THURSDAY, MARCH 9, 1916.

HISTORY OF CHEMISTRY.

Historical Introduction to Chemistry. By Prof. T. M. Lowry. Pp. xv+581. (London: Macmillan and Co., Ltd., 1915.) Price 8*s.* 6*d.* net.

THE history of a physical science like chemistry differs fundamentally from general history inasmuch as in the former, speaking broadly, men create the epochs, whereas in the latter epochs make the men. When we take a retrospective view of the progress of chemistry we see that its development is, in the main, irregular and spasmodic. Although there are no periods of actual retrogression, except possibly the one that followed the burning of the Alexandrine libraries, there are periods of comparative stagnation interrupted by sudden breaks, so to say, in the curve of its continuity. These breaks mark epochs of new departure, arising from discoveries, frequently wholly unexpected and often revolutionary in character, and nearly always due to individuals working independently of their fellows, and not consciously influenced by any *Zeitgeist.*

On the other hand, in political, economic, or sociological history, we are usually able to trace a general movement in communities, or of powerful groups of society, or of definite interests, and the more or less gradual and progressive working of a popular sentiment which is ultimately given practical effect to by the leader or statesman of sufficient perspicacity to read aright the signs of the times.

Hence, on account of this essential difference, the history of chemistry is necessarily to a large extent the history of its leading men—that is, of the pioneers whose work constitutes those new departures which make up the successive epochs in its progress.

This difference between the leaders in science and in politics, it may be noted in passing, is not sufficiently recognised by the community. The successful political leader in these democratic days in reality seldom leads: he follows, and is directed by the popular will; and his success as a practical politician depends upon his astuteness in divining the psychological moment in which to give effect to that will. The leaders in science—the Boyles, Newtons, Davys, Faradays, Daltons—are in no wise controlled or influenced by any analogous movement on the part of a community. They pursue their investigations and make their discoveries independently of any prescribed demand. In this sense they are real leaders, and by their own independent action impose such natural laws as they may be able to promulgate.

It is, of course, possible to teach the historical development of chemistry impersonally, and doubtless this is the more rational method. But it offers far more difficulties than the other, and from the point of view of the ordinary student is probably less instructive, as it is certainly far less interesting. In the book before us something in the nature of a compromise has been attempted between the impersonal and the purely biographical methods, but, as frequently happens in compromises, the result is not wholly successful. The author states that he has made no attempt to write a formal history of chemistry either of its various periods, or of the biographical stories of its pioneers. His method is to take certain substances, or groups of substances, such as the Acids; Chalk, Lime, and the Alkalis; Muriatic Acid and Chlorine; Inflammable Gases, etc., distributed over about a dozen chapters, and in the remaining eight chapters of the twenty chapters constituting the book to deal with certain theoretical conceptions of the science, *e.g.* the Atomic and Molecular Theories; Molecular Architecture; Classification; Balanced Actions, etc. As regards the first section it is not obvious why the particular selection or its particular sequence was adopted. It may be that the merit of any particular selection is largely a matter of opinion; or possibly the author may think that selection is the best which in his judgment enables him to group the largest number of historical facts in something approaching to chronological order.

Each chapter is split up into sections, designated as A, B, C, D, etc., with corresponding sub-headings, and it concludes with a summary and supplement. The object of the supplement, apparently, is to deal with statements that had been omitted from the main body of the chapter, or which for some reason or other could not be conveniently treated in their proper place. In many cases the supplements consist almost wholly of elementary chemical equations in explanation of chemical changes referred to in the text. As these are expressed by up-to-date conventions it may have occurred to the author that their very modernity would be as incongruous as the absurd anachronisms which he rightly condemns, such as the substitution of the bunsen burner for the big spirit lamp in illustrations of Dumas's apparatus for determining the gravimetric composition of water; or in the picture of Lavoisier's red-hot gun-barrel, in which rubber corks take the place of clay-joints.

But whatever may be the reasons which induced the author to adopt his particular treatment, the effect is to give his work a somewhat disjointed structure. The treatment is slight and "sketchy," and at times inadequate. It is irrational, for example, to dismiss the work of twenty centuries in about as many lines, but this is practically all the space that is given to ancient and alchemistic chemistry. To say that the study of chemistry begins with the work of Boyle is on a par with Wurtz's famous statement that it owes its origin to Lavoisier, and is equally untrue.

Dr. Lowry's book, in spite of occasional slipshod writing, is interesting reading, and the student, if already furnished with a little chemical knowledge, will pick up much information concerning certain broad features in the development of the science since the middle of the eighteenth century. The illustrations of classical apparatus are a valuable feature, although we are unable to see the relevancy of the pictures of crystallised minerals and salts taken from the national collections in the British Museum. They are like the tropes and metaphors which King James deprecated in the sermon—"brilliant wild flowers in the field of corn, very pretty, but of no particular advantage to the corn."

RELATIVITY AND ELECTRONS.

Relativity and the Electron Theory. By E. Cunningham. Pp. vii+96. (London: Longmans, Green and Co., 1915.) Price 4*s.* net.

THE principle of relativity has gradually acquired a fundamental position in theoretical physics, and the appearance of an introductory monograph on the subject will be welcomed by all who wish to have a knowledge of its essentials. The present work, as stated in the preface, is written with the purpose of setting out as clearly as possible the relation of the principle to the generally accepted electron theory. Only quite elementary mathematical analysis is employed throughout the book; those who wish to penetrate more deeply in the subject being referred to the author's larger work on "The Principle of Relativity."

In the latter part of the book the principle of relativity is presented from Minkowski's point of view. The four-dimensional form of relativity is of very great importance, partly on account of its elegance and simplicity, but also because of its suggestiveness in the present transition stage of dynamics. Unfortunately, only a short outline of the four-dimensional vector analysis of Minkowski and his disciples is given. On p. 72 examples of 4-vectors are given in a form which is open to criticism. The point-instant (x, y, z, t) is called a 4-vector. It would be more satisfactory to denote the 4-vector by (x, y, z, ict), since ict and not t is actually the fourth component of the vector in question. A similar remark applies to $\kappa(u_x, u_y, u_z, 1)$ (on the same page), which should be written $\kappa(u_x, u_y, u_z, ic)$, in which form it would be consistent with the equation at the foot of p. 75, viz.:

$$(S_x, S_y, S_z, S_u) = \rho(U_x, U_y, U_z, ic)/c.$$

The quantity denoted by "κ" is, in consequence of a printer's omission, imperfectly defined. The author introduces four-dimensional vectors in the "New Mechanics" in an excellent way by showing how they serve to unify the two aspects of "force" as the "time rate of change of momentum" (Galileo) and "space rate of change of energy" (Huygens). One of the characteristic features of Minkowski's presentation of the principle of relativity is its capacity for unifying or reconciling different and, in some cases, apparently contradictory aspects of phenomena.

In the final chapter the author outlines the way in which the "objections of those who demand a *real* æther to carry *real* effects" can be met.

The work is one of considerable merit, and provides a really good and sound introduction to the subject with which it deals. W. W.

THE HANDWORKING OF IRON AND STEEL.

Forging of Iron and Steel. By W. A. Richards. Pp. viii+219. (London: Constable and Co., Ltd., 1915.) Price 6*s.* 6*d.* net.

THE title of the above work is somewhat misleading, in that its scope is much narrower than is suggested by the title. Apart from a short chapter at the end on steam and power hammers, it deals only with hand-forging in its various aspects. The book, which is stated to be intended both for the "high-school boy" and the "veteran smith"—it is written by an American—opens with a chapter on the historic use of iron and steel from early periods. It then deals in brief review with the smelting of iron ores and the production of cast irons, wrought irons, and steels, the author stating that it is unnecessary to go deeply into the subject of metallurgy or to introduce metallurgical theory. We are told (on page 20) that the air pressure in the blast furnace is from 15 to 25 lb. per square inch. No doubt in the hard-driven American furnaces, where

Forge work
× Drop Forging

everything is sacrificed to output, the blast pressures are higher than in this country, where they seldom exceed from 8 to 9 lb. per square inch, but the above figures are certainly higher than the highest we had associated with American practice. They throw light, however, on the performance of an American blast furnace erected in Middlesbrough some years ago which was worked by American engineers, and which blew so much iron ore out of the top of the furnace that it was put, and has remained, on the low pressures that are found to be suitable in English practice.

A few pages later we are informed that the temperature of the cementation furnace in the production of blister steel—a process in which the iron is never melted—is about 3000° F. This corresponds to 1650° C., which is nearly 150° C. above the melting point of iron. The author makes several unsuccessful attempts to spell the name "Siemens," the inventor of the open-hearth furnace. Sometimes he calls him Sieman; at others Siemans. On the whole, it is as well that he does not introduce metallurgical theory.

Chapters on equipment and fuel are followed by four others dealing with the various operations involved in hand forging. These are succeeded by two on welding and one on brazing. The remainder of the book is given up to the manufacture and treatment of the various kinds of tool steels, together with short chapters on art ironwork and calculations. At the end of each chapter are appended questions for review, of which the following is a fair specimen:—"What is carbon steel? What is air-hardening steel? What is high-speed steel? Tell how each differs. Tell how to harden and temper tools made from high-speed steel. Describe the working of high-speed steel in the forge fire. Describe the annealing of high-speed steel. Describe the grinding of high-speed steel." The chapter containing the information from which the foregoing questions are to be answered is less than four pages in length.

The author states that the methods described in his book have been "thoroughly tried out during ten years of experience in teaching and supervising manual training." His book therefore should contain much that is of value to those who are interested in such methods. We think, however—largely no doubt owing to the way in which it has been written—that it will appeal more to American than English readers, and chiefly because elementary education in this country, in spite of its shortcomings, is better than in America.

H. C. H. C.

OUR BOOKSHELF.

A Plea for an Orderly Almanac. By A. Philip. Pp. 62. (Brechin: *Advertiser* Office, D. H. Edwards, 1915.) Price 1*s*. net.

THE author indicates some minor changes that might be carried out without altering the existing calendar. He points out the inconveniences that arise from the present plan of arranging fixtures for (say) the "third Wednesday of the month." Such fixtures do not come in a regular order; the second Tuesday may either precede or follow the second Wednesday. This system offers little facility for adjusting dates so as to fit each other with a minimum of clashing.

The remedy proposed is to take the "trimestre," or three-monthly period, as our unit instead of the month. Each trimestre must contain twelve complete weeks from Sunday to Saturday, with odd days at the beginning, end, or both. If fixtures are arranged for definite days of these twelve weeks, their relative order is invariable, and the list can be prepared, once for all, so as to secure the maximum convenience. It is suggested that the trimestres should be: (i) March, April, May (92 days); (ii) June, July, August (92 days); (iii) September, October, November (91 days); (iv) December, January, February (90 or 91 days). These practically coincide with the four seasons, and the placing of the leap day at the end reduces its inconvenience to a minimum. In fact, the device of counting from March 1 is not new to astronomers, some tables having been drawn up on these lines.

The author points out a decided convenience that would result from beginning our national financial year on March 1, instead of April 1. It would avoid the anomaly that the financial year may contain two, one, or no Easters. The effect of these variations on the national income is quite appreciable, and has been pointed out in the House of Commons. He gives some suggestions for adapting wages, weekly insurance payments, and old age pensions to his scheme, and appends tables showing the incidence of his twelve-week periods up to the end of 1919.

A. C. D. CROMMELIN.

Flora of the Presidency of Madras. By J. S. Gamble. Part i. *Ranunculaceae to Aquifoliaceae.* Pp. 200. (London: West, Newman and Co. and Adlard and Son, 1915.) Price 8*s*. net.

IN the review of Prof. Fyson's "Flora of the Nilgiri and Pulney Hill-tops" in NATURE for February 3, an account is given of the general scheme for local Indian floras. The "Flora of the Presidency of Madras" has now to be added to their number, the first part having been published at the end of January.

The "Flora" is being prepared by Mr. J. S. Gamble, late of the Indian Forest Department, well known for his book on Indian timbers, and is a model of what such a local flora should be. This first part consists of 200 pages, comprising the families Ranunculaceæ to Aquifoliaceæ, but, unfortunately, we have to wait for the concluding part of the work for the appearance of the introduction and key to the families. Without these the "Flora" loses some of its value and much of its interest, and it is to be hoped that the publication of the succeeding parts will take place as rapidly as may be possible.

The plan followed in the "Flora" is that adopted by Prain in his "Bengal Plants," and is a plan admirably suited for a local flora where the easy identification of the plant is the object in view. Descriptions of species are therefore omitted, and the whole flora is in the form of key. A description of the natural family is succeeded by a key to its genera. Each genus is concisely described, and a key to its species follows, and then under each species there is no further descriptive matter, but only geographical and economic information and vernacular names. In those genera represented by only a single species, a short description is given. The keys are well drawn up, and a good test of their efficacy is to be seen in the genus Impatiens with its seventy species, which are all clearly differentiated. It should be mentioned that Mr. Gamble was assisted by Mr. S. T. Dunn in the preparation of about the first 132 pages of this part.

The Theory of Abstract Ethics. By T. Whittaker. Pp. viii+126. (Cambridge: At the University Press, 1916.) Price 4*s*. 6*d*. net.

THIS book is the result of stimulus applied, as the author informs us, by Prof. Juvalta's "Old and New Problem of Morality." Though awakened from dogmatic slumber by Renouvier, Mr. Whittaker had continued, in accordance with English tradition, to try to derive the ethical law of justice from "ends" or "goods." But the *a priori* cannot be avoided; and if a metaphysical doctrine emerges that is more in harmony with the moral aspirations of mankind, we must not refuse to consider it out of a forced austerity.

The fundamentals of every moral system are liberty and justice; and abstract ethics, as distinguished from the art of life in general, is a kind of impersonal science of the conditions under which all the types are bound to live in common. In the present state of affairs, however, the author naturally expatiates into concrete ethics and politics, giving a useful summary of Kant's view. The moral law recognised within states should be extended to their mutual relations, with the aim of eternal peace, which will be possible when we have progressed to a permanently superior political society. But he did not postulate a world-state so much as a family of states each respecting each other's individuality. Finally, on the last page, the author permits himself a legitimate speculation, perhaps too friendly, in the direction of reincarnation, which is certainly one feasible way of resolving many moral problems.

LETTERS TO THE EDITOR.

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

The Method of Curves.

THE expression of the results of observations and experiments by curves became common during the first half of the nineteenth century. One of the first instances was given by Perkins (*Phil. Trans.*, 1826) in a paper on the compressibility of water.

Six years later Sir John Herschel (Trans. Ast. Soc., v., 1) gave an account of the method of graphical construction on squared paper as applicable to astronomical computations and physico-mathematical inquiries.

"The dates in years and decimals are measured as abscissæ, and the angles in degrees and decimals as ordinates. The next step is to draw by the mere judgment of the eye, and with a free but careful hand, not through but among the points, a curve presenting as few and slight departures from them as possible, consistently with the character of large and graceful sinuosity, which must be maintained at all hazards.

"But since an equal trustworthiness can probably not be placed on all the observations, we must take care to distinguish those points which correspond to observations entitled to the greatest confidence, such as those which appear to have been made under peculiarly favourable circumstances, or which rest upon the average of a very great number of individual measurements. These should be marked on the chart in some special manner not liable to be mistaken, and when we draw the curve we must take care to make it pass either through or very near all those points which are thus distinguished; or at least to deviate from them with much more reluctance than from such as have no claim to our peculiar attention.

"By substituting the curve for the points we have made a nearer approach to nature, and in a great measure eliminated errors of observation."

A few years later Regnault (Mem. Acad. Sci., 1847, xxi., p. 316) reduced the method to a fine art. To represent the expansion of mercury he used four copper sheets, 80 cm. square, each divided into 10,000 squares. Within these squares values were marked by a special dividing engine, one bevelled edge of the heavy base of which was graduated into 8 mm. divisions and tenths. A carriage running on a half-millimetre screw, the large head of which was divided into 50, so that 0·01 mm. could be accurately measured, carried the burin. Experimental values were marked by the intersections of lines drawn by the burin. A free curve was drawn by Regnault, which was completed and engraved by an artist. Even with these precautions a constant error was detected in the last plate.

The introduction of the copper plate and dividing engine seems to conduce to the accuracy and permanence of the record.

The method has been rendered more easy of application and possibly more accurate by the introduction of mechanically ruled paper, a good sample of which of French manufacture consists of sheets a metre square, ruled into millimetre squares, each edge of which is divided into 0·2 mm. by dots. Free hand-curves have also been more or less replaced by mechanically cut curves and flexible laths.

Notwithstanding the very general use of the method and many theoretical accounts of it (Whewell, "Nov. Org. Ren.," 1858, p. 204; Stanley Jevons, "Principles of Science," 1877, p. 492), culminating in the admirable reports of Prof. Hele-Shaw (B.A., 188–92) "On Graphic Methods in Mechanical Science," there still seem to be many doubtful points in the theory and practice of the process; much valuable information has never been published, and is confined to individual workers, while the few attempts which have been made to estimate the accuracy attainable have given widely different results.

The following questions seem to present themselves among others for consideration.

What is the best material for a diagram sheet?

Mechanically ruled paper is by far the most generally used, but it is not very permanent and is apt to be injured by the points of measuring instruments. Possibly the best material would be ordinary, white, or blue glass, which alters very little with time, has a low coefficient of linear expansion, $<0{\cdot}000\ 009$, and is not easily scratched. The requisite lines could be marked by a diamond, carborundum wheel, or special ink; or the whole plate might be varnished, the lines then drawn on the varnish and etched in.

Does the colour of the sheet or ink make any difference in the accuracy or ease of the work?

Babbage found that black on green conduces to ease and accuracy in the use of tables. Chocolate on white is said to be more legible than black on white.

Is it more advantageous to work with lines as fine as consistent with visibility, or always to the same edge of thicker and more visible lines?

Is there a limit of size, say, about a square metre, beyond which increase in size does not conduce to accuracy?

What is the best method of measuring lengths on diagrams? What is the effect of time and damp on paper sheets and of change of temperature on metallic ones?

A difference of 10° C. in the temperature of the room would alter the length of a copper sheet by 0·00017, but this is corrected by using the sheet as the measuring instrument.

What is the best form of lath? Wood, steel, or steel backed by lead? How should the lath be held or pinned?

In what cases are other forms of ruling, such as semi-logarithmic, logarithmic, triangular, or circular, advantageous?

By general consent the curve selected should show as few changes of curvature as possible consistently with passing through or near the great majority of the experimental points and lying fairly among them. Suppose one or more points lie at a considerable distance from the curve—is this due to experimental error and to be therefore neglected?—to a rapid but continuous change in the condition of the substance under examination, to be represented by a change of curvature, or to a change in the nature of the substance to be represented by a break and a new curve?

The answer to these questions depends upon the estimate which the experimenter forms of the "error" of his experiments. One may consider his error as large, and prefer a simple curve which does not represent his results very exactly; another may deem his error less, and prefer a more complicated curve passing more nearly among the experimental points; a third may consider that his error is very small, and that his results are best expressed by two or more simple curves, and hence assume a very fundamental change in the nature of the substance.

In very accurate work, then, the experimenter is more or less obliged to estimate or determine the error of his observations, and much has been written on methods for the purpose. Most experimenters seem not to repeat their experiments several times under as nearly as possible the same conditions, without which no determination of the error is possible, but trust to subsequent correction by the curve. The "probable error" is generally the most convenient; it may be obtained from a considerable number (n) of observations upon a single quantity by finding the residuals (v), that is, the excess or defect of each observation from the arithmetical mean, adding the squares of the residuals together, dividing the sum of the squares by $n\ (n-1)$, and multiplying the square root by 0·67449, or $p.e. = 0{\cdot}67449\sqrt{\Sigma v^2/n(n-1)}$.

The estimates of the accuracy attainable are, as might be expected, very various. It is stated (J.S.C.I., xxii., 1227) that a density determination, such as that of dilute nitric acid, can be carried to 1 part in 75,000, and this claim is moderate.

On the other hand, it is curious to find (Clarke's Tables, 298) that the results for the density of chloroform found by a great recent experimenter at two different temperatures each differ by about 1 part in 2500.

It is perhaps not so generally recognised that the graphical method itself introduces a fresh series of errors which may be quite comparable in magnitude with, or even greater than, those incidental to careful experiments.

Every graphical reduction comprises five operations, each liable to error—measurement of the abscissæ, measurement of the ordinates, drawing the curve, measurement of the abscissa, and of the ordinate of the new value required. Hele-Shaw remarks that the results given by the use of graphical methods cannot be regarded as very accurate, and quotes Poncelet and Culmann:—"The constructing engineer will give preference to geometrical solutions whenever an accuracy of results up to three decimals (one-thousandth), which can be perfectly well obtained, is sufficient." By mechanical engineers about 1/2000 seems to be considered the limit of accuracy. To take the simple case of ordinary rectangular co-ordinates, the draftsman depends upon the accuracy of the machine ruling. Suppose an ordinate is 1′ out of the perpendicular, the measured abscissa is too long or too short by 1/3400 of the length of the ordinate.

It is extremely difficult to make a valid estimate of the error introduced by a graphical reduction, depending as it does upon individual eyesight and hands. Good eyes can distinguish a tenth of a millimetre between two points, but age, accompanied as it too often is by astigmatism, may much impair this estimate.

Stanley Jevons attempted to find the value of π by the careful use of compasses; he did not come nearer than 1/540. He does not mention which of the numerous approximate constructions he used.

To obtain the probable error of the experiments and reduction, the square root of the sum of the squares of the separate sets of residuals must be taken.

The adequate estimation of the errors, both of the results and the reduction, becomes of still greater importance when it is attempted to establish breaks in the curve and discontinuity in the results by obtaining differential coefficients from the equation to the curve, by plotting differences, or by mechanical means (Proc. R.S.E., May, 1904). It must also be remembered that each of these processes introduces a new series of errors of its own, and may apparently increase the original errors, which are more or less removed by the first curve.

Each experimental result is represented by a point, and however much the scale of the diagram is enlarged these points remain points, and may give a false appearance of accuracy. In very accurate work would it not be worth while to extend Herschel's suggestion and determine the probable error of each experimental result? Each result could then be expressed by a circle the radius of which is equal to half the probable error, and which would increase with the size of the diagram. If another experiment be made under similar conditions it is about an equal chance that it falls within or without the circle, which therefore affords a measure of the precision of the observations. Since there is little evidence against any curve which cuts the circle, the variations in size might profoundly modify the opinion of the draftsman as to the direction of his curve.

SYDNEY LUPTON.

Ground Rainbows.

I HAVE seen with pleasure Mr. Heath's clear and instructive letter and diagrams on this subject in NATURE of March 2. Some fourteen years ago I calculated the altitudes of the sun required to produce the elliptic and other arcs, and obtained results in agreement with Mr. Heath's, except that I took 41° instead of 42° for the semi-angle of the cone.

For Petersfield, at 11 a.m. on October 14, 1915, the sun's altitude, 23°, appears to be somewhat underestimated, and I make it just above 30°, but this, of course, leaves the bow still hyperbolic.

I was led to consideration of the curves for the ground rainbow when seeking for a reason why the sky rainbow is seen always circular, though, when the sun is not on the horizon, the bow might perhaps have been expected to appear elliptical, the circle being projected into an ellipse on a plane perpendicular to a sight-line, assumed horizontal.

I came to the conclusion that, there being no definite plane of reference in the sky, and the rays being parallel, there is, as it were, no element of definite distance involved, so that the sky bow always appears circular. But for the ground bow we have a definite horizontal plane of reference, so that this bow becomes a conic section, varying with the sun's altitude.

I had some interesting correspondence at the time with the late Sir G. G. Stokes, and I may perhaps quote from one of his letters, dated August 22, 1902, only six months before his death. Replying to my question as to whether a dew bow is seen as a circle or an ellipse, he wrote:—

"It is a question of the combination of sensation and expectation. In a dew bow we are impressed with the idea that the luminosity we see is spread over a horizontal plane; and we tacitly ask ourselves the question: What must be the actual form of the locus of the drops on the grass in order that the luminosity may appear as it does? The answer, of course, is, an ellipse, or it might be an hyperbola. If the question be: As what do we see the bow? the answer depends on a combination of sensation with interpretation of sensation. If we merely saw the luminosity, and knew absolutely nothing about its history, we should never think of anything but circularity about it."

I have often looked for a ground bow, but have never been fortunate enough to see one.

Observing a fine lunar rainbow on January 21, I found the light to be polarised in planes passing through the point looked at and the radius at the point, just as is the case with the solar rainbow. I hope that Mr. Heath will test the next ground bow with a Nicol prism.

C. T. WHITMELL.

Invermay, Hyde Park, Leeds, March 3.

IN the Proceedings of the Royal Society of Edinburgh, vol. vii. (1869–70) Clerk Maxwell has a short note on a bow seen on the surface of ice. This was observed on January 26, 1870, on the frozen surface of the ditch which surrounds St. John's College, Cambridge. Maxwell remarks, "How a drop of water can lie upon ice without wetting it and losing its shape altogether I cannot profess to explain." In 1898, in vol. xxii. of the same Proceedings (1898) there is a note on dew bows by Dr. R. A. Lundie and myself. These were produced at night on the ground, the source of light being the gas lamp or electric light of the street. A short account will be found in NATURE of January 12, 1899 (vol. lix., p. 263).

C. G. KNOTT.

Royal Society, Edinburgh, March 4.

Science and the State.

REFERRING to Prof. Cohen's letter in NATURE of March 2, it may not be untimely to cite another paragraph written in 1831 *re* neglect of science in this country. Sir David Brewster, in his "Life of Newton," published in that year, says:—

"But what avails the enthusiasm and efforts of individual minds in the intellectual rivalry of nations? When the proud science of England pines in obscurity, blighted by the absence of the royal favour, and of the nation's sympathy—when its chivalry fall unwept and unhonoured—how can it sustain the conflict against the honoured and marshalled genius of foreign lands?"

The position to-day is fortunately not quite so bad as here indicated by Brewster, but is it not still the case that, in the words of Sir Archibald Geikie, science rests under an incubus of apathy and indifference? Expansion of science and national evolution are two matters that in the opinion of the writer are intimately bound up one with the other. Neglect of the former really means inhibition of political progress.

DAVID BALSILLIE.

Greyfriars Garden, St. Andrews, March 4.

THE NATIONAL IMPORTANCE OF THE DYE INDUSTRY.

AT the annual meeting of the Bradford Dyers' Association held on February 28 the chairman of the directors, Mr. Milton S. Sharp, made a highly interesting statement on the national position with regard to the supply of dyes. He described with great force and clearness the close connection between the manufacture of dyes and high explosives, and pointed out how Germany by reason of her huge, highly organised, and ably administered colour works, producing all the raw materials for the making of high explosives, was able immediately to divert much of their plant to war purposes. He paid a high tribute to Lord Moulton and the High Explosives Department for their services, the value of which, he said, the country will probably never know, in improvising the manufacture of high explosives. He urged that whatever it involves, we must establish the aniline dye industry in this country, so that in case of war we may have the ability to produce quickly any amount of high explosives the Army or Navy may need. The extensions of plant that have been made for the temporary purpose of manufacturing high explosives will, he says, make a long and essential step towards the colour industry, and to break them up after the war would be little short of criminal folly. Mr. Sharp quoted some effective examples of German activity in relation to the chemical service of the war. He alluded to one

Dyes and dyeing

colour works with 14,000 men, and another with 9000, now engaged wholly in the manufacture of high explosives; to the fact that 75 per cent. of the German collieries have coke ovens installed; to the synthetic production of 200,000 tons per annum of ammonia, and the conversion of ammonia into nitric acid.

Great praise was given by Mr. Sharp to the efforts of the older dye-makers in this country and to the new British Dyes (Limited) for their efforts to augment the supply of dyes, and of the Swiss makers he said that he dare not contemplate what our position would have been during the last eighteen months without their aid. Alluding to the desirability of greater sympathy and closer co-operation between dye-users and dye-makers, he quoted the example of a firm with which the Bradford Dyers' Association had been in close association, and with which shortly before the war they had placed a contract for 1000 tons of a colour previously obtained from the only maker in Germany.

The general and fiscal policy urged by the directors of the Bradford Dyers is the appropriation by Government for a term of years of a grant-in-aid of 500,000*l.*, to be administered by a commission charged with the duty of securing the establishment of the industry in this country by grants on production and for enterprise and initiative. Such a commission, they think, with enterprising, energetic, and fearless leadership, would secure the establishment of the industry in this country, not only on less debatable lines, but also much more quickly than by import duties. In the absence of import duties, however, it is thought essential to have most stringent provisions to prevent dumping. Whether import duties are imposed or not, the directors feel that special and extraordinary aid is needed, and they believe that such a commission would make the removal of dependence on Germany more certain than could possibly be hoped for by leaving British colour-makers to their own unaided and unco-ordinated efforts.

Mr. Sharp's speech is a weighty utterance, remarkable for the clear perception of the grave national and scientific implications of the dye question; and such pronouncements from our leading industrialists cannot be over-valued for their influence in giving to the public a just perspective.

WOOD PULPS FOR PAPER-MAKING.

IN the revision of values, moral and material, which is imposed upon us under the present awakening to a new order of realities, it is recognised that we have to create in and for the empire a definitive industrial science, and a co-ordinated scientific industry. To contribute to this effectually, science has to concentrate the trained mind upon manufactures, so as to grapple with its problems by scientific method, which is quantitative *qua* matter and energy, and comprehensive *qua* the moral and political factors of production. Manufacturers and business men have the more difficult task of undertaking a whole-hearted study of science so as at least to arrive at a clear grasp of what this comprehensive term connotes in the creative influences of the old order, and the potential directing genius of the new. Both parties to the new order would be thus reciprocally enlightened as a necessary preparation for earnest co-operation.

In either direction of inquiry it is necessary to set out from clear perspectives of related values, and it is self-evident that those of the natural order claim first attention. Thus, in the organic world, cellulose, starch, and sugar represent primary values of preponderating importance. The industries based upon cellulose, starch, and sugar: their production by agriculture, their transformation by mechanical and chemical means into the derived forms in which they are actually used, together with the countless dependent industries of which these derivatives are in turn but the raw materials, constitute an industrial aggregate which represents, say, one-half of the productive energy of the community. An unprejudiced view of the wider relations of these industries would also recognise that Great Britain has well maintained a premier position in their more important sections, as well as in their later and more definitely scientific developments.

This result is due to ordinary scientific, technical, and business enterprise, and the activity of individual pioneers, not to any conscious or co-ordinated movement towards preposed objectives. More particularly is this true of the cellulose industries, which comprise colossal textile manufactures: paper-making, and such special manufactures as nitrocellulose and high explosives, celluloid, and artificial silk; the latter, which is the youngest—in fact a twentieth-century product—rapidly growing from an *article de luxe* to the position of a staple textile.

There is one feature of these industries which marks them for special consideration in relation to the new order to which the civilised world is shaping or being shaped; that is, their almost complete dependence upon exotic raw materials. In the new order of co-ordinated industrial objectives how are we to deal with the present condition of dependence for essential raw materials?

This is much too vast a question to be discussed within the necessary limits of the present article. We must be satisfied to treat a single typical case: and we select the paper-making industry. The modern expansion of this industry in Great Britain has been conditioned by the discovery of new forms of raw material, chiefly of esparto grass (1861), and the wood pulps (1880).

The importation of esparto in the period 1861–1883 steadily increased to 200,000 tons, at which figure it remains constant, with a variation of 5000 tons. The wood pulps, on the other hand, show a uniform progressive increase, and in 1913 the figures reached:—

	Tons
"Chemical" pulps, *i.e.*, wood celluloses	400,000
"Mechanical" pulps, *i.e.*, ground wood	280,000

Pulp wood Pulpwood

The technical and commercial points represented in these figures are as follows:—(1) the enormously increased production of paper has been *mainly* conditioned by the utilisation of wood pulps; (2) esparto rapidly displaced rags in the production of printing and writing papers: it established new qualities in papers of this class, producing very fine printing surface with "bulk." (3) The wood pulps (celluloses) were adopted not only on their quality or merits, *as celluloses*, but being obtained from a massive material, they were produced in a state of exceptional cleanliness, and by economical processes.

Moreover, the paper-maker found himself provided with a half-stuff, clean, cheap, and in presumably unlimited quantities. It will be appreciated that a "half-stuff" is half-manufactured stuff, and its introduction displaces the chemical pulping of actual raw material. Hence, a progressive and two-fold dependence of our paper mills upon exotic supplies. This point is very clearly emphasised by the statistics of the census of production.

In the censal year (1907) the gross output of our paper-mills was in value 13,621,000*l.*

In that year we imported:—

	Tons	£
Wood pulps: chemical and mechanical	672,500 ...	3,312,347
Esparto	202,253 ...	738,834

This represented about 80 per cent. of the total of raw materials consumed. We imported of fully manufactured products, *i.e.*, papers and boards, to the value of 5,362,000*l.*, so that our home production was 70 per cent. of our consumption.

The rate of increase of our importation of raw materials will be seen by comparison with the subjoined figures for 1912.

	£
Esparto	743,354
Wood pulp { chemical	3,200,000
Wood pulp { mechanical	1,220,000
Linen and cotton rags	312,351
Miscellaneous	318,700
Total	5,794,405

The wood pulps thus representing 70–80 per cent. of the raw material for this important industry, the question arises, Can we advantageously produce this quantity within the empire? That we have a sufficiency of forest area there can be no doubt. In his estimates of the forest areas of the world, Schlich assigns to Canada 800 millions of acres, whereas Germany, which may be regarded as self-contained in regard to wood-pulp production, has a forest area of only 35,000,000 acres.

It may be interesting to state the average required to supply pulp for producing 300 tons per week of newspaper. This is generally estimated at 2500 acres per annum; a forest area of 100,000 acres would therefore mean a forty years' supply, and as forty years is the period for the spruce to reproduce itself fully in well-matured timber, it is clear that a mill of such dimensions in the centre of this area is a "self-contained proposition."

It is evident that Canada under a system of organised forestry is capable of meeting our full requirements. In further evidence of her productive capabilities it is to be noticed that she is already responsible for about one-sixth of the world's production, as will be seen from the following figures for 1907–1908:—

Annual Production of Wood Pulp for Various Countries, calculated on the Air Dry Basis (1907–1908).

Country	Mechanical pulp Air dry tons	Chemical pulp Air dry tons	Total annual production
Germany ...	315,000 ...	320,000 ...	635,000
Norway ...	421,000 ...	270,000 ...	691,000
Sweden ...	78,000 ...	510,000 ...	588,000
Finland ...	69,000 ...	52,000 ...	121,000
America ...	868,000 ...	988,000 ...	1,856,000
Canada ...	565,000 ...	172,000 ...	737,000
	2,316,000	2,312,000 ...	4,628,000

Under present conditions (1914) there is little exportation of Canadian pulp to Europe, and this small proportion is mechanical pulp.

As to our own islands, the question of afforestation was investigated by a Commission, which published its report in 1909. The Commission concluded that the available area was 9,000,000 acres, which would absorb for development an annual sum of 2,000,000*l.*; in forty years the self-supporting stage is reached. After eighty years the revenue was estimated to reach 17,500,000*l.*, representing $3\frac{3}{4}$ per cent. on the net cost, calculated at compound interest (3 per cent.).

The question of esparto, if raised from this political point of view, is either that of finding substitutes of indigenous origin, *i.e.*, within the empire, or of cultural experiments towards its establishment in selected areas affording similar conditions as obtain in the Mediterranean littoral.

On the former problem, attention should be directed to the work of the Imperial Institute, and the record of its many investigations of potential supplies of paper-making material. In the Journal of the Institute there are many of these reports on fibrous materials; from India, South and East Africa, the Sudan, British West Indies, British Guiana, and the Malay States. If an "Imperial opportunity" is judged to have presented itself in the matter of a supply of these raw materials within the Empire, advantage may well be taken of the excellent work of the Institute.

It is characteristic of our political "method" to leave everything industrial, technical, and scientific to individual enterprise, whether of persons or corporations; and in this region of fibrous raw materials, whether for paper or textiles, we have come through under the old order with some success, and not a few conspicuous successes. In this region, moreover, we owe nothing of moment to "German method," and we are not under any moral pressure to advertise it by reiterated comparisons. But we are conscious of a new order under which we have to co-ordinate our industries. In the small section under consideration much work has been done by individuals and corporations—prophetic individuals and some profit-earning corporations—much material has accumulated, and it is open to a political pioneer, not necessarily a lawyer, to take in hand a matter which affects immediately an important section of our industrial community—labour and capital.

Should a definite organisation result it would probably be extended to embrace the whole range of vegetable textile materials which we estimate to affect directly the interests of one-third of the working community.

C. F. CROSS.

PROF. J. W. JUDD, C.B., F.R.S.

MANY will regret to hear of the death of Prof. John Wesley Judd on March 3 at his home in Kew, after some months of illness. He was born at Portsmouth on February 18, 1840, but in his eighth year went to London with his father. There he attended a school in Camberwell, and at an early age showed a love for astronomy and geology. When grown up he accepted a mastership in a school at Horncastle, Lincolnshire, where his spare time was devoted to chemistry and geology. In 1863 he became a student at the Royal School of Mines, after which he took the post of analytical chemist in some important iron and steel works in Sheffield. There began, in 1864, his friendship with H. C. Sorby, who imparted to him his newly-devised methods of petrological study, but his work in that city was brought to an end by a railway accident, which for a long time compelled him to abstain from continuous labour, so he resumed his geological studies in Lincolnshire.

In 1867 Judd joined the Geological Survey, and for the next four years was engaged in mapping Rutlandshire, with parts of the adjoining counties. But in 1871 a desire for greater freedom led him to accept an offer of temporary employment in the Education Department, and during this time began his studies of the Wealden deposits. When this work had come to an end, he devoted himself to investigating the Triassic and Jurassic deposits in Scotland and of the igneous rocks so grandly displayed in its western islands. This was a difficult task, owing to the want of good maps and to travel in that part of Scotland being less easy than at the present time. The result was a group of important papers, the first of which appeared in 1873.

These attracted much attention and led to friendships with Charles Lyell, Poulett Scrope, and Charles Darwin, the second of whom commissioned him to carry on an investigation of the volcanic districts of Europe, which he had been obliged to abandon. In April, 1874, Judd visited the Lipari Islands, going on to Vesuvius, the Phlegræan fields, and the adjacent volcanic district. He also studied the Ponza Islands, on which Scrope had published an important paper in 1827, with the great crater lakes of Central Italy, the Euganean Hills, and the volcanic districts of Hungary. After his return to England he was appointed, in 1876, professor at the Royal School of Mines in succession to Sir Andrew Ramsay. He at once began to organise the teaching, but there was not room at Jermyn Street to do this effectively, so his department was soon transferred to South Kensington, and ultimately lodged in galleries which had been constructed for the 1862 Exhibition. There he established a complete system of instruction, which was then unequalled and has never been surpassed in this country, and, in addition to this, his lucidity, patience, and kindness as a teacher secured him a full and attentive classroom. In 1896 he became Dean of the Royal College of Science, and in 1905 retired under the rule of age. It is painful to add that, after accomplishing so great a work, the officials of the Government awarded him a lower pension than he had expected, on a pretext which, if in accordance with the letter of a law, was certainly inequitable.

Judd was elected a fellow of the Geological Society in 1865, was secretary from 1878 to 1886, and president from the latter year until 1888. In 1891 he received the Wollaston medal. He was elected F.R.S. in 1877, and twice served on the council. In 1885 he was president of Section C, when the British Association met at Aberdeen, and subsequently received the degree of LL.D. from that university. In 1895 he was created a C.B., and in 1913 was made an emeritus professor of the Royal College of Science. He married in 1878 Jeannie Frances Jeyes, niece of a well-known Northamptonshire geologist, who with a son and a daughter survive him.

A list of Judd's geological papers up to 1905 (after which they become rather infrequent) is added to a biography in the *Geological Magazine* for 1905. The majority fall into groups, determined by his successive fields of work, almost all appearing in the *Quarterly Journal* of the Geological Society or the *Geological Magazine*. The first group contains papers on the Neocomian, the most noteworthy clearing away many difficulties from the Speeton Clay, and showing its relation to the Neocomian beds of the Lincolnshire wolds and of North Central Europe. Another and most important group of papers deals with the Italian islands, mentioned above, the crater lakes of Central Italy, and Lake Balaton, with the old volcano of Schemnitz in Hungary, after which the older volcanic districts, especially those connected with the Alpine system, are discussed. A third not less important group refers to Scotland, in which he investigated sundry igneous rocks on the mainland and those of Tertiary age in Skye and other islands of the western coast. These papers put an end to many misunderstandings and added much to our knowledge, although his view that the gabbro is later than the granite has not been accepted by the Survey. That also, expressed in two papers, on the relation of the fluviomarine beds of Headon Hill and Colwell Bay in the Isle of Wight has not found favour, but the two on deep borings in the London district added much to our knowledge of the underground geology of south-eastern England.

For minor papers we must refer to the abovenamed list, but must not forget his presidential address; the one on past and present relations between geology and mineralogy, the other on those between mineralogy and palæontology, where he attributed life to crystals, or his study of the borings in the Nile Delta, his petrological investigations of the rocks ejected from Krakatoa in 1883, and his studies of the materials from the Funafuti borings, all published by the Royal Society. The last involved much organisation, of which he took the lion's share. The Survey memoir on the geology of Rutland (1875) was written by him, and a small but excellent book on volcanoes in 1878. He twice revised and added much to Lyell's "Students' Elements of Geology" (1896 and 1911), and contributed the "Coming of Evolution" to a Cambridge series. In this small volume he tells the story, brightened by his reminiscences of the chief actors, in a most attractive way. He was a man whose like will not readily be found.

T. G. BONNEY.

DR. PIERRE CHAPPUIS-SARASIN.

PHYSICAL science has suffered a severe loss in the death of Dr. Pierre Chappuis-Sarasin, formerly of the Bureau International des Poids et Mesures at Sèvres, who passed away at Basle on February 15.

Dr. Chappuis was born in Switzerland in 1856, and his early youth was spent in his native country. In 1881 he joined the staff of the Bureau International, then under the directorship of Dr. O. J. Broch. One of the most important early tasks of the newly-founded International Committee of Weights and Measures was to place upon a proper basis the whole system of the measurement of temperature, to define with precision the temperature-scale to which all measurements relating to length and mass were to be referred, and to set up the necessary ultimate standards. The classic work of Regnault and of Rowland had shown that practical realisation of temperatures by the gas-thermometer depended on the working limits of pressure adopted and the choice of the gas selected as thermometric substance. It was to the solution of the problem of a satisfactory ultimate thermometric standard that Dr. Chappuis at once devoted himself, and his brilliant investigations carried on at the Bureau over a period of more than twenty-two years have won him a place in the very front rank of physicists concerned with the science of exact measurement. His classic memoir on the gas-thermometer published in vol. vi. of the "Travaux et Mémoires" describes his researches on the coefficient of expansion of different gases suitable for thermometric substances, and led to the adoption by the International Committee in 1884 of the fundamental hydrogen scale of temperature.

Among other investigations may be mentioned his determination of the volume of the kilogram of water, employing the optical methods of Benoit and Michelson, and measurements to very high precision of the expansion of mercury and of water.

Family claims and the call of his native mountains led Chappuis to resign his connection with the Bureau and return to Switzerland in 1903, adopting the additional name of Sarasin, to which well-known family his wife belonged. He built himself a fine private laboratory at his house at Basle, where until quite lately he continued his researches. His last considerable piece of work, hitherto unpublished, was a redetermination of the sulphur boiling point. In these experiments the quartz reservoir of the gas-thermometer was directly immersed in sulphur vapour.

M. Chappuis was of a retiring disposition, disliking self-advertisement, and rarely appeared on scientific platforms. He visited the British Association at the Dover meeting. It is impossible for one who knew him well to conclude this memoir without a tribute to his genial disposition, his indomitable energy and high personal character. All who knew him in his hospitable home at Sèvres or Basle will feel they have lost a true friend.

J. A. HARKER.

A COMMONWEALTH INSTITUTE OF SCIENCE AND INDUSTRY.

WE have just received a copy of the report of a committee appointed in pursuance of a motion passed at a conference convened by the Prime Minister of the Commonwealth of Australia that "An Advisory Committee be constituted to formulate proposals to the Government to establish a Commonwealth Bureau of Science and Industry." The members of the committee were: Representatives of universities:—Sydney—Sir T. Anderson Stuart; Melbourne—Prof. Orme Masson; Queensland—Prof. A. J. Gibson; Adelaide—Sir Douglas Mawson. Interstate Commissioners:—Mr. A. B. Piddington, the Hon. G. Swinburne. The Associated Chambers of Commerce of Australia:—Mr. W. T. Appleton. The Associated Chambers of Manufactures of Australia:—Mr. W. W. Forwood, Messrs. G. D. Delprat, W. P. Wilkinson (Commonwealth analyst), W. S. Robinson, J. M. Higgins, W. Russell Grimwade, E. W. Knox. Ex-officio Members:—Prime Minister of the Commonwealth; the Hon. F. Hagelthorn, Minister of Agriculture, Victoria; the Hon. W. Lennon, Minister of Agriculture, Queensland; the Hon. C. Goode, Minister of Agriculture, South Australia.

It will be noticed that the committee includes representatives of commerce and manufacture as well as of science and departments of State. We understand that the committee's report, which is subjoined, has the approval of the Federal Government, and that it is probable a Bill will be laid before the Federal Parliament to give effect to the recommendations after the Prime Minister's return from his present visit to England. The proposals of the committee are on lines somewhat similar to those of the British Government's scheme for the organisation and development of scientific and industrial research. Primary as well as secondary industries are included, and particular notice may be directed to the recommendations as to the governing body of the proposed institute, by which, as consistently advocated in our columns, the balance of power is placed in the hands of men of science. We are fortunate in being able to publish this valuable report.

I.—*Introduction.*

The committee appointed in pursuance of the motion set out above met in the Cabinet Room, Commonwealth Offices, on January 6, 7, 8, 12, and 13, 1916.

The committee, in formulating the following scheme, has been greatly impressed with the magnitude and the possibilities of the proposals made by the Prime Minister, and is strongly of opinion that the time has arrived for initiating the extensive scheme of scientific research work in connection with industry which he has outlined.

The committee is convinced that the results of properly conducted investigations into many of the subjects referred to in his address will amply repay considerable expenditure and fully justify a bold and comprehensive policy being adopted. Not only will the results be a greatly increased productivity and output in many directions—in both primary and secondary industries—but the stimulus generally given to scientific research in relation to our industries will exert a powerful influence on our educational institutions and bring them and the industrial community to realise the commercial value of science more fully than hitherto. In fact, the initiation of the scheme will, in the opinion of the committee, go far to inaugurate a new era in the economic and industrial life of the Commonwealth.

The proposals which follow will provide for the formation of a Commonwealth Institute of Science and Industry under the control of directors of the highest business and scientific attainment, acting with the advice and co-operation of a council representing science and the primary and secondary industries of Australia.

II.—*Recommendations.*

(1) There should be established under Act of Parliament a Commonwealth Institute of Science and Industry.

(2) The functions of the institute should be:—

(i) To consider and initiate scientific researches in connection with, or for, the promotion of primary or secondary industries in the Commonwealth.

(ii) The collection of industrial scientific information and the formation of a bureau for its dissemination amongst those engaged in industry.

(iii) The establishment of national laboratories.

(iv) The general control and administration of such laboratories when established.

(v) To promote the immediate utilisation of existing institutions, whether Federal or State, for the purposes of industrial scientific research.

(vi) To make recommendations from time to time for the establishment or development of special institutions or departments of existing institutions for the scientific study of problems affecting particular industries and trades.

(vii) The establishment and award of industrial research studentships and fellowships, to include either travelling fellowships or fellowships attached to particular institutions.

(viii) To direct attention to any new industries which might be profitably established in the Commonwealth.

(ix) To keep in close touch with, and seek the aid of, all Commonwealth and State Government Departments, learned and professional societies, and private enterprises concerned with, or interested in, scientific industrial research.

(x) The co-ordination and direction of scientific investigation and of research and experimental work with a view to the prevention of undesirable overlapping of effort.

(xi) To advise the several authorities as to the steps which should be taken for increasing the supply of workers competent to undertake scientific research.

(xii) To recommend grants by the Commonwealth Government in aid of pure scientific research in existing institutions.

(xiii) To seek from time to time the co-operation of the educational authorities and scientific societies in the States with a view of advancing the teaching of science in schools, technical colleges, and universities, where its teaching is determined upon by those authorities.

(xiv) To report annually and from time to time to Parliament.

(3) The committee gave careful attention to the relation between the proposed institute and the existing Commonwealth Laboratory. It was recognised that the daily routine of Customs, naval and military stores, and other departments requires the performance of a great deal of important scientific work, particularly chemical analysis of material, and that the laboratories in which such routine scientific work is carried out must necessarily remain under departmental control, though they might with advantage be co-ordinated and their equipment increased. On the other hand, as the work of the proposed institute develops there will be an increased scope for work in national laboratories devoted to special branches of research and experimental investigation which are not otherwise provided for. Such laboratories and their scientific staffs should, in the committee's opinion, be kept distinct and placed under the control of the institute.

In the future it will be necessary to undertake experimental work in connection with the growth of our naval and military defence, the testing of materials with regard to the physical reasons underlying deterioration and change of structure due to mechanical and heat treatment, and as to failure in operation under varying conditions, the testing and trying out of processes in connection with the metallurgical industry and biological and geological problems.

The highly specialised intricate work of standardising electrical instruments and other scientific apparatus for use as substandards by different Government departments and other institutions in which research work may be carried on would also naturally fall within the functions of the institute.

A convincing reason for drawing a line of distinction between laboratories primarily for scientific research and laboratories primarily for the necessary routine work of departmental testing is that any attempt to combine the two would lead to confusion and hamper and weaken both branches of activity, and would tend to drown the research work for which the institute is being created.

It cannot be too strongly insisted that the qualifications of a staff for "researching" are different in character from those of a staff which is to carry out scientific routine testing.

The committee therefore recommends that:—

(*a*) The control of the present Commonwealth laboratories be not disturbed, but that they be co-ordinated, their staff increased, and their equipment improved.

(*b*) Any new national laboratories which may be created for special purposes of research and experimental inquiry, including a physical laboratory for testing and standardising purposes, should be controlled by the institute.

(4) With regard to the constitution of the institute the committee passed the following resolutions:—

(i) "That an Advisory Council consisting of nine members representing science and the principal primary and secondary industries be appointed who shall advise and co-operate with the directors in framing the policy and in the administration of the institute."

(ii) "That the members be appointed by the Governor-General in Council."

(iii) "That for the purposes of controlling and administering the institute and of collecting information and determining on the researches to be undertaken and directing their elucidation, three highly qualified salaried directors, of whom one should be chairman of the directors, shall be appointed by the Governor-General in Council. The directors shall seek the advice and co-operation of the Council and shall be *ex-officio* members thereof."

(iv) "That of the three directors one should be an expert business and financial man with ability in organisation; the other two should be chosen mainly on account of scientific attainments and wide experience."

(v) "The tenure of the directors shall be fixed by the Act."

(vi) "That the scientific staff should be appointed by the Governor-General in Council on the recommendation of the directors."

(5) The committee further resolved as follows:—

(i) "That all discoveries, inventions, improvements, processes, and machines made by workers directly employed by the institute should be vested in trustees appointed by it as its sole property, and should be made available, under proper conditions and on payment of gratuities or otherwise, for public advantage."

(ii) "That the council of the institute should be empowered to recommend to the Government the payment of bonuses to successful discoverers or inventors working under the auspices of the institute."

(iii) "That the institute should be empowered to charge fees for special investigations subject to regulations approved by the Governor-General in Council."

(6) Though these matters are not directly connected with the proposed institute the committee passed two further resolutions:—

(i) "That steps should be taken with a view to co-ordinating the work of our technical colleges and trade schools throughout Australia, so that a supply of scientifically taught craftsmen will be available to support the expansion of industry that it is hoped will result from the operations of the Institute of Science and Industry."

(ii) "That with a view to promoting our export trade in Australian products it is desirable that serious attention be given to the study of modern languages, including Oriental languages, for commercial purposes."

Immediate Arrangements.

(7) The committee realises that the establishment of the institute will necessarily involve some delay, but being impressed with the urgent need for work of the character proposed the committee resolved as follows:—

(i) "That until the institute is established an Advisory Council be appointed by the Governor-General in Council particularly to carry out the objects expressed in resolutions 2 (i) and (ii), viz.: 'To consider and initiate scientific researches in connection with, or for, the promotion of primary or secondary industries in the Commonwealth,' and (ii) 'The collection of industrial scientific information and the formation of a bureau for its dissemination amongst those engaged in industry.'"

(ii) "That the Federal and State Munitions Committees, heads of the Commonwealth and State scientific departments, and bodies representative of Commonwealth manufacture, commerce, agriculture, mining, and engineering, the universities and technical colleges, and private enterprises, be invited to suggest branches of industrial scientific research in which investigation would be of immediate practical use to producers and manufacturers."

(iii) "That the Advisory Council be appointed forthwith, and that when appointed it immediately take steps to initiate research work into the most pressing matters needing investigation and seek the co-operation of existing institutions and utilise the resources of staff and equipment at our disposal at the present time."

(iv) "The committee suggests for the consideration of the Advisory Council that the following problems, among others, are pressing:—The sheep fly pest; improved methods of extracting zinc from Australian ores, including the commercial manufacture of electrolytic zinc; the utilisation of brown coal with recovery of by-products; the introduction of a mechanical cotton picker; the eradication of the prickly pear; the production of aluminium and ferro alloys; the recovery of potash, manufacture of alkali, and condensation of sulphurous acid gas at present being wasted; the cultivation of useful indigenous grasses and salt-bushes; the manufacture of fine chemicals, drugs, and explosives.

It is, of course, impossible to predict, in matters of research, what the outcome of investigations may be. And the committee realises that not all the above subjects can be examined to the point of final results during the interval before the institute gets to work. The committee, however, suggests that in many, if not all, of the above matters most valuable work could be done in collecting data, and, in effect, making a preliminary census both as to present discoveries, and the staff and apparatus available in Australia. Such work is an indispensable first step in all research.

In addition to this, there is ample scope for practical work during the interval in vigorously prosecuting the dissemination of known information as to processes, etc., amongst our producers and manufacturers.

(v) "That funds be placed at the disposal of the Advisory Council for the above purposes."

(8) The committee desires to thank the Prime Minister for having placed at its disposal the services of Mr. Gerald Lightfoot, barrister-at-law, whose work as secretary has been greatly valued by the committee.

(Signed) Orme Masson (chairman), A. B. Piddington, G. D. Delprat, W. Russell Grimwade, J. M. Higgins, Wm. S. Robinson, George Swinburne, Alex. J. Gibson, Douglas Mawson, W. W. Forwood.

(Signed) Gerald Lightfoot, secretary to committee.

NOTES.

WE are glad that the *Times* has published in its Educational Supplement for March 7 a selection of letters upon the place of science in education received since the publication of the recent memorial on the neglect of science, to which we have referred on more than one occasion. The memorial was drawn up by a small committee of public-school science masters, and the thirty-six distinguished men of science who signed it subscribed to the views expressed in it without themselves being actively concerned with the construction of the document. If they and the professors at the Imperial College who supported them in a later short memorial to Lord Crewe, the chairman of the governors of the college, had met and discussed in detail the subject of science in national affairs, we might have had a manifesto which would have outlined a national programme on a scientific basis, instead of a memorandum on the defects of the public-school curricula and Civil Service examinations as regards the study of science, and their consequences in public administration and legislation. There is not much new to be said upon these subjects, and the scientific aspects have been surveyed in our own columns from every point of view. In a leading article the *Times* Educational Supplement acknowledges that men of science will have little difficulty in establishing the following contentions:—(1) That much of our present teaching is antiquated, and, in method, unscientific; (2) that natural science, if taught at all, has too small a place in the average curriculum; and (3) that our social organisation makes it far easier for literary than for scientific ability to find its level. These undoubted defects might well be placed before a committee, independent of any Government department, appointed to inquire into the entire question of the organisation of our educational system, as suggested by Sir Philip Magnus. The subject should be included in the national programme which, we learn from a letter by Sir William Mather and Sir Norman Lockyer, is being deliberated by the British Science Guild. Any suggestions for such a programme should be sent to the honorary secretaries of the Guild, 199 Piccadilly, W.

FURTHER regulations under the Defence of the Realm Act, issued on March 1, contain provisions prohibiting speculative transactions in the various metals required in the production of war material. The new regulation provides that it shall not be lawful for any person on his own behalf, or on behalf of any other person, to sell or buy iron (including pig-iron), steel of all kinds, copper, zinc, brass, lead, antimony, nickel, tungsten, molybdenum, ferro alloys, or any other metal which may be specified as being a metal required for the production of any war material. Rather curiously, tin, which is an important constituent of many naval alloys, including Admiralty gun-metal and Admiralty brass, and the price of which is very liable to sudden and large fluctuations owing to speculation, is absent from this list. On the face of it this metal should certainly have been included. The effect of these regulations on the operations of the metal exchanges of London, Birmingham, and Glasgow was at once evident. All business in regard to the above metals and alloys was suspended. A sobering influence on market prices should certainly result. A deputation from the London Metal Exchange was to discuss the situation with the Minister of Munitions on March 3.

PROF. W. KILIAN, of Grenoble, has contributed to the *Revue Scientifique* (vol. liv., pp. 33–40) a long and interesting article on proposals for the organisation of scientific research in France after the war. He points out how pre-eminent Germany has become in the provision of bibliographies, synoptical treatises, other works of reference, more or less international journals, and materials of every kind for laboratory work and the lecture-room. Writing as a geologist, he is able to enumerate many important illustrations with which the efforts of French scientific men and publishers compare very unfavourably. While admitting that the progress of science must never be hampered by international boundaries, he urges the importance of some organisation for raising the prestige of French science in the early future. He proposes that an association be formed for the better co-ordination of work in providing bibliographies and reference books; that more posts be endowed for pure scientific research; and that more effort be made to secure for French scientific men a fair proportion of the appointments abroad, which are usually filled by graduates from the great European universities.

THE sixth annual May lecture of the Institute of Metals will be given on Thursday, May 4, by Prof. W. H. Bragg, on "X-Rays and Crystal Structure, with Special Reference to Certain Metals."

THE twenty-fifth annual meeting of the Royal Society for the Protection of Birds will be held at the Middlesex Guildhall, Westminster, S.W., on Thursday, March 16. Mr. Montagu Sharpe, chairman of the council, will take the chair at 3 p.m.

WE learn from the *British Medical Journal* that Prof. M. Weinberg, of the Pasteur Institute, Paris, will deliver a lecture on bacteriological and experimental researches on gas gangrene before the Royal Society of Medicine (1 Wimpole Street, London, W.), to-morrow (Friday), at 5 p.m.

THE prize of 10*l.* and a silver medal, offered under the Peter Le Neve Foster Trust by the Royal Society of Arts, for an essay on "Zinc: its Production and Industrial Applications," has been awarded to Mr. J. C. Moulden, of Seaton Carew, co. Durham. Honourable mention has also been awarded to Mr. E. A. Smith, deputy assay master of the Sheffield Assay Office, for his essay.

THE Rev. E. W. Barnes, F.R.S., Master of the Temple; Mr. E. Newton, president of the Royal Institute of British Architects; and Prof. T. F. Tout, professor of medieval and ecclesiastical history in the Victoria University of Manchester, have been elected members of the Athenæum Club, under the rule which empowers the annual election of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public services."

THERE will be a discussion on "The Sphere of the Scientific and Technical Press in Relation to Technical Education and Industrial Research" at the next meeting of the Circle of Scientific, Technical, and Trade Journalists, on Tuesday, March 14, in the hall of the Institute of Journalists (Tudor Street, Blackfriars, London, E.C.). The chairman of the circle, Mr. L. Gaster, will preside, and the discussion will be opened by Dr. William Garnett, late educational adviser to the London County Council.

THE following new officers and members of council were elected at the annual general meeting of the Institute of Chemistry on March 1:—*Vice-Presidents*: Dr. A. Harden and Prof. Herbert Jackson. *Members of Council*: Mr. R. Bodmer, Mr. H. C. H. Candy, Prof. G. G. Henderson, Mr. P. H. Kirkaldy, Dr. A.

Lauder, Mr. Bedford McNeill, Prof. G. T. Morgan, Mr. D. Northall-Laurie, Mr. G. Stubbs, and Mr. T. Tickle.

THE Faraday Society will hold an informal discussion on "Methods and Appliances for the Attainment of High Temperatures in the Laboratory," on Wednesday, March 15, at 8 p.m., at the Institution of Electrical Engineers, Victoria Embankment, London, W.C. Dr. J. A. Harker, of the National Physical Laboratory, will open the discussion, over which Sir Robert Hadfield, the president of the society, will preside. Workers interested in the subject, and particularly those prepared to speak on the results of their personal experiences, are invited to be present and take part in the discussion. Further particulars may be obtained from Mr. F. S. Spiers, secretary of the society, 82 Victoria Street, London, S.W.

THE following officers and council of the Geological Society of London have been elected for the ensuing year:—*President,* Dr. A. Harker; *Vice-Presidents,* Sir T. H. Holland, Mr. E. T. Newton, the Rev. H. H. Winwood, and Dr. A. Smith Woodward; *Secretaries,* Mr. H. H. Thomas and Dr. H. Lapworth; *Foreign Secretary,* Sir Archibald Geikie; *Treasurer,* Mr. Bedford McNeill. In addition to these officers the members of the new council are:—Mr. H. Bury, Prof. J. Cadman, Prof. C. G. Cullis, Mr. R. M. Deeley, Prof. W. G. Fearnsides, Dr. W. Gibson, Dr. F. L. Kitchin, Dr. J. E. Marr, Mr. R. D. Oldham, Mr. R. H. Rastall, Prof. T. F. Sibly, Prof. W. J. Sollas, Dr. J. J. H. Teall, and Mr. W. Whitaker.

THE third Indian Science Congress met at Lucknow on January 13–15. The growing interest in scientific inquiry observable in India is evidenced by the rapidly increasing popularity of this body. In spite of the war, about seventy papers were read at the congress and more than 300 visitors attended the meetings. The list of papers discloses a surprisingly large volume of scientific work in India, and there is every reason to look for a successful and useful future of the congress. The presidential address was delivered by Sir S. G. Burrard, F.R.S., who took as his subject "The Plains of Northern India, and their Relationship to the Himalaya Mountains." Sir A. G. Bourne, F.R.S., has been elected president for 1916–17, and the next meeting will probably be held at Bangalore.

WE have received a provisional programme of the eighth meeting of the Italian Society for the Advancement of Science, arranged to be held at the Royal University of Rome on March 1–4. The session was originally intended to be held at Bari, but as this city is too near the theatre of war it was resolved to meet at Rome instead. The president was Prof. Camillo Golgi, the vice-presidents being Prof. Guido Castelnuovo and Prof. Vittorio Rossi, and the secretary Prof. Vincenzo Reina. The inaugural address, delivered by Prof. G. Cuboni, dealt with the problems of agriculture at the present time. General discourses were given by Prof. R. Nasini on Italian chemistry; by Prof. G. Valenti on hydraulic problems and water legislation; by M. Pantaleoni on economic lessons of the war; by G. Luigi on eugenics and the decay of nations; and by P. Fedele on imperialism in German history. Sectional papers were given by G. Levi on inorganic chemical industry; by E. Molinari on the industry of some important organic compounds; by F. Garelli on the industry of fats; by E. Miolati on electrochemical industry; by M. Ascoli on electrotechnics; by E. Bianchi on the state of the Italian industry of geodetic-astronomical instruments; by P. Gamba on the exploration of the upper atmosphere. In the medical-hygienic section C. Moreschi dealt with the prophylactic use of antityphoid and anticholera injections; V. Pensuti with vaccino-therapy of typhoid; and A. Perroncito and G. Grixoni with hygienic problems of modern war. A list of philosophical and geographical papers is also given in the programme issued.

THE death is announced of Prof. Vladimir A. Tichomirov, professor of pharmacy and materia medica at Moscow University and Russian Councillor of State.

THE death has occurred at Sheffield, in his sixty-fourth year, of Mr. G. T. W. Newsholme, who was the first provincial pharmacist to occupy the position of president of the Pharmaceutical Society. Mr. Newsholme became vice-president of the society in 1897, and in 1900 was elected president, holding the office for three years. He was a governor of Sheffield University.

THE death is announced, in his fifty-eighth year, of Dr. J. Nelson, a native of Copenhagen, and a graduate of the University of Wisconsin, who had occupied the chair of biology at Rutgers College, New Jersey, since 1888. He had also held various scientific appointments under the State of New Jersey, including membership of a tuberculosis commission and the post of investigator of oyster culture.

MR. L. DUNCAN, formerly associate professor of applied electricity at Johns Hopkins University, and head of the department of electrical engineering at the Massachusetts Institute of Technology, has died at the age of fifty-three. He was twice president of the American Institute of Electrical Engineers, and had written on electric traction for the "Encyclopædia Britannica." He served as consulting engineer during the electrification of the transit systems of New York.

THE death is announced, in his eighty-first year, of Dr. W. A. Knight, emeritus professor of moral philosophy in the University of St. Andrews. Prof. Knight was the author of many literary works, including "Studies in Philosophy and Literature" (1879), "Essays in Philosophy, Old and New" (1890), and "Varia, being Studies on Problems of Philosophy and Ethics" (1901), but he will be remembered chiefly as the devoted editor and interpreter of the poet Wordsworth and the Wordsworth family.

THE death has occurred in his sixtieth year of Prof. Pietro Grocco, director of clinical medicine in the R. Istituto di Studi Superiori of Florence. After studying in Paris and Vienna he was, we learn from the *Lancet,* appointed to a chair of practice of medicine at Perugia, which he occupied for three years, when he was elected to a post on the same subject at Pisa, whence in 1892 he was transferred to Florence. The Florentine school enjoyed his special care and generosity, founding as he did, mainly from his own resources, the Istituto Antirabico on the lines of Pasteur, and making the thermal waters of the neighbouring Montecatini a balneary centre in practical connection with his courses on the vast group of rheumatoid maladies. In 1905 he was made a senator of the kingdom, in accordance with Italy's custom to promote men of scientific distinction to the Upper Chamber, and here again his advice on intervention was of public benefit in more than one hygienic departure.

THE death is announced, at seventy-two years of age, of Prof. E. Heckel, professor of botany in the University of Marseilles. We learn from the *Chemist and Druggist* that after the war of 1870 he became head pharmacist at Montpellier and assistant-professor at the local School of Pharmacy. Five years later he accepted the post of professor of natural history at the Nancy School of Pharmacy, but his stay there was short. After a few months at the Grenoble Faculty of Sciences, Heckel obtained two professorial chairs at Marseilles, teaching botany at the Faculty of Sciences and materia medica at the School of Medicine. To these double duties he added those of director of the Botanic Garden of Marseilles. In 1880 his contributions to science were recognised by his election to the corresponding membership of the Paris Academy of Medicine, and later by a similar election at the Academy of Sciences. It was in 1892 that he founded the Colonial Institute, where he placed his collections. He specialised in the study of such tropical plants as were likely to be of value for alimentary purposes or local industry, and his name is associated with the introduction of several of them into France.

THE *Times* of March 2 reports the death of Ernst Mach, once professor of physics in the University of Prague, but for the greater part of his academic life professor of the history and theory of inductive science at Vienna. The news will cause widespread regret, for, though Mach was not a great investigator or constructive thinker either in positive science or in philosophy, he did admirable secondary work for both by his illuminating interpretations of the history of physics. His psychological investigations, best represented by his book on "The Analysis of Sensations," had technical merits which earned high praise from so competent a judge as William James. They are interesting chiefly, however, as "studies" in the radical empiricism that found its most characteristic expression in his epistemological essays—particularly in his "Science of Mechanics." The essential positions of this famous work were (as Mach pointed out pathetically) published so long ago as 1868, that is, six years before Kirchhoff astonished the scientific world by the announcement of similar but less thoroughgoing views. The book itself appeared in 1883. It has undoubtedly had great influence not only upon current views as to the real nature of science, but also upon the actual development of mathematical physics from Hertz down to the relativists of the present day. In a farewell communication which the unhappy state of Europe makes the more dignified and touching, Prof. Mach "sends greetings to all who knew him and asks for serene remembrance." Men of good will in all countries will respond to the wish, for no chauvinistic bias distorted Mach's vision of the progress of the human spirit, and none has shown more clearly than he that in the disinterested pursuit of knowledge men of all times and tongues are members one of another.

THE recent completion, almost simultaneously, of three masonry dams for the main impounding reservoirs of important water supply systems in this country is an event somewhat unique in its way. None of the three structures—the Angram, the Derwent, and the Alwen Dams—is perhaps of such magnitude as the Kensico Dam in the United States, to which reference was made in our issue of January 27 (p. 602), but they are all noteworthy examples of this department of waterworks engineering. The Angram Dam, in Yorkshire, holds up 1250 million gallons of water derived from the river Nidd and the Stone Beck, for the supply of the town of Bradford. The capacity of the reservoir formed by the Derwent Dam is 2000 million gallons; it forms the second instalment of a great scheme destined to serve the Derwent Valley, including the towns of Leicester, Derby, Sheffield, and Nottingham, and the counties of Derby and Nottingham. There are to be five dams in all in this undertaking, and the first, the Howden Dam, of about equivalent storage capacity with the Derwent Dam, was completed some few years back. The third dam of the three forming the subject of our note, the Alwen Dam for the Birkenhead Corporation Water Supply, holds up 3000 million gallons from the river Alwen. The reservoir capacity is thus much greater than that of either of the other two dams, but the structure itself is smaller, both as regards length and height. The crest is only 458 ft. long, and the height from the river bed 90 ft., whereas the crest of the Derwent Dam is 1110 ft. in length and 114 ft. in height, and the crest of the Angram Dam 1200 ft. long, and its height 130 ft.

THE Madras Museum has done good service to the study of Indian antiquities by publishing a new edition of the catalogue of prehistoric antiquities collected by the late Mr. R. B. Foote, which forms the most valuable portion of the museum collections. To this has been added a catalogue of the prehistoric antiquities, collected by Mr. A. Rea, of the great burial grounds of Adichanallur and Perumbair. These collections contain a large number of specimens of objects in metal and pottery, which are of the highest value for the study of the early history of the Dravidian races.

IN his presidential address to the Hellenic Society, published in part ii. of the Proceedings of the Society in 1915, Dr. W. Leaf discussed the history of Greek commerce, a subject dealt with in his important work on Homer and history, recently reviewed in these columns. He made the interesting suggestion that the society should undertake an edition of at least the three books of "Strabo's Geography" describing Asia Minor. This should be on the lines of Sir James Frazer's edition of "Pausanias," dealing in the first instance with topography, and summarising the stores of epigraphic and numismatological information, with an account of the many characteristic religions and myths of that region. Sir William Ramsay and Mr.

Hogarth have promised to assist in the proposed edition of Strabo, and it may be hoped that after the close of the war the Hellenic Society will be in a position to undertake this important work, which will be of the highest value to historians and geographers.

A VERY acceptable addition to our knowledge of the nesting habits of the Australian mistletoe-bird (*Dicaeum hirundinaceum*), by Messrs. S. A. Lawrence and R. T. Littlejohn, appears in the *Emu* for January. The authors were so fortunate as to be able to study the final stages of the building of the nest, and later to obtain photographs, both of the parents and nestlings. The former displayed extraordinary confidence, allowing the nestlings to be removed from the nest and feeding them on the hand of one of the photographers. The tameness of these birds enabled the authors to watch closely the peculiar method employed by them in extracting the seeds of Loranthus berries, which constituted a large portion of the food of the young, insects completing the dietary. The same number also contains some valuable notes by Mr. Charles Barrett on the spotted bower bird, with a photograph of its remarkable bower, or playing ground. This most interesting bird is unfortunately incurring the resentment of the fruit-growers on account of the damage it is said to inflict on the orchards, a charge, however, which does not seem to have been established.

IN the January number of that admirable journal, *California Fish and Game*, it is announced that an attempt is to be made to interest the fish-dealers of San Francisco in a project for the production of caviare from the roes of salmon and shad. M. Cotoff, a Russian expert, is the moving spirit in this project, which, it is to be hoped, will meet with success, since about half a million pounds of salmon roe from the canning stations in San Francisco are thrown away annually. It is claimed that caviare thus made will exceed in quality the imported caviare made from the sturgeon. The same number contains a lucid account of experiments which have been made recently to test the effect of strychnine sulphate on the California Valley quail. Barley soaked in this poison is now used to eradicate the ground squirrels, and hence it was feared the quail might be involved in their destruction. Experiments have shown, however, that the squirrels are very susceptible to strychnine, while the quail, under natural conditions, may consume relatively large amounts of this poison without hurt. This conclusion has been arrived at in consequence of a series of experiments on a number of captive quail. In one case 280 grains of barley containing no fewer than 40 milligrams of strychnine were ingested, and yet without any toxic symptoms, while, in a squirrel, 19 grains of barley containing as little as 2·7 milligrams of poison sufficed to produce convulsions and death within ten minutes. The grain in this case was not swallowed, but merely taken into the buccal pouches, where the poison was absorbed through the mucous membrane of the pouch. The maximum dose of poison taken by a squirrel was 5·7 milligrams taken up with 40 grains of barley, death taking place within an hour.

Symons's Meteorological Magazine for February inaugurates the commencement of the second half-century of its issue. A tentative summary of the rainfall over the British Isles for January shows that the general rainfall for England and Wales was 89 per cent. of the average, that for Scotland was 147 per cent., for Ireland 86 per cent., and for the British Isles as a whole 109 per cent. An article on "The Mildness of January, 1916, in London," presumably from the observations at Camden Square, shows the month to have been unique for its temperatures compared with the observations from 1858 to the present time. The mean temperature for the month was 45·7°, which is 7·2° above the average, and exceeds by 1·8° the next highest value, 43·9°, which occurred in 1884. A discussion by Mr. H. A. Hunt, Commonwealth Meteorologist, on the "Temperature Departures in Australia, 1915," exhibits the remarkably warm winter and greater part of the year 1915, the excess of temperature in June and July being more than 5° over Central Australia. The article is illustrated by a series of temperature charts embracing the whole of Australia.

THE series of articles on the "Economic Resources of the German Colonies" in the Bulletin of the Imperial Institute is concluded in the current number (vol. xiii., No. 4) with an article on Germany's recent possessions in the Pacific. The large amount of zinc required for war purposes and the resulting increased demand lend special interest to an article on the sources of the metal within the British Empire. By far the most important zinc deposits in the Empire are those of the Broken Hill Mines, New South Wales, the output of which alone is sufficient to supply the entire demands of the United Kingdom. The Broken Hill ore before the war went mainly to Germany for smelting, but the Australian Government has adopted measures which will prevent this in the future. The issue also contains useful reports based on the work done at the Imperial Institute on Indian opium, tobacco from Cyprus, copra from Queensland, cocoa from Nigeria, piassava from British West Africa, and asbestos from South Africa.

THE January number of the *Journal of the British Science Guild* contains a number of articles dealing with organisation and education and with the application of science to warfare. A letter written by the president, Sir William Mather, to the Prime Minister in July last, dealing with the application of the scientific resources of the country to the prosecution of the war, is printed in full. Of particular interest to opticians and glass manufacturers are the specifications of three types of microscopes and a list of educational institutions which have undertaken to use only British-made chemical glass apparatus during the war and for a period of three years after. Dr. H. S. Willson contributes an article on organisation and education. The part played by science in war is dealt with by "Anagapa." Prof. R. A. Gregory contributes a timely article on the introduction of the metric system. Experience of the past eighteen years has shown that permissive legislation is not of much practical effect. The Weights and Measures Act of 1897 rendered it lawful to use the metric system in this country for the general purposes of trade, but little advantage has been taken of it, either in internal or external trade. The system must be made compulsory before the trading community as a whole will take advantage of it. Several recent instances show that the metric system can be introduced without the difficulties which some people suppose would come with it.

AN article by Mr. R. G. Skerrett in the *Scientific American* for February 12 describes Fricke's apparatus for locating vessels at sea during fogs. It depends on the difference in the time required for a wireless signal and for a sound signal sent out from the same point at the same instant to reach some distant point. This difference is proportional to the distance apart of the sending and receiving points. The receiving apparatus consists of a wireless receiver and sixteen telephones arranged at equal angular intervals round the ship, and so protected that each will respond only to sounds coming in approximately its direction towards the ship. The arrival of the wireless signal starts sixteen bands travelling outwards from a common centre towards the sixteen corresponding telephones. The arrival of the sound signal at the telephone directed towards the quarter from which the sound originates actuates a marking point carried by the corresponding band, and a mark is made on the under side of a piece of translucent paper placed over the bands and ruled with concentric circles representing the number of miles of the source from the vessel. The marking points are brought back to the zero circle after each observation, and a series of observations gives the direction, distance, and course of the source from the ship.

IN the last number of the Proceedings of the Geologists' Association (December, 1915) Dr. A. Holmes gives a useful summary account of the manner in which the study of radio-active minerals can be applied to the measurement of geological time. The science of radio-activity has already destroyed the argument by which Lord Kelvin deduced a relatively short age for the earth from its apparent rate of cooling. But the same science also furnishes data for a direct estimate of the age of a rock which contains radio-active minerals. There is doubtless a considerable margin of error, but the best results are consistent, and seem to be reasonable. Prof. Strutt's method was based upon the accumulation of helium from the gradual break-up of uranium and thorium. Dr. Holmes takes instead the ratio of the final product, lead, to uranium, and his results are in general higher than Strutt's, probably owing to the loss of helium by leakage. Various Carboniferous and Devonian intrusions are estimated to have an age of the order of 300 to 400 millions of years, and for granitic intrusions of the Middle pre-Cambrian is deduced an age of the order of 1000 to 1200 millions of years. Such figures will be comforting to geologists who dislike hurrying unduly the operations of nature.

IN the current number of the Transactions of the English Ceramic Society there are several important papers, notably one by M. Bigot on the distribution of heat in pottery ovens, and one on pottery pyrometry by Mr. R. W. Paul. There is a memorial lecture on the famous ceramic artist, M. Solon, by Mr. Hobson, of the British Museum, and a number of papers of purely technical interest by Messrs. Audley, Dressler, Guy, Hill, Mellor, Singleton, and Wilson. The English Society is doing good work in getting the empirical experience of the potters into a systematic form, so that the underlying principles may finally be made clear; and it is gradually winning for itself general recognition among the manufacturers who pay for the work of abstracting the home and foreign pottery, clay, and glass journals. These abstracts are an important feature of the journal.

THE following forthcoming books of science are announced, in addition to those referred to in recent issues of NATURE. By *George Allen and Unwin, Ltd.*—Elements of Folk Psychology: Outlines of a Psychological History of the Development of Mankind, W. Wundt, translated by E. L. Schaub; Anthropomorphism and Science: A Study of the Development of Ejective Cognition in the Individual and the Race, O. A. Wheeler. By *D. Appleton and Co.*—The Book of Forestry, F. F. Moon; The Care and Culture of House Plants, H. Findlay; The Fundamentals of Plant Breeding, J. M. Coulter; Sanitation in Panama, W. C. Gorgas; Irrigation Management, F. H. Nowell; Irrigation in the United States, R. P. Teele; The Theory of Steam Traction Engineering, S. R. Eighinger and M. S. Hutton; Minerals and Rocks, W. S. Bayley. By *A. and C. Black, Ltd.*—A Manual of Mendelism, Prof. J. Wilson; First Principles of Evolution, Dr. S. Herbert, new edition, illustrated; A Manual of Medical Jurisprudence, Toxicology, and Public Health, Dr. W. G. A. Robertson, new edition, illustrated; Diseases of Children, Dr. A. D. Fordyce, illustrated. By the *Cambridge University Press.*—A Factorial Theory of Evolution, Prof. W. L. Tower; Chemical Signs of Life, S. Tashiro (University of Chicago Science Series.) By *Cassell and Co., Ltd.*—Alfred Russel Wallace: Letters and Reminiscences, J. Marchant. By *J. and A. Churchill.*—Handbook of Colloid Chemistry: the Recognition of Colloids, Theory of Colloids, and their General Physico-Chemical Properties, Dr. W. Ostwald, translated by Prof. M. H. Fischer. By *John Murray.*—Agriculture after the War, A. D. Hall. By the *University of London Press.*—The New Regional Geographies, L. Brooks, vol. i., The Americas, vol. ii., Asia and Australia, vol. iii., Europe and Africa; An Economic Geography of the British Empire, C. B. Thurston. By *Witherby and Co.*, under the title, "A Veteran Naturalist," a life of the late Mr. W. B. Tegetmeier, by his son-in-law, Mr. E. W. Richardson.

WITH reference to the note in NATURE of March 2 (p. 16), Mr. Perrycoste writes to say that he pointed out not only the advantages consequent on the suggested use of Latin, but the counterbalancing risks and the necessity of discarding Latin "prose-composition," as well as Latin verse.

IN the article on "The Utilisation of Peat" in NATURE of March 2, it should have been stated that the blocks of Figs. 1 and 2 were lent to us by the Department of Agriculture and Technical Instruction for Ireland, which, as stated on p. 19, publishes the pamphlet from which the article was abridged. Fig. 3 was from a block lent by the Power Gas Corporation, Ltd., Stockton-on-Tees.

OUR ASTRONOMICAL COLUMN.

THE SOLAR ACTIVITY.—Sun-spot activity has been especially noteworthy during the past few days, a feature being the great extent and disturbed character of several of the groups.

COMET 1916*a* (NEUJMIN).—The discovery of the first comet of the year by M. G. Neujmin, of the Simeis Observatory, Crimea, on February 24 was announced last week. According to a telegram received last Friday from Prof. E. Strömgren, the comet was observed by Prof. Biesbroeck (Yerkes) on February 29, at 14h. 41·3m. G.M.T.; its position was R.A. 8h. 58m. 46·5s., declination $+13^{\circ}\ 35'\ 14''$. The comet is thus a little south of κ Cancri.

COMET 1915*e* (TAYLOR).—On February 4, 1891, Dr. Spitaler, searching for Winnecke's comet, observed a cometic object that afterwards could not be refound. On the basis of the orbit calculated by M. J. Braae and Mlle. J. Vinter Hansen, Prof. A. Berberich finds (*Astronomische Nachrichten*, No. 4827) that this solitary observation possibly refers to comet Taylor. Assuming changes of $+6·5^{\circ}$ and $-6·3^{\circ}$ in longitudes of node and of perihelion respectively, and calculating the comet's place for $M=5·1^{\circ}$, gives about the position of the object seen by Dr. Spitaler. Decided alterations in the position of the nodes due to perturbations by Jupiter were possible in 1901, and again in 1912–13. If perihelion occurred in 1891·0, then the interval, 25·1 years$=4\times6·27$, would be equivalent to four revolutions. Dr. Spitaler recorded that at about 9½h. he saw the object "between the faint stars lying together in the same parallel 20s. preceding the star DM+26°, 1714," *i.e.* R.A. 7h. 58m. 43s., declination 26° 15′. This position was in fairly close agreement with that calculated for Winnecke's comet according to the orbit of von Haerdtl.

THE ORBIT OF VV ORIONIS.—A paper by Mr. Zaccheus Daniel (Publications, Allegheny Observatory, vol. iii., No. 21) deals with this eclipsing variable and spectroscopic binary. Chief interest centres in the fact that situated within 1° of δ Orionis it is now found to present the same spectral peculiarity, the calcium K line not sharing the oscillations shown by the lines of other elements. Its spectrum is of the B2 type, and the lines are generally diffuse. The period, 1·4854 days, agrees with that previously found by Hartmann from photometric observations, but this rapid oscillation is superposed on a slower, having a period of 120 days. The velocities given by the K line are not quite constant, hence possibly the calcium atmosphere belongs to the system, and has an orbital movement in the same direction as the brighter component. The mean value from the K line is +16·7 km./sec., agreeing with the mean for δ Orionis (+17·2) and ϵ Orionis (+15·6), and with the value of the sun's motion away from that part of space. Thus the calcium vapour is stationary, but as the early type stars themselves have very small velocities, the present evidence does not settle whether the calcium belongs to the stars or not.

OBSERVATIONS OF VARIABLE STARS.—Dr. C. Hoffmeister (*Astronomische Nachrichten*, No. 4827) has recently published a considerable collection of observations of many Algol and short-period variables, and also of a number of suspected variables. Among the latter is η Ursæ Majoris, for which the present observations indicate a range of 0·3 magnitude. Dr. G. Hornig (*Astronomische Nachrichten*, No. 4828) gives dates of maxima and minima of ϕ Persei observed during November, 1914–April, 1915. The period of the latter star is found to be 18·1 days, very nearly one-seventh that found by Lau. Maxima date from November 28, 1914, and thus the next would be due March 12. The variation is of the Cepheid type ($M-m=7·5$ days). Observations of 7 Arietis, 15 Trianguli, and 31 Orionis show them to be irregularly variable in periods of about 70, 200, and 356 days respectively.

SEA-SPIDERS AND FEATHER-STARS.[1]

DR. CALMAN reports on the Pycnogons or sea-spiders collected by the British Antarctic Expedition of 1910. The collection far exceeds that of any Antarctic expedition yet reported on, comprising no fewer than forty-four species, eleven of which are new. There seems no doubt that Antarctic seas are far richer in these quaint, slow-living creatures than any other area of the oceans. While most of the species were obtained in very small numbers, this was not always the case, for we read that two hundred specimens of *Nymphon australe* were obtained at a single station, and presumably at a single haul.

The author discusses the meaning of the ten-legged species which occur, the great majority being eight-legged, and defends, against Prof. Bouvier, the view, which he shares with Prof. Carpenter, that the decapodous Pycnogons represent a recent specialisation, not a primitive survival. An interesting parallel is found in Pliotrema, a Pristiophorid shark, described by Mr. C. Tate Regan, which has six gill-arches instead of the usual five, but is evidently a very highly specialised form, derivable from some ancestor like Pristiophorus, with the normal number of arches.

Attention has been directed to the great range of variability in sea-spiders, but Dr. Calman does not think that it is greater than, for instance, in many groups of Crustaceans. And as to the theory of Döderlein, that lack of the power of wandering is a factor which favours the development of local races, varieties, and species in any group of animals, the author finds no corroboration in the case of Pycnogons, which are extremely slow-going creatures. Although some species can swim in the adult state, their efforts seem to be awkward and ineffective, and none of the larvæ are better adapted for locomotion. The memoir is marked by Dr. Calman's well-known carefulness of workmanship, and the illustrations drawn by Miss Gertrude M. Woodward are remarkably fine.

Mr. A. H. Clark is to be congratulated on the appearance of the first part of the monograph on present-day Crinoids, to which he has largely devoted his energies during the last ten years. The study of these singularly beautiful animals has been heretofore dominated by the palæontological approach, and not unnaturally, since the fossil record is extraordinarily complete, and not very many recent forms have been known or have been available for investigation. This, as the author says, has led to "the recent Crinoids being considered as the impoverished and decadent remnants of a once numerous and powerful class, the last forlorn and pitiful exponents of a dwindling phylogenetic strain. During the 1906 cruise of the *Albatross* I handled tens of thousands of specimens; several times I saw the forward deck of the steamer literally buried under several tons of individuals belonging to a species exceeding any fossil form in size; everywhere we went we found Crinoids; we dredged them at all depths."

[1] "British Museum (Natural History). British Antarctic (*Terra Nova*) Expedition, 1910 Natural History Report. Zoology, vol. iii., No. 1, Pycnogonida." By Dr. W. T. Calman. Pp. 1–74+22 figs. (London: British Museum (Natural History), 1915.) Price 5*s*.

Smithsonian Institution, U.S. National Museum, Bulletin 82. "A Monograph of the Existing Crinoids." By A. H. Clark. Vol. i. The Comatulids. Part i. Pp. 1–406+17 plates+513 figs. (Washington: Government Printing Office, 1915.)

So Mr. Clark ceased to regard the group as decadent or degenerate, and became convinced that recent Crinoids play as important a *rôle* in the economy of the sea-floor as do the other Echinoderms. He has written his monograph, therefore, under the influence of a study of recent forms rather than of extinct forms.

The present instalment contains a general introduction, a history of investigation, a most elaborate glossary, and a general account of Crinoid structure which is strongest as regards skeletal parts, dealing rather sketchily with the "innards" and the development. We regret to see that the learned author defends the extraordinary view that Echinoderms are affiliated to Crustaceans and to barnacles in particular. To support this by "the very close correspondence between the development of the larvæ of the Echinoderms and that of the larvæ of certain types of Crustaceans," or by the correspondence between the crustacean eye and the asteroid eye, or by comparing the genital plates of a sea-urchin to the protopodites of the walking legs of a crayfish, or indeed by any of the arguments used, seems to us an extraordinary perversion of morphological judgment. Attention should be directed to the numerous graphic figures drawn by Miss Violet Dandridge for the text.

CHEMISTS AND THEIR TRAINING.

SPEAKING at the thirty-eighth annual general meeting of the Institute of Chemistry, held on March 1, Sir James Dobbie, the president, referred briefly to the work of the institute during the war and the importance of the services of professional chemists to the nation, particularly in the production of munitions and other material of war. His address is here summarised.

Both in the interests of the profession and of the industries of the country, the institute has encouraged by every means possible the production of laboratory requirements of all kinds hitherto obtained almost entirely from Germany and Austria. In co-operation with the Society of Public Analysts, steps have been taken to ensure supplies of satisfactory chemical reagents, and a number of British firms have undertaken their manufacture according to standards prescribed by a joint committee of the two societies.

The work of the Glass Research Committee of the institute has been remarkably successful. At the end of six months' work formulas were produced for practically all the various kinds of glass required in chemical operations, in addition to glasses for miners' lamps, pharmaceutical ampoules, and X-ray tubes. A number of manufacturers who have taken up these industries are now able to supply immediate requirements, and there is good reason to expect that within a short while they will have completely mastered the technique involved in the production of such articles. The credit for this achievement is due to Prof. Herbert Jackson, of King's College, London, assisted by Mr. T. R. Merton. The work of the committee has received the recognition of the Advisory Council on Scientific and Industrial Research, from whom grants have been received for the furtherance of investigations with a view to the determination of formulas for other glasses required for scientific purposes, including certain forms of optical glass.

As to the necessity for taking adequate measures for equipping ourselves for the economical struggle which must ensue when peace is restored, the discussions which have taken place on the subject have revealed a wide divergence of views, both as to the cause of the unsatisfactory position in which we found ourselves and the steps required to remedy it. In chemical industries, however, it is generally agreed that the relations between chemical science and chemical manufactures should be more intimate in the future than they have been in the past. That condition can be fulfilled only if the country possesses an ample supply of highly trained chemists. Dr. Beilby has expressed the belief that the remarkable development of chemical industry in Germany resulted much more from the large command of chemists and engineers of sound professional training than from the possession of an even larger supply of research chemists of mediocre ability. That opinion should not, however, be taken as giving the impression that the value of research is to be underrated. So far as the supply of chemists of sound professional training is concerned, we can face the future with some confidence, particularly as the facilities for training chemists have been remarkably increased. It has to be admitted, however, that the great public schools are, for the most part, unsympathetic towards the study of science, and, even when they are excellently equipped for the purpose, the results are meagre and unsatisfactory.

As to the older universities, it must be allowed that Cambridge has lately achieved an extraordinary measure of success in adapting its teaching to the needs of modern times, while the fact that Oxford is rousing herself to meet her responsibilities is shown by the terms of a memorandum issued by the Natural Sciences Board in support of a reform in the regulations for the honours degree in chemistry, whereby research will become a compulsory part of the curriculum. What must be advocated is a system of general education on broad lines throughout, including both classics and science, up to the proper age for specialisation. Should the expectation of the country in this matter not be realised, the inevitable result will be that schools established on more modern lines will gradually replace the old public schools as the training ground of the leaders of the nation.

The council of the institute is about to give further consideration to the problem of promoting a more complete organisation of professional chemistry in the interests of the industries of the country. Chemistry is a comparatively young profession, which is gradually establishing itself in the knowledge and the good opinion of the community. It will be successful in this in proportion as it attracts men of strong character and individuality, efficient and capable of holding their own as professional men. As it gains in strength its services will become more widely recognised and will meet with the same appreciation as that accorded to the older learned professions. The fact that the title chemist has long been identified in this country, alone of all European countries, with the craft of pharmacy is responsible for much of the confusion existing in the public mind, but the public is learning at present so much about the work of the chemist that we need not despair of seeing the day when it will be common knowledge that while in law all pharmacists are chemists, all chemists are not pharmacists.

We extract from the report of the council a statement as to the work on glass research to which Sir James Dobbie referred in his address.

The Advisory Council on Scientific and Industrial Research has allotted the institute a grant of 400*l.* for one year's research work on laboratory glass of various kinds, and a grant of 500*l.* for research on optical glass, covering a period up to March 31, 1916. The grants are made on certain conditions, providing for the use of the results by British firms on terms to be arranged between the Advisory Council, the Glass Research Committee, and the manufacturers concerned. The Glass Research Committee has lately forwarded to the Advisory Council reports on formulas for:—Blue enamel for sealing metallic wire into glass; lead glass suitable for electric light bulbs; lead glass similar to above, but avoiding potassium carbonate; opal glass designed to join perfectly with glass made to the committee's formulas Nos. 1 and 10; high-temperature thermometer glass; a leadless opal glass which unites with No. 19 and can be worked with it as an enamel backing for thermometers, etc.; thermometer glass for ordinary temperatures.

The fact that these formulas are available has been reported to British glass-makers, from whom a large number of applications have been received and are now under the consideration of the authorities.

With regard to research on optical glass, the Advisory Council has asked that the Glass Research Committee shall keep in touch with the National Physical Laboratory, to which a grant has also been allotted. The primary object of the work of the laboratory will be "the study of the process and condition of melting and producing glass of good optical quality with special reference to refractories and electric furnace methods, with a view to putting the whole process of manufacture on a practical scientific basis."

The line of investigation undertaken by the Glass Research Committee of the institute is "the study of certain specific optical glasses urgently required for industrial purposes, with a view to their early production by manufacturers."

REPORTS OF CARNEGIE FOUNDATIONS.

A COPY of the year-book for 1915 of the Carnegie Institution of Washington has reached us. As usual, the bulky volume, which this year runs to 429 pages, contains not only detailed particulars of the large amount of scientific research carried out under the auspices of the institution, but full information of the income and expenditure of the corporation. The total financial receipts for the year 1915 amounted to 243,000*l.*, bringing up the grand total received since the inauguration of the institution in 1902 to 2,331,300*l.* The expenditure during 1915 may be summarised as follows:—Investments in bonds, 41,240*l.*; large projects, 154,100*l.*; minor and special projects, research associates and assistants, 21,914*l.*; publications, 9340*l.*; and administration, 9645*l.* The following list shows the departments of investigation to which the larger grants were made and the amounts allotted during the year:—

	£
Department of Botanical Research ...	8,123
Department of Economics and Sociology	600
Department of Experimental Evolution ...	9,784
Geophysical Laboratory	17,833
Department of Historical Research ...	6,280
Department of Marine Biology	3,830
Department of Meridian Astronomy ...	5,276
Nutrition Laboratory	9,013
Division of Publications	2,000
Solar Observatory	44,026
Department of Terrestrial Magnetism ...	28,262
Department of Embryology	6,436
Total	£141,463

A table showing the growth and extent of the institution's publications shows that, since 1902, two hundred and ninety-nine volumes, embracing a total of more than 79,000 pages of printed matter, have been issued.

The executive committee of the Carnegie Trust for the Universities of Scotland has submitted to the trustees its report on the administration of the trust for the year 1914–15.

Under the third quinquennial scheme of distribution, which came into operation on October 1, 1913, a sum of 203,250*l.*, or 40,650*l.* per annum, was allocated among the Scottish universities and colleges. Of this sum 21,250*l.* was applicable towards providing books, etc., for libraries; 160,750*l.* towards the cost of new buildings and of permanent equipment; while 21,250*l.* was assigned towards endowments for lectureships and other general purposes.

The operations of the trust under the research scheme were affected considerably by the war, though the expenditure for the year under the scheme reached 6957*l.* During the year six fellows and nine scholars were engaged on military duty, and in these cases the fellowship or scholarship has been kept open in case the recipient should be able subsequently to resume research work. Notwithstanding adverse conditions, the experts have been able to report favourably upon the work accomplished during the year.

For the academic year 1915–16, seventeen fellowships and thirty-three scholarships were awarded, and fifty-three grants were made. Four of these fellowships and nine of the scholarships were awarded to graduates who are at present engaged on military duty, and they, too, are being held over in the hope that the holders may be able to take up their research work again at a later date.

In the laboratory of the Royal College of Physicians the effect of the war has also been felt, and the ordinary activities have to a large extent given place to special work adapted to the circumstances of the time.

During 1914–15 the expenditure of the trust on assistance in payment of class fees has been further diminished by the war, which has depleted the Scottish universities of so many of their students. As compared with a sum of 41,789*l.*, which was paid on behalf of 3901 individual beneficiaries for 1913–14, the expenditure for the year under review was 33,847*l.* on behalf of 3246 individual students. During the year a sum of 704*l.* was voluntarily refunded by or on behalf of eighteen beneficiaries for whom class fees had been paid by the trust. This is the largest sum yet received in this way in any one year.

The report is provided with four appendices dealing respectively with: the grants to universities and colleges, the post-graduate study and research work done by the fellows and scholars, the amount of the assistance rendered to students, and an abstract of the financial account for the year. The list of publications by fellows, scholars, and grantees received by the committee during the year runs to about six pages, and an examination of it shows that very many branches of science have derived benefit from the trust, which is being admirably administered.

THE SUPPORT OF THE HIMALAYA.[1]

THE major prominences of the earth's surface are in some way compensated by a defect of density underlying them, with the result that they do not exert the attractive force, either in a vertical or in a horizontal direction, which should result from their mass. A study of the distribution of this compensation shows that there is a general balance between it and the topography, such that the weight of any vertical column through the crust of the earth is, on the average, constant, whatever may be the elevation of the surface. To this condition the term isostasy has been applied, which does not merely denote a static condition, but implies a power of adjustment of the compensation to the variation in load produced by surface-denudation and transport.

1 Abstract of a lecture delivered before the Geological Society of London on February 2 by Mr. R. D. Oldham, F.R.S.

The explanations that have been proposed of the existence of compensation fall into two classes. One supposes the relief of the surface to be due to an alteration in the volume of the underlying rock, and may be regarded as hypotheses of tumefaction. They involve no addition of matter to the crust under a mountain-range, and do not provide, either for any departure from a balance between topography and compensation, or for a restoration of the balance when disturbed by denudation. The other group of hypotheses attributes the origin of the range to a compression of the crust, the injection of molten matter, or the "undertow" of the lower part of the crust. To provide for compensation any hypothesis of this class will require a downward protuberance of the nether surface of the crust, causing a displacement of denser by lighter material, as also an effect of buoyancy owing to this difference of density: this group of hypotheses, therefore, may be regarded as one of support by flotation. They involve a migration of matter from outside to beneath the range, they allow of a considerable local departure from exact balance between load and support (or topography and compensation), so long as the defect in one tract is balanced by an excess in an adjoining one, and they provide for an adjustment of any disturbance of this balance.

The geodetic observations in the Himalayas show that there is a defect of compensation in the outer hills, which increases in amount until at about 50 miles from the edge of the hills it reaches an equivalent to an overload of about 2000 ft. of rock. In the interior of the Himalayas the only observation yet published shows that at about 140 miles from the edge of the hills this overload has disappeared, and compensation is in excess. The variation in the balance between topography and compensation points to one of the second group of hypotheses, to a support of the range by flotation, and to the conclusion that the growth of the support has been more rapid than that of the range. The primary problem then becomes, not as to how the Himalayas are supported at their actual height, but why they are not even loftier: in other words, the problem is carried one stage farther back, from the origin of the range to the origin of its "root."

This result of the examination of the geodetic data simplifies the explanation of some difficult geological questions. It affords an easy explanation of the indications which are found in the interior of the Himalayas, and of other similar ranges, of simple vertical uplift without disturbance, and also of the manner in which the contorted and faulted strata, the disturbance of which must have taken place under the pressure of some thousands of feet of rock, have been brought up to a level where they are exposed to denudation and their structure revealed; but it brings us very little nearer to an explanation of the ultimate origin of the range. It is a distinct step forward in illustration of the mechanism of the production of mountain-ranges of the type of the Himalayas and the Alps, but we are as far as ever from an understanding of the power by which this mechanism is driven.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—The Huxley Lecture is to be delivered on Friday, March 10, by the Right Hon. the Viscount Bryce, who has chosen as his subject, "War and Progress: an Inquiry from History of how far War and Peace have respectively contributed to the Progress of Mankind."

OXFORD.—On March 7 the statute providing for the introduction of research in the honour school of chemistry was promulgated in Congregation. The adoption of the statute, which had received the support of every teacher of chemistry in the University, was warmly advocated by the Rev. G. B. Cronshaw, fellow of Queen's College, who spoke especially of the educational aspect of the proposed change, and by the Waynflete professor of chemistry (Prof. Perkin), who urged that Oxford should lead the way in a matter of pressing national concern. Similar changes were foreshadowed in the physiology and other natural science examinations. The preamble of the statute was approved without a division.

CORNELL UNIVERSITY has recently suffered the loss of its valuable chemical laboratories, housed in Morse Hall, which has been destroyed by fire. The damage, estimated at 60,000*l.*, is partly covered by insurance. Fortunately the students were able to remove about 5000 books from the library on the ground floor; platinum worth 400*l.* and radium worth 200*l.* were also saved.

WE learn from the issue of *Science* for February 18 that the U.S. General Education Board has announced the following grants to American colleges:—Maryville College, Maryville, Tennessee, 15,000*l.* toward an endowment fund of 60,000*l.*; Western College for Women, Oxford, 20,000*l.*, toward an endowment fund of 100,000*l.*; Milwaukee-Downer College for Women, Milwaukee, Wisconsin, 20,000*l.*, toward an endowment fund of 100,000*l.* Including the foregoing, the General Education Board has since its organisation thirteen years ago appropriated to colleges 2,464,492*l.* toward a total sum of 11,475,105*l.* to be raised. Our contemporary also states that the board of trustees of the Carnegie Institute, Pittsburgh, announces the gift of 50,000*l.* from the Carnegie Corporation of New York, the money to be used for the purchase of ground north of the present campus.

AT a meeting held in Paris in April, 1914, the International Commission on Mathematical Teaching decided to undertake an inquiry regarding the preparation, both academic and practical, of teachers of mathematics in various countries. The continuation of this inquiry has naturally been checked by the present war; at the same time, it is hoped that the various national sub-commissions will continue their work at least so far as the preliminaries are concerned. For this purpose a series of questions in English, French, Italian, and German has been drawn up under the editorship of M. H. Fehr, from whom it may be obtained (address 110 Route de Florissant, Geneva). The replies were to be sent to Prof. Gino Loria, 41 Piazza Manin, Genoa. Most of the questions are evidently suggested by conditions differing widely from those which prevail in Great Britain.

THE issue of *Science* for February 18 gives the following particulars as to numbers of students in attendance at German universities and technical schools from a report by the Berlin correspondent of the Journal of the American Medical Association:—During the semester preceding the opening of the war 79,077 students (of whom 4500 were women and about 9000 foreigners) attended the fifty-two universities and other higher institutions of the German Empire. Of this number 60,943 (4,117 women, 4,100 foreigners) were enrolled in the twenty-one universities; 12,232 (82 women, 2500 foreigners) were enrolled in the eleven technical schools. The six schools of commerce (Berlin, Cologne, Frankfort, Leipzig, Mannheim, and Munich) had 2625 students, and the four veterinary colleges (Berlin, Dresden, Hanover, and Munich) had

1404 students. The three agricultural colleges had 938 students. Three schools of mining had 668 students, and 267 students were registered in the four schools of forestry. During the first semester following the beginning of the war, the total number of matriculants fell to 64,700 in forty-seven of these institutions. The four schools of forestry were closed, and the veterinary school in Munich became a part of the University. During the winter of 1914–15 about 50,000 of these students were in the field or available for service; that is, 75·75 per cent. of the 66,000 German male students registered at the beginning of the war. Of the 66,000 German male students who were registered at the end of the summer of 1915, only 12,000 are still in attendance at the schools, so that about 54,000, or 81·81 per cent., of German higher students are now enrolled in the army. Of the 13,785 university students registered during the summer semester of 1870, only 4400 (32 per cent.) were at the front, and 3200 of this number fell in the field.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 24.—Sir J. J. Thomson, president, in the chair.—Prof. Karl **Pearson**: Mathematical contributions to the theory of evolution. XIX.—Second supplement to a memoir on skew variation. This memoir adds certain additional types of frequency curves to those published by the author in memoirs in the *Phil. Trans.* of 1895 and 1901. It sums up by aid of a diagram the old results and the present additions. It further illustrates by an important general case that frequency curves are distributed over a wide area of the β_1, β_2, plane, where β_1, β_2 are fundamental statistical constants, and that only evil can arise from inflating the Gaussian point ($\beta_1=0$, $\beta_2=3$) to cover the whole of this area. The entire subject is, in the author's opinion, of much importance, as significant differences are in many branches of science determined by the so-called "probable error" of the measured quantities, whether they be means, standard deviations, or correlations. But such "probable errors" have little, if any, meaning, if it can be shown that the sample value is not even the most probable value of the statistical constant in the sampled population, and that the samples are not distributed in a form in the least approaching the Gaussian distribution about the mean value of samples. In every case it is needful to determine the actual frequency distribution, and in nine cases out of ten in samples such as are in common use in psychology, astronomy, or physics—what the statistician terms small samples—it is easy to demonstrate that the distribution is very far from the Gaussian type, but may be markedly skew to such an extent that the ordinary "probable error" is meaningless.—F. P. **Burt** and E. C. **Edgar**: The relative combining volumes of hydrogen and oxygen. The gases were measured successively in a constant-pressure pipette at 0° C. and 760 mm. pressure. (i) In the first series hydrogen and oxygen were prepared by electrolysis of barium hydroxide solution. The hydrogen was purified by passage over charcoal cooled in liquid air; the oxygen by liquefaction and fractionation. Mean value for ratio of combining volumes from twelve experiments was 2·00294. The figure 2·00288 is adopted as final value for ratio of combining volumes at 0° C. and 760 mm. pressure. This differs from the value of Scott (2·00285) by only 3 parts in 200,000. The resulting atomic weight for hydrogen (O=16) computed from Morley's value for the density ratio (0·089873/1·42900) is 1·00772, very nearly the arithmetic mean of Morley's and Noges's values (1·00762 and 1·00787).—W. **Mason**: Speed effect and recovery in slow-speed alternating stress tests. Repeated cycles of equal direct and reverse torque have been applied to mild steel specimens of tubular form, and systematic measurements made of the range of the corresponding torsional strains. The author attempts to account for variations of strain on the hypothesis of alternate production and hardening of "mobile material" in the steel.—W. M. **Thornton**: The ignition of gases by impulsive electrical discharge. The ignition of gases by impulsive discharge is considered first as a function of sparking distance. It is shown that the shorter the distance the greater the spark, so that the volumes of the least igniting sparks are, in a typical case, the same for all spark lengths. Ignition may occur with intense momentary brush discharge, generally with the true disruptive spark. The products of combustion are found to be ionised and to carry a positive charge. The gases examined were mixtures in air of hydrogen, methane, propane, and pentane; of ethylene and acetylene; carbon monoxide and cyanogen; coal gas and a mixture of equal volumes of hydrogen and methane. Hydrogen, propane, pentane, and carbon monoxide rise gradually in difficulty as the percentage of oxygen is reduced; methane is ignited by the same spark whatever the percentage of gas may be; acetylene and cyanogen have the stepped atomic type of ignition; ethylene is more inflammable in rich mixture. Hydrogen and methane in equal volumes are ignited as methane in type, hydrogen in magnitude.

March 2.—Sir J. J. Thomson, president, in the chair. —J. B. **Cohen**, H. D. **Dakin**, M. **Daufresne**, and J. **Kenyon**: The antiseptic action of substances of the chloroamine group. The probability that the formation from proteins of substances containing halogen was an intermediate agent in the germicidal action of hypochlorites made it desirable to investigate systematically a number of substances containing the (NCl) group. Among the substances investigated, the most promising were the group of sulphochloroamides first prepared by Chattaway. The following are the main results of this investigation:—(1) almost all the substances examined containing the (NCl) group possessed very strong germicidal action. (2) The presence in the molecule of more than one (NCl) group does not confer any marked increase in germicidal power. (3) The germicidal action of many of these chloroamine compounds is molecule for molecule greater than that of sodium hypochlorite. (4) Substitution in the nucleus of aromatic chloroamines by Cl, Br, I, CH_3, C_2H_5, or NO_2 groups does not lead to any very great increase in germicidal activity. More commonly there is a moderate diminution. (5) The chloroamine derivatives of naphthalene and other dicyclic compounds of sulphochloroamide type closely resemble simpler aromatic chloroamines in germicidal action. (6) The few bromoamines examined show a slightly lower germicidal action than the corresponding chloroamines, but sodium sulphobromoamides are much more active than sodium hypobromite. (7) Derivatives of proteins prepared by the action of sodium hypochlorite and containing (NCl) groups are strongly germicidal. Blood serum inhibits their germicidal action to much the same extent as it does with sodium hypochlorite or the aromatic chloroamines. Among the above products *p*-toluene sodium sulphochloroamide was selected as being on the whole most suitable for practical use. It is easily and cheaply made; it is relatively non-irritating to wounds; it is non-toxic and very soluble in water, and may be kept unchanged, both in the solid state and in solution for a long period.—I. J. B. **Sollas** and Prof. W. J. **Sollas**: The structure of the Dicynodont skull. This is an account of a skull of Oudenodon studied in serial transverse sections. It supplements and confirms the author's previous description of the skull of a Dicynodon (*Phil Trans.*, B., vol. cciv., 1913).—W. L. **Balls**: Analyses of agricultural yield. Part iii.—The influence of natural environmental factors upon the yield of Egyptian cotton. A discussion is given of all existing data for the behaviour of the Egyptian cotton crop under the conditions of field cultivation during five years as analysed by the author's method of plant-development curves. The term pre-determination is given to the fact that a fluctuation may be due to causes acting at some date long prior to its visible appearance. Thus daily fluctuations in rate of flowering are due to environmental conditions existing a month beforehand. Many other reactions of crop to environment are inexplicable unless allowance is made for pre-determination. It is shown that there is no factor of "season" as such. The action of such factors as weather and climate, soil-water and soil-fertility, are differentiated and traced in the various curves. The predominant influence of an autumnal rise of water-table in determining yield of crop is indicated, and the sensitivity of the plant to root-asphyxiation is shown. A discussion of the function of the root-system, and of the importance of the factors operating through it, is made possible by the nature of the data. The factor of varietal constitution is shown to be of relatively insignificant importance, as compared with environmental factors, in determining yield of crop. The results of these three analyses show that yield of crop can be studied physiologically as yield of an average plant by statistical records of development, and these can be satisfactorily interpreted in terms of the limiting factors of environment, reacting upon inherited genetic properties of plant, provided that the phenomenon of predetermination is taken into account.—A. J. **Ewart**: The function of chlorophyll, carotin, and xanthophyll. In the assimilation of carbon dioxide chlorophyll acts as a light energising enzyme. It takes direct part in the cycle of chemical changes which have xanthophyll as an intermediate product, and glucose, levulose, formaldehyde, and oxygen as end products. Most of the sugar is formed directly and not through the medium of formaldehyde. A large part of the energy represented by this sugar is absorbed during the reconstruction of the chlorophyll molecule. Apart from its protective function, carotin seems to be especially important as providing, during its photo-oxidation, the massive hydrocarbon combination in the phytyl radicle of chlorophyll, the addition of which is necessary to convert the dicarboxylic glaucophyllin into the tricarboxylic chlorophyll. Carotin and xanthophyll are mutually transformable by the aid of metallic oxydases and reductases respectively. Oxidation in darkness is not necessarily the same as that taking place in light. An emulsion of carotin in light in the presence of copper sulphate and salt develops reducing sugar and formaldehyde, whereas in darkness, although slowly oxidised, no sugar or formaldehyde is produced. The oxidation of chlorophyll, carotin, and xanthophyll is more rapid at high temperatures than at low ones.

Zoological Society, February 22.—Dr. A. Smith Woodward, vice-president, in the chair.—B. F. **Cummings**: Report on a collection of Anoplura and Mallophaga obtained from animals in the society's gardens. The author dealt with the structure and development of the various species, and gave descriptions of three new forms.—Dr. P. Chalmers **Mitchell**: Further observations on the intestinal tract of mammals.

CAMBRIDGE.

Philosophical Society, February 21.—Prof. Newall, president, in the chair.—Dr. **Doncaster**: Some gynandromorphic specimens of *Abraxas grossulariata*. In 1915 two specimens of *A. grossulariata* were bred which showed a mixture of male and female characters. Both were from matings of *grossulariata* female by *lacticolor* male. The specimen which was predominantly male was *lacticolor*, although only *grossulariata* males are expected from this mating, and the predominantly female specimen was *grossulariata*, where *lacticolor* females are expected. Reason was given for supposing that previously reported exceptions to sex-limited transmission may have been to some extent gynandromorphic.—L. **Harrison**: A preliminary account of the structure of the mouth-parts in the body-louse. The stomatodæum of Pediculus comprises a buccal cavity, pumping-pharynx, pharynx, and œsophagus. Upon the floor of the buccal cavity opens a long diverticulum, containing two piercing stylets and a chitinous salivary duct. A hitherto undescribed structure, the buccal tube, formed of two apposable half-tubes rising from the floor of the buccal cavity at its junction with the pumping-pharynx, carries blood to the latter. It is suggested that this buccal tube and the whole of the piercing apparatus are derived by modification of the Mallophagan hypopharynx, and that the Anoplura have no close affinity with the Rhynchota.—E. H. **Neville**: The field and the cordon of a plane set of points.

PARIS.

Academy of Sciences, February 21.—MM. Ed. Perrier and d'Arsonval in the chair.—L. **Maquenne**: The presence of reducing substances in commercial sugars other than invert-sugar. It is shown that known quantities of invert-sugar added to pure cane-sugar can be accurately determined by the methods described by the author in previous communications, working either at 65° C. or 100° C. On the other hand, commercial sugars, both crude and refined, show appreciable differences in the invert-sugar obtained from analysis at these two temperatures, and this is held to be due to the presence of other reducing substances.—Pierre **Duhem**: The electrodynamics of dielectric media.—A. **Khintchine**: An extension of Denjoy's integral.—Ed. **Sarasin** and Th. **Tommasina**: Study of the Volta effect by induced radio-activity: proof of two new facts. It is established that, either in the case of electrodes separated by air containing emanations and the radiations of induced radio-activity, or in that where the electrodes (of different metals) are in direct contact, but in contact also with induced radio-activities and always under the influence of an electrostatic charge, there is a production of current. The radio-active medium in these experiments behaves similarly to the electrolyte of a battery.—Thadée **Peczalski**: The law of integral radiation and the yield of light of metals at high temperatures. The law of integral radiation of tantalum is found by experiment to be $E = \sigma T^{4 \cdot 2}$. Graphite sensibly follows Stefan's law; and its emissive power corresponds to that of a black body.—C. **Benedicks**: A new thermo-electric method for the study of the allotropy of iron and other metals. The wire under examination is moved at a constant velocity (1·6 mm. per second) through a small electric furnace maintained at a constant known temperature, and measurements made of the electromotive forces developed. Iron shows clearly the point A_3, but no discontinuity was found for the point A_2.—Léon **Bérard** and Auguste **Lumière**: Retarded tetanus. Commenting on a recent note on this subject by M. P. Bazy, the authors have noticed cases of tetanus developing 84, 90, and 102 days after the wound. It is recommended that a fresh dose of antitetanus serum should be administered every time a surgical operation is made, as such an operation may provoke the liberation of septic products latent in the suspected wounds.

—C. **Houlbert** and C. **Galaine**: The causes of inclusion of foreign material (*chambrage*) in oysters. This phenomenon is caused by a deficiency of organic nutriment, and means are suggested for dealing with oyster-beds to prevent its occurrence.

BOOKS RECEIVED.

The Carnegie United Kingdom Trust. Second Annual Report. Pp. 73. (Edinburgh: T. and A. Constable.)

Year Book of the Royal Society, 1916. Pp. 238. (London: Harrison and Sons.) 5*s.*

Carnegie Institution of Washington. Year Book, No. 14, 1915. Pp. xii+429. (Washington: Carnegie Institution.)

Psychological Effects of Alcohol. By R. Dodge and F. G. Benedict. Pp. 281. (Washington: Carnegie Institution.)

Ptolemy's Catalogue of Stars: A Revision of the Almagest. By Dr. C. H. F. Peters and E. B. Knobel. Pp. iii+207. (Washington: Carnegie Institution.)

Rural Arithmetic. By A. G. Ruston. Pp. xi+431. (London: University Tutorial Press, Ltd.) 3*s.* 6*d.*

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland, 1915. Pp. vi+351. (London: C. Griffin and Co., Ltd.) 7*s.* 6*d.* net.

A Text Book of Geology. Part i. Physical Geology. By Prof. L. V. Pirsson. Pp. vii+444. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 10*s.* net.

Analytic Geometry. By Dr. H. B. Phillips. Pp. vii+197. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 6*s.* 6*d.* net.

Mathematical Monographs. No. 16. Diophantine Analysis. By R. D. Carmichael. Pp. vi+118. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 5*s.* 6*d.* net.

DIARY OF SOCIETIES.

THURSDAY MARCH 9.

ROYAL SOCIETY, at 4.30.—The Distribution of Intensity in Broadened Spectrum Lines: Prof. J. W. Nicholson and T. R. Merton.—Prof. Joly's Method of avoiding Collision at Sea: Prof. H. C. Plummer.—Apparatus for the Determination of Gravity at Sea: Prof. W. G. Duffield.

ROYAL INSTITUTION, at 3.—Recent Excavations in Mesopotamia—The Southern Capital, Babylon: Prof. L. W. King.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Continuous-current Railway Motors: E. V. Pannell.

OPTICAL SOCIETY, at 8.—A Simple Focometer for the Determination of Short Focal Lengths both Negative and Positive: T. F. Connolly.—The Manufacture and Testing of Prismatic and other Compasses: F. E. Smith.

MATHEMATICAL SOCIETY, at 5.30.—Some Applications of General Theorems of Combinatory Analysis: Major P. A. Macmahon.—Mr. Grace's Theorem on Six Lines with a Common Transversal: Prof. H. F. Baker.—The Integrals of a certain Riccati Equation connected with Halphen's Transformation: H. E. J. Curzon.—A Certain Plane Sextic: Miss Hilda P. Hudson.—The Construction of Co-apolar Triads on a Cubic Curve: Dr. W. P. Milne.—The Dynamical Equations of the Tides: J. Bondman.

FRIDAY, MARCH 10.

ROYAL INSTITUTION, at 5.30.—Illusions of the Upper Air: Sir Napier Shaw.

ROYAL ASTRONOMICAL SOCIETY, at 5.—General Solution of Hill's Equation: E. Lindsay Ince.—Distribution of Star Clusters: O. R. Walkey.—Mean Areas and Heliographic Latitudes of Sun-spots in 1914: Royal Observatory, Greenwich.—Remarks on the Formation of Sun-spots: F. Henroteau.—Calculation of Longitude from Moon and Moon-culminating Stars: F. J. Broadbent.—Observations of Jupiter: F. Sargent.—Statistics of Minor Planets: H. C. Plummer.—Faint Stars with large Proper Motions (ninth note): F. I. Pocock.—Longitudes of Jupiter's Satellites: W. de Sitter.—*Probable Papers:* The Nature of the Coronium Atom: J. W. Nicholson.—The Eclipsing Binary TT Aurigæ: C. Martin and H. C. Plummer.—Note on Bright Meteors: H. C. Plummer.—Baxendell's Observations of Variable Stars, T. Herculis: H. H. Turner and M. A. Blagg.

PHYSICAL SOCIETY, at 5.—Experiments Illustrating the Flow of Heat in Conducting Sheets: S. Skinner.—The Absorption of Gas by a Quartz Vacuum Tube: Dr. R. S. Willows and H. T. George.

SATURDAY, MARCH 11.

ROYAL INSTITUTION, at 3.—Radiations from Atoms and Electrons: Sir J. J. Thomson.

TUESDAY, MARCH 14.

ROYAL INSTITUTION, at 3.—Sea Power as a Factor in the Evolution of Modern Races: Prof. A. Keith.

WEDNESDAY, MARCH 15.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Meteorology of the Globe in 1911: Sir Napier Shaw.

ROYAL SOCIETY OF ARTS at 4.30.—Forestry and the War: E. P. Stebbing.

FARADAY SOCIETY, at 8.—Discussion on Methods and Appliances for the Attainment of High Temperatures in the Laboratory. Opener: Dr J. A. Harker.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Original Factors in Evolution: Prof. J. Arthur Thomson.—The Supposed Exhibition of Purpose and Intelligence by the Foraminifera: Sir E. Ray Lankester.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, MARCH 16.

ROYAL INSTITUTION, at 3.—Organic Products used as Propulsive and Explosive Agents: Prof. H. E. Armstrong.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Possibilities in the Design of Continuous-current Traction Motors: N. W. Storer.—The Use of Direct Current for Terminal and Trunk Line Electrification: N. W. Storer.

LINNEAN SOCIETY, at 5.—Resemblance between African Butterflies of the genus Charaxes; a New Form of Mimicry: Prof. E. B. Poulton.—Notes on Plants collected in Sikkim, including the Kalimpong district: C. C. Lacaita.—Exhibition of Species of Ribes and their Garden Derivation: E. Bunyard.—Early Botanical Exploration of North America: B. Daydon Jackson.

CHILD STUDY SOCIETY, at 6.—The Unconscious Mental Life of the Child: Dr. E. Jones.

FRIDAY, MARCH 17.

ROYAL INSTITUTION, at 5.30.—The Search for New Coal Fields in England: Dr. A. Strahan.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—The Composition of the Exhaust from Liquid-fuel Engines: R. W. Fenning.

SATURDAY, MARCH 18.

ROYAL INSTITUTION, at 3.—Radiation from Atoms and Electrons: Sir J. J. Thomson.

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