"the closer the tie between the University and the prime industries of the city the better for both." The honorary graduates were introduced to the Chancellor by the Public Orator (Prof. A. H. Leahy) in terms which did full justice to a great occasion, for an assembly which included the Ambassadors of the great Allied Powers, France, the United States, and Italy, was a memorable assertion of the University's faith in the common cause, and the presence there of representatives of sister universities made that assertion more deeply significant. The University also did honour to itself by conferring the degree of Doctor of Letters on the President of the Board of Education, its former Vice-Chancellor.

DR. R. S. WILLOWS, head of the department of physics and mathematics at the Sir John Cass Technical Institute, Aldgate, London, has been appointed head physicist to Messrs. Tootal Broadhurst, Lee, and Co., of Manchester, in connection with their scheme for cotton research.

MR. D. B. MAIR and Mr. L. C. H. Weekes have been appointed Assistant Civil Service Commissioners. The former will also hold the office of Director of Examinations, and the latter that of Secretary to the Civil Service Commission. Mr. Stanley M. Leathes remains the First Commissioner, but Mr. Herbert W. Paul has retired from the post of Second Civil Service Commissioner which he has held since 1909.

THE course of public lectures on "Some Biological Problems of To-day," arranged in co-operation with the Imperial Studies Committee, are being continued at University College (Gower Street, W.C.) on Mondays at 4 p.m. The remaining lectures of the present term will deal with important questions of food production, as follows:—(1) The possibilities of increased crop production, by Dr. E. J. Russell; (2) Grassland and arable, by Mr. R. G. Stapledon; (3) Farm strategy of the past and for the future, by Mr. K. J. J. MacKenzie; (4) Spraying problems, by Dr. A. S. Horne; (5) Birds and insects in relation to crops, by Prof. S. J. Hickson; (6) Co-operation in food supply, by Mr. A. G. Tansley. The lectures are open to the public without fee or ticket.

THE first four lectures of the public university course on "Animal Life and Human Progress" at King's College, London, have been very well attended. Prof. A. Dendy delivered an introductory discourse on "Man's Account with the Lower Animals," Prof. G. C. Bourne has lectured on "Some Educational and Moral Aspects of Zoology," Mr. C. Tate Regan on "Museums and Research," and Prof. J. Arthur Thomson on "Man and the Web of Life." The remaining lectures of the course will be given by Prof. F. Wood Jones on "The Origin of Man" (February 27); Dr. R. T. Leiper, on "Some Inhabitants of Man and their Migrations" (March 6); Prof. R. T. Punnett, on "The Future of the Science of Breeding" (March 13); Prof. W. A. Herdman, on "Our Food from the Sea" (March 20); and Prof. Robert Newstead on "Tsetse-flies and Colonisation" (March 27). It is intended to publish the lectures in book form with Messrs. Constable and Co., Ltd., after the conclusion of the course.

THE annual general meeting of the Association of Technical Institutions will be held on February 22 and 23, at the Drapers' Hall, Throgmorton Street, E.C. The president, Sir Alfred Keogh, G.C.B., will take the chair, and deliver a short address. Papers will be read on the training of teachers for technical institutions and day continuation classes, by Principal Watson of Keighley, and on the Education (No. 2) Bill, 1918, by Prof. Wertheimer, of Bristol. Among the resolutions to be submitted to the meeting may be mentioned those urging, in the interest of technical education, that scales of salary providing for adequate increases and reasonable prospects should be adopted for all fully qualified full-time teachers, and that the Government be requested to make a grant to technical-school teachers, as it has done in the case of primary- and secondary-school teachers; those expressing general approval of the provisions of Education (No. 2) Bill and recording the opinion that an alternative plan should be allowed in Section 10 of the Bill, such plan being half-time compulsory attendance from fourteen to sixteen years of age, together with encouragement of, and ample facilities for, attendance afterwards at evening classes for two evenings per week on technological or other subjects from sixteen to eighteen years of age, and those expressing disappointment that the Board of Education has not yet withdrawn or modified the objectionable features of the Regulations for Junior Technical Schools.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 7.—Sir J. J. Thomson, president, in the chair.—Prof. O. W. **Richardson**: The photo-electric action of X-rays. In this paper the excitation of electron emission by X-rays is discussed in relation to our knowledge of the photo-electric action of other types of radiation. The ratio E_K/E_A of the energy E_K emitted in the form of K secondary X-radiation to the energy E_A of the primary radiation (wave-length λ) absorbed is found in the case of bromine to be expressed to within the degree of accuracy of the available observations by the formula

$$E_K/E_A = \frac{\lambda}{(1+p)\lambda_K}$$

where

$$p = e^{-0\cdot46}\,\frac{\lambda_{K\gamma}-\lambda}{\lambda}$$

λ_K is the average wave-length of the K radiations and $\lambda_{K\gamma}$ is the wave-length of the shortest K radiation.—F. **Soddy** and J. A. **Cranston**: The parent of actinium. (1) In a full historical introduction the data obtained in 1909 relative to the rays and products of uranium-X are discussed, in so far as they throw light on the various possible modes of origin of actinium. (2) The minute growth of actinium previously put on record in 1913 as having been observed in the old uranium-X preparations has been confirmed by their later history and is now established beyond doubt. (3) Uranium-X_2 can be separated from uranium-X_1 by sublimation in a current of air charged with vapours of carbon tetrachloride at a temperature below visible red-heat. (4) 470 grams of a very pure Indian pitchblende were similarly treated in the expectation of removing eka-tantalum isotopic with uranium-X_2 and giving actinium in an α-ray change of long period. (5) The preparations so obtained were initially free from actinium, but one of them has produced it continuously with the lapse of time. (6) A direct comparison of the amount of actinium in this preparation after the lapse of 2·5 years with that in the original pitchblende showed that it was equal to that in about 0·25 gram. (7) On the assumptions that eka-tantalum and actinium are both long-lived, that no intermediate members intervene between them, and that the preparation contained the whole of the parent of actinium in the original mineral, the period of average life of actinium is calculated to be 5000 years. Nothing can yet be said definitely as to the period of the parent. (8) A second preparation separated from Joachimsthal pitchblende, the treatment of which commenced in 1903, and ended in 1914, with the carbon tetrachloride

sublimation, has given a similar growth of actinium. (9) The work was undertaken to test and confirm the view that the parent of actinium occupies the eka-tantalum place in the periodic table, and gives actinium in an α-ray change of long period, itself being formed as the product of uranium-Y, discovered by Antonoff, who suggested that it was the first member of the actinium series. But this mode of origin of actinium, though at present the most probable, is not yet conclusively established to the exclusion of all the other possible modes of origin, discussed in the historical introduction.—Prof. A. **Schuster**: Some problems in the theory of radiation. This paper deals with the oscillatory energy taken up by a simple resonator under the action of white light, and the translatory energy imparted to a molecule by radiation. The first problem has been treated by Planck. It is solved here in a very simple manner, and the method used, when applied to the second problem, leads to the important result that a molecule at rest, within an enclosure of uniform temperature, will, while taking up an oscillatory energy, be set in motion with an acceleration that will increase its speed until the average energy reaches a definite value. If the Rayleigh-Jeans laws of radiation be assumed to hold, the ultimate average energy due to radiation alone is two-thirds of that derived from the kinetic theory of gases.—E. A. **Owen**: The absorption of the radiation emitted by a palladium anticathode in rhodium, palladium, and silver. (1) A short account is given of some preliminary experiments carried out with the rays from an ordinary X-ray bulb. (2) A spectrum of the rays from a palladium anticathode is obtained over a limited range of wave-lengths by reflection in the (111) face of a carborundum crystal. The spectrum shows that the bulb emits a continuous band of wave-lengths upon which are superposed the characteristic rays of the metal of the anticathode, and under the conditions of working in this particular case the relative intensities of the different wave-lengths in the spectrum remained approximately constant. (3) The "end radiation" of the bulb was found to be very homogeneous. (4) There is a minimum of intensity in the spectrum corresponding with the wave-length $0{\cdot}493\times10^{-8}$ cm. On the assumption that the minimum is due to the selective absorption of this wave in the crystal, the value $0{\cdot}493\times10^{-8}$ cm. is assigned to the β line of the J series of silicon. From the experimental results of Barkla and White on the J series of the elements Al, C, and O, the approximate values deduced for the β line of the J series of oxygen and carbon are $0{\cdot}519\times10^{-8}$ cm. and $0{\cdot}559\times10^{-8}$ cm. respectively. (5) Assuming Bragg's mean value of the α line of palladium to be $0{\cdot}586\times10^{-8}$ cm., the following values are obtained for the wave-lengths of the β and γ lines: $\beta=0{\cdot}520\times10^{-8}$ cm.; $\gamma=0{\cdot}509\times10^{-8}$ cm. (6) The absorption coefficients of the rays from the bulb have been measured in rhodium, palladium, and silver. The results show that the relation between wave-length and absorption coefficient is expressed by the relation $\tau/\rho=K\lambda^3$, where τ/ρ is the fluorescent coefficient and K is a constant for a given substance over the range of wave-lengths between the absorption bands of that substance. (7) The critical wave-length necessary to excite the characteristic rays of a substance lies in the neighbourhood of the β ray of that substance. The α ray is not excited until the β ray is excited. (8) It is pointed out that the purity of the characteristic lines emitted by a bulb and isolated by reflection at a crystal face will depend, to a great extent, upon the state of working of the bulb.

Zoological Society, February 5.—Dr. A. Smith Woodward, vice-president, in the chair.—Prof. B. L. **Bhatia** and Baini **Prashad**: Skull of *Rana tigrina*, Daud.—G. A. **Boulenger**: Description of a new snake of the genus Oligodon, from Upper Burma.—Dr. R. **Broom**: Two rare South African golden moles. One specimen was described as a new species of Bematiscus, *B. leschae*. Hitherto the giant moles of the eastern Cape Colony have been referred to *B. trevelyani*, but the present type from St. Cuthbert's, Isolo, differs from *B. trevelyani* and agrees with *B. transvaalensis* and *B. villosa* in having the temporal bulla markedly projecting from the side of the skull. The other specimen exhibited was one of the rare mole, *Chrysochloris sclateri*. Hitherto it has been only known from the Nieuwveld and from Basutoland—localities 350 miles apart. The present specimen was from New Bethesda, 130 miles nearer to Basutoland than the original locality.

Mathematical Society, February 14.—Prof. H. Hilton, vice-president, in the chair.—Prof. A. C. **Dixon**: Note on functional equations which are limiting forms of integral equations.—Prof. D. M. Y. **Sommerville**: The singularities of trochoidal curves.—O. **Hoppe**: The primality of $(10^{19}-1)$ (second communication).—L. J. **Mordell**: A statement by Fermat.

EDINBURGH.

Royal Society, January 14.—Dr. John Horne, president, in the chair.—Prof. R. A. **Sampson**: Notes on the Coupar Angus meteorite. This meteorite, which attracted much attention from its brilliancy before it burst, fell on December 3, 1917, and fragments were found in Perthshire and Forfarshire. It is an aerolite or stony meteorite, but the detailed mineralogical characters have not yet been given. It was estimated, from the evidence of a number of witnesses, that it began to blaze at a height of about twenty miles in the atmosphere, probably above Coupar Angus. In regard to the origin of such bodies, it was suggested that they might have been ejected in bygone ages from lunar volcanoes, continuing to circulate since then between the earth and the moon in irregular orbits until finally drawn down upon the earth.—Dr. C. G. **Knott**: The propagation of earthquake waves through the earth and connected problems. When a large earthquake occurs at any part of the earth elastic waves are sent out in all directions through the earth, emerging at the surface as disturbances which can be recorded on delicate seismometers. Up to about 120° from the epicentre, the times at which these variations emerge after the time of occurrence of the earthquake were first tabulated by J. Milne. The increasing number of observations and the improvement of the instruments have led to the tabulation of more accurate data than was possible in the earlier days. Following up certain calculations made in 1908, Dr. Knott, using these more recent data, has made fresh calculations of the velocities of the seismic waves through the earth by a mathematical method based on the theory of integral equations and entirely free from assumptions. As has long been recognised, two types of wave are transmitted through the body of the earth known as the primary (P) and the secondary (S) waves. The broad results of the investigation may be stated thus:—The velocity of the P wave increases steadily with depth from 4·46 miles (7·18 kilometres) per second at the surface to 6·2 miles (10 km.) per second at a depth of 400 miles (650 km.), continuously increasing at a slightly smaller rate of increase until it reaches 7·95 miles (12·8 km.) per second at a depth of 1000 miles (1600 km.), after which, at greater depths, the speed of propagation remains constant. The S wave travels more slowly than the P wave, but changes in very much the same way, the values of the speed being 2·47 miles (3·98 km.) per second at the surface,

3·43 miles (5·53 km.) at a depth of 400 miles, and 4·25 miles (6·84 km.) at depths greater than 1000 miles.—Prof. W. H. **Metzler**: A determinantal equation the roots of which are the products of the roots of given equations.—Prof. R. A. **Sampson**: Studies in clocks and timekeeping. (1) The theory of maintenance. This paper, the first of a series of studies which are in course of execution at the Royal Observatory, Edinburgh, describes in outline the arrangements of the thermostat chamber, etc., and the construction of the three clocks, Riefler 258, Synchronome, and Cottingham, upon which most of the studies are made. Its direct occupation is, however, chiefly theoretical, considering with sufficient detail various dynamical points which arise from the suspension and different maintenances of the clocks and the derivation of a satisfactory differential equation of the motion when the internal resistance is taken into account. The solution of this equation presents some novelty, showing that the frequency in maintained motion is dependent upon the first power of friction, not the second, as has hitherto been held. The discontinuous maintenance is resolved into a Fourier series, and expressions are found for calculating the escapement error and the arc described in each case. In the case of the three clocks above the calculated arcs are numerically verified by comparison with their actual performance.

BOOKS RECEIVED.

Laboratory Glassware Economy. By Prof. H. B. Dunnicliff. Pp. x+92. (London: Macmillan and Co., Ltd.) 4*s*. net.

Hand Grenades. By Major G. M. Ainslie. Pp. v+59. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 6*s*. net.

Text-Book of Ordnance and Gunnery. By Lt.-Col. W. H. Tschappat. Pp. x+705. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 30*s*. net.

A Text-book in the Principles of Science Teaching. By Prof. G. R. Twiss. Pp. xxvi+486. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 7*s*. 6*d*. net.

A Short History of Science. By Prof. W. T. Sedgwick and Prof. H. W. Tyler. Pp. xv+474. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 12*s*. 6*d*. net.

A Text-Book of Physics for the Use of Students of Science and Engineering. By J. Duncan and S. G. Starling. Pp. xxiii+1081. (London: Macmillan and Co., Ltd.) 15*s*.

Applied Mechanics. Second Year. By H. Aughtie. Pp. 227. (London: G. Routledge and Sons, Ltd.) 2*s*. 6*d*. net.

Airfare of To-day and of the Future. By E. C. Middleton. Pp. xv+192. (London: Constable and Co., Ltd.) 3*s*. 6*d*. net.

The Edinburgh School of Surgery before Lister. By A. Miles. Pp. viii+220. (London: A. and C. Black, Ltd.) 5*s*. net.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 21.

ROYAL SOCIETY, at 4.30.—The Scattering of Light by Spherical Shells, and by Complete Spheres of Periodic Structure, when the Refractivity is Small: Lord Rayleigh.—The Nature of Heat as Directly Deducible from the Postulate of Carnot: Sir Joseph Larmor.—Curved Beams: J. J. Guest.—(1) Monoclinic Double Selenates of the Iron Group; (2) Selenic Acid and Iron. Reduction of Selenic Acid by Nascent Hydrogen and Hydrogen Sulphide. Preparation of Ferrous Selenate and Double Selenates of Iron Group: Dr. A. E. H. Tutton.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Switchgear Standardisation: Dr. C. C. Garrard.

INSTITUTION OF MINING AND METALLURGY, at 5.30.

CHEMICAL SOCIETY, at 8.—Recent Studies on Active Nitrogen: Hon. R. J. Strutt.

LINNEAN SOCIETY, at 5.—Notes on the Bionomics, Embryology, and Anatomy of Certain Hymenoptera Parasitica, with Special Reference to *Microgaster connexus*, Nees: J. Bronté Gatenby.—Experimental Studies in the Specific Value of Morphological Characters in the Fungi: W. B. Brierley.

FRIDAY, FEBRUARY 22.

PHYSICAL SOCIETY, at 5.—Note on the Use of Approximate Methods in Obtaining Constructional Data for Telescopic Objectives: T. Smith.—A Suggestion as to the Origin of Spectral Series: Dr. H. Stanley Allen.

SATURDAY, FEBRUARY 23.

ROYAL INSTITUTION, at 3.—Problems in Atomic Structure: Sir J. J. Thomson.

MONDAY, FEBRUARY 25.

ROYAL SOCIETY OF ARTS, at 4.30.—The Economic Condition of the United Kingdom Before the War; the Real Cost of the War, and Economic Reconstruction: E. Crammond.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A Recent Journey in East Africa: Comte Renauld de Briey.

TUESDAY, FEBRUARY 26.

ROYAL INSTITUTION, at 3.—A National Laboratory of Industrial Research: Sir R. T. Glazebrook.

ILLUMINATING ENGINEERING SOCIETY, at 5.—A Survey of Methods of Directing and Concentrating Light: Lieut.-Commander H. T. Harrison.

WEDNESDAY, FEBRUARY 27.

ROYAL SOCIETY OF ARTS, at 4.30.—Organisation of Commercial Intelligence: Sir W. H. Clarke.

THURSDAY, FEBRUARY 28.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Scattering of Light by Dust-free Air, with Artificial Reproduction of the Blue Sky. Preliminary Note: The Hon. R. J. Strutt.—The Lommel-Weber Ω Function and its Application to the Problem of Electric Waves on a Thin Anchor Ring: Dr. J. R. Airey.—Investigations on Textile Fibres: W. Harrison.—Critical Loading of Struts and Structure: W. L. Cowley and H. Levy.

FRIDAY, MARCH 1.

ROYAL INSTITUTION, at 5.30.—The Modern Dye-stuff Industry: Prof. A. G. Green.

SATURDAY, MARCH 2.

ROYAL INSTITUTION, at 3.—Problems in Atomic Structure: Sir J. J. Thomson.

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