estate was $271,068 l$., and about $150,000 l$. is devoted to bequests for charities and employees.

The annual gathering of the South-Western Polytechnic was held on Friday, March 12. The chair was taken by Archdeacon Bevan, and Mrs. Hayes Fisher distributed the certificates and prizes. The report of the principal showed that the chief feature of the session 1913-14 was the large number of scholarships gained by the past and present evening students. These scholarships included a Beit fellowship, the research studentship at Emmanuel College, Cambridge, a science scholarship and an art scholarship given by the London County Council. Amongst the degrees gained in London University were three D.Sc. degrees in chemistry. The principal also directed attention to the large number of present and past members of the institute who were serving with the forces. A vote of thanks was proposed by the Mayor of Chelsea, Principal Hudson, of St. Mark's College, and was seconded by Mr. J. B. Coleman, who gave some account of the present condition of chemical industries and of what the chemical department of the institute was doing to help those industries.
The steady progress of education, and especially of scientific education, in India, has frequently been noticed in these columns, and we are glad to see confirmatory evidence in the Presidency College Magazine, issued from the Presidency College, Calcutta, and edited by Mr. Joges Chandra Chakravarti. The magazine contains some interesting papers and notes, and prominent among them is an article on Prof. H. E. Armstrong's visit to Calcutta as reader in chemistry to the University, when he delivered a course of five lectures. There is also a review of "Forty Years of Progress of Chemistry at the Presidency College," by Dr. P. C. Ray, showing how a school of chemical research is being gradually built up, of which Dr. Ray himself is the leader. A very appreciative obituary notice of Prof. J. A. Cunningham, who was professor of chemistry at the Presidency College from 1906-9 is given. Further, a series of notices of eminent Presidency College men is published, and the subject of the article in this number is Sir Asutosh Mookerjee, lately Vice-Chancellor of the University, who has done much for Indian education.
The number of undergraduates in residence at Oxford and Cambridge, as stated in a note on March 4 (p. 24) is almost exactly one-third that of a year ago, the other two-thirds-about 2000 from each Uni-versity-being on active service with the Army or Navy. According to the Kreuz-Zeitung there are upon the books of the twenty-two German universi-ties-the twenty-second university being that of Frankfurt a/M., opened in October last-for the winter semester, including those at the front, $5^{2,504}$ students, of whom 4000 are women, as against 59,600 and 3700 respectively last year. On leave-i.e. on military service-there are 29,882 students, including 300 women, mostly studients of medicine. There are present in the universities 18,922 men and about 3700 women. Of those present, 1500 , including several hundred women, are foreigners. The number of students on military service is, however, larger than appears from these statistics, since the Technical High Schools have not been taken into account. The real number is only obtained by subtracting from last year's number of German men students those of this semester, which gives about 32,000 students in the field. This does not even include those called to arms after the closing of the statistics Their number is at least one-third of those present, so that the number
of students under arms must be raised by a further 6300. Seventy-five per cent. of the German students are therefore in the field. Of the German students of Technical High Schools about 80 per cent. are in the army.

The War Office gives notice that an Army entrance examination will be held on June 29 next. At this examination there will be open to competition:-(a) Not fewer than 125 cadetships at the Royal Military Academy, Woolwich (for the Royal Artillery and Royal Engineers); (b) not fewer than 300 cadetships at the Royal Military College, Sandhurst (for the Cavalry, Foot Guards, Infantry, and Army Service Corps). The competition will be conducted in accordance with the regulations issued in November, 1911, except that no oral or practical tests will be included in the examination. To be eligible to compete for admission to the academy, a candidate's age must be such that he will have attained the age of $16 \frac{1}{2}$, and will not have attained the age of 25 , on July 1, 1915 . To be eligible to compete for admission to the college, a candidate's age must be such that he will have attained the age of 17 , and will not have attained the age of 25 , on that date. The contributions usually paid by parents of cadets will be dispensed with in the case of candidates admitted as a result of this examination. This will not affect the payment of $35 l$. required for the provision of uniform, books, etc. A sum not exceeding 35 . a day will be contributed from Army funds towards the cost of each cadet's messing, washing, and contingencies. Camp kits are issued in kind at the academy or college. Outfit allowance of $50 l$., from which the cost of the camp kit will be deducted, is issuable to cadets on appointment to commissions. A limited number of cadetships in the Royal Navy and supplementary first appointments in the Royal Marines will also be open to competition.

## SOCIETIES AND ACADEMIES. London.

Royal Society, March 4.-Sir William Crookes, president, in the chair.-Prof. W. A. Bone, Prof. H. L. Callendar, and H. J. Yates : A bolometric method of determining the efficiency of radiating bodies. In view of the increasing uses of incandescent surfaces in heating operations of all kinds, the authors have investigated, as a scientific problem, the measurement of radiant efficiencies of such surfaces, by a bolometric method, which can be standardised by direct comparison with a radio-balance, and which the authors propose to substitute for the existing water-radio-meter-cum-thermopile method (known as the "Leeds method") used hitherto. The paper describes the construction and use of a new bolometer, specially designed for the purposes in view, in which the radiation from an incandescent surface, falling on a blackened coil of platinum wire, can be determined in absolute units for the increase in the electrical resistance of the receiving coil, the area of which is sufficiently small to allow of the instrument being standardised from a source of known intensity. And, by way of example, the application of the method to the measurement of both the absolute radiation of a gas fire and its "distribution factor," is described and discussed.-E. Chappell : The simplification of the arithmetical processes of involution and evolution. An arithmetical process can be said to be completely simplified when it is reduced to either addition or subtraction. The invention of logarithms completely simplified multiplication and division, but involution and evolution were only replaced by multiplication and division, so that these processes may still be laborious even with the use of logarithms. The paper describes
a table of the logarithms of numbers recently compiled, by the use of which involution and evolution are also completely simplified. The frequency with which fractional indices, positive and negative, occur in most branches of modern experimental science gives rise to the hope that the tables in question will accomplish for the modern investigator what logarithms did for the man of science of the seventeenth century.-F. E. Rowett: The elastic properties of steel at moderately high temperatures. The difference in the behaviour of hard-drawn steel tubes, before and after annealing, under stress, led to the experiments described in the paper. At a suitable temperature a hard-drawn tube, which contains a good deal of amorphous material, behaves like a viscous fluid, that is, it flows more or less freely under stress, whereas, at the same temperature, an annealed tube being crystalline will flow in a much less degree, corresponding to the small amount of amorphous material in it. At a temperature of about $300^{\circ} \mathrm{C}$. a hard-drawn tube shows properties similar to those of pitch at ordinary temperatures or of glass at a temperature rather below its softening point. It is still highly elastic under rapidly varying stress, but flows perceptibly when the stress is applied for a long time. On the other hand, in the annealed tube at $300^{\circ} \mathrm{C}$, the energy dissipated in a cycle of stress is still almost independent of the time taken over cycle. At a higher temperature, for example, at $540^{\circ} \mathrm{C}$., the hard-drawn tube flows rapidly and continues to flow for a long period, though at a diminishing rate, under a shear stress of less than one ton per square inch. Moreover, like pitch or glass, the steel at this temperature shows considerable elastic afterworking. If the stress be suddenly removed the immediate elastic recovery is followed by a slow backward flow which persists for many minutes.-Prof. J. W. Nicholson: The laws of series spectra. The paper contains a critical analysis of the diffuse, sharp, and principal series of helium, especially in the light of recent interferometer measurements of the leading lines of these series. The investigation depends on a mode of accurate calculation of the limits of series, not dependent on the type of formula used. The limits of series with many lines, for which a Hicks formula is already known, can be calculated with extreme accuracy by a new method. Interferometer measures of leading lines of helium series enable the best form of the series to be obtained. This form is an extension of that of Rydberg, dependent on $m+\mu$ and not $m$. The value of Rydberg's constant, 109679.2, given by Curtis for hydrogen, is the true value for the arc spectrum of helium, and is, in fact, a rigorous constant for arc spectra. Spark spectra are not treated. The Rydberg-Schuster law of limits is exact for helium. It seems probable that $\mu$ is a simple fraction the denominator of which is a multiple of 5 , as Halm has suggested. It is exactly 0.7 for the short series of helium.

March II.-Sir William Crookes, president, in the chair.-E. Heron-Allen : Contributions to the study of the bionomics and reproductive processes of the foraminifera. The mechanical functions of the protoplasm in locomotion and food catching and its reaction to stimuli are considered. The phenomenon hitherto known as plastogamy is only fortuitously connected with reproduction, and is in most cases a budding-off of a daughter-individual from a parent shell. Certain species of foraminifera, if not all, vary the processes of reproduction by amœebulæ formed of protoplasm discharged from the shells, and by flagellispores, by the formation of fully formed and calcareously invested polythalamous young inside the parent shell which are set free by the resorption of the parent shell.

The dual nature of the terminal chamber in Cymbalopora brelloides, d'Orbigny, is confirmed, and its functions in the life-history of the organism are discussed. A new species, C. milletti, Heron-Allen and Earland, is established. The species, C. tabellaeformis, Brady, is recorded as exhibiting a new phenomenon in the bionomics of foraminifera, namely, the excavation of crypts in suitable hosts where it passes its life, boring by chemical action tunnels for the protrusion of its pseudopodia. The secretion of calcium carbonate by porcellanous and hyaline foraminifera is considered, and the phenomena of "purpose" and "intelligence" are claimed as being exhibited by certain species of arenaceous foraminifera in the construction of their tests, either with a view to adaptation to environment or for defensive purposes. The "monadiform bodies" of Cymbalopora and the siliceous foraminifera from great depths, attributed to the late Sir John Murray, are explained by publication of his original notes made on board H.M.S. Challenger.-G. E. Nicholls: The occurrence of an intracranial ganglion upon the oculomotor nerve in Scyllium canicula, with a suggestion as to its bearing upon the question of the segmental value of certain of the cranial nerves. The occurrence of actively functional ganglion cells in large number, associated with numerous smaller and more deeply staining cells to form a small ganglion upon the oculomotor nerve in the adult $S$. canicula, has not hitherto been recorded. The true sensori-motor character of this nerve has recently been established by Sherrington and Tozer. This fact, in conjunction with the existence of the ganglion, becomes extremely significant, when it is remembered that the oculomotor plays an important part in the development of a related sympathetic ganglion (the ciliary). The author's suggestion is that the oculomotor be regarded as a distinct segmental nerve, not merely as a ventral root. From this it follows that the ophthal. profund. is not the dorsal root of the oculomotor neuromere, but has encroached upon that segment, while itself related to another (probably more posterior) head segment.Prof. R. Kennedy : Experiments on the restoration of paralysed muscles by means of nerve anastomosis. Part III.-Anastomosis of the brachial plexus, with a consideration of the distribution of its roots. The experiments recorded consist of division of one or more roots of the brachial plexus and anastomosis of the divided root or roots either to another part of the plexus or to the spinal accessory. Restoration of function took place, and physiological examinations showed that this was due to the nerve which was substituted for the severed roots. When fewer than two roots were divided restoration of function took place much earlier, and was shown to be a spontaneous recovery due to the affected muscles being each supplied through more than one root.-A. F. S. Kent : The mechanism of the cardiac valves-a preliminary communication. The communication deals with the structure and mode of action of the auriculoventricular valves of the mammalian heart. Muscular tissue derived from the auricular wall runs for a considerable distance into the substance of the valve flaps, being situated principally towards their auricular surfaces. It is permissible to conclude that this muscle exercises an important function in connection with the closure of the valves. Receiving its stimulus from the base of the auricle, of which it is indeed an extension and with which it is directly connected, it comes into action at the appropriate moment in the cardiac circle, and contracts-and remains contracted-last of all the auricular muscle. Thus it keeps the valve flaps away from the ventricular wall, and ensures free play to the retro-valvular eddy right up to the time
when the valve closure begins to be finally accomplished. The function of the muscular slips now described may be regarded as a double one-(a) to keep the flaps away from the ventricular walls, and thus to ensure the provision of an adequate space between the flap and the ventricular wall for the full development of the retro-valvular eddy, and (b) to afford by their contraction direct mechanical assistance in the raising of the flaps into the position of final closure.
Geological Society, February 24.-Dr. A. Smith Woodward, president, in the chair.-Dr. J. E. Marr: The Ashgillian succession in the tract to the west of Coniston Lake. The author has studied in detail the succession of the Ashgillian strata in Ashgill Beck and the adjoining tract. An account of the lithological characters and lists of the fossil contents of the various divisions are given, and confirmatory sections from Coniston Village to Appletreeworth Beck are described. A comparison is made with the beds of the Cautley district, previously described by the author. Some fossils which have not yet been found in the Lower Ashgillian of the Cautley district occur in the beds of that division at Coniston. From a study of the fossils of the Coniston tract and of other areas in Britain and the Continent, it would appear that a twofold division of the Ashgillian strata which is of more than local value may be made. The lower division is characterised by the abundance of Phillipsinella parabola, and the upper by the profusion of Phacops mucronatus.--H. S. Shelton: The radioactive methods of determining geological time. The author holds that the radio-active method of determining geological time, while of great interest, is not of such certainty as to be independent of confirmation from other lines of investigation. The various radio-active methods, helium ratios, lead ratios, and pleochroic haloes are severally examined, and the various sources of uncertainty, general and particular, are pointed out. The most important general cause of uncertainty is to be found in the fact that mechanical and chemical changes of composition in minerals are the rule rather than the exception; and, in instances where constancy of composition throughout long periods of geological time is asserted, the burden of proof lies with those who make the assumption. The attempt to assess exact, or even approximate times by means of lead ratios is premature and entirely invalid. At the same time, the weight of the evidence is such as to render it exceedingly probable, so far as radio-active evidence goes, that geological time must be reckoned at least in hundreds of millions of years. There is a high degree of improbability that the errors in the radioactive methods should always be errors of overestimation. The next step in the investigation of the time problem is to be found in a reversion to other lines of reasoning. The sea-salt methods, and those based on the thickness of the sedimentary rocks in particular, need careful reconsideration. Reference is made to a number of papers which show that the first of these is worthless, and the second based on a misapprehension of the nature of deposition. The argument from tidal retardation is still of value, as also is that from the evolution of carbonate of lime. To the author radio-active experiments come as a confirmation of views held on other grounds, but are not sufficiently important in themselves to be authoritative against the balance of the evidence derived from other lines of investigation.
Mathematical Society, March Ir.-Sir Joseph Larmor, president, in the chair.-Prof. E. W. Hobson: Some theorems in the theory of series of orthogonal functions.-Major P. A. MacMahon: In-
vestigations in the theory of the partition of numbers by a new method of partial fractions.-Col. R. L. hippisley: Reciprocal and parallelogram linkages.Dr. J. R. Wilton: A pseudo-sphere the equation of which is expressible in terms of elliptic functions.T. C. Lewis : Circles and spheres, etc., associated with a triangle, orthocentric tetrahedron, etc.

## Paris.

Academy of Sciences, March 8.-M. Ed. Perrier in the chair.-The President announced the death of Prof. Hittorf, foreign associate.-A. Leduc: Diffraction phenomena and the motion of the earth. Pointing out an error in the calculations of Mascart in his memoir on the modifications undergone by light by reason of the movement of the source or the observer.-Emile Saillard: Catalysis in the oxidation of the alkaline sulphites. The oxidation of alkaline sulphites is retarded by the presence of saccharose, invert sugar, and other bodies, and accelerated by rise of temperature. The practical bearing of these observations on the process of sugar refining is discussed.-Maurice Lugeon and Gerhard Henny: The Canavese zone and the southern limit of the Alps.-Med. Gard: A hybrid of Fucus ceranoides and F. vesiculosus.-M. Weinberg : Researches on gas gangrene. In the majority of cases the organism producing the disease is $B$. perfringens. A description of the preparation of a vaccine and an antiserum (through the horse) is given; the latter appears to offer the most promising results.-Agasse Lafont, M. Desmoulins, and F. Heim : Pneumokoniosis in metal polishers.

## BOOKS RECEIVED.

A Handbook to the Collection of Kaolin China-Clay and China-Stone in the Museum of Practical Geology, Jermyn Street, London, S.W. By J. A. Howe. Pp. viii +27 I. (London : H.M.S.O.; E. Stanford, Ltd.) 3s. $6 d$.
A Pocket Synopsis of the Families of British Flowering Plants (Based upon the System of Engler). By W. B. Grove. (Manchester University Press; London: Longmans and Co.) is. net.

A Birdlover's Year. By the Hon. Gladys Graham Murray. Pp. viii + I5o. (London: Eveleigh Nash.) 3 s. $6 d$. net.
My Life. By Sir Hiram S. Maxim. Pp. ix +322 . (London: Methuen and Co., Ltd.) 16 s . net.

Annuaire Astronomique et Météorologique pour 1915. Pp. 436. (Paris: E. Flammarion.)

Carnegie Institution of Washington. Year Book No. 3, 1914. Pp. xvi + 399. (Washington: Carnegie Institution.)
The Idols. By R. Rolland. Pp. 12. (Cambridge: Bowes and Bowes.) 6d. net.

A Manual of Oils, Resins, and Paints. By Dr. H. Ingle. Vol. i. Analysis and Valuation. Pp. 129. (London: C. Griffin and Co., Ltd.) 3s. $6 d$. net.

Geometry of Building Construction. Second Year Course. By F. E. Drury. Pp. xii +226 . (London: G. Routledge and Sons, Ltd.) 3s. net.

Canada. Department of Mines. Mines Branch. Gypsum in Canada : its Occurrence, Exploitation, and Technology. By L. H. Cole. Pp. $x+256$. (Ottawa : Government Printing Bureau.)

Canada. Department of Mines. Geological Survey. Memoir No. 38 . Geology of the North American Cordillera at the Forty-ninth Parallel. By R. A. Daly. Part i. Pp. xxvii +546 . Part ii. Pp. xxvii + $547-857$. Part iii. Sheets 17. (Ottawa: Government Printing Bureau.)

The Counties of Moray and Nairn. By C. Matheson. Pp. $x+139$. (Cambridge: At the University Press.) is. 6d. net.

