

provide maintenance. Many localities feel they have done all they can, and they also feel they are not merely doing local work, but national and Imperial, indeed, world-wide work. Students are drawn from every part of the Empire and from foreign countries, particularly China and Japan, and they are under no obligation to give their services where they are trained. Any increased grant now given by the nation will be used, not in the fixed and ordinary work of the institutions, but in the highest class of work and in various enterprises that are being kept back for want of funds. The speakers also pointed out that there is under present conditions a certain amount of wastefulness, not in money, but in brains and energy, because at their meetings the authorities are generally occupied, not in discussing how best to spend the money and what undertakings will be best for the country, but merely how to economise their funds and how to save 10l. or 50l. Work is lying ready at hand which they are powerless to undertake. Mr. Lloyd George, in the course of a sympathetic reply, told the deputation they could not have come at a worse time. Nothing definite was settled, but a committee has been appointed by the deputation to prepare more detailed information for the Chancellor of the Exchequer as to the financial requirements of the various institutions.

### SOCIETIES AND ACADEMIES.

LONDON.

**Royal Society, January 27.**—Sir James Dewar: Long-period determination of the rate of production of helium from radium. In a previous communication the rate of the production of helium from 70 milligrams of radium chloride was determined by a succession of observations on the growth of pressure measured by a McLeod gauge. These observations extended over a period of about six weeks. It was thought desirable to make an experiment to determine the amount of helium resulting from this same sample of radium, after standing in a sealed bulb for an extended period. For this purpose the bulb containing the radium chloride was sealed off at the conclusion of the above-mentioned experiment of 1908 and kept for nine months. In order to measure the helium thus produced it was necessary to devise a vacuum-tight joint between the sealed radium bulb and a McLeod gauge so constructed that, after thoroughly exhausting the gauge, the drawn-out end of the radium bulb could be broken off, thus allowing the pressure of the accumulated helium in the radium bulb to be rapidly determined. The total volume of the apparatus was 320 c.c. The pressure in the radium bulb when sealed off at the conclusion of first experiment was 0.00406 mm., the partial pressure due to this amount of helium would be 0.00008 mm., which must be deducted from the observed pressure to get the true pressure due to the helium produced in the radium bulb during the period in which it remained sealed up; also the pressure in the gauge, before breaking (0.00005 mm.), must also be deducted. This gives a corrected pressure of 0.01613 mm., obtained after heating the salt, due to the helium produced from 70 milligrams of pure radium chloride during a period of 275 days, in a space the total volume of which was 320 c.c. The value of the rate in terms of cubic millimetres of helium per gram of radium per day is thus deduced as 0.463.

March 3.—Sir Archibald Geikie, K.C.B., president, in the chair.—T. G. Bedford: The depression of freezing point in very dilute aqueous solutions.—J. Mercer: Sturm-Liouville series of normal functions in the theory of integral equations. It is the purpose of this memoir to develop the theory of Sturm-Liouville series of normal functions as a branch of the theory of integral equations. In the first place, two theorems are established relative to the series

$$\psi_1(s) \int_a^b \psi_1(t) f(t) dt + \psi_2(s) \int_a^b \psi_2(t) f(t) dt + \dots \\ \dots + \psi_n(s) \int_a^b \psi_n(t) f(t) dt + \dots,$$

in which  $\psi_1(s), \psi_2(s), \dots, \psi_n(s), \dots$  are a complete system of normal functions corresponding to a function  $(K(s, t))$  of

positive type in the square  $Q$  defined by  $a \leq s \leq b, a \leq t \leq b$ : the normal functions are assumed to have such an order that the singular value corresponding to  $\psi_n(s)$  does not decrease as  $n$  increases: no restriction is placed upon  $f(s)$  beyond that it should have a Lebesgue integral in  $(a, b)$ . Denoting by  $K_\lambda(s, t)$  the solving function corresponding to  $K(s, t)$ , the first theorem is to the effect that the upper and lower limits of indeterminacy of the above series include

$$\lim_{\lambda \rightarrow -\infty} -\lambda \int_a^b K_\lambda(s, t) f(t) dt$$

between them. According to the second

$$\lim_{\lambda \rightarrow -\infty} -\lambda \int_{(a)} K_\lambda(s, t) f(s) f(t) (ds dt)$$

exists and is equal to the sum of the series

$$\left[ \int_a^b \psi_1(t) f(t) dt \right]^2 + \left[ \int_a^b \psi_2(t) f(t) dt \right]^2 + \dots \\ \dots + \left[ \int_a^b \psi_n(t) f(t) dt \right]^2 + \dots,$$

when the latter is convergent; whilst the limit is  $+\infty$ , when the series is divergent. It is then shown that, when  $K(s, t)$  is the Green's function of

$$\frac{d^2 u}{ds^2} + q(s)u = 0$$

satisfying a pair of boundary conditions at the end points of  $(0, \pi)$ , an asymptotic formula for  $K_\lambda(s, t)$  exists which permits the deduction of important theorems relative to the canonical Sturm-Liouville series

$$\psi_1(s) \int_0^\pi \psi_1(t) f(t) dt + \psi_2(s) \int_0^\pi \psi_2(t) f(t) dt + \dots \\ \dots + \psi_n(s) \int_0^\pi \psi_n(t) f(t) dt + \dots$$

The normal functions  $\psi_1(s), \psi_2(s), \dots, \psi_n(s), \dots$  are now solutions of

$$\frac{d^2 u}{ds^2} + (q(s) + \lambda)u = 0,$$

which, for suitable values of  $\lambda$ , satisfy the same pair of boundary conditions as  $K(s, t)$ ; to particular systems of these functions correspond Fourier's sine and cosine series. The results obtained for any canonical Sturm-Liouville series are very similar to, but slightly more general than, those for the two particular series which are associated with the names of Fejér, Hurwitz, and Lebesgue. The fourth section of the memoir is devoted to an investigation of the convergence of canonical Sturm-Liouville series. In the course of this, it is shown that the convergence of any one of these series at a point of the open interval  $(0, \pi)$  involves the convergence of all the other series which correspond to the same function  $f(s)$ . The memoir contains an extension of all results obtained for the canonical to the most general type of Sturm-Liouville series.—A. Von Antropoff: The solubility of xenon, krypton, argon, neon, and helium in water.—L. N. G. Filon: Measurements of the absolute indices of refraction in strained glass. If light be transmitted through a slab of glass under tension  $T$  in a direction perpendicular to the line of stress, it is broken up into two components, polarised in planes perpendicular and parallel to the line of stress. If  $\mu$  be the index of refraction of the glass in the unstrained state, then, in the strained state, the indices of refraction corresponding to the above two components are  $\mu + C_1 T$ ,  $\mu + C_2 T$  respectively. The coefficients  $C_1, C_2$  are spoken of as the stress-optical coefficients for the two rays. The present paper gives an account of measurements of  $C_1$  and  $C_2$  according to a method described by the author in Roy. Soc. Proc., A, vol. lxxix., pp. 440-2. The measurements have been carried out on two Jena glasses bearing catalogue Nos. O. 935 and VV. 3199 respectively, the first being a borosilicate, the second an "ultra-violet" glass. So far as is known, this is the first series of absolute measurements of  $C_1$  and  $C_2$  extending fairly continuously throughout the spectrum. The only previous measurements are due to Pockel (*Ann. d. Phys.*, 1902), and give the

values of  $C_1$  and  $C_2$  for the sodium, thallium, and lithium lines only, obtained by quite a different method. The coefficients  $C_1$ ,  $C_2$  are found to be negative, so that both rays are accelerated by tension, but the effect is much larger for  $C_2$ , i.e. for the ray polarised in the direction of stress. With regard to the dispersion in O. 935, both  $C_1$  and  $C_2$  show a slight general decrease as we move towards the violet, but in VV. 3199,  $C_1$  shows a decrease, whereas  $C_2$  shows an increase. The above general variation is broken by a number of local oscillations, some of which are well marked and confirm previous observations of  $\{C_1 - C_2\}$  (Phil. Trans., A, vol. ccvii., pp. 293-301), whilst others are more doubtful; but it seems probable that both indices of refraction due to stress are affected locally by free periods of the constituents of the glass, causing irregularities in the curves of  $C_1$  and  $C_2$  similar to those exhibited by the curve of the index of refraction in anomalous dispersion.

**Royal Microscopical Society**, February 16.—Prof. J. A. Thomson, president, in the chair.—Prof. J. A. Thomson: Notes on *Dendrobrachia fallax*, a rare and divergent antipatharian.—A. A. C. E. Merlin: The measurement of the first nine groups of Grayson's finest twelve-band plate.—F. H. Collins: The labelling of microscopic slides.

## CAMBRIDGE.

**Philosophical Society**, February 7.—Prof. W. Bateson, F.R.S., president, in the chair.—E. A. Newell Arber: A note on some fossil plants from Newfoundland. Two new records from Newfoundland, either of Lower Carboniferous or Upper Devonian age. The first appears to be *Sphenophyllum tenerrimum*, Stur., both leaf whorls and stems being preserved. The second is a large fan-shaped leaf, probably new specifically, which recalls the Palaeozoic fossils attributed to the genus *Psymphyllum*.—W. T. Gordon: The relation between the fossil *Osmundaceæ* and the *Zygopteridæ*. The members of the *Zygopteridæ* and *Osmundaceæ* are shown to exhibit parallel development, and their most primitive genera, *Zygopteris Römeri*, Solms, and *Thamnopteris Schlechtendalii*, Eichwald, respectively, are compared as regards the structure of the stem and the origin of the petiole to demonstrate an ancestral relationship between these groups.—W. T. Gordon: A new species of *Physostoma* from the Lower Carboniferous of Pettycur (Fife). A new seed, showing a number of tentacular processes at the apex and an outer coat studded with small peg-like hairs. This is the most ancient example of the genus known.—Mrs. E. A. Newell Arber: A note on *Cardiocarpon compressum*, Will. The results of a re-examination of a Coal-measure seed originally figured and described by Williamson in 1877 under the name of *Cardiocarpon compressum*.—H. Hamshaw Thomas: The assimilating tissues of certain Coal-measure plants. Some points in the structure of the leaves of *Calamites*, *Lepidophloios*, and other Coal-measure plants from the point of view of their physiological anatomy.—L. J. Wills: Notes on the genus *Schizoneura*. Schimper and Mougeot. A description of examples of *Schizoneura paradoxa*, S. and M., recently discovered in the Keuper of Bromsgrove (Worcestershire), and a comparative review of other members of the genus.—R. D. Vernon: The occurrence of *Schizoneura paradoxa*, S. and M., in the Bunter of Nottingham.—D. G. Lillie: Petrified plant remains from the Upper Coal-measures of Bristol. Petrified material of *Cordaites* and other allied genera, and also of *Myeloxylon*, has been obtained from the Upper Coal-measures of Staple Hill, Bristol.

## MANCHESTER.

**Literary and Philosophical Society**, January 25.—Mr. Francis Jones, president, in the chair.—Prof. W. W. H. Gee and F. Brotherton: The electrical resistance of the human body. Measurements have been made with direct and alternating currents, the hands of the subject being as a rule immersed in solutions of common salt. Values of the resistance in the first case are from 1000-2000 ohms, but only from 700-800 ohms with alternating currents. The high values in the first case are due to polarisation, the human body acting like a storage battery made up of concentration cells. When a direct current is applied to the body the current falls for a time and then increases, there

being a gradual increase of polarisation during the first period, and a decrease of the body resistance during the second period. The maximum voltage for direct currents used in the experiments was about 40, which must be gradually introduced, and very gradually withdrawn, otherwise painful shocks are administered. It was found that the resistance is inversely proportional to the area of the surface of the wet skin. The ratio of the direct to the alternating values of the resistance is much higher when dry or nearly dry skin is tested. With the dry fingers applied to 100-volt direct current terminals the shock at the kathode is greater than at the anode, and enables the polarity of the terminals to be readily determined. With nearly dry fingers it is also easy to test polarities of circuits of less than 20 volts. This method is useful in practice. With about 10 volts and the fingers immersed in salt solutions containing metal electrodes, the body can be used as a telegraphic receiving instrument, the shocks at the kathode as the current is reversed by a transmitting commutator enabling messages to be received by the usual code. The resistance of the body being relatively low when the skin is moist, precautions must be taken in using supply circuits, especially in chemical and other works. Electric-light fittings in bathrooms, public baths, and medical baths require special precautions.

February 8.—Mr. Francis Jones, president, in the chair.—G. Hickling: The anatomy of *Calamostachys Binneyana*, Schimper. It was shown that the so-called "nodes" at which the sporangiophores arise are not true nodes. There is no secondary xylem at that level, the protoxylem canals are not obliterated, no "gaps" are seen in the cauline bundles, and the medulla is not modified as at the true node. The slender vascular traces supplying the sporangiophores may be arched before entering them. Below the sporangiophore the traces may occasionally be seen lying on either side of the corresponding cauline bundle, often freed from it by maceration. There is considerable evidence to show that the sporangiophore trace preserves its identity down to the subjacent true node. The axes, which are commonly described as possessing six bundles in three pairs, are shown to possess only three single bundles. Both three and four bundles are proved by serial sections to characterise different parts of the same cone. There is some evidence that the alternation of the bracts has been brought about by their lateral displacement. It was shown to be possible to obtain good series of sections by grinding the blocks containing the material and taking photomicrographs of the successively exposed surfaces.—L. E. Adams: A hypothesis as to the cause of the autumnal epidemic of the common and the lesser shrew. The fact that more corpses of shrews are found in autumn than during the other seasons of the year has been a standing puzzle to naturalists, and no wholly satisfactory explanation has hitherto been suggested. The known agencies of destruction, such as conflicts among themselves, attacks of enemies, scarcity of food, and drought, whilst resulting in many deaths, fail to account for the sudden rise in mortality during the autumn. The author, as the result of observations and investigations carried out during a number of years, is decidedly of the opinion that the autumnal "epidemic," as it is called, is due to nothing more than old age, old age in the case of the common and the lesser shrew being reached in, roughly, thirteen or fourteen months. This conclusion is supported by the fact that all specimens of the common and lesser shrew trapped during and after December in a series of years were found to be immature. This hypothesis would account also for the absence of wounds and other marks of violence in many of the corpses found.

**Royal Meteorological Society**, February 23.—Mr. H. Mellish, president, in the chair.—Dr. W. Makower, A. J. Makower, and Miss M. White: Investigation of the electrical state of the upper atmosphere made at the Howard Estate Observatory, Glossop.—A. W. Harwood: The results of twenty-five registering balloon ascents made from Manchester on June 2-3 last. These were sent up at intervals of one hour, and some extremely interesting and valuable results were obtained from them.—R. G. K. Lempfert and R. Corless: Line squalls and associated phenomena.