THURSDAY, APRIL 5, 1917.

## THE TEACHING OF PHYSIOLOGY.

(1) *Human Physiology: a Text-book for High Schools and Colleges.* By P. G. Stiles. Pp. 405. (Philadelphia and London: W. B. Saunders Co., 1916.) Price 6*s*. 6*d*. net.

(2) *The Problems of Physiological and Pathological Chemistry of Metabolism for Students, Physicians, Biologists, and Chemists.* By Dr. Otto von Fürth. Authorised translation by Prof. Allen J. Smith. Pp. xv+667. (Philadelphia and London: J. B. Lippincott Co., n.d.) Price 25*s*. net.

(1) AT the January Conference of Headmasters a resolution was passed recommending the teaching of the "natural laws underlying the phenomena of daily life." A similar resolution was passed at a meeting of the Association of Science Teachers, in which the value of exciting a "spirit of interest and inquiry with regard to the world around us and the universe at large" was emphasised (see NATURE of February 1, p. 442). It was thought that the best way of doing this was by courses of generalised science. It was doubtless not intended to exclude knowledge of the activities of living organisms, inclusive of man, and of our own bodily functions. In other words, physiology should be part of the course. We may remember Huxley's advocacy of physiology as of especial value as a means of mental discipline, and it has also an important practical side. The ignorance of most people with regard to questions of vital consequence is scarcely less than scandalous, and it is unfortunate that there appears to be a widespread belief that physiology is only of use to the medical man. Of course, it is necessary to him in order that he may understand the abnormalities of disease; but a knowledge of the normal working of our bodies is surely a matter that concerns everyone. The pressing question of food is one that presents itself at once, and there are many others.

The book before us is an excellent attempt to provide a text-book for high schools. But, good as it is as an elementary account of the present state of physiological science, it cannot be regarded as altogether successful. It is apt to be dull and didactic rather than stimulating. This is probably incidental to the practice, intentionally adopted, of omitting reference to names of discoverers and details of experimental procedure. In the hands of a good teacher such details may be made to give a human interest to dry description, and bring what is being taught into relationship with other bodies of knowledge, such as history and art, a valuable aspect of true education. It would be an improvement if a part of the wealth of the book in facts were sacrificed for a more intensive treatment of some of them. In certain cases further space could be found by omitting reference to views that are now disproved. Similarly, a rather more dogmatic tone might be used in many instances. A text-book should take the responsibility of recommending a particular view as being most in accordance with facts, although this view may be contrary to the opinion of some isolated physiologists.

It will be agreed that the mode of teaching of science suggested in the resolutions given above depends for its success almost entirely upon the teacher. A very wide knowledge is required, not only of science, but of other branches of learning, and it may well be that a special training is advisable. Indeed, the capacity necessary is probably of a higher order than that of many a university professor. It need scarcely be said that the right kind of teacher must be able to demand a high salary.

We cannot help expressing the hope that preparation for any particular examination will be left entirely out of account. The conviction is forced upon us more and more that the examination system has a very serious degrading effect both upon the teacher and the student. It is natural that the student, whose prospects depend on passing some examination, has little inducement to take account of questions or new advances in science, however important they may be, if they are not to be found in the recognised text-books, while the teacher feels reluctant to refer to them, however hampered he may be by his inability to do so. Moreover, there is an ever-present temptation to learn a number of facts by heart, since most examinations are easily passed in this way. If time is taken to understand principles, although the student is hereby caused to think for himself, he may well find that some facts have to be neglected. Under the present system facts count for more than laws. It is to be feared that Prof. Stiles's book may lend itself to the mere committal to memory. The examination problem is undoubtedly one of great difficulty, and at present no satisfactory solution is in sight. It seems that, on the whole, a book frankly written for the teacher rather than for the student would be the more useful for schools. In such a case more attention could be given to the experimental side. This does not really require elaborate and costly apparatus. It is astonishing what a wealth of significance there is in such a simple experiment as the burning of sugar in air and comparing the products with those given off in the breath.

A word must be said on the manner of dealing with the question of sex—a difficult problem for the teacher, but one that ought not to be shirked. Prof. Stiles's treatment is good, so far as it goes. But we are inclined to think that a reference to the physiological meaning and value of the union of two individuals as the basis of the discussion would go far to remove the mischievous way of looking at such problems which is almost universal.

The book is remarkably free from errors. We have detected only one serious mistake. On

p. 303 the fat resynthesised in the intestinal wall is stated to be different from the original fat hydrolysed in the cavity of the intestine. This is not the case.

(2) Dr. von Fürth's book is well known to many of us in the original as a valuable presentation of the facts of the subject at the time it was written. The use of the word "problems" in the title may cause a little disappointment to those who look for assistance in attacking difficult questions; something resembling Leathes's "Problems of Animal Metabolism" may have been expected.

It seems doubtful to the reviewer whether the translation of a general text-book is worth the trouble and expense unless the translator is possessed of the knowledge and capacity to bring it up to date. A new edition of the original work is almost certain to appear before the translation is exhausted, so that the latter prolongs the life of an antiquated edition, which is undesirable. The contents of the present book date from some time prior to 1913. On the whole, it is questionable whether any real necessity existed for its translation, since there are other books in the English language which serve the purpose. W. M. BAYLISS.

## SOME MATHEMATICAL TEXT-BOOKS.

(1) *Dynamics*. By R. C. Fawdry. Part i. Pp. viii+177+ix. (London: G. Bell and Sons, Ltd., 1916.) Price 3*s*. net.

(2) *Differential and Integral Calculus*. By Dr. Clyde E. Love. Pp. xviii+343. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1916.) Price 9*s*. net.

(3) *Engineering Applications of Higher Mathematics*. By V. Karapetoff. Part ii. Pp. iv+103. Part iii. Pp. v+113. Part iv. Pp. v+81. Part v. Pp. vii+64. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1916.) Price 3*s*. net each.

(1) THIS is a text-book of elementary dynamics, leading up to circular motion. One naturally turns first to see how the foundations are treated, and here we must confess to some disappointment. Various experiments with a "trolley-apparatus" are quoted, and are used as a basis for the fundamental inductions. As a matter of fact, dynamics did not begin in this way, but with the testing of hypotheses. Such experiments are useful and instructive enough, as verifications, at a somewhat later stage; but they are too rough and too liable to error to serve as the basis of dynamical faith. They are also necessarily indirect, and various assumptions have to be made before they can be regarded as bearing specifically on the points they are meant to illustrate. The article on "mass" also is vaguely worded, and scarcely adequate to its purpose. Nevertheless, the book has points which may make it useful to a teacher who takes the theory largely into his own hands. The examples are well chosen and of the right standard of difficulty, and there are good exemplifications of such things as relative motion and centrifugal force.

(2) This book gives an account of the calculus from the first elements to the theory of ordinary differential equations. It includes also chapters on the applications to geometry and mechanics. Since the whole takes up only some 300 pages, it will be seen that the treatment is necessarily concise. It can, however, be recommended as a good introduction to the subject, and it is doubtless intended that it should be supplemented by plentiful oral comment. The examples are of a simple character, and bear directly on the text.

The book, naturally and properly, having regard to its scale, does not attempt to deal with the more abstruse logical points which present themselves in the beginning of the subject. The author is, however, to be congratulated on the practice he has generally adopted of stating explicitly when he makes an assumption which it is not convenient to stop and prove. There are two respects in which he has, we think, been unduly conservative. The treatment of the exponential and logarithmic functions and of their derivatives scarcely brings out the special importance of the former function, the logarithm being practically used as the primary conception. The proof of Taylor's theorem, again, is of the usual indirect and artificial character. One cannot but feel sympathy for the type of student whom Todhunter tried (vainly, we hope) to placate with the somewhat cruel remark that "he must not, while engaged in the elements of a subject, expect to be able, as it were, to *rediscover the theorems for himself*." It is no doubt difficult to present these matters in a way at once natural and fairly rigorous, but the attempt should be made.

(3) We have here four parts of a work on the application of higher mathematics to engineering. In the words of the author:—"The book may be called a summary of the most common engineering applications of higher mathematics, or a mathematical cross-index to engineering text-books. It fulfils its purpose if it saves the teacher the trouble of consulting many engineering books for the purpose of selecting a few mathematical problems for his students. The author also hopes that the book may stimulate interest in higher mathematics among his fellow-engineers." It should be said that the term "higher" is used in rather a restricted sense, and that the reader will find many quite elementary things explained to him. For example, it is formally proved that the minimum value of $x+y$ subject to the condition $xy=\text{const.}$ occurs when $x=y$; this with the help of the calculus!

The four slender volumes before us deal with hydraulics, thermodynamics, elasticity, and electricity respectively. The treatment is, on the whole, sound, though the diction is often rather loose. For instance, it is not easy to justify the offhand statement that the internal stresses in a cross-section of a beam are proportional to the bending moment, "since the action of these forces is to bend the beam." The mathematical work is not distinguished by neatness, and one finds awkward and cumbrous proofs where often quite simple methods are available. The author appears afraid of making undue demands on the knowledge of his readers, and when a real difficulty occurs contents himself with a reference to a textbook.

The treatment of the strength of thick cylinders and spheres may be cited as characteristic. The final formula is evolved as the result of five successive approximations, and the whole investigation takes up twenty-four pages. Would it not be really simpler, as well as much shorter, to give the well-known correct investigation at once? It is a little more difficult, but there are no precarious assumptions, and by the time he had mastered it the engineering student would really know something about stresses and strains.

These criticisms must not be taken to reflect on the competence of the author, whose aims, as recorded in his prefaces, are excellent. But he does not seem to have a high opinion of the attainments of the class of students whom he addresses.

## OUR BOOKSHELF.

*The Problem of Pain in Nature.* By C. F. Newall. Pp. 131+7 illustrations. (Paisley: Alexander Gardner, 1917.) Price 3*s.* 6*d.* net.

THIS little book may be useful to those who are troubled in spirit by what they believe to be a fact: that animals in wild life suffer much pain. Mr. Newall explains in a simple way why he regards this shadow on Nature as, on the whole, of man's imagining. For the humblest animals "no brain, no pain" seems good sense; and animals of the little-brain type, such as insects, the behaviour of which is predominantly reflex and instinctive, often go on as if they were callous to serious injuries. A dragon-fly which has lost its hindquarters is not thereby hindered from eating a good many flies, and finishing up with its own lost parts.

We cannot, of course, be sure how much sensation of pain there is among invertebrates, but Mr. Newall's quiet consideration of the facts suggests that there is but little. When we pass to vertebrate animals the argument from analogy becomes more trustworthy, and Mr. Newall refers to the experiences of men who have been in the grip of wild beasts without feeling much, if any, pain or fear.

In most cases in wild life the *coup de grâce* is instantaneous. It may be argued, indeed, that Nature is rich in efficiencies that lessen the chance of pain. Selous was strongly of opinion that Wallace erred in his low estimate of the evolution of pain-sensations among animals, but he himself attached too much importance to cries and the like. Many a one might conclude from a baby's cries that the mother was slowly torturing it. We think that there is good sense in Mr. Newall's conclusion that men have greatly exaggerated the prevalence of pain in Nature, but we are afraid of some of the arguments, for they seem also to banish pleasure. In a short book like this the reader should be spared "amydallin," "etherial," "Eperidæ," "Barlett," and "Sir James Lister," which we happened to notice.

*The Elements of Engineering Drawing.* By E. Rowarth. Pp. xii+131. (London: Methuen and Co., Ltd.) Price 2*s.* 6*d.* net.

THE main purpose of this book is to give examples of, and instruction in, the art of draughtsmanship, for the benefit of young students just entering on an elementary course of engineering. It is intended as a corrective to the unworkmanlike finish and execution which are apt to accompany a too exclusive use of models and machine parts, with their dimensioned sketches, in the teaching of machine drawing.

The general treatment of the subject is somewhat meagre and crude, but the plates are executed in a style that would be approved by the professional draughtsman; the instructions annexed to each plate are full and precise, being helped by pictorial views; and the book seems to be specially suitable for dealing with large classes of junior students where it is not practicable to give much individual attention.

The text is divided into four sections relating to the manipulation of instruments, the method of projection, and the forms and proportions of the commoner machine fastenings, with examples of their use.

## 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.]*

### British Optical Science.

As a manufacturer, may I be allowed to reply to Sir Joseph Larmor's letter in NATURE of March 1 on the subject of British optical science, in which he makes certain statements that must create an entirely wrong and unfortunate impression of the circumstances?

What is the reason for the comparative smallness of the British optical industry? If one considers the pre-war output of the important German firms, it will be seen that they are based upon their military departments, of which the public of other countries knows very little. It only knows the German firms by their civilian productions. The German War Office in peace-time issued large orders for optical instruments and placed them with German firms, on the principle that the optical industry would be a vital one in time of war. Having such large orders to deal with, and having the certainty of continuity of work, the German firms were enabled to develop special machinery and appliances and to develop their general organisation.

As suppliers of the largest Continental Army, the German firms naturally obtained the bulk of the orders of other Armies, with a consequent increase of their facilities and experience. In such circumstances it was comparatively easy to establish and maintain a civilian world trade.

Consider now the British conditions. The pre-war British orders were of negligible importance compared with the Continental ones. Where single orders for thousands were received by Continental firms from all sources, British firms received orders for tens. Any-one who is familiar with industry knows how difficult it is to compete with large firms under such conditions.

During the war, however, the British optical firms have received large and continuous orders, and as a result the increase of output has been very great. To have rushed a small industry in war-time and in so short a period up to its present size is a marvellous performance, probably unsurpassed in any other industry demanding exceptional skill.

But the important points to observe are that, so far as their knowledge was concerned, the principal British firms were competent to undertake the work, and that, having the orders, they were able to erect new premises, install plant, provide special jigs and tools, train unskilled labour, find suitable materials, and in these extraordinary circumstances to produce instruments that satisfy the requirements of the Services.

If in peace-time military orders of reasonable size had been placed in this country, the optical industry would have dealt with them as it has during the war. It is largely a question of orders of reasonable size and, above all, continuity of orders.

Having pilloried the optical manufacturer, Sir Joseph Larmor proceeds to praise the British optical writers. It is suggested that their works contain information that the manufacturers lack.

In Germany and in Britain it is not the type of book cited by Sir Joseph Larmor that is used by the optical manufacturers. Not one of the books cited deals with the method of optical computation actually adopted in the German workshops, and, indeed, there are extremely few books in Germany that do divulge the whole system. The British books are, no doubt, well adapted to enable students to pass examinations on general optics. For example, one of the best of those cited has a large index, which includes the rainbow and the principle of relativity—questions no doubt that will find a place of honour in examination papers—but which does not refer to so vital a question as coma, to which alone a whole book should be devoted.

There is a great similarity in the present optical books. They all contain the same stereotyped material. Some deal with it in a non-mathematical way, while others attack the propositions with heavy algebraic artillery. Generally the sign convention changes without warning from page to page, for the simple reason that the matter is mostly copied from previous writers who used no standard system.

No doubt these books are the unfortunate result of circumstances. A book devoted to, say, coma would have a very limited market, whereas a book on optics, if made sufficiently general, can be made to appeal to students and school teachers and thus find a profitable market.

In the early days of the optical industry in this country our pure mathematicians were also real craftsmen. They were not content with the evolution of general equations. To day "the science of the best optical instrument makers is far ahead of the science of the text-books." That is the opinion of the late Prof. Silvanus P. Thompson, who also said: "But the teaching of the colleges and the university teaching at Cambridge—well, what is it in optics? They call it optics, but it is really purely mathematical gymnastics applied to the optical problems of a hundred years ago. I do not think there is really what one can truly call optical work going on at Cambridge. . . . Optical teaching, I am sorry to say, is very largely at its lowest conceivable ebb."

If our present-day mathematicians wish to help the industry (and their help is desired), they must enter the workshops first as learners, not teachers. They may find the work laborious and monotonous from the point of view of the mathematician to whom a pretty solution is an object of importance, but once they have experienced the pleasure of testing a system that accords with their calculations, they will never again be satisfied with the publication of untried formulæ.

JAMES WEIR FRENCH.

Anniesland, Glasgow, March 28.

## Floating Earths.

IN reference to the inquiry of Dr. Walter Leaf in NATURE of March 15 as to the interpretation of a passage of Strabo, the fact may possibly be of some interest that in the island of Mors, in Denmark, bricks are made from a local sandy clay which, after burning, float in water. These bricks are used, I understand, both as a refractory material and for ordinary building purposes, their lightness and porosity giving them certain advantages for the latter purpose. Their mechanical strength is said to be considerable. The porosity is not obtained by the addition of combustible or volatile matter during moulding.

If the expression πηγνυμένας, used by Posidonius, be consistent with a process of burning the clay into bricks, and if clays of somewhat similar physical character to that of Mors, although of different geological origin, occur in Asia Minor and Spain, an explanation of the passage might perhaps be found in this direction.

CECIL H. DESCH.

Metallurgical Laboratory,
University of Glasgow,
March 24.

## Gravitation and Thermodynamics.

IF Dr. P. E. Shaw's contention (NATURE, March 29) for a perpetual motion consequence of gravitational heat were justified, it would be an argument against the supposed effect on which such a conclusion could be based; but it does not seem to me that the contention is justified. For the line joining maximum to minimum temperature is vertical, and, unless the rate of heating differs from the rate of cooling, every horizontal chord will be an isothermal; so there is nothing to keep a vertical disc rotating.

OLIVER LODGE.

THE suggestion in NATURE of March 1 that thermodynamics might throw light on the question of the temperature variation of gravitation has not been unkindly received. The criticisms have not been directed so much against this suggested application of thermodynamics as against the expression deduced for the attraction between two bodies.

It has been pointed out to me that $dQ$ is not a perfect differential, and therefore it is not valid to equate

$$\frac{\partial^2 Q}{\partial r \, . \, \partial \theta} = \frac{\partial^2 Q}{\partial \theta \, . \, \partial r}.$$

The correct expression for the attraction, assuming that the specific heat is independent of $r$, is

$$F = m \, . \, \theta \, . \, f(r) + \psi(r),$$

where $m$ is the mass of the body the temperature of which is $\theta$. This expression has none of the objections which the previous incorrect expression had, for at the absolute zero the temperature coefficient vanishes and $\psi(r)$ is probably $GMmr^{-2}$.

The assumption that $\partial s / \partial r = 0$ is, of course, only a special case, for $s$ may depend on $r$ or on the gravitational field in which the mass $m$ is situated. Since the introduction of comparatively small masses on the earth's surface would have no perceptible effect on the gravitational field, *s* may be taken as constant in any experiments on the earth's surface.

Dr. P. E. Shaw (NATURE, March 29) argues that my hypothesis involves a violation of the conservation of energy. To avoid the difficulty of perpetual motion I would suggest making $\partial Q/\partial r$ positive instead of negative. This will not alter the expression for F, but the turning moment on Dr. Shaw's disc will then bring it to rest. GEORGE W. TODD.

Newcastle-upon-Tyne.

## *THERMIONIC DETECTORS IN WIRELESS TELEGRAPHY AND TELEPHONY.*

THE arts of wireless telegraphy and telephony involve the use in the receiving circuit of some device named a detector, which is sensitive to electric oscillations of very high frequency. In the earliest years of radiotelegraphy the appliance used was the so-called coherer, in which a small mass of metallic filings or an imperfect contact between two pieces of metal was converted into a better conductor by the passage through it of the high-frequency oscillations. All the various forms of coherer have now been abandoned and are no longer used as detectors. In modern radiotelegraphy, so far as regards the spark or damped-wave system, only three types of detector are at present in practical use. The first of these is the magnetic detector, chiefly the rotating band form, invented by Marconi; the second type is some form of rectifying contact or crystal, such as the carborundum detector due to Dunwoody, or the zincite-chalcopyrite rectifier of Pickard; and the third is some modification of the thermionic detector, or Fleming oscillation valve.

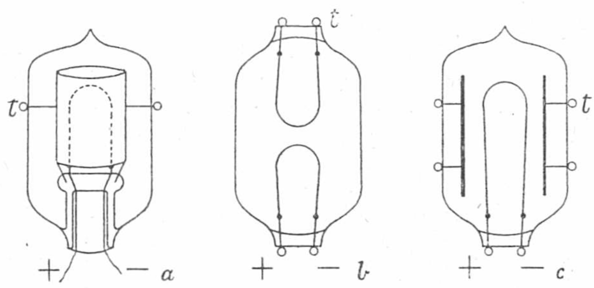
In the magnetic detector the electric oscillations to be detected are caused to circulate round a magnetised iron wire and alter its magnetic permeability or hysteresis in such a fashion as to create a sudden change in the magnetisation of the iron. This in turn is made to create an induced electric current in a second coil and reveal itself by a sound made in a telephone in series with that coil. The rectifying contacts or crystals depend upon the fact that a contact of small surface between certain substances, generally crystalline, has a greater electric conductivity in one direction than in the other. Hence, if such a contact as that, for example, between a fragment of zincite or native oxide of zinc and a piece of chalcopyrite or copper pyrites is traversed by a train of electric oscillations, these will be converted into a movement of electricity chiefly in one direction. Accordingly, if a rapid sequence of such oscillations passes through such rectifying contact placed in series with a telephone receiver, the latter will be traversed by a series of intermittent gushes of electricity in the same direction, and will emit a sound the pitch of which is determined by the group frequency of the oscillations. A very commonly used rectifying contact is a crystal of carborundum, or carbide of silicon, held between metal clips. Although this rectifying property of certain contacts and crystals has been much studied, the reasons for it are not yet fully elucidated, but it is probably connected with the thermoelectric properties of the materials.

The third type of detector is the thermionic detector first suggested and used by Dr. J. A. Fleming, of University College, London. The construction and mode of operation of this form of detector may be briefly described as follows:—It had been known for many years prior to the advent of radiotelegraphy that the electric conductivity of a highly rarefied gas was greatly determined by the temperature of the negative electrode by which the current left the exhausted vessel containing it. It had been found by Hittorf and also by Elster and Geitel that if the negative electrode was a platinum wire which could be rendered incandescent, the conductivity of the highly rarefied gas was greatly increased. The emission of positive and of negative ions from incandescent solids *in vacuo* had been studied particularly by Elster and Geitel, beginning in 1880.

In 1884 Edison made known an interesting fact connected with carbon-filament glow-lamps. He sealed into the bulb of one of his bamboo-filament lamps a metal plate placed between the legs of the horseshoe-shaped filament, the said plate being carried on a platinum wire sealed through the glass bulb. He found that when the filament was rendered incandescent by a continuous current, a galvanometer connected between the terminal of the plate and the external negative terminal of the filament indicated no current, but that if connected between the plate and the positive filament terminal, it showed a current of a few milliamperes. Edison gave no explanation of this, nor did he make any application of the discovery. He supplied a certain number of lamps made with middle plates to the late Sir William Preece, and the latter communicated to the Royal Society in 1885 a paper describing various experiments with these lamps. This "Edison effect" was more completely examined by Dr. J. A. Fleming in researches described by him in papers to the Royal Society in 1890 and to the Physical Society in 1896. Dr. Fleming showed that the effect was in some way due to the scattering of particles charged with negative electricity from the hot filament, and that it could be prevented by enclosing the negative leg of the carbon in a glass tube, or placing a sheet of mica between the carbon and the plate. He also proved, as Elster and Geitel had done in another way, that a vacuum tube having two carbon filaments as electrodes had a very large conductivity for small voltages when the negative electrode was made incandescent.

It was not until 1899, when Sir J. J. Thomson announced his epoch-making discovery of electrons, or corpuscles smaller than atoms, carrying a negative charge, that it was clearly recognised that incandescent solids in high vacua emit electric ions, some positive and some negative.

This electronic emission from hot bodies has been very fully investigated by Prof. O. W. Richardson, who has collected most of the known facts in an excellent manual on the subject. None of the investigators of this subject made any practical application of this knowledge until it occurred to Dr. Fleming in 1904 to employ an incandescent electric lamp having one or more plates or cylinders of metal sealed into the bulb as a means of detecting high-frequency electric




. 1.—Various forms of Fleming oscillation valve or thermionic detector used in wireless telegraphy.

oscillations, as used in radiotelegraphy. Accordingly he constructed such electric glow-lamps with carbon filaments and a metal plate or cylinder surrounding, but not touching, the filament, the said cylinder being attached to a platinum wire sealed through the bulb (see Fig. 1). He employed this device as follows:—The carbon filament in the lamp O (see Fig. 2) is rendered in-

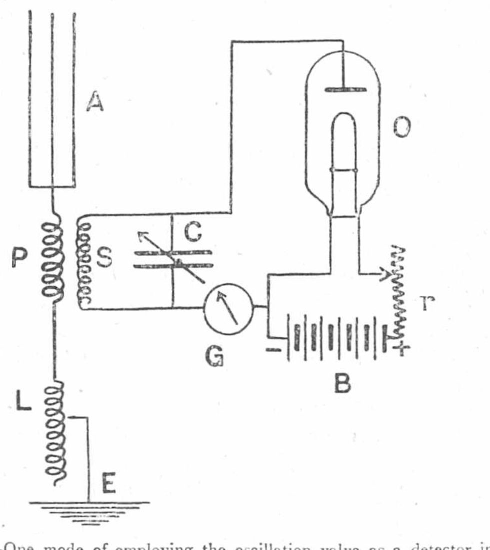



FIG. 2.—One mode of employing the oscillation valve as a detector in a radiotelegraphic receiving circuit. A, antenna; P S, oscillation transformer; C, condenser; O, oscillation valve; B, battery; G, current-detecting instrument.

candescent by a suitable battery of storage cells, B; most usually a 12-volt or 4-volt filament is employed. A circuit is formed external to the bulb by connecting the metal plate or cylinder to the negative terminal of the lamp. In this circuit is placed a current-detecting instrument, such as a galvanometer, G, or a telephone. In the circuit is also inserted the secondary circuit of an oscillation transformer, P, S, the terminals of which are closed by a condenser, C (see Fig. 2).

If electric oscillations are created in the above circuit, the alternations of current are rectified: that is to say, a unidirectional current flows through the galvanometer or telephone. The highly vacuous space between the incandescent filament and the metal cylinder inside the bulb possesses a unilateral conductivity. When the filament is at a very high temperature negative electricity can pass from the filament to the plate, but not in the opposite direction. Hence the device acts as a valve and was called by Dr. Fleming an oscillation valve. Another way of viewing the effect is as follows:—When the electric oscillations take place through the condenser, the plate or cylinder in the bulb tends to become charged alternately positive and negative. The incandescent filament is continuously emitting negative ions or electrons, and these at once discharge any positive charge on the metal plate, whereas they do not discharge a negative charge. There is, therefore, a continuous movement of positive electricity to the plate from outside the lamp. If the electric oscillations are in trains of damped groups, then the effect is to convert them into gushes of electricity in one direction which pass through the telephone. If these groups come at the rate of several hundred per second the telephone receiver emits a continuous sound of corresponding pitch, and if the groups are cut up into Morse signals at the sending end, the listener at the telephone hears these signals as long and short sounds.

An electric incandescent lamp with metal plates, grids, or cylinders in the bulb is now called a thermionic detector, because it serves to rectify and render detectable by a galvanometer or telephone receiver the feeble electric oscillations used in wireless telegraphy or telephony. It depends for its action upon the emission by the incandescent filament of electrons, or thermions as they are termed.

Dr. Fleming found that a tungsten filament was of special utility for this purpose. The thermionic receiver has great advantages in that it is not injured or put out of adjustment, like crystal detectors, by powerful electric oscillations or atmospheric discharges acting on its receiving circuits.

In some of Dr. Fleming's experiments he employed an incandescent lamp with two plates sealed into the bulb carried on separate terminals. An illustration of such a double-anode or two-element valve was given by him in a paper published in the Proceedings of the Royal Society early in 1905 (see *c*, Fig. 1). The new thermionic detector naturally attracted the attention of radiotelegraphists, and amongst others of Dr. Lee de Forest in the United States. After adopting the detector in substantially the same form, Dr. de Forest patented in 1907 a modification in which the two metal electrodes were sealed into the vacuous bulb, in addition to the metallic or carbon filament to be rendered incandescent. One of these electrodes was in the form of a plate, and the other of a grid or zigzag of wire interposed between the filament and the plate. In using this double-plate thermionic detector, Dr. de Forest connected the grid terminal to one side of the receiving circuit condenser, and the negative terminal of the filament to the other side of the same condenser; but, instead of inserting the telephone or current-detecting instrument in this grid circuit, he included it in a separate external circuit connecting the plate with the filament, and placed in this circuit also a battery with negative pole connected to the filament (see Fig. 3).

Dr. de Forest called this arrangement an *audion*, and maintained that the physical action was different from that of the Fleming valve, though valves with two anode plates had already been in use for certain experiments. It has been shown, however, to be essentially the same. It is clear that the performance of the audion as a radiotelegraphic detector depends entirely upon the thermionic emission from the incandescent filament. It has been demonstrated by Dr. E. H. Armstrong in a paper in the Proceedings of the Institute of Radio-Engineers for September, 1915, that the physical actions taking place in the grid circuit of Dr. de Forest's audion are precisely the same as in those in the Fleming valve.

The thermionic emission of negative ions causes the grid to become negatively charged. On the other hand, the battery in the external circuit connected to the plate sends a thermionic current through the vacuous space between the filament and the plate inside the bulb, in virtue of the incandescence of the filament or negative electrode. This current flows also through the telephone or current-detecting appliance. When the grid becomes negatively charged, due to the rectification of electric oscillations impressed upon the grid circuit, it reduces the thermionic current flowing between the filament and the plate, and therefore varies the current through the telephone. The physical actions which contribute to the operation are therefore all dependent upon the thermionic emission from the filament and upon the increased unilateral conductivity of a highly rarefied gas or vacuous space when the cathode or negative electrode is rendered incandescent.

This action is not necessarily dependent upon the presence of any residual gas in the bulb, because even in a highly perfect vacuum the electronic emission from the incandescent filament would take place.

The double-anode Fleming valve, or the valve with grid and plate, called an audion, has the property that an amplification of current variation can be produced by it.

Thus, if the grid-plate thermionic detector is arranged as in Fig. 3, feeble electric oscillations taking place in the grid external circuit can be made to produce large variations in the continuous current flowing in the external plate circuit.

Moreover, by connecting two or more such double-anode thermionic detectors in series, the current in the plate circuit of one, acting inductively on the grid circuit of the next, enables a double amplification to be produced.

Furthermore, such double-anode thermionic valves can be used as generators of electric oscillations by inductively connecting through a suitable transformer the grid and plate circuits *g* and *h*

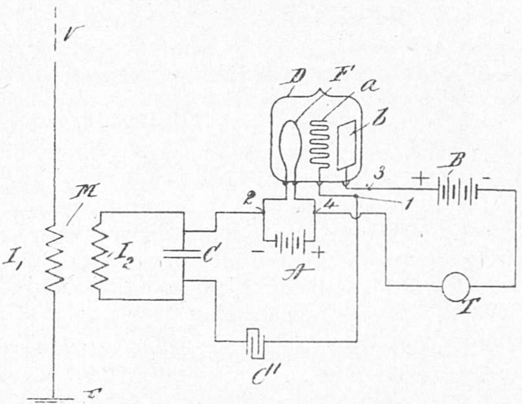



FIG. 3.—De Forest audion or form of thermionic detector. D, bulb of glow-lamp; F, incandescent filament; *a*, grid; *b*, plate; T, telephone; A, B, batteries; C', C'', condensers.

of one and the same bulb V (see Fig. 4). The arrangement then acts as follows:—Feeble electric oscillations set up in the external plate circuit by any means create induced oscillations in the grid circuit, and the latter sustain and enhance the former, the energy to create these enhanced oscillations coming from the battery in the plate circuit.

The process exactly resembles that in which a

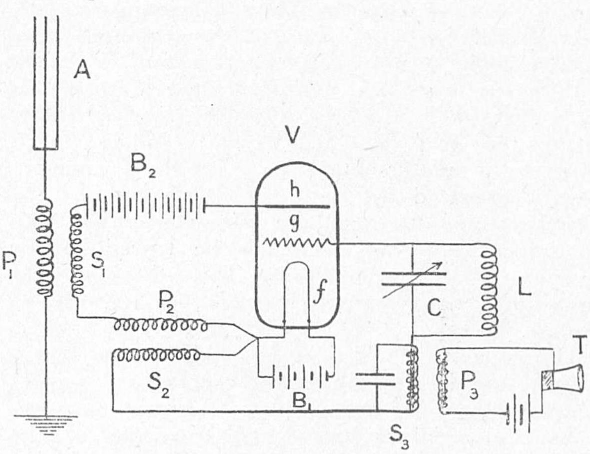



FIG. 4.—Mode of using double-anode valve or thermionic detector as a generator for electric oscillations.

Bell telephone receiver in circuit with a battery and carbon microphone transmitter emits a continuous musical note when the diaphragm of the receiver is held near that of the transmitter. Feeble vibrations are set up in the microphone diaphragm by noises in the room, and these vary the current through the telephone receiver, and the sound so emitted keeps the transmitter diaphragm in motion.

Again, the double-anode valve can be used as a telephonic relay in ordinary telephony to magnify and repeat sounds.

The oscillation valve is not simply a detector; it is a quantitative detector, and hence has been extensively used as a receiver in all experiments in wireless telephony. In fact, most of the successful long-distance experiments in radiotelephony have been conducted by it. For when so used it rectifies the continuous high-frequency oscillations in the receiving circuit into a direct current. Hence the variations in amplitude in these oscillations which are produced by the microphone in the transmitter circuits make themselves evident as variations in the rectified current which flows through the telephone receiver, and these reproduce the sounds of the speech made to the microphone in the transmitter. This thermionic detector promises, therefore, to be of great use in the solution of the problem of radiotelephony, as well as that of repeating or relaying ordinary telephonic currents.

## THE INDIAN SCIENCE CONGRESS.

THE Indian Science Congress held its fourth annual meeting in Bangalore on January 10 and the three following days, under the presidency of Sir Alfred Bourne, F.R.S. The six sections—those, namely, of Mathematics and Physics, Chemistry, Agriculture, Botany, Zoology, and Geology—met in the mornings, and in all seventy-two papers were read. It is obviously impossible, in the space available for this notice, to give an account of the work of the various sections or even to enumerate the papers, but certain points in connection with the present meeting are deserving of mention. Two of the sectional presidents departed from the usual custom in giving addresses on general topics. In the Mathematics and Physics Section the Rev. Dr. Mackichan referred to the great value of early Indian contributions to mathematics, both pure and applied, but deprecated the suggestion put forward by some enthusiasts that there was no scientific truth of importance that could not be traced in the ancient Hindu scriptures. The other address, given to the Chemistry Section, is referred to below.

There was a comparatively large proportion—about one-third of the total number—of papers dealing with the application of science to particular industrial problems. The increase in the number of papers of this kind is undoubtedly due to war conditions, which have stimulated industrial enterprise in many parts of India. The papers on industrial science read at meetings of the Congress represent but a small part of the work which is being carried on in different parts of the country; those on pure science, on the other hand, record very nearly the whole of what is being done in Indian colleges, and one cannot help noticing their fewness. The causes of the paucity of research work were examined by Dr. J. L. Simonsen in his presidential address to the Chemistry Section. Lack of proper training in past years, understaffing of colleges—resulting in a man's whole time being taken up by routine work—and inadequate pay in subordinate grades of the teaching profession were mentioned as among the most important; and to these must be added the absence of the research atmosphere that is so marked a feature of the larger English educational centres. The Indian Science Congress constitutes at present the only means of remedying this situation effectively. It can, through the proper official channels, direct the attention of the Imperial and local Governments to those defects of the present system which it is in their power to remedy; it can also provide once a year the research atmosphere and facilities for discussion and criticism which are lacking in the colleges, partly because the great distances which separate them make the personal exchange of ideas almost impossible, and partly because, excepting a few agricultural research stations, not more than one or two men are working at the same subject in any one place.

Although the actual amount of research in pure science is small, it is large when compared with what was being done four years ago. At the first meeting of the Congress in 1914 only twenty papers were read: the number this year had increased to seventy-two. This year, too, a new rule was in force, making it necessary for authors to submit their papers to a referee. While in some of the sections—that of Zoology, for example—the quality of the papers was excellent, this is not true of all. There were a number of papers from a certain quarter that appear to have been inspired by a determination to produce the maximum quantity of "research" in a given time. Work of this type falls into its proper place in the course of the discussion and criticism which take place in the sectional meetings, and there is no doubt that the Congress is doing a good deal towards setting up a higher standard of work than exists at present.

An interesting discussion took place, under the chairmanship of Sir Sydney Burrard, F.R.S., on scientific libraries in India, following some suggestions which had been made to the effect that research work in India was sometimes hampered by inability to obtain references. It appeared from the contributions to this discussion that the difficulty was felt chiefly by zoologists, to whom plates and diagrams were frequently of greater importance than the text of a paper (which could always be copied and sent by post). But the general feeling was that any lack of library facilities in India could scarcely be considered a contributory factor in hindering research, and that the existing needs would be adequately met by the preparation of a catalogue showing the periodicals available in different places and the rules under which they could be lent or copied.

The remaining activities of the Congress may be briefly mentioned. Three public lectures were delivered, and were attended by large audiences. The first was by Mr. C. Michie Smith on "The

Sun," and this was succeeded by a lecture on "Soaring Flight" by Dr. E. H. Hankin, and one by Mr. F. L. Usher on "Explosives." The only social function took place on the afternoon of January 11, when the members were received at the palace by H.H. the Maharajah of Mysore, to whose Government the Congress is indebted for the invitation to meet this year in Bangalore. On the following afternoon the members visited the laboratories of the Indian Institute of Science at the invitation of the director and staff.

At the concluding business meeting it was announced that the Congress would meet next year in Lahore, under the presidency of Dr. Gilbert Walker, F.R.S. F. L. U.

## NOTES.

WE regret to learn from the *Times* that the death of Dr. E. von Behring, the discoverer of the curative effect of the serum of immunised animals in the treatment of diphtheria, is announced in the German newspapers.

THE annual general meeting of the Chemical Society was held at Burlington House on March 29, Dr. Alexander Scott being in the chair. Prof. W. J. Pope was elected president, Col. Smithells and Prof. Sydney Young were the two new vice-presidents elected, and Prof. H. C. H. Carpenter, Prof. A. Findlay, Prof. A. Harden, and Dr. T. A. Henry were elected as new ordinary members of council. Dr. Scott delivered his presidential address upon the subject of "The Atomic Theory."

A NEW branch of the Ministry of Munitions has been established under Sir Lionel Phillips as Controller, to deal with the examination and development of such mineral properties (other than coal or iron ore) in the United Kingdom as are considered likely to be of special value for the purposes of the war. The Minister of Munitions has appointed the following to act as an advisory committee on the development of mineral resources:—Sir Lionel Phillips, Bt. (chairman), Mr. F. J. Allan, Mr. C. W. Fielding, Mr. R. J. Frecheville, Prof. F. W. Harbord, Mr. F. Merricks, Sir Harry Ross Skinner, Dr. A. Strahan, and Mr. Edgar Taylor, together with a representative to be nominated by the Board of Trade.

WE learn from *Science* that Prof. A. V. Stubenrauch, professor of pomology in the University of California, died at Berkeley, Cal., on February 12. A graduate of the University of California of 1899, Prof. Stubenrauch was for ten years in the U.S. Department of Agriculture, resigning in 1914 his position as pomologist in charge of field investigations to return to service in the University of California. He was the first to demonstrate that dates could be grown with commercial success in the Imperial Valley, on the desert in southern California; and in association with Mr. G. H. Powell he developed the pre-cooling method, which has greatly contributed to success in the shipping of fruit from California.

A KINEMATOGRAPH film of great interest is now being shown at the Philharmonic Hall, Great Portland Street, by Capt. Campbell Besley. Capt. Besley, who is an Australian, undertook an expedition to the head waters of the Amazon at the request of the President of Peru in co-operation with Mr. Bryan, then Secretary of State of the United States of America. The chief objects of the expedition were to determine the source of the Amazon and to ascertain the fate of former explorers, who were supposed to have been killed by hostile Indians. The expedition, which was away two years, achieved its objects, but at considerable cost of life, for of the twelve white men who started only four returned. Several fell victims to the poisoned arrows of the natives. The pictures, which are explained by Capt. Besley, show the great rivers, the vegetation, and animal life of the region visited. They are an example of the great educational value of the kinematograph. The film is at present shown daily at 3 and 8 p.m.

THE seventieth annual meeting of the Palæontographical Society was held on March 30 in the Geological Society's rooms, Burlington House, Dr. Henry Woodward, president, in the chair. The report referred to the delay of the publications owing to existing circumstances, but noted that there was no diminution in the number of monographs offered. Instalments of the volumes on Pliocene Mollusca, Palæozoic Asterozoa, and Wealden and Purbeck fishes were about to be issued. Dr. Henry Woodward, Mr. R. S. Herries, and Dr. A. Smith Woodward were re-elected president, treasurer, and secretary respectively, and the new members of council were Mr. H. A. Allen, Mr. E. Heron-Allen, Rev. H. N. Hutchinson, and Mr. C. T. Trechmann. In a brief address the president mentioned that when the society was founded on March 23, 1847, it was estimated that the description and illustration of all the British fossils could be completed in twenty-five years. The long series of volumes published during seventy years, however, had proved to do little more than make a good beginning of the task.

ON Thursday, March 29, a representative assembly of the friends and admirers of the late Sir William Huggins, O.M., and Lady Huggins met together in the crypt of St. Paul's Cathedral to witness and participate in the unveiling and dedication of a medallion commemorating conjointly the achievements of a great astronomer and the inspiring efforts of a wife who, for some thirty-five years, identified herself with his aims and labours. Among those present were Sir Joseph Thomson, O.M., president of the Royal Society; Dr. A. Schuster and Mr. W. B. Hardy, secretaries R.S.; Sir Alfred Kempe, treasurer R.S.; Sir Archibald Geikie, O.M.; Major MacMahon, president of the Royal Astronomical Society; the Astronomer Royal; Sir W. Crookes, O.M.; Mr. H. F. Newall; Sir Joseph Larmor; Mr. E. B. Knobel; Sir W. Tilden; Mr. E. W. Maunder; Mr. W. H. Wesley; and the Rev. T. R. R. Stebbing. A number of ladies were also present. After the memorial had been unveiled a short form of service was conducted by Dean Inge, with whom were Canon Simpson and Canon Alexander. In committing the memorial to the charge of the Dean and Chapter, Sir Joseph Thomson paid eloquent tribute to the scientific achievements of Sir William Huggins. Born and educated in London, and all his work having been carried on and issued from a London observatory, St. Paul's appeared the fittest of destinations for a medallion. Major MacMahon, referring to certain points in a great life, said that Huggins saw celestial chemistry looming in front of him, and before many years had elapsed he was the pioneer of a new branch of science. The medallion of Sir William Huggins, it should be noted, was the primary object of the memorial, but, on the death of Lady Huggins, it was decided to place her portrait beneath that of her husband, on the same slab. Both are the work of Mr. Henry Pegram, A.R.A. The inscriptions run respectively: "William Huggins, Astronomer, 1824–1910"; "Margaret Lindsay Huggins, 1848–1915."

SECOND LIEUT. CYRIL DOUGLAS MCCOURT, who lost his life while gallantly leading a bombing attack in France on October 8, 1916, was born in 1883, and educated at St. Charles's College, North Kensington, whence he gained an institute scholarship at the City and Guilds of London Central Technical College, now part of the Imperial College of Science and Technology. After gaining the college associateship in chemistry, he served for a brief period as private assistant to Prof. H. E. Armstrong. In 1903 he was appointed chief chemist to the Morgan Crucible Co., Ltd., and during the six years that he held that post he carried out a number of valuable investigations bearing upon the manufacture and uses of various refractory materials, but the outstanding feature of his work was the part he played in the invention and subsequent development of the Morganite brush for dynamos and motors. This brush possesses exceptionally good lubricating and commutating properties, which are principally due to the comparatively low temperature at which it is burnt during its process of manufacture. In 1909 Mr. McCourt resigned his appointment with the company in order to work out, in collaboration with Prof. W. A. Bone, in Leeds, the industrial applications of the phenomenon now known as "incandescent surface combustion," a field of technical research which strongly attracted him, and afforded him ample scope for turning to good account his considerable knowledge of refractory materials. This collaboration speedily resulted in the many important scientific inventions comprised under the "Bonecourt" surface combustion system, the value of which has been more appreciated in America and Germany, where already considerable developments have been successfully worked out, than in the country in which they originated. Mr. McCourt showed great versatility and ingenuity in all his experimental work, to which he was passionately devoted, whilst his frank and generous nature was highly valued by all with whom he came in contact. Shortly after the outbreak of war he abandoned his research work in order to join the Army, where he anticipated that his scientific training and experience of the management of men would stand his country in good stead. His death is a real loss to science.

DR. J. W. FEWKES has reprinted from the Holmes anniversary volume an interesting monograph on the remarkable cliff-ruins in Fewkes Cañon, Mesa Verde National Park, Colorado. The author was deputed in 1915 by the Smithsonian Institution to continue the work of excavation and repair of these buildings. A report on the general results of the work was published under the title of "Excavation and Repair of the Sun Temple." In the course of the season's work he also excavated and repaired a cliff-dwelling, called Oaktree House, the results of which are described in the present publication. A plan of this building, which cannot be called characteristic, but resembles that of Spruce-tree House and other cliff-houses in Mesa Verde Park, is given. In another building, known as the Painted House, a series of representations of men and animals was discovered. The monograph is complete and well illustrated, and gives much information on the religious cults of the builders.

DR. MAYNIE R. CURTIS continues (*Biol. Bull.* xxxi., No. 3) previous interesting studies in the "Physiology of Reproduction in the Domestic Fowl" with a paper on double eggs. From the observations given it appears that an egg, after having received its membrane or its membrane and shell, may be propelled up the oviduct instead of being laid. In such case it may, on re-entering the terminal part of the duct, stimulate the secretion of another set of envelopes around those already formed, or, if it meets its successor, return along with it, and with it become enclosed in a common set of envelopes.

A USEFUL vegetation map of the United States by Mr. F. Shreve, of the Arizona Desert Laboratory of the Carnegie Institution, is published in the *Geographical Review* for February (vol. iii., No. 2). The map, which is produced in colours, differs in some respects from previous maps, and shows eighteen vegetation areas. The basis of the classification is, as usual, desert, grassland, and forest. Of these the desert and the forest are subdivided, but the natural grassland in want of data has been left as a single region. The local influence of soil has been ignored so far as possible. The map forms a valuable basis for geographical work, and has the merit of steering a course between excessive detail valuable only to the botanist and wide generalisations which are a danger to geographical research.

A NEW method of expressing the representative fraction of a map is suggested by Mr. A. R. Hinks in a paper on British and metric measures in geographical work in the *Geographical Journal* for March (vol. xlix., No. 3). Mr. Hinks proposes to take the fraction of the "million" map, 1/M, as a unit and to write the representative fraction of all maps on a larger scale than 1/M as a fraction with M in the denominator and the proper numerator; thus 1/125,000 would be written 8/M, and 1/63,360 as 15·8/M. In maps on a smaller scale than 1/M the denominator would be expressed in M's; thus 1/1,680,000 would be written 1/1·68M. Mr. Hinks proposes that this system should be given a trial by adding it as an alternative to the ordinary form. It is certainly less inconvenient and easier to write than the large number of figures required in the usual representative fraction.

THE first part of vol. xvi. of the Transactions of the Geological Society of Glasgow (1916, price 7s. 6d.) contains a presidential address by Prof. J. W. Gregory that deserves to be widely read, on "The Geological Factors Affecting the Strategy of the War and the Geology of the Potash Salts." The careful annexation of the Lorraine ironfield by Germany in 1871, and the equally far-sighted occupation of the best French coalfields since 1914, are judiciously pointed out. A summary of Everding's paper on the potash-salt area of Prussia includes sections not easily available. Other sources of potash are usefully reviewed, and to these alunite might now be added.

NOW that the development of marine warfare has compelled every nation to look into its own resources, it is cheering to receive Mr. C. H Clapp's report on the geology of the Nanaimo map-area (Mem. 51, Canada Geological Survey), in which a promising report is given of the Upper Cretaceous coals on Vancouver Island, directly opposite the terminus of the Canadian Pacific Railway. Though the ash is often about 9 per cent., the seams provide "high volatile bituminous coals of fair quality" and thicknesses of 5 ft. and 6 ft. are common. Admirably produced topographical and geological maps on the scale of 1 : 62,500 are provided with the memoir.

THE importance of a suitable site for the installation of seismographs is illustrated in a recent number of the Georgetown (U.S.A.) University Publication. Two Wiechert seismographs were placed temporarily at the base of a tower 212 ft. in height, and the rocking of this tower by heavy winds affected the records of the instruments. These and other seismographs were then erected in a heat- and damp-proof cave excavated beneath the quadrangle. The Publication referred to contains the records of these instruments for the whole of the year 1916, and Press notices of earthquakes which occurred during the same year in various parts of the world. The influence of the war is shown by the fact that all but ten of these earthquakes were of American origin.

THE Department of Mines of the South Australian Government has recently issued its first metallurgical report. The author is Mr. J. D. Connor, the Government metallurgist, who has undertaken a visit to the United States of America with the view of studying the recovery of copper from its ores by leaching and precipitation. His object was to secure such information as might assist in rendering available for realisation the mineral assets of South Australia, and in particular the unworked oxidised copper ores of the northern mining fields. Too much stress cannot be laid on the absolute necessity for exhaustive experimentation before any attempt is made to deal with the problem of leaching copper ores on a large scale. The principle of insisting on properly controlled tests before a working plant is erected is applicable to almost every metallurgical proposition. Mr. Connor's visit was not so successful in its outcome as he had anticipated. Although he travelled more than 10,000 miles, he saw only two leaching plants in actual operation, one of a capacity of 2000 tons a day, and the other an experimental plant of 40 tons per day. He did not visit the great plant at Chuquicamata, in Chile, where 10,000 tons of ore are leached per day. His general conclusion is that the leaching of copper ores is not being carried out in the United States to anything like the extent that might have been anticipated considering the amount of literature on the subject. A great deal of experimental work has been done in the past by very able operators backed by large organisations. To a considerably less extent this work is going on now, but it has been completely put into the background by the recognition of the possibilities of the "flotation" process (see NATURE, March 22). That American metallurgists should have been so long in taking up this process is certainly surprising, but now that they have done so, and particularly after litigation difficulties have been removed, it is likely that great developments will take place. As yet oxidised ores are not susceptible to treatment by flotation processes.

IN view of the movement for the establishment in France of a number of national laboratories at which the scientific problems which arise in the industries may be investigated, *La Nature* has commenced the publication of a series of articles dealing with the laboratories which have been founded in other countries for the same purpose. On account of the prominent position the National Physical Laboratory at Teddington has made for itself in the short time it has been in existence, it has been chosen as the first of the series, and in the issue of *La Nature* for March 10 a well-illustrated article giving an account of the foundation, method of management, and equipment of the laboratory appears.

THE *British Journal Photographic Almanac* for this year has at length appeared. Present circumstances have not only delayed its issue, but reduced its size to little more than the half of what it used to be; still, it is a bulky volume of 780 pages. The maximum number of pages allowed to any one advertiser having been very much reduced, some manufacturers' announcements are a great deal more condensed than heretofore, but the advertisement pages remain a very good guide to the various branches of the trade. The "Epitome of Progress" is curtailed chiefly with regard to kinematography, the literature of which published during the last year is very voluminous. The new British-made developers are included in the tables of formulæ. The section referring to sensitisers and dyes for colour-filters remains very much as before. The editor's article treats in a lucid manner with the elementary principles of chemistry so far as concerns the practice of photography, and this, therefore, is an appropriate time to point out a chemical error that is of many years' standing. The lengthy and useful table of chemical names, symbols, and atomic weights of numerous compounds has the atomic (or molecular) weights given described as "equivalent weights," which, of course, they are not.

THE *Biochemical Journal* for December, 1916, contains an important paper by Mr. H. Ackroyd and Prof. F. G. Hopkins, entitled "Feeding Experiments with Deficiencies in the Amino-acid Supply: Arginine and Histidine as Possible Precursors of Purines." In the authors' experiments young growing rats were fed first on a diet composed of acid-hydrolysed caseinogen, potato-starch, cane-sugar, lard, butter, and ash from equal weights of oats and dog-biscuit, then on the same diet from which the arginine and histidine had been removed, and finally on this second diet plus arginine or histidine, or both. The necessary vitamine supply was given in the form of a protein-free alcoholic extract of fresh-milk solids. In other experiments the tryptophane or the vitamine was absent from the diet. The results show that when both arginine and histidine are removed from the diet there is a rapid loss of body-weight of the rats, and a renewed growth when the missing diamino-acids are restored. Nutritional equilibrium is possible in the absence of one of these protein constituents, but not in the absence of both. The suggestion is made that this is because each of the two diamino-acids can, in metabolism, be converted into the other. If both arginine and histidine are removed from the food, the amount of allantoin excreted is much diminished, but the decrease is very much less when only one diamino-acid is removed When both are replaced, the excretion returns to the normal. When tryptophane or vitamine is removed from the food there is no decrease in the amount of allantoin excreted, although nutritional failure is then greater than when arginine and histidine are withheld. It is accordingly suggested that these two diamino-acids play a special part in purine metabolism, probably constituting the raw material for the synthesis of the purine ring in the animal body.

THE registrar of the Institute of Chemistry is particularly well situated to appreciate the important part played by chemists in the war, since he has had control of the register of chemists available for Government and other services maintained by the Institute. This fact adds an enhanced interest to the article "Chemists in War" which he contributes to the Proceedings of the Institute for February. The general community is probably at last beginning to know that the *rôle* of the chemist in the manufacture of high explosives is all-important, but it is very doubtful whether it realises even yet that his help is necessary in the production of all metals, cloth, leather, india-rubber, glass, food, pure water, and medicine—in fact, of practically every article of everyday life. Many chemists have been appointed to commissions in the Royal Army Medical Corps, the Army Service Corps, and the Army Ordnance Corps, whilst in order to fight the German with his own weapon, a special force of chemists was enlisted for the preparation and employment of poisonous gas at the front in Flanders. The chemists employed in the

Army have received the recognition both of Lord French and of Sir Douglas Haig. A large number of chemists have been engaged to work in the laboratories and works of Government and controlled establishments making munitions of war. The chemical staffs of Woolwich Arsenal and of the Government Laboratory have been largely increased, whilst university and college laboratories have in many cases become small factories for the preparation of drugs, antiseptics, etc. Finally, and perhaps most important of all, the Government has accepted the guidance of our most able and experienced chemists in the investigation of such problems—become acute by reason of the war—as merit their special attention. At last the chemist seems to be coming into his heritage.

AN interesting paper on the subject of sulphur in petroleum oils was read by Dr. F. M. Perkin at a recent meeting of the Institution of Petroleum Technologists. Nearly all naturally occurring petroleum oils contain sulphur, some having only a very small proportion, others large amounts. Oils obtained by the distillation of shales also contain sulphur, the proportion depending partly upon the quantity present in the material distilled, and partly upon the form in which the sulphur exists in that material. The paper illustrates the numerous forms in which sulphur may occur in the oils by reference to the homologous thiophenes, thiophanes, and alkyl sulphides; the probable origin of the sulphur in petroleum is also discussed. Be the origin what it may, as a constituent of petroleum oils sulphur is very objectionable. In petrol it gives rise to a disagreeable exhaust; in lamp-oils it causes an unpleasant odour, decreases the luminosity, and tarnishes domestic ornaments; in oil fuel it vitiates the atmosphere of the stokeholds and corrodes boiler-plates and tubes. Hence the question of desulphurising the oils is one of much importance. We have in the Kimmeridge shales a considerable source of shale oil, but, unfortunately, the sulphur content is very high. If a practicable method of removing the sulphur could be found, the Kimmeridge shale oil would be of immense value to this country. Many attempts have been made, but so far without success. Dr. Perkin describes various methods of desulphurising which have been employed or proposed, and also outlines a new process, which consists in the treatment of the oil at high temperatures with gaseous ammonia. In these circumstances sulphur is eliminated from the oil in the form of hydrogen sulphide. At present, however, the process is only in its initial stages, and not much information could be given as to its practical application.

THE eighty-third annual report of the Royal Cornwall Polytechnic Society (vol. iii., part ii., 1916), just issued, is of more than local interest, because of the important scientific and industrial research papers included in it. A paper on "The Physical Condition of Cassiterite (Tin Ore) in Cornish Mill Products," by the late Mr. J. J. Beringer, contains a new theory to account for the loss of the tin mineral which present appliances fail to recover. It is explained by a thoughtful introduction by Mr. W. H. Trewartha-James, who collated and revised the author's notes just before he died. This paper attracted wide attention, and nearly all the mine managers in Cornwall were present at the society's meeting at Falmouth in 1915 to discuss the important conclusions. The discussion ultimately resulted in the decision of the Government Department of Scientific and Industrial Research to subsidise and establish a scheme of research in tin and tungsten minerals at the suggestion of the Institution of Mining and Metallurgy in co-operation with the Royal Cornwall Polytechnic Society. Other papers in the report are: "Tin and Tungsten Minerals in the West of England," by the late Mr. J. H. Collins; "The Prospects of Tin in the United States," by Mr. H. Foster Bain, presenting important facts with regard to the international position of the tin industry; "The Development of Mechanical Appliances in China Clay Works," by Mr. J. M. Coon; "Piskies," a Cornish folk-lore study, by the president, Mr. H. Jenner; and a lecture on the fly problem by Mr. F. Balfour Brown. The report can be obtained from the society, or from William Brendon and Sons, Ltd., printers, Plymouth, price 5s.

## *OUR ASTRONOMICAL COLUMN.*

COMET 1917*a* (MELLISH).—The discovery of a new comet by Mr. Mellish, on March 20, has been announced by Prof. Strömgren. It was observed at Copenhagen on March 22 in R.A. 2 h. 9 m., decl. 15° 1′ N., and was rated at mag. 7·5. The comet is situated in the constellation Aries, and is consequently only visible for a short time after sunset.

D'ARREST'S PERIODIC COMET.—On the basis of corrected elements for this comet, which has a period of six and a half years and returns to perihelion this year, the following ephemeris has been given by J. Braae (*Ast. Nach.*, 4874):—

| 1917 | | R.A. h. m. s. | Decl. ° ′ | Log $r$ | Log $\Delta$ |
|---|---|---|---|---|---|
| March | 29 | 22 41 59 | −6 25·3 | 0·1031 | 0·3101 |
| April | 2 | 22 56 29 | 5 34·9 | 0·1027 | 0·3092 |
| | 6 | 23 10 52 | 4 43·8 | 0·1030 | 0·3086 |
| | 10 | 25 8 | 3 52·1 | 0·1039 | 0·3084 |
| | 14 | 39 14 | 3 0·4 | 0·1054 | 0·3086 |
| | 18 | 23 53 11 | 2 8·9 | 0·1076 | 0·3088 |
| | 22 | 0 6 58 | 1 17·9 | 0·1103 | 0·3094 |
| | 26 | 20 34 | −0 27·8 | 0·1136 | 0·3102 |
| | 30 | 33 57 | +0 21·2 | 0·1175 | 0·3113 |
| May | 4 | 0 47 9 | 1 8·8 | 0·1218 | 0·3125 |
| | 8 | 1 0 9 | +1 54·7 | 0·1266 | 0·3138 |

The date of perihelion passage is April 2. During the above period the comet will be about two hours west of the sun.

BRIGHT METEORS IN MARCH.—Mr. Denning writes: On March 14 at 10 h. a meteor equal to Jupiter was observed at Totteridge and Stowmarket. It fell over the south-east coast from a height of 71 to 17 miles. On March 15 at 11 h. 30 m. a meteor as bright as Venus was observed by Miss G. Lewis from Droitwich, and by several other persons in various parts of the country. The records of its flight are not, however, in good agreement, though the radiant point was probably in the Lynx, and the position of the object nearly over Cheltenham at its disappearance. On March 19 at 7 h. 32 m., a fine meteor was seen through clouds at Bristol, as it sailed almost vertically down the northern sky. On March 27 at 10 h. 17 m. and 10 h. 43 m. a pair of brilliant meteors were seen by Mrs. Wilson at Totteridge, and by Miss T. E. Gall at Hornsey, N. They were directed from a radiant low in the east near $\mu$ Libræ, and pursued nearly horizontal flights at heights of about 54 miles, and velocity 15 miles per sec.

PHOTOGRAPHS OF JUPITER.—Photographs of the planet Jupiter showing a large amount of interesting detail were obtained during the recent apparition by Mr. J. H. Reynolds with a 28-in. reflector at his observatory near Birmingham (Journ. B.A.A., vol. xxvii., p. 151). The telescope was adapted as a Cassegrain with an equivalent focal length of 55 ft., and the image was further magnified from three to six times by a Barlow lens. At the opposition of 1916, the N. temperate belt, which was absent in 1915, reappeared with strength and size comparable with that of the S. temperate belt, and the intervening zone between it and the N. tropical belt was occupied by a remarkable series of bright elliptical formations, usually accompanied by dark condensations on the south preceding side. These elliptical forms appear on all the photographs taken during 1916, and are probably to be interpreted as representing cyclones.

## THE INSTITUTION OF NAVAL ARCHITECTS

THE spring meetings of the Institution of Naval Architects were held in the rooms of the Royal Society of Arts on March 28 and 29. In the unavoidable absence of the president—the Earl of Durham—the Marquis of Bristol took the chair and delivered an address, in which he referred to the question of the formation of a council for co-ordinating the common interests of the various institutions representing engineering professions. Such a council, in making recommendations, would have the weight of the whole profession behind it.

The Elgin scholarship has been awarded to Mr. R. J. Shepherd, and the annual gold medal to Prof. T. B. Abell for his paper on experiments to determine the resistance of bilge keels to rolling. A premium has been awarded to Mr. A. T. Wall for his paper on some effects of the Bulkhead Committee's report in practice.

Despite the disadvantages under which the institution has been placed owing to so many of its members being engaged on work intimately connected with the war, thirteen papers were read and discussed. The standard of the papers has in no way diminished, and many contain matter of considerable scientific interest.

Mr. D. B. Morison's paper on standardisation as applied to the machinery for cargo-boats is of much interest at the present time, when a strong effort is being made to make good losses due to piratical submarine operations. A specification for such machinery is being discussed now by the North-East Coast Institution, and an appeal was made for joint action by all the institutions connected with shipbuilding. An interesting feature of Mr. Morison's paper is the many references to economic problems. It is futile for capital to expect that labour will consent to any great reduction in wages, and equally hopeless for labour to expect the maintenance of the present high rate of wages without concession on its part. To render it possible to pay high wages in the future and yet maintain our trade, the requisites are (i) a candid acknowledgment by labour of the economic law that good general trade is dependent on maximum production, and (ii) capital must recognise that maximum production entails correspondingly high pay.

Mr. J. Montgomerie contributed a valuable paper giving an account of experiments conducted at the West Ham Technical Institute on stress determination in a flat plate. In these experiments the plates were bolted in a very heavy frame, rectangular in plan, leaving a surface of plate measuring 4 ft. by 2 ft. exposed to water-pressure. The object was to hold the plate round the edges as rigidly as possible. Bach's plates—which constitute the only experimental work on the large scale up to the present—were not held so rigidly at the edges. Crawford's experiments on the same subject were on too small a scale. Mr. Montgomerie has experimented on several plates of various thicknesses; the plate 0·75 in. thick alone is reported upon in the paper, although the experiments on the other plates have been completed.

Measurements of deflection were made at many stations on the plate, and curves plotted showing the cross-sections in directions parallel to the edges. From these curves, by application of graphical methods, the stresses at the stations were determined. Owing to the nature of the graphical methods employed, it was considered desirable that the strains in the plate should be measured directly, and for this purpose a strain-meter was devised by Mr. J. Duncan and used in such a manner as to determine the principal axes of strain at the stations. The principal strains were then measured at each station, and from the knowledge thus obtained, together with the measured values of Young's modulus and Poisson's ratio for the material, the principal stresses were determined and the ellipses of stress drawn for each station. The results by these two methods show very fair agreement.

The resulting diagram is very interesting, and shows the elastic behaviour of the entire plate. It shows that the maximum stress actually occurs at the centre of the plate and not at the frame ends of the short diameter, as has been supposed hitherto. There is no doubt that this fact is due to the elastic movements of the portion of the plate clamped in the frame, which permit the "wall section" to assume slope instead of remaining in the plane of the wall, as is assumed in the usual mathematical theory. The effect of this behaviour is to diminish the bending moment at the plate edges and to increase that at the centre; the stresses, of course, alter correspondingly. Mr. Montgomerie has promised further information regarding the other thinner plates tested, and his contribution must be regarded as a valuable addition to our knowledge of cases of complex stresses.

Mr. Thomas Graham described an apparatus for interpreting stability for the use of shipmasters, whereby the stability of vessels under any ordinary conditions of loading can be shown graphically and easily interpreted. This instrument illustrates three features of stability which are of most practical importance, viz.:—(i) An automatic record of the variation of the righting arm as the ship heels over from the upright to the vanishing angle. (ii) The approximate angle of heel at which the freeboard deck edge becomes awash. (iii) The position of the water-line throughout the range of moderate angles met with in practice. The appliance consists of a pivoted wooden lamina representing a cross-section of the ship, and having a pointer moving over a protractor showing angles of heel. A plumb line is hung from the position on the lamina corresponding to the known centre of gravity of the ship. A brass plate having a curved edge representing the metacentric evolute for the given draught and displacement is attached to the lamina, and another plumb line is arranged to pass over the edge of this evolute and to hang tangentially. The distance between the two plumb lines thus shows to scale the magnitude of the actual righting lever at all angles of heel. An additional feature is an arrangement for indicating the position of the water-line.

Prof. W. E. Dalby read a paper illustrating the inner structure of mild steel, and showing how its strength is correlated with this inner structure. This paper is one of the most readable produced up to date, and contains explanations which can be followed readily by reference to the many micrographs included. Load extension diagrams of all the steels have been obtained by use of the author's well-known apparatus.

Lieut. Walter A. Scoble contributed a paper on the design of pin joints based on ultimate strength. The author gives reasons leading to the conclusion that the maximum load carried is the best criterion for the strength of a pin joint, and describes in detail a method by which the calculations required in designing a joint can be made.

Mr. J. J. King-Salter gave an account of some experiments on the influence of running balance of propellers on the vibration of ships. Since the introduction of turbines in warships, running at a much higher speed than reciprocating engines, the necessity of seeing that the propellers were suitable not only as regards form, but also as regards their being in proper mechanical balance, has received considerably more attention. Experiments have been carried out in two destroyers and a Town class cruiser built at the Commonwealth Naval Dockyard at Sydney. The paper describes experiments made by rotating the propeller at speed on spring bearings, noting the vibration and removing material from certain parts of the blade and even the boss. From subsequent observations on the ships it was apparent that there was a decided improvement. The problem to be solved is by no means easy, since removal of material from the blades of a propeller has the effect of altering the pitch, and naval architects, as a rule, have very stringent specifications regarding the exactitude of the pitch of a propeller.

Sir George Greenhill contributed a paper on the theory of wave-motion on water. In this paper the author discusses mathematically the trochoidal wave as treated by Rankine. Mr. John H. Macalpine gave particulars of marine applications of reduction gears of the floating-frame type. The success of this type of gear appears to be very marked. The first floating-frame gear was installed at Granite City, Illinois, in 1911; when examined on April 30, 1916, the scraper marks were still visible on the gear teeth. Originally these marks were of imperceptible depth.

Messrs. P. A. Hillhouse and W. H. Riddlesworth presented a paper on launching. This paper contains an account of some interesting experiments made at the Fairfield Shipbuilding Yard. A model of the ship was constructed and arranged in all respects to be a reduced copy. Model ways were constructed and a tank arranged with water at proper tide level. By these means valuable information was obtained regarding the motion of the ship during launching. The authors make an interesting suggestion whereby an accurate record of the complete motion of the actual vessel from start to finish might be obtained by means of the kinematograph. Two machines would be required, one placed near the stern of the vessel when on the slip, and the other somewhat less than the length of the vessel further aft. Both would stand at a convenient distance away from the vessel's side, and would have their axes at right angles to the middle line of the berth. In the field of view of each, two uprights would be placed as near to the vessel's side as possible, and on each upright a vertical scale of feet would be clearly marked in black and white. On the ship's side would be painted a continuous longitudinal white line crossed by short vertical lines numbered in succession from either end. As the vessel moved the cameras would record continuously the movements of the white line in relation to the ship and to the water level and ground ways, and the whole motion could be reconstructed. If, in addition, there could be placed in front of each camera a large clock-face with seconds pointer, the two sets of photographs could be correlated and a record of velocities obtained.

## *BRITISH FILTER-PAPERS.*

AS is well known to laboratory workers, in pre-war days the better kinds of filter-paper used in chemical operations were not produced in this country. They were imported chiefly from Germany and Sweden. In particular, the so-called "ashless" filters, from which most of the mineral matters have been extracted by treatment with hydrochloric and hydrofluoric acids, had made the name of one German firm familiar in probably every chemical laboratory of importance throughout the kingdom. The outbreak of war, however, stopped the supply of German filters, and British paper-makers turned their attention to meeting the demand.

The qualities required in filter-paper depend upon the purpose to which it is to be applied. Thus for certain technical operations, such as the filtration of oils and fruit juices, a soft paper of open texture is desirable. Further, as such paper is often used for filtration under pressure, a high degree of elasticity is required in it to prevent fracture. In analytical work, on the other hand, whilst a paper with open texture which filters rapidly is preferable for flocculent precipitates like ferric hydroxide, a close-texture paper is required for the retention of fine precipitates such as barium sulphate. Moreover, the proportion of mineral matter is important. Compounds of calcium and iron, frequently with a little copper, and sometimes silica and alumina, are the chief mineral impurities found in filter-paper; and for accurate quantitative work the amount of these should be small. Indeed, it should preferably be so small as to be negligible except where a high degree of exactitude is required. In any case, it should be definitely known, and ought always to be stated on the packets of filters by the makers.

The ability to retain fine precipitates, a minimum proportion of ash, and reasonable rapidity of filtration are thus the chief desiderata in the best filters for chemical laboratory purposes. The last alone is sufficient in many technical operations. Discussing this question in the *Analyst* some months ago, Messrs. Bevan and Bacon indicated that for paper required to filter with moderate rapidity the ratio of the volume of the paper to that of its constituent fibres should be about 3·5 to 1. It does, in fact, as a rule vary between the limits 3 and 4·5 to 1. "Pin-holes" are sometimes found in paper having this ratio or "bulk" (as the technical term goes); they are attributable to faults in the milling.

Some time ago specimens of the filter-papers now produced in this country were supplied to us by three manufacturing firms, namely, Messrs. W. and R. Balston, Ltd., Maidstone; Messrs. J. Barcham Green and Son, Maidstone; and Messrs. Evans, Adlard and Co., Ltd., Winchcombe. Judging by the reports furnished with certain of the papers, supplemented by tests applied in actual working practice, a number of the samples compare quite well with the foreign filters which they have replaced. It is evident that a serious endeavour is being made to produce filters which will compare favourably in quality with even the best of those hitherto imported, and the efforts appear to have met already with a considerable measure of success. Naturally, it will take time and careful study completely to outvie the foreign articles, which are the result of long specialisation. Uniformity of product is an important point to aim at, so that the user may know that he can rely upon the constancy of the quality. There is no obvious reason why British paper-makers should not, with proper technical advice, compete successfully with foreign manufacturers in this branch of industry, and, in fact, there is good reason to believe that they will do so. In this matter, as in so many others, we ought not to have to revert to the *status quo ante bellum.*

## *COMPULSORY CONTINUATION CLASSES.*

THE final report of the Departmental Committee on Juvenile Education in Relation to Employment after the War has just been issued (Cd. 8512, price 6*d.* net).

The terms of reference of the committee were: To consider what steps should be taken to make provision for the education and instruction of children and young persons after the war, regard being had particularly to the interests of those (i) who have been abnormally employed during the war; (ii) who cannot immediately find advantageous employment; (iii) who require special training for employment. Among the twenty-three recommendations made by the committee are the following:—

(1) That a uniform elementary school leaving age of fourteen be established by statute for all districts, urban and rural, and that all exemptions, total or partial, from compulsory attendance below that age be abolished.

(2) That steps be taken, by better staffing and other improvements in the upper classes of elementary schools, to ensure the maximum benefit from the last years of school life.

(3) That it be an obligation on the local education authority in each area to provide suitable continuation classes for young persons between the ages of fourteen and eighteen, and to submit to the Board of Education a plan for the organisation of such a system, together with proposals for putting it into effect.

(4) That it be an obligation upon all young persons between fourteen and eighteen years of age to attend such day continuation classes as may be prescribed for them by the local education authority, during a number of hours to be fixed by statute, which should be not less than eight hours a week, for forty weeks in the year, with the exception of: (*a*) Those who are under efficient full-time instruction in some other manner; (*b*) those who have completed a satisfactory course in a secondary school recognised as efficient by the Board of Education and are not less than sixteen; (*c*) those who have passed the matriculation examination of a British university, or an equivalent examination, and are not less than sixteen; (*d*) those who are under part-time instruction of a kind not regarded as unsuitable by the Board of Education and entailing a substantially greater amount of study in the daytime than the amount to be required by statute.

(5) That all classes at which attendance is compulsory be held between the hours of 8 a.m. and 7 p.m.

(6) That it be an obligation on all employers of young persons under eighteen to give them the necessary facilities for attendance at the statutory continuation classes prescribed for them by the local education authority.

(7) That where there is already a statutory limitation upon the hours of labour, the permitted hours of labour be reduced by the number of those required for the continuation classes

(8) That the curriculum of the continuation classes include general, practical, and technical instruction, and that provision be made for continuous physical training and for medical inspection, and for clinical treatment where necessary, up to the age of eighteen.

(9) That suitable courses of training be established and adequate salaries be provided for teachers of continuation classes.

(10) That the system of continuation classes come normally into operation on an appointed day as early as possible after the end of the war, and that the Board of Education have power to make deferring orders fixing later appointed days within a limited period, where necessary, for the whole or part of the area of any local education authority.

(11) That the State grants in aid of present as well as future expenditure on education be simplified and very substantially increased.

## *RECENT PROGRESS IN SPECTROSCOPY.*[1]

TEN years ago the subject of Prof. Crew's vice-presidential address was "Facts and Theories in Spectroscopy." Since that time some notable discoveries have been made and some remarkable theories have challenged attention. It is my purpose to review a few of the more important experimental results and to discuss the relations of some of them to theories brought before you in two recent vice-presidential addresses on "Atomic Theories of Radiation" and "The Theory of the Nucleus Atom." Inasmuch as it will be necessary to refer to them, I will restate the salient features of the theories which have attracted the most attention.

Planck derived an expression for the spectral energy distribution of black-body radiation from the assumption that the radiation was emitted and absorbed by electric oscillators in definite quanta, each equal to the frequency of the oscillator multiplied by a universal constant, $h$, the wirkungsquantum. Later he modified this theory so far as absorption is concerned. Einstein and others went farther in assuming that these quanta preserve their identity in their propagation through space, thus reviving a form of corpuscular theory. This extreme view has been generally abandoned, but it has been found impossible to explain away the wirkungsquantum $h$. It appears in too many relations to be the result of chance. The work of Millikan in particular proves the exact validity of Einstein's relation $Ve=h(\nu-\nu_0)$ in the photoelectric effect, in which $Ve$ is the measure of the emission energy of the electrons, $\nu$ the frequency of the incident light, and $\nu_0$ the minimum frequency which will cause emission of electrons. A similar relation appears to hold good in many cases of X-ray and light spectra. It seems probable that this constant depends upon atomic structure only, and affects radiation through space only in so far as emission and absorption are determined by atomic structure.

The theory of the nucleus atom is likewise of fundamental importance in spectroscopy. The work of Rutherford and others leaves no escape from the conclusion that the nucleus of the atom is a concentrated group of positive charges and electrons, with an excess of positive elementary charges approximately equal to half the atomic weight, while the same number of electrons circulate about the nucleus in rings. The spectroscopist must try to fit his theories to these probable facts, but he is met at the outset with apparently insuperable difficulties in accounting for the stability of such atoms and for the manifold complexity of spectra according to accepted electrodynamical laws. Bohr cut the Gordian knot by supposing that the classic laws apply only to conditions of stability, when no energy is radiated, and that radiation attends the transition of an electron from one state of stability to another, the frequency being determined by the relation that $h$ multiplied by the frequency is equal to the difference between the energies of the system in the two stable states. In the case of hydrogen, to which he assigns one radiating electron and one nucleus charge, it is difficult to account for the existence of so many stable states, for the failure to radiate while subject to uniform radial acceleration, and for monochromatic radiation while passing between two positions of stability. Nevertheless, Bohr derived an expression like that of Rydberg which locates accurately not only the Balmer series, but also an infra-red and an ultra-violet series predicted by Ritz and found by Paschen

[1] Address delivered to Section B—Physics—of the American Association for the Advancement of Science at the New York meeting, December, 1916 by the chairman of the Section, Prof. E. P. Lewis.

and by Lyman, respectively. His attempt to apply the same method to helium led to results which are still in dispute, and will be referred to later.

In reviewing recent progress we may begin with that field in which the United States has taken a leading part—that of astrophysics. This domain belongs as much to the physicist as to the astronomer. The heavenly bodies are laboratories on a vast scale, in which nature has provided conditions of temperature, pressure and electrical state which we may never hope to rival on the earth. The spectroscope gives us data from which it may be possible to form some idea of these conditions by comparison with our feeble laboratory imitations of celestial phenomena, and conversely, the latter may aid in the interpretation of terrestrial phenomena.

One of the most fruitful astronomical applications of the spectroscope is to the determination of velocities in the line of sight, by the Doppler-Fizeau principle. A large mass of such data has been collected, from which some important generalisations have been derived. For example, Campbell has determined the velocity and direction of motion of the solar system through space, and has found a remarkable and as yet unexplained relation between the velocities of stars and their apparent age, the redder and presumably older stars and a class of nebulæ having in general the greater velocities. It likewise appears that two immense star streams are crossing each other in the Milky Way. Many spectroscopic binaries have been discovered and their orbits determined, and recently there have been found remarkable displacements and rotations in nebulæ which may throw some light on the nature and destiny of these bodies. The spectroscope has enabled astronomers to undertake the ambitious task of tracing the course of stellar evolution.

The most ingenious and fruitful device for studying the sun is the spectroheliograph, invented by Hale in 1892. With this instrument photographs of the distribution of a given constituent of the solar atmosphere may be obtained by restricting the light falling on the photographic plate to the wave-length of one of the characteristic lines of the element. The configuration of the hydrogen clouds in the neighbourhood of sunspots led Hale to suspect vortical motions in such regions. In 1908 the study of a number of plates, which showed that hydrogen flocculi were actually drawn into these spots from great distances, proved without question that sunspots are cyclonic areas of enormous extent. Thus the long-disputed question as to the nature of sunspots was answered, but this was not all. Vapours which emit or absorb line spectra are ionised, and as the more mobile electrons would diffuse more rapidly to higher levels than the positive ions, Hale inferred that the immense whirls of electrified vapours in the neighbourhood of the spots must cause a radial magnetic field. If such fields are sufficiently intense, the longitudinal Zeeman effect should be produced. As a matter of fact, the spectrum of light from the spots is characteristically different from that of the surrounding photosphere, one of these peculiarities being the doubling of many lines. As Hale anticipated, an examination of the state of polarisation of such lines showed them to be circularly polarised, and the direction indicated that the whirling vapour was negatively electrified. Hale likewise sought for the more minute effects which might be expected from the rotation of the solar atmosphere as a whole. A study of the breadth of spectral lines at different latitudes and the detection of traces of circular polarisation at their edges showed that the sun possesses a magnetic field with polarity corresponding to that of the earth, but of much greater intensity. Although the atmospheric conditions on the earth are very different from those on the sun, it is possible that these investigations may assist us in solving the baffling problem of the earth's magnetism.

One of the most impressive facts revealed by the spectroscope is the substantial identity of constitution of the heavenly bodies. Everywhere we find evidence of the existence of such elements as hydrogen, sodium, calcium, and iron. But we also find an infinitude of differences in the appearance of the lines, which we must attribute to differences of temperature, vapour density, pressure and electrical condition. It is suggestive to find that the spectrum of some stars resembles that of the arc, of others that of the spark. We may hope by comparing the spectra of these bodies with those produced in our laboratories under varied conditions to reach some conclusions regarding their physical state. The Mount Wilson physical laboratory is doing much valuable work of this kind.

In the spectra of the solar corona and of nebulæ and nebulous stars certain lines are found which do not belong to known elements. This need not indicate any fundamental differences between the life-history of such bodies and that of the older stars. Twenty-five years ago Lockyer's views regarding the dissociation of elements in the stars were treated with levity by most physicists and astronomers. To-day such notions are held to be quite rational. The more elementary forms of matter would naturally be of small atomic weight, and hence would diffuse to higher levels than the heavier elements, and might ultimately escape into space. If it were not for the fact that it is held captive in chemical combinations, we should know nothing of hydrogen. Helium first revealed itself to us through its solar lines, and would still be otherwise unknown to us were it not for its continuous production in radioactive processes. The elements giving the spectra of the corona and of the nebulæ are presumably of small atomic weight, and are possibly the units out of which more complex known elements are built, in later stages of development; or they may be, conversely, the results of the disintegration of such elements. It is not impossible that in the future we may detect traces of these elements on the earth or manufacture them by some powerful disintegrative process. Meanwhile, deductions from known relations between frequencies of the spectral lines, their breadth, and the atomic weight of the elements may give us some clue to their atomic weights. Nicholson has succeeded in constructing hypothetical atoms with given nuclear charges and electron ring systems which give with remarkable accuracy the positions of the lines of the corona and nebulæ. Rayleigh showed from kinetic theory and Michelson proved experimentally that at low pressures the width of lines may be entirely due to Doppler displacements, which vary directly as the square root of the absolute temperature and inversely as the square root of the atomic weight. Buisson and Fabry have verified this law and applied it to the study of nebulæ. The width of certain lines, determined from the limit of interference, indicates that the temperature of the Orion nebula is about 15,000 degrees, and that two groups of lines are due to atoms of weights 2·72 and between 1 and 2 respectively. This is a remarkable confirmation of Nicholson's previous conclusion that the emission centres are of atomic weights 2·95 and 1·31.

During the past ten years the boundaries of the known spectrum have been greatly extended in both directions. The difficulties of investigation in the infra-red are very great, but by the methods of reststrahlen and of focal isolation Rubens, working in succession with Nichols, Wood and von Baeyer, has isolated and measured certain regions of great wave-length. The longest wave-length measured is about 0·3 mm., while the shortest Hertzian waves so far obtained are 2 mm. long. The study of line radiation in this region is even more difficult, but Paschen and his pupil, the American Randall, have succeeded in measuring many lines extending to about 90,000 Ångström units.

In the ultra-violet Lyman has extended the region first made known to us by Schumann to a wave-length of about 600 Ångström units. Beyond this point it is difficult to go, on account of absorption, lack of sensitiveness of the photographic plate, and small reflecting power of speculum metal. Gratings ruled on silicon and photoelectric detectors may enable us to bridge the gap between these waves and the much shorter ones which may be examined with the aid of nature's diffraction gratings, crystals which have made the study of X-ray spectra possible.

Of all the discoveries of recent years, that of the wave nature of the X-rays and of a practical method of examining their spectra is the most remarkable and the most important, for it has revealed to us the most fundamental radiations of the elements and has given us a glimpse into the very heart of the atom. In quick succession Laue and his pupils demonstrated the diffraction effects produced by crystals, the Braggs showed how reflection might be employed to isolate waves of different lengths by a principle similar to that producing colours of thin plates, but of far greater resolving power by reason of the greater number of effective reflecting surfaces, and Moseley photographed many characteristic spectra by an extraordinarily simple method. He found that the principal lines in the spectra of a large number of elements were connected by a remarkably simple relation, namely that the square roots of the frequencies are proportional to the ordinal numbers, which increase by one in passing from one number of a periodic group to the next. When there are anomalies between the atomic weight and the place of an element in a group, this anomaly disappears when the atomic number rather than the atomic weight is considered. This work has been extended by others, notably by Siegbahn and Friman, to include nearly all the known elements between sodium and uranium, inclusive, with the result that all the atomic numbers between hydrogen and uranium are accounted for, with the exception of six gaps. As interpreted by Bohr's theory, the ordinal number which determines the frequency is the excess number of positive elementary charges in the nucleus, and these results are, therefore, in complete harmony with the theory of the nuclear atom developed by Rutherford, van den Broek, Soddy, and others. The comparison of the X-ray spectrum of lead obtained by Siegbahn with the gamma-ray spectrum of radium B obtained by Rutherford and Andrade shows the identity of ten of the principal lines. This strikingly confirms the accepted theory of isotopes, or elements of different atomic weights, which are chemically and spectroscopically alike beause they have the same resultant nuclear charge.

The positions of the principal lines are consistent with Bohr's general formula, but perhaps this relationship is purely formal. But whether or not this theory applies, apparently we cannot dispense with the wirkungsquantum. In addition to the characteristic X-radiation of an element, there is a continuous spectrum, with a sharply defined boundary on the side of shorter wave-lengths. The investigations of Duane, Hull and D. L. Webster have shown that this boundary is accurately defined by Einstein's relation $Ve=h\nu$ for fields up to 110,000 volts. Such a simple law does not hold for the characteristic radiations; but Webster has shown that they do not appear until the voltage somewhat exceeds that demanded by the Einstein relation. The longest X-waves so far discovered by Siegbahn are about 12 Ångström units in length, so that there is not a very great gap between them and the shortest waves discovered by Lyman. The investigation of this region is difficult, but undoubtedly means will be found to attain success. Much also remains to be done in the study of details of X-ray spectra, which contain many weak lines, and possibly bands, which have not so far been carefully examined.

During the past ten years great advance has been made in our knowledge of spectral series. Rydberg, Ritz, Paschen, Fowler and others have shown that a generalised form of the Balmer equation, with Rydberg's universal constant and a few special constants, is capable of wide application. Different combinations of a few constants have been found to give a number of related series, and many new lines so predicted have been found. The common limit and other numerical relationships between different series of the same element indicates that the different emission centres have some dynamic coupling and Rydberg's universal constant indicates a structural element common to all substances. According to Bohr, this quantity is a function of the electronic and atomic mass, the elementary electrical charge, and the wirkungsquantum $h$, and should slightly increase with increasing atomic weight. As it is commonly assumed that it is an absolute constant, careful measurements may furnish a test of the validity of Bohr's theory.

The relationships of frequency to atomic number found by Moseley recalls that Ramage, Watts, Runge and Precht and Hicks have found linear relationships between the squares of the atomic weights and the frequencies or frequency differences of homologous lines in the spectra of elements of the same group. Ives and Stuhlmann have shown that in some cases the results are improved by substituting atomic numbers for atomic weights, but the relationship is evidently not so simple as in the case of X-ray spectra.

The discovery of the Zeeman effect and the explanation of its simpler forms by Lorentz was the first step toward a rational spectroscopic theory. The later discovered complexities and anomalies, while they may defy mathematical analysis, do not lessen our confidence in the theory, for they are what we might expect as a result of complicated atomic structure. The same intellectual satisfaction does not attend the discovery of the analogous effect of an electric field, because the simplest cases are so complex that they cannot be adequately explained by any theory yet proposed. The possibility of such an effect had long been the subject of speculation, but Stark was the first to realise and attain the necessary conditions for its occurrence. Lo Surdo also discovered it in the neighbourhood of the cathode in capillary tubes. As in the case of the Zeeman effect, the phenomena are different when viewed transversely and parallel to the field. In each case the lines are split into a number of components, the number being different for different lines, even for those belonging to the same series. In the transverse effect the components are plane-polarised in hydrogen and helium, the stronger central lines vibrating at right angles to the field, and the stronger outer components vibrating parallel to the field. A remarkable relation is found for the series lines of hydrogen, helium and lithium. For each the number of principal normal components appears to be equal to the ordinal number of the line in the series. Higher dispersion shows that in the case of hydrogen each component is double. If this rule holds good throughout the series, the last known line, the twenty-eighth, would have fifty-six such components, an equal number polarised at right angles to these, and a number of weaker components of both kinds—truly a formidably complicated system. In general, the longitudinal components appear to be unpolarised, although Miss Howell has found some anomalies with lithium and calcium. In some cases the components are unsymmetrical both in position and in intensity. Of all the other elements investigated, mercury alone shows a slight broadening. It might be expected that the great nuclear charges of heavy atoms would diminish the effect of an external field. The inverse absorption effect has so far not been observed.

Long before the Stark effect was observed Voigt showed that such results might be expected from quasi-elastic forces in the atom and the stresses produced by the field. Schwarzschild has attempted to explain it by the ordinary laws of electrodynamics, and Warburg, Gehrcke, Garbasso and Bohr by Bohr's theory. Each attempt was successful in some respects, but each failed to account fully for all the components, their displacements and their state of polarisation, and all the theories assign the same number of components to each line of a series, whereas one of the most significant features is the progressive difference in number of components, displacements and relative intensities in passing from one line to another. Stark not only rejects them all, but is led by his study of the phenomenon to abandon finally the quantum and light-cell theories, because he considers that he has proved that the greatest possible energy which an electron can acquire in its orbit falls far short of one energy quantum. Moreover, he argues that it seems impossible to explain the phenomenon in terms of Bohr's one electron. He concludes that a number of electrons must take part in the emission of a single line, each having the same frequency under ordinary conditions or in a magnetic field, but different frequencies when displaced unsymmetrically in an electric field. It is difficult, however, to understand why hydrogen has only one detachable electron if Stark's view is correct.

It has already been mentioned that at low pressures the width of lines may be ascribed entirely to the Doppler effect. The great broadening at higher pressures has never been explained, but it has been assumed that damping, collisions and rotations all play a part. Stark suggests that it may be largely due to atomic electric fields, which may exercise a large influence when the atoms are crowded together. It seems significant that the broadening increases with the ordinal number of a line in a series, is often unsymmetrical, and diminishes with increasing atomic weight in most cases, quite in harmony with the effects of an electric field. Nicholson and Merton have found that the broadening of hydrogen lines is in quantitative agreement with Stark's suggestion.

With changes in vapour density, pressure, temperature or the mode of excitation lines belonging to one series may weaken or disappear, other lines may be strengthened, and new lines may appear. We must assume that different groups of lines are due to different emission centres. These differences must depend upon the size of the particles, or upon the number and arrangement of electrons. Any theory must take account of the molecular or atomic state or the electrical charge of the emission centres. In some cases we have rather definite information on these points.

A number of elements emit band spectra under some conditions, line spectra under others. One conclusion which seems to be well established is that band spectra are emitted by molecules, line spectra by atoms. Universally, we find that compounds give band spectra, never line spectra. If a compound is dissociated by the discharge the line spectrum of one or both constituents appears. Elements give band spectra with feeble excitation, line spectra when the discharge is so intense as to cause dissociation. It seems reasonable to infer that the band spectra of elements is likewise associated with the molecular condition. In the case of monatomic elements which give both band and line spectra electrical conditions must determine the nature of the radiation.

(*To be continued.*)

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

The war has brought women students into prominence in Germany. They form a third of the actual number of students in residence at the twenty-two universities of the Empire, and one-tenth of the total number of registered students. During the winter of 1916–17 there were more women than men at several German universities, *e.g.* Marburg and Münster; in Bonn, Frankfurt, Munich, Heidelberg, and Jena the women formed half the students, while they were in a minority at Strassburg, Leipzig, Breslau, and Giessen. Altogether, there were 5757 women undergraduates at the German universities during the last term, distributed as follows:—Literature and history, 2789; mathematics and science, 1036; medicine, 1479; dentistry, 64; economics and agriculture, 225; law, 116; Protestant theology, 18; and pharmacy, 30.

The committee appointed to consider arrangements for post-graduate teaching in the Calcutta University has, we learn from the *Pioneer Mail*, presented a report dealing exhaustively with that subject. In summing up the recommendations the committee states that the proposals, in the main, amount to the acceptance of two fundamental principles: (*a*) an intimate association and co-operation between the college and the university staffs is imperative in the interest of all concerned and of the development of higher teaching; (*b*) it is necessary to constitute a suitable organisation within which the teachers will be enabled by discussion among themselves efficiently to conduct the teaching and examination of graduates. Beyond this, says the report, the committee has been unable to go and has refrained from commenting on the wider problems which confront the University.

## *SOCIETIES AND ACADEMIES.*

### London.

**Royal Society.** March 22.—Sir J. J. Thomson, president, in the chair.—J. C. **Mottram** and Dr. S. **Russ**: Observations and experiments on the susceptibility and immunity of rats towards Jensen's rat sarcoma. Observations have been made upon the modes of growth of Jensen's rat sarcoma following inoculation. There is a gradual transition from those cases in which the tumours spontaneously disappear to those in which they grow in a uniformly progressive manner. The experimental production of the immune condition can be brought about in several ways. Animals made refractory to the growth of the tumour have been given various doses of X-rays; the effect of such irradiation upon the blood was to cause a marked reduction in the number of lymphocytes. Over suitable conditions of exposure it has been possible to destroy the immune condition and thus convert refractory into tumour-bearing animals. There is a tendency for the immune condition to be restored. Histological and other evidence is brought forward which indicates that the failure of sarcoma cells to grow in an immune animal is due to an active resistance thereto on the part of the host.—S. **Pickering**: Problems bearing on residual affinity. It has been ascertained that the alkali metals, like the other metals previously examined, form metallo compounds isomeric with normal salts, and that, therefore, these metals may assume a valency higher than that usually exhibited by them. A class of compounds intermediate between the metallo and normal salts also exists. These are termed metallato compounds. The possibility of most metals, other than carbon and hydrogen, assuming a valency value higher than that usually exhibited by them is shown to explain (i) the constancy in the heat of substitution of $CH_3$ for H as contrasted with want of constancy in the case of the substitution of OH or Cl for H; (ii) the fact that the heat of neutralisation of organic acids is lower than that of inorganic acids, and exhibits certain distinctive features when only partially effected; (iii) that all true acids must contain a doubly linked oxygen atom, and that the apparent exceptions to the constancy of the heat of neutralisation are due to the acid not being a true acid; (iv) that the so-called normal salts of the alkali metals with organic acids are strongly alkaline, and that those with inorganic acids are feebly so; (v) that the usual method of titration of an acid by an alkali, as well as the precipitation of the acid or base by usual methods, fails in the presence of an organic acid; (vi) that the actual value of the heat of neutralisation constant can be explained.—Prof. E. **Wilson** and Prof. J. W. **Nicholson**: Residual magnetism in relation to magnetic shielding. (i) The paper contains a further contribution to the study of the problems presented by the necessity for constructing a magnetic shield capable of reducing the earth's field to an order as low as 0·001 C.G.S. unit in a large space. The main problem not treated in earlier papers is that of residual magnetism in the various shells of the shield, and this problem is discussed in connection with exhaustive experiments in the present paper. (ii) It is found that the ordinary process of demagnetisation of a mass of iron fails to be completely effective if, during the operation of the current which is diminished by steps and continually reversed, a constant magnetic field such as that of the earth is present at the same time. This phenomenon has escaped notice hitherto, probably on account of the smallness of the earth's field, but it becomes prominent in experimental work involving the measurement of fields so small as that specified in (i). (iii) This effect of the steady magnetic field is shown to be associated with a reversal of the residual effects of hysteresis in iron when tested in the earth's field by currents lying within a certain range in which they approximately annul the field. (iv) It has been found possible to ensure complete removal of irregular polarisation or previous magnetic history of the shells, provided that during the preliminary demagnetisation of the shells the earth's steady field on them is annulled by a steady current of suitable amount enclosing the whole shield. (v) The well-known fact that iron, polarised by a large force, and afterwards tested for permeability at a lower force, shows diminished permeability at the lower force, gives, in combination with these results, an interpretation of the increase of permeability manifested by iron when tested within a magnetic shield.—Dr. S. **Chapman**: The solar and lunar diurnal variations of terrestrial magnetism.

**Zoological Society,** March 20.—Dr. A. Smith Woodward, vice-president, in the chair.—E. P. **Allis**, Jr.: The prechordal portion of the chondrocranium of *Chimaera colliei*.—D. M. S. **Watson**: A sketch-classification of the pre-Jurassic Tetrapod vertebrates. The classification introduced in this paper is founded on a detailed consideration of all parts of the skeleton of such old amphibia and reptiles as are at all well known. In previous papers the author has analysed the features presented by many of these forms, distinguishing between those which are common to all early reptiles and those which are restricted to definite stocks, the latter being divided into those dependent on "adaptive radiation" and the more fundamental characters, especially those of the brain-case and ear, which are not to be correlated with any special mode of life. These non-adaptive characters, which appear in typical forms even in early members of a stock, serve for the ordinal and superordinal grouping, adaptive changes being used for groups of lower order and the gradual loss of primitive structures giving horizontal dividing lines.

DUBLIN.

**Royal Dublin Society,** March 27.—Prof. Hugh Ryan in the chair.—Prof. W. **Brown**: The change in Young's modulus of nickel with magnetic fields. The change is smaller for alternating than for direct longitudinal magnetic fields. With transverse magnetic fields, both direct and alternating, the Young's modulus first increases, then decreases; and the magnetic field in which the maximum value occurs is smaller the greater the constant load on the nickel wire.

PARIS.

**Academy of Sciences,** February 26.—M. A. d'Arsonval in the chair.—E. **Ariès**: The entropy of perfect gases at the absolute zero of temperature. The entropy at the absolute temperature is not $-\infty$, but is in the indeterminate form of two infinite quantities of opposite signs. It is shown that for a gram-molecule of a solid, the increase in the entropy, when vaporising entirely at a low temperature as a perfect gas, tends towards the gas constant R, as the temperature approaches the absolute zero.—P. **Vuillemin**: *Eurotium amstelodami,* supposed parasite of man.—Henri Lecomte was elected a member of the section of botany, in the place of the late Ed. Prillieux.—G. **Julia**: Binary forms of any degree.—P. **Gaubert**: A new property of sphærolites.—L. **Gentil**: The Upper Marine Miocene of West Algeria.—M. **Stuart-Menteath**: The interior basins of the Pyrenees.—M. **Miège**: New attempts at the disinfection of the soil. The antiseptics used included toluene, carbon bisulphide, hydrogen peroxide, lysol, formol, potassium permanganate, copper sulphate, sulphur, bleaching powder, and wood charcoal. In large-scale experiments, toluene and carbon bisulphide proved the most efficacious, as regards both increased yield and the health of the plants.—M. **Weinberg** and P. **Séguin**: Study on gas gangrene. *B. oedematiens* and anti-*oedematiens* serum.

March 5.—M. A. d'Arsonval in the chair.—A. **Lacroix**: The phonolitic rocks of Auvergne. A delicate case of interpretation of the chemical composition of felspathoid rocks.—G. **Bigourdan**: Some seventeenth-century observatories in the provinces. Historical details are given of La Flèche, Le Maurier, Loudun, and Arles.—G. **Giraud**: Hyperfuchsian functions and systems of total differential equations.—E. **Cotton**: Characteristic number and radius of convergence.—R. de Montessus de **Ballore**: Left algebraic curves.—E. **Belot**: The possible *rôle* of volcanoes in the production of meteorites.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the fourth quarter of 1916. Observations were made on sixty-four days during the quarter, and the results are given in tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—A. **Berget**: A differential refractometer for measuring the salinity of sea-water. The two liquids to be compared are placed in a rectangular box separated into two parts by a diagonal glass partition. An image of a slit, after passage through this double prism, is focussed in a microscope, and the displacement of the image measured by a micrometer eyepiece. Densities can be indirectly determined by this refractometer to the fifth decimal figure with great rapidity.—L. **Abonnenc**: The laws of flow of liquids by drops in cylindrical tubes. Vaillant has shown that when a liquid falls in drops from the orifice of a cylindrical tube the weight of a drop is a parabolic function of the frequency of fall. An extension of these experiments to tubes of less than 2 mm. external diameter is given.—P. **Gaubert**: The rotatory power of liquid crystals.—A. **Guilliermond**: Vital observations of the chondriome of the flower of the tulip.—C. **Vincent**: The forms of phosphorus in Breton granitic soils. The amount of phosphorus found in these soils will be underestimated if the method of extraction by strong mineral acids is used in the analysis. The organic phosphorus present in the humus may amount to 50 per cent. of the total phosphorus, and this explains the effects of liming these soils. From these results a rational method of manuring is deduced.—M. **Herlant**: The variations of the volume of the nucleus of the egg rendered active by butyric acid.—J. **Effront**: Achrodextrinase. Certain species of *B. mesentericus*, cultivated in a nitrogenous medium, secrete a diastase liquefying starch. The hydrolysis of starch by this ferment was studied in comparative experiments with malt extract, ptyalin, and pancreatic amylase. The behaviour of the mesenteric amylase was distinctive, and the name achrodextrinase is proposed for it. Some practical applications in the textile industry and in the laundry are suggested.—M. **Marage**: Arterial pressure in cases of deafness caused by shell shock. Eighty-two per cent. of the cases examined showed arterial pressure above the normal, and insomnia generally accompanied the hypertension. The pains in the head, usual in these cases, do not appear to be connected with the arterial pressure. The best treatment is d'Arsonvalisation.—M. **Lautier**: The treatment of cases of war-deafness. The Marage method is easy to apply, generally useful, and never harmful. Its general employment in these cases is strongly recommended.—M. **Rappin**: Antituberculous vaccination.

## *BOOKS RECEIVED.*

British Wild Flowers: Their Haunts and Associations. By W. Graveson. Pp. xv+320+plates l. (London: Headley Bros.) 7*s*. 6*d*. net.

The Tutorial Chemistry. By Prof. G. H. Bailey. Part ii., Metals and Physical Chemistry. Third edition. Pp. viii+460. (London: University Tutorial Press, Ltd.) 4*s*. 6*d*.

Météorologie du Brésil. By C. M. Delgado de Carvalho. Pp. xix+525. (London: John Bale, Ltd.) 25*s*. net.

Chemistry for Beginners. By C. T. Kingzett. Pp. vi+106. (London: Baillière, Tindall, and Cox.) 2*s*. 6*d*. net.

Contributions to Embryology. Vol. iv. Nos. 10, 11, 12, 13. Pp. 106+plates iv. (Washington: Carnegie Institution.)

Carnegie Institution of Washington. Year book, No. 15. Pp. xii+404. (Washington: Carnegie Institution.)

Studies on the Variation, Distribution, and Evolution of the Genus Partula. The Species inhabiting Tahiti. By Prof. H. E. Crampton. Pp. 311+34 plates. (Washington: Carnegie Institution.)

X Rays. By Dr G. W. C. Kaye. Second edition, with illustrations. Pp. xxi+285. (London: Longmans and Co.) 9*s*. net.

Electrical Laboratory Course. By Dr. M. Maclean. Pp. 120. (London: Blackie and Son, Ltd.) 2*s*. net.

A Short System of Qualitative Analysis. By Dr. R. M. Caven. Pp. viii+162. (London: Blackie and Son, Ltd.) 2*s*.

The Chemists' Year Book. Edited by F. W. Atack, assisted by L. Whinyates. 2 vols. Pp. 1030 (London and Manchester: Sherratt and Hughes.)

Studies in Insect Life, and other Essays. By Dr. A. E. Shipley. Pp. ix+338. (London: T. Fisher Unwin, Ltd.) 10*s*. 6*d*. net.

An Introduction to a Biology, and other Papers. By A. D. Darbishire. Pp. xviii+291. (London: Cassell and Co., Ltd.) 7*s*. 6*d*. net.

The Manufacture of Sulphuric Acid and Alkali, with the Collateral Branches. By Prof. G. Lunge. Fourth edition. Supplement to Vol. i., Sulphuric and Nitric Acid. Pp. xii+347. (London: Gurney and Jackson.) 15*s*. net.

Bill's School and Mine: a Collection of Essays on Education. By W. S. Franklin. Second edition. Pp. vii+102. (South Bethlehem, Pa.: Franklin, McNutt, and Charles.) 1 dollar.

Geology: Physical and Historical. By Prof. H. F. Cleland. Pp. 718. (New York: American Book Co.) 3.50 dollars.

## DIARY OF SOCIETIES.

*THURSDAY*, APRIL 12.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Wayleaves: C. Vernier.

OPTICAL SOCIETY, at 8.—Light Filters for Eye Protection: L. C. Martin —Accuracy of Observation and Precision in Measurement: Dr. G. A. Carse.—Some Methods of Analysing Lens Systems: S. D. Chalmers.—A Simple Proof of the Expression for the Focal Power of a Thick Lens C. Cochrane.

*FRIDAY*, APRIL 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.

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MACMILLAN AND CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C. 2

*Advertisements and business letters to be addressed to the Publishers.*

*Editorial Communications to the Editor.*

*Telegraphic Address:* PHUSIS, LONDON.
*Telephone Number:* GERRARD 8830.