty.

The report of the Manchester Museum for the year 1912–13 bears witness to plenty of hard work, but contains nothing of outstanding interest. It is, however, worth reading in order that one may admire the healthy spirit of cooperation as regards museum matters that breathes in Manchester. Representatives of the University, of the City Council, and of subscribers among the outer public, constitute the committe of management. The City Council has increased its grant from 400*l.* to 800*l.* per annum. Professors of the University supervise and aid the museum staff. In the transference of the Egyptian antiquities to the new building, which, with its cases, was provided by Mr. Jesse Haworth, valuable help was given by a number of ladies and gentlemen. Several ladies have maintained a supply of fresh flowers, and at least four other names are mentioned in connection with solid pieces of work of more expert character. To a museum combining so many forces there naturally flow considerable donations, both in money and in kind.

RADIATION OF GAS MOLECULES EXCITED BY LIGHT.

THE first Guthrie lecture of the Physical Society was delivered on February 27, at the Imperial College of Science, South Kensington, by Prof. R. W. Wood, of Johns Hopkins University, Baltimore. The lecture has been established in memory of Prof. F. Guthrie, who was professor of physics in the Royal College of Science, and was founder of the society, the first meeting having been held in his lecture theatre at the college in 1874. Before Prof. Wood's lecture, Prof. G. Carey Foster gave a short biography of Guthrie, who was born in 1833 and died in 1886, and Sir Oliver Lodge recalled some personal reminiscences of him. Prof. Wood's lecture is summarised in the subjoined abstract, published by the Physical Society.

The emission and absorption of light by molecules and the allied phenomenon of dispersion have led us to the conception of something within the atom which is capable of responding to light waves in much the same way as a tuning-fork responds to sound waves of the same frequency as its own, and many mathematical treatments have been built up which explain more or less perfectly many of the phenomena in question. These still leave us very much in the dark as to what is going on. Helmholtz explained absorption by introducing a frictional term into his equations of motion for the atom, and though this led at once to an expression which represented anomalous dispersion, it left us ignorant of how the energy absorbed by the molecules was transformed to heat, or how the mean velocity of the molecules was increased by the excitation of vibrations within them. Planck avoided this difficulty by considering that the energy abstracted from the beam of light is re-emitted, though at the time the only experimental evidence was to be found in selective reflection, which occurs only in liquids and solids.

What becomes of the absorbed energy in the case of a gas? This was what he had been asking himself for many years. While he did not require a working model of the atom, he could not, however, be satisfied by an equation in which absorption was represented by a frictional term or selective reflection predicted by the occurrence of an imaginary quantity.

The problem of the constitution of the atom is one which must be approached from many sides, as it is improbable that any single mode of attack will reveal the secret. The spectroscope alone has proved itself powerless, one great difficulty being that in all known methods of exciting spectra one got "the whole or nothing."

Flames, arcs, sparks, and vacuum-tube discharges set a host of vibrations simultaneously in operation within the atom, and resulted in a complex of lines which were difficult to interpret.

His line of attack had been to maintain the molecules in as calm and tranquil a state as possible, by keeping them cool, and then to excite them to radiation by the application of an alternating electromagnetic field of a definite frequency—usually called monochromatic light. That this method has in some degree simplified matters was proved by the fact that sodium vapour could be made to emit only one of the D lines instead of the usual two.

The conditions necessary to stimulate radiation in this way varied considerably with the nature of the element studied. He would begin, however, with the simplest case, that of a vapour which exhibits a single absorption line and emits radiations similar in every respect to the exciting radiations when stimulated by light of frequency equal to that of the absorption line. This condition was perfectly fulfilled by the vapour of mercury, which has an absorption line at $\lambda=2536$ in the ultra-violet.

If a beam of monochromatic light of this wavelength was focussed at the centre of an exhausted quartz bulb containing a drop of mercury at atmospheric temperature, it was found that the light was powerfully scattered by the vapour, photographs of the bulb made with a quartz lens showing the cone of rays much as if the bulb were filled with smoke. The scattered light is invariably much more homogeneous than the incident beam, in which the "line" has a finite width, whereas the scattered light corresponds only with the centre of this line. The rest gets through the vapour unaffected. With the light thus scattered—the *resonance radiation*—a photograph was made of a quartz bulb containing a minute drop of mercury at room temperature. The bulb appeared as if filled with ink owing to the opacity of the vapour for the rays.

These phenomena, visible only to the camera, can be visually reproduced in the case of sodium vapour excited by the light from a sodium flame. If the density of the vapour is increased by warming it, the distance which the light can penetrate into the bulb is diminished and eventually the resonance radiation is all emitted from a region so close to the surface that it appears as a bright yellow patch on the inner surface of the glass.

If this patch is now used as a lamp, and focussed by a concave mirror on the surface of the same globe (or another in which the vapour is of sufficient density to give the patch effect) so as to fall partly on a surface whitened by deposited magnesia and partly on the enclosed vapour, the brightness of the two contiguous patches thus formed is practically equal.

This proves that, under those conditions, at comparatively low densities, *true absorption does not exist*, the light abstracted from the incident beam being re-emitted as light of the same wave-length but in all directions.

The factor of true absorption makes itself manifest as soon as we admit air or some other foreign gas. Even if the pressure is only a millimetre or two the effect is very marked.

Another point which can be brought out by this method of attack is whether or not the mechanisms the vibration frequencies of which correspond to the various lines in a spectrum are independent of each other or are interconnected.

An ingenious method was described whereby a beam of considerable intensity, consisting, however, of only D_1 or D_2 light, could be obtained, and if the sodium vapour excited by either of these was examined spectroscopically the emitted light contained only that one of the lines which was used to excite it. This shows that the D_1 and D_2 mechanisms are quite independent. In other cases, however, vapours excited by light of any one line of their spectrum gave out a resonance spectrum of that line and one or more others showing that some groups of mechanisms were interdependent and could not be excited separately.

Stimulation by Waves of Very Short Wave-Length.—Experiments were then described in which air, nitrogen, etc., had been caused to emit ultra-violet light when exposed to the action of radiation of wave-length less than the Schumann rays, the smallest waves hitherto known. Schumann rays were completely absorbed by quartz, but would pass through a considerable thickness of fluorite, but the rays to which he referred could be reduced in intensity by 98 per cent. by a plate of fluorite 1 mm. thick.

Nitrogen was more actively stimulated than air by these rays, as oxygen seemed to have a destructive effect on the phenomena. Thus iodine vapour, if mixed with nitrogen, emitted a green light under the action of the rays, while remaining dark if mixed with oxygen.

He urged the necessity of an exact mathematical treatment of the phenomenon of a molecule of vapour re-emitting radiation which it has abstracted from an incident beam, true absorption being absent.

At the conclusion of the lecture a number of interesting experiments illustrative of the subject of the lecture were shown. These included the resonance radiation of sodium stimulated by D light, of iodine vapour stimulated by the light from a quartz-mercury lamp, and of the author's method of extinguishing one of the D lines from the light from a sodium flame.

STRUCTURAL ANALOGIES BETWEEN IGNEOUS ROCKS AND METALS.

IT was in Sheffield that the late Dr. H. C. Sorby lived and worked. It was to the Sheffield Literary and Philosophical Society that, in 1864, Sorby presented the first account of his microscopical examination of the structures of commercial steel. In Sheffield the worth of Sorby's work is now being recognised, and during the presidency of Mr. Arthur Balfour the Sheffield Society of Engineers and Metallurgists, an active and growing society closely associated with the industries of the city, has founded the "Sorby Lecture," to "mark its progress," and to perpetuate the memory of its late honorary member.

The first Sorby Lecture, on February 28, was the occasion for a large gathering of Sheffield's leading manufacturers and citizens at the Cutlers' Hall. The lecture was delivered by Prof. W. G. Fearnsides, the occupant of the Sorby chair of geology at Sheffield University, "On Some Structural Analogies between Igneous Rocks and Metals."

In the first part of the lecture Prof. Fearnsides traced the progressive development of the research by which Sorby, already trained to a knowledge of optics and of chemistry, learned from Williamson the art of making transparent sections of hard objects, and applied it (1849) to the study of rocks. Limestones were the first rocks to claim his attention (1851), then slates (1856), and then igneous rocks (1857), and from these, through meteorites (1862), he was led to study irons (1863–4). The difficulties which Sorby encountered and his patient toil, continued in defiance of indifference and ridicule, were discussed, and it was conjectured that the apathy with which his results were received was due to his own inability to appreciate the difficulties which his refined technique and the vector variations of the optical properties of minerals presented to other people.

The recognition of the value of Sorby's petrographic methods grew gradually through the sixties and seventies of last century, but it was not until after his announcement to the Iron and Steel Institute in 1886, that in the previous year a new microscope had enabled him to see the true composite nature of the "pearly constituent" of steel, that his pioneer work on metals attracted any attention.

It was by a fortunate but unforeseen coincidence that the first Sorby Lecture was delivered within a few days of the fiftieth anniversary of the day on which Sorby read the first of all papers dealing with the micro-structure of commercial metals, and the subject for the lecture was chosen accordingly.

The second part of the lecture dealt with the modern view that igneous rocks and metals are alike products derived by progressive partition of components during the crystallisation of mixed solutions. Being thus homologous in the manner of their origin, it was maintained that a mineralogical nomenclature which is properly applicable to the constituents of igneous rocks is similarly applicable to the constituents of steel; and though a phase rule (temperature-concentration) diagram affords a ready means for the discussion of the behaviour of phases during their partition into other pairs of phases, a metallographic description of their structure modelled on the nomenclature usual in petrography is more manageable when the number of constituents is large.

Special analogies between igneous rocks and metals were suggested. Segregation of the phosphorus and the sulphur in steel ingots was paralleled with "differentiation-*in-situ*" as it occurs in igneous rocks. The time taken in cooling through the temperature range of active crystal growth was shown to control the texture both of igneous rocks and of metals. Viscosity as another factor controlling crystal growth was considered, and the absence of any structures in metals analogous to those developed in viscous rock magmas and in devitrifying glass—*e.g.* "spherulitic structure"—was attributed to essential differences in this respect. "Skeletal crystals," so common in metals, are characteristic of over-rapid growth and as a passing stage in the development of polyhedra are not unknown in rocks.

"Eutectic structures" in metals are like the "graphic" and "pegmatitic" structures of rocks, and their obliteration with slower cooling, both from rocks and metals, was noted.

"Cores" in "mixed crystals" of metals are analogous to "zonary banding" in non-homogeneous isomorphous minerals, and the successive crystallisation of distinct phases above and below a change-point has its parallel in the "corona structure" of some norites.

Partition of solid solutions always at the margins or along the cleavage of pre-existing crystal grains, a process so important in the heat treatment of commercial steels, finds its analogue in the orderly separation of the "schiller constituents" within the minerals of plutonic rocks. "Perthitic structure" in slow-cooled felspars seems to require a similar explanation.

From analogies such as these it was argued that the experience of the geologist may be useful to the metallurgist, and that the knowledge of the structure of metals, which for commercial purposes are manufactured under controlled conditions of temperature and of stress, may provide a key of great adaptability with which, in conjunction with his map, his hammer, and his microscope, the geologist may decipher and interpret the autobiographical secrets of the record contained in the rocks

INDUSTRIAL RESEARCH IN AMERICA.[1]

GERMANY has long been recognised as pre-eminently the country of organised research. The spirit of research is there immanent throughout the entire social structure. This is not the time or place, however, nor is it necessary before this audience, to refer in any detail to the long record of splendid achievement made by German research during the last fifty years. It is inscribed in luminous letters around the rock upon which Germany now stands secure among the nations of the world.

The virility and range of German research were never greater than they are to-day. Never before have the superb energy and calculated audacity of German technical directors and German financiers transformed so quickly and so surely the triumphs of the laboratory into industrial conquests. Never has the future held richer promise of orderly and sustained progress, and yet the pre-eminence of Germany in industrial research is by no means indefinitely assured. A new competitor is even now girding up his loins and training for the race, and that competitor is, strangely enough, the United States—that prodigal among nations, still justly stigmatised as the most wasteful, careless, and improvident of them all.

To one at all familiar with the disdain of scientific teaching which has characterised our industry, and which still persists in many quarters, this statement is so contrary to the current estimate that its general acceptance cannot be expected. It will have served its purpose if it leads to a consideration of the facts which prove the thesis.

The country of Franklin, Morse, and Rumford, of McCormick, Howe, and Whitney, of Edison, Thomson, Westinghouse, and Bell, and of Wilbur and Orville Wright, is obviously a country not wholly hostile to industrial research or unable to apply it to good purpose. It is, however, not surprising that with vast areas of virgin soil of which a share might be had for the asking, with interminable stretches of stately forest, with coal and oil and gas, the ores of metals, and countless other gifts of nature scattered broadcast by her lavish hand, our people entered upon this rich inheritance with the spirit of the spendthrift, and gave little heed to refinements in methods of production and less to minimising waste. That day and generation are gone. To-day their children, partly through better recognition of potential values, but mainly by the pressure of a greatly increased population and the stress of competition between themselves and in the markets of the world, are rapidly acquiring the knowledge that efficiency of production is a sounder basis for prosperity than mere volume of product, however great.

The long-continued and highly organised research which resulted in the development of American agricultural machinery has led to the general introduction of machines which reduce the labour cost of seven crops 681,000,000 dollars, as measured by the methods of only fifty years ago.

You need not to be reminded that the ubiquitous telephone is wholly a product of American research. Munchausen's story of the frozen conversation which afterward thawed out is a clumsy fable. Think of the Niagaras of speech pouring silently through the New York telephone exchanges where they are sorted out, given a new direction, and delivered audibly perhaps a thousand miles away. New York has 450,000 instruments—twice the number of those in London. Los Angeles has a telephone to every four inhabitants. Why should one care to project one's astral body when he can call up from the club in fifteen seconds? Our whole social structure has been reorganised. We have been brought together in a single parlour for conversation and to conduct affairs, because the American Telephone and Telegraph Company spends annually for research, the results of which are all about us, a sum greater than the total income of many universities.

The name of Edison is a household word in every language. The Edison method is a synonym for specialised, intense research, which knows no rest until everything has been tried. Because of that method and the unique genius which directs its application, Italian operas are heard amid Alaskan snows and in the depths of African forests; every phase of life and movement of interest throughout the world is caught, registered, transported, and reproduced, that we may have lion hunts in our drawing-rooms and the coronation in a five-cent theatre. From his laboratory have come the incandescent lamp, multiple

[1] From the presidential address delivered before the American Chemical Society at Rochester, New York, September 9, 1913, by Arthur D. Little.

telegraphy, new methods of treating ores, and a thousand other diverse inventions, the development of a single one of which has sometimes involved millions.

Such development as that of the automobile industry in America has been based upon and vitalised by an immeasurable amount of research, the range and influence of which extend through many other industries. It has accelerated the application of heat treatment more than any other agency. One tyre manufacturer spends 100,000 dollars a year upon his laboratory. The research department organised by my associates for one automobile company comprised within its staff experts in automobile design, mathematics, metallography, and heat treatments, lubrication, gaseous fuels, steel and alloys, paints and painting practice, in addition to the chemists and physicists and assistants for routine or special work.

The beautiful city the hospitality of which has so greatly added to the pleasure and success of the present meeting of our society is the home of two highly scientific industries of which any community may well be proud. The Bausch and Lomb Optical Company, through its close affiliation with the world-famed Zeiss works at Jena, renders immediately available in this country the latest results of German optical research. The Eastman Kodak Company is perhaps more generally and widely known than even the Zeiss works, and in capital, organisation, value of product, and profit of operation will bear comparison with the great German companies whose business is applied science. Like them, it spends money with a lavish hand for the promotion of technical research and for the fundamental investigation of the scientific bases on which its industry rests. As you have happily been made aware, this work is carried on in the superb new research laboratories of the company with an equipment which is probably unrivalled anywhere for its special purposes. The laboratory exemplifies a notable feature of American industrial research laboratories in that it makes provision for developing new processes, first on the laboratory scale and then on the miniature factory scale.

To no chapter in the history of industrial research can Americans turn with greater pride than to the one which contains the epic of the electrochemical development at Niagara Falls. It starts with the wonderful story of aluminium. Discovered in Germany in 1828 by Wöhler, it cost 90 dollars a pound in 1855. In 1886 it had fallen to 12 dollars. The American Castner process brought the price in 1889 to 4 dollars. Even at this figure, it was obviously still a metal of luxury with few industrial applications. Simultaneously Hall in America and Heroult in Europe discovered that cryolite, a double fluoride of sodium and aluminium, fused readily at a moderate temperature, and, when so fused, dissolved alumina as boiling water dissolves sugar or salt, and to the extent of more than 25 per cent. By electrolysing the fused solution, aluminium is obtained.

On August 26, 1895, the Niagara works of the Pittsburgh Reduction Company started at Niagara Falls the manufacture of aluminium under the Hall patents. In 1911 the market price of the metal was 22 cents, and the total annual production 40,000,000 lb.

A chance remark by Dr. George F. Kunz in 1880 on the industrial value of abrasives turned the thoughts of Acheson to the problem of their artificial production, and led to the discovery in 1891 of carborundum and its subsequent manufacture on a small scale at Monongahela City, Pennsylvania. In 1894 Acheson laid before his directors a scheme for moving to Niagara Falls—to quote his own words:—

"To build a plant for 1000 horse-power, in view of the fact that we were selling only one-half of the output from a 134 horse-power plant, was a trifle too much for my conservative directors, and they one and all resigned. Fortunately, I was in control of the destiny of the Carborundum Company. I organised a new board, proceeded with my plans, and in the year 1904, the thirteenth from the date of the discovery, had a plant equipped with a 5000 electrical horse-power, and produced more than 7,000,000 lb. of those specks I had picked off the end of the electric light carbon in the spring of 1891."

The commercial development of carborundum had not proceeded far before Acheson brought out his process for the electric furnace production of artificial graphite and another great Niagara industry was founded. In quick succession came the Willson process for calcium carbide and the industrial applications of acetylene, phosphorus, ferro-alloys made in the electric furnace, metallic sodium, chlorine, and caustic soda, first by the Castner process, later by the extraordinarily efficient Townsend cell, electrolytic chlorates and alundum.

Perhaps even more significant than any of these great industrial successes was the Lovejoy and Bradley plant for the fixation of atmospheric nitrogen, which was perforce abandoned. It is well to recall, in view of that reputed failure, that the present-day processes for fixing nitrogen have made little, if any, improvement in yields of fixed nitrogen in a kilowatt hour over those obtained in this pioneer Niagara plant.

In the year 1800 a young assistant of Lavoisier, E. I. du Pont by name, emigrated to the United States, with others of his family, and settled on the banks of the Brandywine, near Wilmington, Delaware. He engaged in the manufacture of gunpowder. To-day the du Pont Company employs about 250 trained chemists. Its chemical department comprises three divisions: the field division for the study of problems which must be investigated outside the laboratory, and which maintains upon its staff experts for each manufacturing activity, together with a force of chemists at each plant for routine laboratory work; second, the experimental station, which comprises a group of laboratories for research work on the problems arising in connection with the manufacture of black and smokeless powder, and the investigation of problems or new processes originating outside the company; third, the Eastern Laboratory which confines itself to research concerned with high explosives. Its equipment is housed in seventy-six buildings, the majority being of considerable size, spread over fifty acres. Since no industrial research laboratory can be called successful which does not in due time pay its way, it is pleasant to record that the Eastern Laboratory is estimated to yield a profit to its company of 1,000,000 dollars a year. In addition to the generous salaries paid for the high-class service demanded by the company, conspicuous success in research is rewarded by bonus payments of stock.

The Gayley invention of the dry air blast in the manufacture of iron involves a saving to the American people of from 15,000,000 dollars to 29,000,000 dollars annually. A modern furnace consumes about 40,000 cubic feet of air a minute. Each grain of moisture in a cubic foot represents one gallon of water an hour for each 1000 cubic feet entering a minute. In the Pittsburgh district the moisture varies from 1·83 grains in February to 5·94 grains in June, and the water an hour entering a furnace varies accordingly from 73 to 237 gallons. In a month a furnace using natural air received 164,500 gallons of water, whereas with the dry blast it received only 25,524 gallons. A conservative statement, according to Prof. Chandler, is that the invention results in a 10 per cent. increase in output and a 10 per cent. saving in fuel.

Especially notable and picturesque among the triumphs of American industrial research is that by means of which Frasch gave to the United States potential control of the sulphur industry of the world. There is in Calcasieu Parish, Louisiana, a great deposit of sulphur 1000 ft. below the surface under a layer of quicksand 500 ft. in thickness. An Austrian company, a French company, and numerous American companies had tried in many ingenious ways to work this deposit, but had invariably failed. Misfortune and disaster to all connected with it had been the record of the deposit to the time when Frasch approached its problem in 1890. He conceived the idea of melting the sulphur in place by superheated water forced down a boring, and pumping the sulphur up through an inner tube. In his first trial he made use of twenty 150-h.p. boilers grouped around the well, and the titanic experiment was successful. The pumps are now discarded, and the sulphur brought to the surface by compressed air. A single well produces about 450 tons a day, and their combined capacity exceeds the sulphur consumption of the world.

An equally notable solution of a technical problem which had long baffled other investigators is the Frasch process for refining the crude, sulphur-bearing Canadian and Ohio oils. The essence of the invention consists in distilling the different products of the fractional distillation of the crude oil with metallic oxides, especially oxide of copper, by which the sulphur is completely removed, while the oils distill over as odourless and sweet as from the best Pennsylvania oil. The copper sulphide is roasted to regenerate the copper. The invention had immense pecuniary value. It sent the production of the Ohio fields to 90,000 barrels a day, and the price of crude Ohio oil from 14 cents a barrel to one dollar.

Turning from these examples of individual achievement so strongly characteristic of the genius of our people in one aspect, let us again consider for a moment that other and even more significant phase of our industrial research, namely, that which involves the coordinated and long-continued effort of many chemists along related lines.

Chemistry in America is essentially republican and pragmatic. Most of us believe that the doctrine science for science's sake is as meaningless and mischievous as that of art for art's sake or literature for literature's sake. These things were made for man, not for themselves, nor was man made for them. Most of us are beginning to realise that the major problems of applied chemistry are incomparably harder of solution than the problems of pure chemistry, and the attack, moreover, must often be carried to conclusion at close quarters under the stress and strain induced by time and money factors. In these circumstances it should not excite surprise that a constantly rising proportion of our best research is carried on in the laboratories of our great industrial corporations, and nowhere more effectively than in the research laboratory of the General Electric Company, under the guidance of your past president, Dr. Whitney.

Any attempt to present adequately the enormous volume of research work, much of which is of the highest grade, constantly in progress in the many scientific bureaus and special laboratories of the general government, or even to indicate its actual extent and range, is utterly beyond the limits of my attainments or of your patience. The generous policy of the Government toward research is unique in this, that the results are immediately made available to the whole people.

The United States is still essentially an agricultural country, and agriculture is, in its ultimate terms, applied photochemistry. The value of our farm property is already more than 42,000,000,000 dollars, and each sunrise sees an added increment of millions. Even small advances in agricultural practice bring enormous monetary returns.

Chief, therefore, among the government departments, in the volume of industrial research is the Department of Agriculture, which includes within its organisation ten great scientific bureaus, each inspired by an intense pragmatism and aggressively prosecuting research in its allotted field.

The research work of the Department of Agriculture is greatly augmented and given local application through the agency of sixty-four State agricultural experiment stations, established for the scientific investigation of problems relating to agriculture. These stations are supported in part by federal grants, as from the Hatch and Adams funds, and for the rest by State appropriations. Their present income exceeds 3,000,000 dollars. All are well equipped; one of them, California, includes within its plant a superb estate of 5400 acres, with buildings worth 1,000,000 dollars.

It may be said without fear of contradiction that through the combined efforts of the Department of Agriculture, the experiment stations, the agricultural colleges, and our manufacturers of agricultural machinery, there is devoted to American agriculture a far greater amount of scientific research and effort than is at the service of any other business in the world.

In the United States Patent Office Dr. Hall has developed a remarkably comprehensive index to chemical literature, which now contains 1,250,000 cards, and is open to every worker. The Bureau of Fisheries devotes 40,000 dollars to a single study, and the Geological Survey 100,000 dollars to the investigation of the mineral resources of Alaska.

The Bureau of Mines of the Department of the Interior was established to conduct on behalf of the public welfare fundamental inquiries and investigations into the mining, metallurgical, and mineral industries. Its appropriation for the current fiscal year is 662,000 dollars, of which 347,000 dollars is to be devoted to technical research pertinent to the mining industry.

Perhaps no better evidence could be adduced of the present range and volume of industrial research in America than the necessity, imposed upon the author of such a general survey as I am attempting, of condensing within a paragraph his reference to the Bureau of Standards of the Department of Commerce. Its purpose is the investigation and testing of standards and measuring instruments, and the determination of physical constants and the properties of materials. To these objects it devotes about 700,000 dollars a year to such good effect that in equipment and in the high quality and output of its work it has in ten years taken rank with the foremost scientific institutions in the world for the promotion of industrial research and the development and standardisation of the instruments, materials, and methods therein employed. Its influence upon American research and industry is already profound and rapidly extending.

I cannot better conclude this cursory and fragmentary reference to governmental work in applied science than with the words of the distinguished director of the Bureau of Standards:—

"If there is one thing above all others for which the activities of our Government during the past two or three decades will be marked, it is its original work along scientific lines, and I venture to state that this work is just in its infancy."

The present vitality and rate of progress in American industrial research is strikingly illustrated by its very recent development in special industries. It has been said that our best research is carried on in those laboratories which have one client, and that one themselves.

Twenty-five years ago the number of industrial concerns employing even a single chemist was very small, and even he was usually engaged almost wholly upon routine work. Many concerns engaged in business of a distinctly chemical nature had no chemist at all, and such a thing as industrial research in any proper sense scarcely came within the field of vision of our manufacturers. Many of them have not yet emerged from the penumbra of that eclipse, and our industrial foremen as a class are still within the deeper shadow. Meantime, however, research has firmly established itself among the foundation-stones of our industrial system, and the question is no longer what will become of the chemists. It is now what will become of the manufacturers without them.

In the United States to-day the microscope is in daily use in the examination of metals and alloys in more than 200 laboratories of large industrial concerns. An indeterminate but very great amount of segregated research is constantly carried forward in small laboratories, which are either an element in some industrial organisation or under individual control. An excellent example of the quality of work to be credited to the former is found in the development of cellulose acetate by Mork in the laboratory of the Chemical Products Company, while a classic instance of what may be accomplished by an aggressive individualism plus genius in research is familiar to most of you through the myriad and protean applications of Bakelite. The rapidity of the reduction to practice of Baekeland's research results is the more amazing when one considers that the distances to be travelled between the laboratory and the plant are often, in case of new processes and products, of almost astronomical dimensions.

Reference has already been made to the highly organised, munificently equipped, and splendidly manned laboratories of the Du Pont Company, the General Electric Company, and the Eastman Kodak Company. There are in the country at least fifty other notable laboratories engaged in industrial research in special industries. The expenditure of several of them is more than 300,000 dollars each a year. The United States Steel Corporation has not hesitated to spend that amount upon a single research, and the expenses of a dozen or more laboratories probably exceed 100,000 dollars annually. One of the finest iron research laboratories in the world is that of the American Rolling Mills Company.

The steel industry in its many ramifications promotes an immense amount of research, ranging from the most refined studies in metallography to experimentation upon the gigantic scale required for the development of the Gayley dry blast, the Whiting process for slag cement, or the South Chicago electric furnace. This furnace has probably operated upon a greater variety of products than any other electric furnace in the world. Regarding the steel for rails produced therein, it is gratifying to note that after two and one-half years or more no reports of breakage have been received from the 5600 tons of standard rails made from its output.

Industrial research is applied idealism. It expects rebuffs, it learns from every stumble, and turns the stumbling-block into a stepping-stone. It knows that it must pay its way. It contends that theory springs from practice. It trusts the scientific imagination, knowing it to be simply logic in flight. It believes with F. P. Fish, that "during the next generation—the next two generations—there is going to be a development in chemistry which will far surpass in its importance and value to the human race that of electricity in the last few years—a development which is going to revolutionise methods of manufacture, and more than that, is going to revolutionise methods of agriculture"; and it believes with Sir William Ramsay that "the country which is in advance in chemistry will also be foremost in wealth and general prosperity."

Modern progress can no longer depend upon accidental discoveries. Each advance in industrial science must be studied, organised, and fought like a military campaign. Or, to change the figure, in the early days of our science, chemists patrolled the shores of the great ocean of the unknown, and, seizing upon such fragments of truth as drifted in within their reach, turned them to the enrichment of the intellectual and material life of the community. Later they ventured timidly to launch the frail and often leaky canoe of hypothesis, and returned with richer treasures. To-day, confident and resourceful, as the result of many argosies, and having learned to read the stars, organised, equipped, they set sail boldly on a charted sea in staunch ships with tiering canvas bound for new El Dorados.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—The City Council has renewed the annual grant to the University. An amendment by a Socialist member opposing the renewal, on the ground that the elementary education of the city and the technical school were being starved, was defeated by seventy votes to twenty-nine.

Dr. J. E. H. Sawyer has been appointed assistant to the chair of medicine.

Mr. H. A. Scarborough has been recommended to the Commissioners of the Exhibition of 1851 for a research scholarship.

Prof. Bostock Hill is to represent the University at the congress of the Royal Sanitary Institute in July next.

CAMBRIDGE.—The work submitted by Mr. T. W. Price, of Clare College, entitled "Osmotic Pressure of Alcoholic Solutions," has been approved by the Degree Committee of the Special Board for Physics and Chemistry as a record of original research.

OXFORD.—Under the existing constitution of the University, certain seats in the Hebdomadal Council are limited to the heads of colleges and professors respectively. A statute providing for the abolition of "orders" and for throwing the whole of the seats open to members of Convocation of five years' standing, which had been passed by small majorities in Congregation, was submitted in its final stage to Convocation on March 10. The proposed statute was supported by Prof. Geldart, and opposed by the rector of Exeter, and the warden of Wadham. It was rejected on a division by 97 to 83.

The preamble of a statute providing for the establishment of an additional professorship of chemistry, to be called "Dr. Lee's Professorship," passed Congregation without a division.

THE presentation of the portrait of Sir William Ramsay, K.C.B., to University College, London, and of the replica to Lady Ramsay, will be made on Wednesday next, March 18, at 4.30, in the Botanical Theatre.

THE appeal made by Girton College for 8000*l*. by January 1, 1914, to meet conditional promises of 12,000*l*. from an anonymous benefactor and 4000*l*. from Rosalind Lady Carlisle, has been completely successful, and the purpose of the appeal, which was the extinction of a mortgage debt of 24,000*l*., has now been achieved. The donation, we learn from the

Times, included 1000*l.* from the Drapers' Company and 500*l.* from the Clothworkers' Company.

THE presidency of Johns Hopkins University, Baltimore, which has been vacant since the resignation of Dr. Ira Remsen in 1912, has been filled by the appointment of Dr. Frank J. Goodnow, recently professor of administrative law at Columbia University, New York. In choosing an expert in this subject to succeed a chemist, Johns Hopkins has precisely followed the example of Harvard a few years ago, when Prof. A. Lawrence Lowell took the place of Dr. C. W. Eliot.

THE Local Lectures Summer Meeting will be held this year at the University of Cambridge on July 31–August 24. The new University examination halls and lecture-rooms will be used. The inaugural lecture will be delivered at 8 p.m. on July 31 by Sir J. J. Thomson. The lectures will be grouped round the general subject, "Some Aspects of Modern Life," and among the courses announced we notice one by Dr. L. Doncaster on heredity in animals and man. Forms of entry and further information about the meetings will be supplied by the Rev. Dr. Cranage, Syndicate Buildings, Cambridge.

LAST year Messrs. Harrods, Ltd., established a scheme of scholarships providing the holders with a year's training at their stores in commercial English, handwriting, arithmetic, French or Spanish, shorthand, typewriting, business routine, and salesmanship, with free meals. The scholarships are awarded on the nomination of shareholders; the nominees must be between the ages of fifteen and eighteen years, have had a fair education, and be able to pass a medical examination. They will secure a commercial education in which practice and theory will be combined; for the mornings are given to class instruction, and the afternoons to work in the departments, the holder of a scholarship being attached to a different department each month. This arrangement has worked admirably during the past year. Fifty scholarships will be available in September next, and the test examination for the nominees will be held in June or July. Messrs. Harrods' enterprise in establishing this system of training young people in the principles and practice of business-building is to be commended, and we believe it will achieve notable success.

AN article in the *Westminster Gazette* of March 3, by the Berlin correspondent of our contemporary, reveals a growing demand in Germany for more universities. It is alleged that existing universities are overcrowded owing chiefly to the invasion of foreign and of women students, and the more general need of university education for officials. The number of such institutions is smaller than it was a century ago. Cologne, Trier, Duisburg, Helmstedt, Wittenberg, Frankfurt-on-Oder, Mainz, Erfurt, Altdorf, and Ingolstadt have all been university towns. Since the empire was founded the number of students has increased fourfold. In 1880 there were 30,000 students; in 1905, 42,000; and last year more than 60,000. There are 5300 foreign and 3500 women students, and about 4000 non-student auditors. The agitation for new universities came to a head last year when Hamburg, Frankfurt-on-Main, Dresden, Posen, Cologne, and some smaller towns proposed to establish universities. The impulse in some cases was the desire of existing special and technical high schools to expand into universities with full university status, but with a reduced number of faculties. The advocates of new universities complain that the universities have recognised with ill-will the increasing specialisation of science; and that specialisation is now hopelessly ahead of them. Some reformers want not only specialisation within universities, but specialisation of the institutions themselves. Each university, while keeping its faculties and its general culture system, should aim at a predominant position in a particular branch of science; and should be specially well supplied with professorial chairs, seminaries, libraries, and collections bearing on its speciality.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 5.—Sir William Crookes, president, in the chair.—Harold **Wager**: The action of light on chlorophyll. When chlorophyll is decomposed by light, at least two distinct substances are formed, one of which is an aldehyde or mixture of aldehydes, and the other an active oxidising agent, capable of bringing about the liberation of iodine from potassium iodide. The decomposition of chlorophyll appears to be due directly to the action of light and is not an after effect of the photo-synthesis of carbon dioxide and water. It takes place only in the presence of oxygen, and it appears to be a case of photo-oxidation, for oxygen is used up so completely in the process that chlorophyll can be used instead of pyrogallol and caustic potash to determine the amount of oxygen in a given amount of air. In the absence of oxygen no bleaching takes place. Carbon dioxide is not necessary to the photo-decomposition of chlorophyll and is not used up in the process, even when present in considerable quantities.—C. H. **Warner**: Formaldehyde as an oxidation product of chlorophyll extracts.—Franklin **Kidd**: The controlling influence of carbon dioxide in the maturation, dormancy, and germination of seeds. Experiments are described showing that germination of seeds can be completely inhibited by carbon dioxide in the atmosphere (20–30 per cent., varying with the temperatures used). This inhibition is not accompanied by injury. The seeds germinate at once after removal from inhibitory CO_2 pressures. Experiments in the field showed that this action of CO_2 may actually occur in nature. If a quantity of green plant material is buried deep in the ground, seeds planted in the soil over this decaying material are inhibited in their germination by the CO_2 produced beneath them. This is of agricultural significance, and the fact that in the case of mustard seeds suspension of vitality continues, even after the external CO_2 has been removed, suggests an explanation of the common occurrence of dormant seeds of this plant in fields, and possibly of other natural cases of delayed germination.—J. **Hammond** and F. H. A. **Marshall**: The functional correlation between the ovaries, uterus, and mammary glands in the rabbit; with observations on the œstrous cycle.—Dr. J. F. **Gaskell**: The chromaffine system of annelids and the relation of this system to the contractile vascular system in the leech, *Hirudo medicinalis*. The possession of a chromaffine system, consisting of cells which take a yellow stain with chrome salts, is a common property of almost all members of the vertebrate kingdom. The presence of this reaction is coincident with the secretion of the pressor substance, adrenalin, and is probably dependent upon it. Even in the lowest vertebrate, Petromyzon, the system is well developed, being diffusely though segmentally arranged throughout the body. Chromaffine cells have also been observed in certain annelids by Sommet and Poll, reaching their highest development in the Hirudinea; the reaction is given by six nerve cells in each segmental ganglion. The conclusion is drawn that the contractile vascular system of vertebrates and its regulators, the chromaffine system and the sympathetic system, originally arose together in the annelid group.

Institution of Mining and Metallurgy, February 19.—Mr. Bedford McNeill, president, in the chair.—H. W. **Hutchin**: The assay of tin ores. The work recorded in this paper is the result of a prolonged use and study by the author of the well-known Beringer assay of tin ores, and the essential modification introduced consists in the use of lime as a diluent in place of zinc oxide, thus forming calcium stannate, which is more readily soluble in warm hydrochloric acid than is zinc stannate. Temperature influences the speed of the reaction, and the author's detailed experiments showed that the lime modification method was appreciably quicker than the zinc oxide method at "tin furnace" temperatures. Experiments made with diluents other than those already mentioned, as, for instance, barium carbonate and magnesia, showed the general superiority of lime, except in cases where only a small proportion of siliceous mineral is present, in which event zinc oxide shows a superiority to lime. The tests made were varied by differentiating between "tin furnace" and Bunsen burner temperatures, and the author's final opinion is in favour of a large Techlu burner used in conjunction with an asbestos boss, as giving the best conditions for ignition.—E. A. **Wraight** and P. Litherland **Teed**: The assay of tin ores and concentrates: the Pearce Low method. The authors have carried out an exhaustive series of tests with regard to the accuracy of this particular method of assaying tin, the results of which are embodied in their joint paper. As a result they arrived at the following conclusions. The degree of fineness of the ore must be at least 100 mesh, otherwise a representative sample cannot be obtained; nickel crucibles are superior to iron ones, and for tailings fusion in an iron crucible should be avoided; the amount of hydrochloric acid should be about 125 c.c.; the bulk of the solution before reduction should be about 400 c.c.; the temperature of the tin solution at titration should not be more than 70° F.; the strength of the standard solution should not generally be more than 11 grams of iodine and 20 grams of potassium iodide per litre, or less than one-third of that strength; before titration the calcite should have entirely dissolved; titanium, tungsten, and bismuth must be removed, and copper and iron should in special circumstances also be removed before titration; and nickel should always be used for reduction. With the observance of these precautions, the authors are of the opinion that the error should not exceed 2 lb. of black tin a ton with rich ores, and less with poor ores.—W. P. **Dreaper**: Formation of mineral deposits: precipitation and stratification in the absence of gels. This paper is a record of experiments made to determine whether the presence of gels is necessary to induce stratification, and for this purpose precipitation was conducted in capillary tubes, thereby avoiding certain disturbing influences. Under these conditions the author has been able to obtain stratification effects in the absence of secondary gels added to one of the reacting solutions. The substances experimented with comprised lead chloride, lead ferrocyanide, lead sulphate, barium sulphate, barium carbonate, and lead sulphide, and the results seem to show that stratification may be independent of the presence of gels.—T. R. **Archbold**: A device for filling ore sacks. This is a description of a simple device introduced in an out-of-the-way district for filling sacks with ore. A drum is divided into six compartments, and used in conjunction with a hopper, in such a manner that the revolutions of the drum serve to fill the compartments with a fixed amount of ore and deliver it into the sacks, six sacks being dealt with in each complete revolution.—E. O. **Marks**: A mining model. A description of a model constructed of iron, copper, and brass wire to show the direction and the extent of the workings of a mine. For convenience the block of ground is divided into unit sections of 1000 ft. cube, reduced in the model to a scale of 100 ft. to the inch, and the skeleton cubes representing these units are successively fitted with brass and copper wires showing the direction and length of shafts, levels, crosscuts, etc. The advantage of a model of this type, apart from its graphic character, lies in the ease of extension as the mine undergoes development.

Zoological Society, March 3.—Prof. E. W. MacBride, vice-president, in the chair.—C. Tate **Regan**: Freshwater fishes from Dutch New Guinea collected by the British Ornithologists' Union and Wollaston Expeditions. *Symbranchus bengalensis* was obtained for the first time in New Guinea. The collections included examples of two species of Melanotæniine Atherinids.—H. Wallis **Kew**: The nests of Pseudoscorpiones: with historical notes on the spinning-organs and observations on the building and spinning of the nests. The paper described the nests in which these animals enclose themselves for moulting, for brood purposes, and in some cases for hibernation. They are closed cells of spun tissue, with or without a covering of earthy or vegetable matters. The tissue is of innumerable threads crossed and coalesced irregularly, without interspaces, and almost like silk-paper. With regard to the spinning-apparatus, confusion has existed; but the author's observations on living animals place it beyond doubt that the cephalothoracic glands are the organs concerned. Contrary to previous statements, the "combs" of the chelicerae have nothing to do with the silk. The manner in which the nests are built and spun was described in detail.—H. R. **Hogg**: A collection of spiders. The collection was made by Mr. P. D. Montague, supplemented by a few specimens sent by Mr. T. H. Haynes from the Montebello Islands off Onslow, on the north-west coast of Australia. These islands, from geological evidence, were part of the old coast-lines, though now about ninety miles away. Although the larger specimens are mostly widely spread and possibly more or less recent importations, the smaller are nearly all new species, showing evidence of a much longer separation from their congeneric relations on the mainland. Out of seventeen species ten are new, as well as a new genus and two new varieties.—D. M. S. **Watson**: The skull of a Pariasaurian reptile and the relationships of that type. The skull of Pariasaurus is completely described, with the exception of the bony labyrinth of the ear. It is compared with all the members of the order Cotylosauria, which are well enough known to make a comparison of any value, and shown to differ in the very important characters of the brain-case from all of them, representing an entirely distinct branch.—F. J. **Meggitt**: A tapeworm parasitic in the stickleback (*Gasterosteus aculeatus*).—Dr. W. **Nicoll**: Trematode parasites obtained from animals that died in the society's gardens during 1911–12.

PARIS.

Academy of Sciences, March 2.—M. P. Appell in the chair.—F. **Wallerant**: The polymorphism of camphor. Crystals of camphor deposited at the ordinary temperature from an alcoholic solution are rhombohedral. Fused camphor may take three crystalline forms, so that camphor is at least quadrimorphous.—C. **Moureu** and A. **Lepape**: The helium from fire-damp and the radio-activity of coal. Fire-damp from Anzin has been previously shown by the authors to contain 0·04 per cent. of helium, and as the amount of crude gas evolved a day is estimated at 30,000 cubic metres, this corresponds to 12 cubic metres of helium a day. The amounts of radium and thorium in the ash of the coal have been determined, in this and other coals yielding fire-damp containing helium, and do not correspond to such large proportions of helium. The larger part of the gas is not derived from the radio-active material of the coal, and must be regarded as fossil helium.—André **Blondel**: The effect and production of the higher harmonics in the transport of electrical energy at high potentials.—P. **Sabatier** and A. **Mailhe**: The ester oxides of carvacrol. A study of the direct dehydration of carvacrol by the action of thorium oxide upon the vapour at temperatures between 400° and 500° C.—M. **Gambier**: Algebraic curves of constant torsion, real and not unicursal.—F. **Jager**: The application of the method of Fredholm to the tides of a basin limited by vertical walls.—E. **Mazurkiewicz** and W. **Sierpinski**: An ensemble superposable with each of its two parts.—A. **Pchéborski**: A generalisation of a problem of Tchébischeff and of Zolotareff.—C. **Gutton**: The specific inductive capacity of liquids. According to Voigt's hypothesis, the force which acts on an electron deviated from its equilibrium position in an electric field should not be exactly proportional to the deviation, and hence the specific inductive capacity ought to depend on the intensity of the field. In measurements made with toluene the deviations observed in the specific inductive capacity were of the same order as the experimental error. A slight diminution with increase of field was noticed with bromonapththalene, 4·72 to 4·69.—Maurice **de Broglie**: The spectra of the Röntgen rays. Rays emitted by antikathodes of copper, iron and gold.—J. de **Kowalski**: An explosive luminous phenomenon in rarefied nitrogen. The author confirms the observations of Strutt that nitrogen free from the smallest trace of oxygen is transformed into active nitrogen in a discharge in electrodeless tubes. A curious explosive phenomenon is described which is attributed to a temporary combination between the active nitrogen and traces of mercury vapour unavoidably present to form mercury nitride, the latter decomposing spontaneously.—H. **Labrouste**: A molecular transformation of thin layers on water.—F. **Baud**, F. **Ducelliez**, and L. **Gay**: A calorimetric study of the system water-monomethylamine.—H. **Gault**: A new method of preparation of tricarballylic acid. Oxalocitric lactone cannot be distilled under reduced pressure without decomposition. The liquid obtained by distillation is not, as was supposed by Wislicenus and Beckh, the unchanged lactone, but proves to be ethyl $\alpha\alpha\beta\gamma$-propane-tetracarboxylate. With dilute mineral acids a quantitative yield of crystalline tricarballylic acid is obtained.—Enrique **Hauser**: A new method for the detection and determination of gaseous hydrocarbons dissolved in mineral waters. After adding potash to the water it is shaken with air and the latter analysed.—M. **Piettre** and A. **Vila**: Observations on fibrinogen and the oxalated plasma.—W. **Kopaczewski**: The influence of acids on the activity of dialysed maltase. The observed effects cannot be explained exclusively by the concentration of the acid ions.—Mlle. Jeanne **Weill**: The amount of fatty acids and cholesterol in the tissues of cold-blooded animals.—Paul **Fallot**: The tectonic of the sierra of Majorca.—Emile **Belot**: An attempt at a physical theory of the formation of the oceans and primitive continents.—F. **Malméjac**: The importance of the estimation of chlorides for the control and evaluation of drinking water.—A. **Boutaric**: The thermal state of the atmosphere.

BOOKS RECEIVED.

Om Forandringer i Ringkobing Fjords Fauna. By A. C. Johansen. Pp. 144. (Kobenhavn: Bianco Lunos Bogtrykkeri.)

Wissenschaftliche Ergebnisse der Deutschen Zentral-Afrika-Expedition, 1907–8. Band v. Zoologie iii. Lief. 1. Orthoptera. By J. A. G. Rehn. Pp. 223. (Leipzig: Klinkhardt und Biermann.) 8.40 marks.

Albin Haller. Biographie, Bibliographie Analytique des Écrits. By E. Lebon. Pp. 120. (Paris: Gauthier-Villars; Masson et Cie.) 7 francs.

Cours de Physique. By Prof. E. Rothe. Première Partie. Généralités—Unites—Similitude—Mesures. Pp. vi+183. (Paris: Gauthier-Villars.) 6.50 francs.

Theorie Mathematique de l'Echelle Musicale. By A. Vaucher. Pp. 68. (Paris: Gauthier-Villars.) 2.25 Francs.

The Fleet Annual and Naval Year Book, 1914. Compiled by L. Yexley. Pp. 135. (London: The Fleet, Ltd.) 1*s*. net.

Progress of Education in India, 1907–12. By H. Sharp. Vol. i. Pp. xvii+284+xxxii. (Calcutta: Superintendent Government Printing, India.) 6*s*.

The Pigments and Mediums of the Old Masters. By Prof. A. P. Laurie. Pp. xiv+192+xxxiv plates. (London: Macmillan and Co., Ltd.) 8*s*. 6*d*. net.

Intermetallic Compounds. By Dr. C. H. Desch. Pp. vi+116. (London: Longmans and Co.) 3*s*. net.

Die Theorie der Strahlung und der Quanten. Edited by A. Eucken. Pp. xii+405. (Halle a. S.: W. Knapp.) 15.60 marks.

Industrial Chemistry for Engineering Students. By Prof. H. K. Benson. Pp. xiv+431. (London: Macmillan and Co., Ltd.) 8*s*. net.

The Mineral Resources of the Philippine Islands for the Year 1912. Pp. 76+vii plates. (Manila: Bureau of Science.)

Careers for University Men. By H. A. Roberts. Pp. 22. (Cambridge: Bowes and Bowes; London: Macmillan and Co., Ltd.) 6*d*. net.

The Principles of War Historically Illustrated. By Major-General E. A. Altham. Vol. i. Pp. xv+436, and 5 maps to illustrate the volume. (London: Macmillan and Co., Ltd.) 10*s*. 6*d*. net.

Anthropology as a Practical Science. By Sir R. C. Temple. Pp. 96. (London: G. Bell and Sons, Ltd.) 1*s*. net.

Die Stoffwanderung in ablehenden Blattern. By Dr. N. Swart. Pp. 118+v plates. (Jena: G. Fischer.) 6 marks.

Kristallberechnung und Kristallzeichnung. By Dr. B. Gossner. Pp. vi+128 (Leipzig und Berlin: W. Engelmann.) 8 marks.

Muscular Work. By F. G. Benedict and E. P. Cathcart. Pp. vi+176. (Washington: Carnegie Institution.)

Piebald Rats and Selection. By W. E. Castle and J. C. Phillips. Pp. 54+3 plates. (Washington: Carnegie Institution.)

Carnegie Institution of Washington. Year Book. No. 12, 1913. Pp. xvi+336. (Washington: Carnegie Institution.)

DIARY OF SOCIETIES.

THURSDAY, MARCH 12.

ROYAL SOCIETY, at 4.30.—Note on a Functional Equation Employed by Sir George Stokes: Sir James Stirling.—The Mercury Green Line $\lambda=5461$ as Resolved by Glass and Quartz Lummer Plates and on its Zeeman Components: Prof. J. C. McLellan and A. R. McLeod.—The Electrical Condition of a Gold Surface During the Absorption of Gases and their Catalytic Combustion: H. Hartley.—The Diffusion of Electrons through a Slit: J. H. Mackie.—The Rate of Solution of Hydrogen by Palladium: Dr. A. Holt.—The Dispersion of a Light Pulse by a Prism: Dr. R. A. Houston.

Royal Institution, at 3.—Heat and Cold: Prof. C. F. Jenkin.

Concrete Institute, at 7.30.—Forms for Concrete Work: A. Graham.

Institution of Electrical Engineers, at 8.—The Design of Rolling Stock for Electric Railways: H. E. O'Brien.

FRIDAY, March 13.

Royal Institution, at 9.—An Indian State: Sir Walter R. Lawrence, Bart.

Malacological Society, at 8.—Diagnosis of Four New Land Shells from German New Guinea: C. R. Boettger.—Characters of Three New Species of Ennea from Southern Nigeria: H. B. Preston.—A Synopsis of the Family of Veneridæ. II.: A. J. Jukes-Browne.

Royal Astronomical Society, at 5.—(1) Correction of Errors in the New Lunar Theory; (2) The Terms in the Moon's Motion Depending on the Node; (3) The Perigee and Eccentricity of the Moon, 1750—1901; (4) The Determination of the Node, the Inclination, the Earth's Ellipticity, and the Obliquity of the Ecliptic, from Greenwich Meridian Observations of the Moon, 1847—1901: E. W. Brown.—Baxendell's Observations of Variable Stars: R. Bootis, R. Cancri, R. Coronæ, S. Coronæ, H. H. Turner, and Mary A. Blagg.—Micrometrical Measures of Double Stars in 1913: Rev. T. E. R. Phillips and H. F. Acocks.—The Spectra of Hydrogen and Helium: J. W. Nicholson.—The Total Light of the Stars: S. Chapman.

Junior Institution of Engineers, at 8.—Lightning Conductors and their Tests: F. H. Taylor.

Alchemical Society, at 8.15.—Roger Bacon: R. Rowbottom.

Physical Society, at 8.—Time Measurements of Magnetic Disturbances and their Interpretation: Dr. C. Chree.—The Ratio of the Specific Heat of Air, Hydrogen, Carbon Dioxide and Nitrous Oxide: H. N. Mercer.—The Asymmetric Distribution of the Secondary Electronic Radiation produced by X-Radiation: A. J. Philpot.—A Lecture Experiment on the Irrationality of Dispersion: Prof. S. P. Thompson.

SATURDAY, March 14.

Royal Institution, at 3.—Recent Discoveries in Physical Science: Sir J. J. Thomson.

MONDAY, March 16.

Royal Society of Arts, at 8.—Surface Combustion. I: Prof. W. A. Bone.

TUESDAY, March 17.

Royal Institution, at 3.—Modern Ships. The War Navy: Sir John H. Biles.

Royal Statistical Society, at 5.—The Sizes of Businesses, Mainly in the Textile Industries: Prof. S. J. Chapman, and T. S. Ashton.

Zoological Society, at 8.30.—(1) The Annelids of the Family Nereidæ collected by Mr. F. A. Potts in the N.E. Pacific in 1911, with a Note on Micronereis as a Representative of the Ancestral Type of the Nereidæ; (2) The Genera Ceratocephale Malmgren and Tylorrhynchus, Grube: L. N. G. Ramsay.—The Structure and Development of the Caudal Skeleton of the Teleostean Fish, *Pleuragramma antarcticus*: A. K. Totton.—Report on the Mollusca collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea: G. C. Robson.—The Mechanism of Suction in the Potato Capsid Bug (*Lygus pabulinus*, Linn.): P. R. Awati.—Coleoptera Heteromera collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea: K. G. Blair.—The Malay Race of the Indian Elephant: R. Lydekker.—Fauna of Western Australia. I. The Onychophora of W. Australia. II. The Phyllopoda of W. Australia: Prof. W. J. Dakin.

Institute of Metals, at 8.—Annual General Meeting.—President's Inaugural Address: Sir Henry J. Oram.

Illuminating Engineering Society, at 8.—A Comparison between Illumination Estimates and Performance in Practice: W. C. Clinton.

Institution of Civil Engineers, at 8.—*Concluding Discussion*: Rail steels for Electric Railways: W. Willox.—Rail-corrugation and its Causes: S. P. W. D'Alte Sellon.—*Papers*: Some Recent Developments in Commercial Motor-vehicles: T. Clarkson.—Comparative Economics of Tramways and Railless Electric Traction: T. G. Gribble.

Mineralogical Society, at 5.30.—An Occurrence of Bornite Nodules in Shale from Mashonaland: F. P. Mennell.—Augite from Bail Hill, Dumfriesshire: A. Scott.—(1) A Sulpharsenite of Lead from the Binnenthal; (2) Gmelinite and Chabazite from Co. Antrim: Dr. G. T. Prior.

WEDNESDAY, March 18.

Royal Meteorological Society, at 7.30.—Climate as Tested by Fossil Plants: Prof. A. C. Seward.

Aeronautical Society, at 8.30.—Lessons Accidents have Taught: Col. H. C. Holden.

Royal Society of Arts, at 8.—House Flies and Disease: E. H. Ross.

Institute of Metals, at 10.30 a.m.—First Report to the Beilby Research Committee, dealing with the Solidification of Metals from the Liquid State: Dr. C. H. Desch.—Bronze: J. Dewrance.—Vanadium in Brass: The Effect of Vanadium on the Constitution of Brass containing 50—60 per cent. of Copper: R. J. Dunn and O. F. Hudson.—The Quantitative Effect of Rapid Cooling on Binary Alloys. II: G. H. Gulliver.—Crystal Protomorphs and Amorphous Metal: Prof. A. K. Huntington.—First Report of the Nomenclature Committee.—The Influence of Nickel on Some Copper-Aluminium Alloys: Prof. A. A. Read and R. H. Greaves.—Muntz Metal: The Correlation of Composition, Structure, Heat Treatment, and Mechanical Properties, etc.: Dr. J. E. Stead and H. G. A. Stedman.—The Micro-Chemistry of Corrosion. II: S. Whyte and Dr. C. H. Desch.

Entomological Society, at 8.—(1) A Contribution to the Life-History of *Agriades thersites*; (2) A New Form of Seasonal (and Heterogoneutic) Dimorphism: Dr. T. A. Chapman.

THURSDAY, March 19.

Royal Society, at 4.30.—*Discussion*: Constitution of the Atom. Opener: Sir E. Rutherford.

Royal Institution, at 3.—Heat and Cold: Prof. C. F. Jenkin.

Child Study Society, at 7.30.—The Dramatic Impulse in Children: Prof. J. J. Findlay.

Institution of Mining and Metallurgy, at 8.—Annual Meeting.

Institution of Electrical Engineers, at 8.—Discussion on Electric Battery Vehicles.

Royal Society of Arts, at 4.30.—Indian Water Gardens; Mrs. Patrick Villiers-Stuart.

Linnean Society, at 8.—The Bearing of Chemical Facts on Genetical Constitution: Dr. E. F. Armstrong.

FRIDAY, March 20.

Royal Institution, at 9.—Fluid Motions: Lord Rayleigh.

Institution of Mechanical Engineers, at 8.—The Chemical and Mechanical Relations of Iron, Tungsten and Carbon, and of Iron, Nickel, and Carbon: Prof. J. O. Arnold and Prof. A. A. Read.

Junior Institution of Engineers, at 8.—Aeroplanes as Engineering Structures: W. H. Sayers.

SATURDAY, March 21.

Royal Institution, at 3.—Recent Discoveries in Physical Science: Sir J. J. Thomson.

CONTENTS.

PAGE

Editorial and Publishing Offices:
MACMILLAN & CO., Ltd.,
ST. MARTIN'S STREET, LONDON, W.C.

Advertisements and business letters to be addressed to the Publishers.

Editorial Communications to the Editor.

Telegraphic Address: Phusis, London.
Telephone Number: Gerrard 8830.