ferro-nickel alloys, his first experiments were on their magnetic properties, as these were easier to investigate than the coefficients of expansion. Dr. Guillaume showed and explained curves representing the variation of magnetic properties, and of the coefficients α and β in the expansion equation $l=l_0(1+\alpha\theta+\beta\theta^2)$ for alloys in both the irreversible and reversible categories, and showed from the curves how it was possible to obtain alloys with any desired coefficient. The anomalous magnetic behaviour of some of the alloys was illustrated by demonstration experiments of the effect produced on the magnetic condition of bars of the materials by dipping in hot water or liquid air. The lecturer then dealt with the properties of ternary alloys containing iron, nickel, and a third element. Manganese alloys were those most extensively used. He exhibited a cardboard model of Guthrie's three-dimensional diagram for ternary alloys. The addition of the third element raised the minimum expansion. In the case of carbon and chromium the elastic constant is raised. The curve connecting Young's modulus with the percentage of nickel in ferro-nickel alloys also showed an anomaly in the same region as the expansion.

The chief weakness of the alloys from the point of view of the metrologist was instability. If a piece of invar was cooled from a high temperature in air at 100° C. its length reached a steady value in about 100 hours. If it was then cooled to 50° C. its length would increase to another steady value, reached in about 1000 hours or so. If it were then cooled to zero it would still further lengthen, a steady state not being reached for a very long time. If the temperature were then raised again to 100°, the length would diminish to its initial value for 100°. The total change of this character between 0° and 100° amounted to about 30 millionths of the length.

With increasing carbon content the instability very rapidly increased. It was possible from the amount of the instability to estimate the carbon to 1/100th per cent. Moreover, the curve connecting the instability and the carbon content passed through zero, showing that the instability was due to the carbon. It was therefore possible to get an invar of perfect stability.

Among the applications to which invar had been put, the lecturer instanced pendulum rods, leading in wires for electric lamps (an alloy being chosen from the curves so as to have the required coefficient of expansion), wire standards for base measurements in surveying, etc., and showed curves of the variation of height of the Eiffel Tower with temperature, as measured relatively to invar wires.

Another important application of these alloys was in chronometer construction. The temperature coefficient of the rate of a watch was due to variation of the elasticity of the hair-spring. This was corrected in the Graham compensation by a variation of angular momentum of the balance wheel, depending on the difference in expansion of two metals; but it was possible to choose for the spring a nickel steel having a temperature coefficient of elasticity nearly zero. If chosen to give the same rate at 0° and 30°, there would be a secondary error of only 20 seconds per day at 15°. But a more important chronometric application was the correction of the secondary error of 2 seconds in Graham's compensation. This error, discovered by Dent in 1832, is due to the fact that the variation of elasticity of the hair-spring is not a linear function of the temperature, whereas the variation of angular momentum of the balance wheel is. If however, for one component of the bimetallic compensator a nickel steel of negative β be chosen, it is possible to get a curve connecting the momentum with temperature which exactly compensates the elasticity variation over the whole range.

Reverting to the curves for Young's modulus, the lecturer predicted that an alloy would shortly be produced having a practically constant modulus over a range of 200° C.

Technical Education and Mind Training.

THE proceedings of the annual conference of the Association of Teachers in Technical Institutions, which was held in the Polytechnic, Regent Street, London, on Whit-Monday, were full of interest. The president, Mr. E. L. Rhead, of Manchester, gave a stimulating address, in the course of which he reviewed unfavourably the attitude of the Workers' Educational Association towards technical education as tending to narrow the workers' educational outlook, and as merely serving to create a human tool better calculated to promote the interests of employers and the sordid aims of industry. He claimed, on the contrary, that, rightly presented, technical education has in it all the elements of mind training and of a wide view of life and its problems. It may, in short, be, properly interpreted, constituted as the pivot of a liberal education. He deprecated the exclusive devotion of much of modern higher education to dead languages, dead history, and ancient philosophy, but that is surely to ignore a prime element in the evolution of mankind—the progress of man in his endeavour to search into and to solve the phenomena of Nature. Mr. Rhead went on to consider the status of the technical teacher as compared with that of the secondary-school teacher, and contended that the former should be at least as liberally considered as the latter, not only by reason of his long and arduous practical training in the processes of industry, but also in respect of the claims of industry itself upon his services. He urged the desirability of transfer from lower to higher schools at different periods in the course of the educational life of the capable pupil, and especially dwelt upon the value of the junior technical school, which he would in no wise desire to convert into a trades school, and pleaded that restrictions on their present aims and curricula should be removed. A far more liberal system of scholarships, including maintenance, should be established in co-operation with widely extended administrative educational areas, which should have regard not only to the pupils in day institutions, but also to the equally urgent requirements of the promising evening students, enabling them to devote themselves to whole-time study in their special vocation. There should likewise be an efficient representation of teachers on all education authorities, so that the present and future problems of technical education should be better considered. Resolutions were passed urging a large increase in salaries for the several grades of technical teachers; that all works continuation schools should ultimately be provided by the local education authorities and the present schools be open to inspection by the local and central authorities; and that a national Whitley council for teachers should be set up.

University and Educational Intelligence.

CAMBRIDGE.—Prof. J. T. Wilson, professor of anatomy in the University of Sydney, has been elected to the chair of anatomy rendered vacant by the death of Prof. A. Macalister.

We are informed by the secretary of the Cambridge Philosophical Society that the adjudicators of

the Hopkins prize have made the following awards:—For the period 1903–6 to Dr. W. Burnside, of Pembroke College, for investigations in mathematical science; for the period 1906–9 to Prof. G. H. Bryan, of Peterhouse, for investigations in mathematical physics, including aerodynamic stability; and for the period 1909–12 to Mr. C. T. R. Wilson, of Sidney Sussex College, for investigations in physics, including the paths of radio-active particles.

Dr. T. G. Adami, Vice-Chancellor of the University of Liverpool, has been elected to an honorary fellowship at Christ's College.

An offer of 30,000*l.* has been made to the University by the Committee of Council for Scientific and Industrial Research for the erection, equipment, and maintenance at Cambridge of a low-temperature station for research in biochemistry and biophysics. The proposal emanates from the Research Board of the Department charged with the co-ordination of researches related to the scientific problems arising out of the preservation and handling of food. It is desired to erect the new station close to the existing biological laboratories, where a large proportion of the researches initiated by the Board have been carried out. It is proposed to vest the management of the station in a committee of the Senate containing some members nominated by the Department of Scientific and Industrial Research. The director of the station would be appointed by the Lord President of the Council after consideration of a report by the committee.

LIVERPOOL.—A Congregation of the University was held in St. George's Hall on Friday, May 28, when honorary degrees were conferred. Mr. J. W. Alsop, Pro-Chancellor of the University and chairman of the Liverpool Education Committee; Sir Alfred Booth, chairman of the Cunard Steamship Line; Sir Alfred Dale, the former Vice-Chancellor of the University; Mr. John Rankin, a leading citizen and merchant of Liverpool; and Sir Michael Sadler, Vice-Chancellor of the University of Leeds, received the degree of Doctor of Laws. Sir Reginald Blomfield, a member of the Royal Academy and past-president of the Royal Institute of British Architects, and Mr. Frederick Powicke, professor of medieval history in the University of Manchester, received the degree of Doctor of Letters. The degree of Doctor of Science was conferred on Prof. F. G. Donnan, formerly professor of physical chemistry in the University, and now professor of chemistry in University College, London, and on Prof. W. A. Herdman, formerly Derby professor of natural history, and now professor of oceanography, in the University. Mr. Henry Martin, chairman of the St. Helens Higher Education Committee, and representative of the borough on the Court of the University, and Father Thomas J. Walshe, a distinguished scholar, and formerly chaplain and lecturer at the Notre Dame College in Liverpool, were given the degree of Master of Arts. Mr. Joseph Gibson, a leading engineer and president of the Liverpool Engineering Society, received the degree of Master of Engineering.

LONDON.—Two lectures, entitled "Emploi des métaux ammoniums en Chimie Organique" and "L'Œuvre Scientifique d'Henri Moissan," will be given at King's College, Strand, W.C., by Prof. P. Lebeau, professeur à l'Ecole Supérieure de Pharmacie, Université de Paris, at 5 p.m. on Monday, June 28, and Wednesday, June 30. The lectures, which will be delivered in French, are addressed to advanced students of the University and to others interested in the subject. Admission is free, without ticket.

OXFORD.—The honorary degree of Doctor of Letters has been conferred on Dr. Temistocle Zammit, professor of chemistry in the University of Malta and curator of the Valetta Museum.

It was resolved by Convocation on June 1 to confer the title of professor on Dr. T. R. Merton, Balliol College, so long as he continues to hold the office of reader in spectroscopy.

ST. ANDREWS.—The Senatus Academicus will confer the following honorary degrees at the public graduation ceremonial to be held on July 2:—*LL.D.*: Sir Dugald Clerk; Dr. Léon Frédericq, for nearly forty years professor of pathology in the University of Liége, Belgium; Mr. R. A. Herman, fellow and lecturer of Trinity College, Cambridge; Mr. W. J. Matheson, New York, U.S.A.; Dr. N. K. Smith, professor of logic and metaphysics in the University of Edinburgh; and Dr. N. Walker, his Majesty's Inspector of Anatomy for Scotland.

THE medal of honour of the University of Brussels was presented by the Vice-Chancellor on May 22 to Lord Dawson of Penn, Sir Leslie Mackenzie, and Prof. Sir William Smith.

PROF. E. F. NICHOLS has resigned the chair of physics held by him at Yale University to take up the post of director of pure science in the Nela Research Laboratories of the National Lamp Works of the General Electric Co. at Cleveland, Ohio.

IN connection with the London County Council's lectures for teachers on recent developments in science, a lecture on "The World-Problem of Nitrogen" will be given by Prof. F. G. Donnan at University College, Gower Street, W.C.1, on Monday next, June 7, at 6 p.m. The chair will be taken by Lord Moulton.

A PUBLIC meeting in support of the claim of the Imperial College of Science and Technology for degree-conferring power and university status will be held at the Central Hall, Westminster, to-morrow, June 4, at 5 p.m. Lord Morris will preside, and will be supported by Sir Arthur Acland, Bart., Sir Alfred Keogh, Col. Sir Pierre van Ryneveld, Mr. H. G. Wells, Mr. J. A. Spender, and others.

THE foundation-stone of the new wing of the London School of Economics was laid by the King on Saturday last, May 29. His Majesty was accompanied by the Queen and Princess Mary, and the Royal party was received by Dr. Russell Wells, Vice-Chancellor of the University of London. In an address Dr. Wells referred to the meeting held at the Mansion House in 1918, when it was determined to institute London degrees in commerce, and to collect funds in order to found and endow in the University what it is hoped would ultimately become the greatest school of commerce in the world. As a result of the response to the appeal of the University by the bankers, shippers, and merchants of London, and the substantial contribution of Sir Ernest Cassel, through the Cassel Trustees, the sum of more than 300,000*l.* was obtained towards the founding and endowing of the scheme for commercial education. In the course of his reply the King said:—"I am fully sensible of the patriotic work which has been accomplished by the universities during the war, of their instinctive and immediate response to the call of duty, of their heavy burden of sorrow and loss, of their varied and brilliant contributions to the science of modern warfare, and of the extent to which their normal activities have been suspended or deflected by five years of national peril. It is for this reason the more gratifying to me to note that the University of London, which has grudged nothing of its youth and valour to our armies in the field, has been planning the development of

new spheres of usefulness in the furtherance of the fruitful arts of peace. Three centuries ago Francis Bacon censured the universities of his own age as the homes of ignorant dogma and sterile disputation. The bad and narrow tradition which was then attacked has long since disappeared, and the circle of academic studies has been steadily enlarged by the pressure of scientific ideas and of practical needs without injury to the claims of a broad and humane education. When estate management, horticulture, and commerce are included in the curriculum, a university can no longer be described as a place in which nothing useful is taught. It is right and fitting that the new faculty of commerce should be linked to the London School of Economics, which has for many years enjoyed the reputation of being one of the principal centres of economic inquiry in my Empire, and I regard it as no less appropriate that a university situated at the very heart of our commercial system should now resolve to turn the dispassionate and illuminating eye of science upon the facts and principles of commercial life."

Societies and Academies.

LONDON.

Royal Society, May 20.—Sir J. J. Thomson, president, in the chair.—Prof. J. N. **Collie**: Some notes on krypton and xenon. In the paper the measurements of a considerable number of new spectroscopic lines at the red end of the spectrum are given; also a curious property of xenon has been noted. In tubes containing xenon, when a strong current from an induction coil is passed, much splashing of the electrodes occurs, and the xenon disappears as a gas. What becomes of the xenon is not clear, as it does not seem to be liberated again, either by strongly heating the metallic splash or by dissolving up the splash in suitable solvents.—Sih **Ling Ting**: Experiments on electron emission from hot bodies. Experiments on the electron currents from a platinum disc in a uniform field made by Prof. Richardson in 1907–9 showed that under the conditions of these experiments the distribution of velocity among the emitted electrons was very close to the requirements of Maxwell's law for a gas of equal molecular weight and temperature, but it was noted at the time that rough tests made on the liquid alloy of sodium and potassium, on platinum coated with lime, and on platinum saturated with hydrogen indicated an exceptional behaviour. The further investigation of these substances was postponed owing to technical difficulties and to the pressure of other problems. In 1914 Schottky investigated the electrons emitted from tungsten and carbon, and found a distribution of energy in close accordance with Maxwell's law, except that the mean energy varied between 2 per cent. and 25 per cent. in excess of that calculated from the filament temperatures. Errors in the estimation of these temperatures and in other directions might, however, have accounted for these discrepancies. The present experiments show that deviations from Maxwell's law, if not general, are at any rate quite common. With tungsten and platinum in a well-exhausted enclosure a common distribution is one which satisfies the requirements of Maxwell's law, except that the average electron energy is in excess of (frequently about twice as great as) that corresponding to the temperature of the source. Other cases have been recorded in which the velocity distribution has a different functional form.—L. **Silberstein**: The aspherical nucleus theory applied to the Balmer series of hydrogen. The general formulæ for spectrum emission by atomic systems containing an aspherical nucleus, given by the author in a previous paper (*Phil. Mag.*, vol. xxxix., p. 76), are now applied to hydrogen atoms the nuclei of which are treated as axially symmetrical charged distributions. The asphericity and the value of the Rydberg factor are determined from Mr. Curtis's observations of Hα up to Hγ. The series formula thus resulting (and containing but two constants) is shown to agree well with the six observations. The value of the asphericity coefficient is then used to determine the fine structure of the members or groups of the Balmer series, more especially of the groups Hα and Hβ, which are discussed in some detail.—T. E. **Stanton**, Miss D. **Marshall**, and Mrs. C. N. **Bryant**: The conditions at the boundary of a fluid in turbulent motion. Observations were made on air flowing through long pipes of circular cross-section at mean rates of flow covering as wide a range as possible below and above the critical speed. Dimensions of pipes used were 0·269, 0·714, and 12·7 cm. in diameter. Range in experimental conditions varied from $vd/\nu=460$ to $vd/\nu=325{,}000$, where v is mean speed of flow, d diameter of pipe, and ν kinematic viscosity of air. Estimation of velocity of fluid in neighbourhood of boundary was made from observations of difference in pressure existing in a small Pitot tube facing the direction of flow, and that in a hole in the wall of the pipe. The Pitot was of rectangular section, external dimensions at orifice being 0·1×0·8 mm. and internal dimensions 0·05×0·75 mm. By this means observations could be made up to a distance of 0·05 mm. from the wall. For distances less than this, by a special device the wall of the Pitot nearest the wall of the pipe was cut away and its place taken by the wall of the pipe. By this means observations could be taken at a distance of 0·01 mm. from the walls. From a comparison of the curves of velocity distribution near the boundary, obtained from observations with the Pitot and the composite tube, it was found that in the case of the former the interference with the flow near the orifice by side of tube adjacent to boundary was considerable. Velocity curves obtained from the composite tube, when further corrected for interference, were found to tend to a definite slope at boundary, which was identical with that which would exist in a layer of fluid in laminar motion and having the same surface friction as that actually measured.

Linnean Society, May 6.—Dr. A. Smith Woodward, president, in the chair.—Dr. G. P. **Bidder**: Sponges. (1) The fragrance of calcinean sponges. Clathrinidæ have a noticeable aromatic scent, probably due to the excretory granules which give their bright colours. These granules especially surround the pores. May this be to attract the spermatozoa? The author has not seen the fine-lashed spermatozoa of Poléjaeff, but in Sycon has observed a stiff-tailed organism—possibly the result of curious gregarine-like objects produced in cells resembling gonocytes. (2) *Syncrypta spongiarum* (wrongly assigned to Pandorina in his MS.) the author gives as a name to the "alga" abovementioned. He suggests that it is a dangerous parasite, against which *Grantia compressa* has a successful phagocytosis, but that certain other sponges are hosts for its Palmella stage. (3) Notes on the physiology of sponges. (*a*) Cercids, proposed as a name for the "minute wandering cells." (*b*) Cessation of the current in sponges. (*c*) Differences between Calcinea and Calcaronea in their porocytal granules and odour. (*d*) The excreta of collar-cells are gelatinous globules containing dark particles. Probably Dendy is right in comparing these to the "spermatozoon-heads" of Poléjaeff, which may be the ultimate residue of victorious