character as the Board of Trade or the Board of Agriculture. Like the Board of Trade, and unlike the Board of Agriculture, the new department will have a Parliamentary secretary as well as a president; but the office of vice-president will cease to exist, although the present vice-president will continue to be a member of the Board. The Bill will give more elastic powers for the transfer of the educational functions of the Charity Commissioners to the new department. At first there will only be such an inspection and examination of local schools as will bring the endowed, municipal, private, and proprietary schools within their areas to some common local scheme. It is intended that the inspection shall be optional, except in the case of schools which are being conducted under schemes framed by the Endowed Schools Commissioners. In the first instance, no attempt will be made to impose upon the schools anything like uniformity in their course of instruction, but the inspection will be made in accordance with the advice given by the consultative committee. It is considered that the registers of teachers, both in elementary and secondary schools, may be most properly kept by the Department itself; but it is provided that the regulations relating to the registers shall be framed in accordance with the advice given by the consultative committee. The composition of that committee will not be stereotyped by the terms of the Bill, which provides, however, that two-thirds of the members shall be representatives of the Universities or of other teaching bodies. The organisation of the Science and Art Department will be revised, and the task will be undertaken by a departmental committee, which will be appointed as soon as the principle of the amalgamation of this Department with the Education Department has been approved by Parliament. The inquiry will occupy a considerable amount of time, and it is, therefore, proposed that the present Bill shall not come into force until April 1 next year.—The Bill was read for a first time.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 23.—"Deposition of Barium Sulphate as a Cementing Material of Sandstone." By Frank Clowes, D.Sc., Emeritus Professor, University College, Nottingham. Communicated by Prof. H. E. Armstrong, F.R.S.

Some years ago the author described the occurrence of a peculiar sandstone over a large area in Bramcote and Stapleford, near Nottingham (*Roy. Soc. Proc.*, vol. xlvi. p. 363). The sandstone was remarkable for its high specific gravity; and chemical analysis, supported by microscopical examination, proved that the high specific gravity was due to the existence in the sandstone of a large proportion of highly crystalline barium sulphate. In the rock itself the percentage of the sulphate varied from 33·3 to 50·1; and it evidently served as the binding or cementing material which held the sand grains together. The occurrence of this sandstone was stated by geologists to be unique in the United Kingdom.

Mr. J. J. H. Teall made an examination of the sandstone, and, after breaking up a portion of the rock, found that the small cleavage flakes gave the optical characters of crystallised barium sulphate. Mr. Teall further stated that the barium sulphate occurred in large irregular crystalline patches, which included the sand grains.

The author noted that in some parts of the rock the sulphate occurred in reticulated veins enclosing small patches of more or less loose sand grains; while in other parts of the rock the sulphate occurred in spherical or oval masses, between which looser sand was interspersed; occasionally, however, the barium sulphate was uniformly distributed.

The appearance presented by the weathered surface of the rock varied according to the mode in which the resistant sulphate was distributed. When it was uniformly distributed, it formed an almost complete protection against weathering: the reticulated distribution of the sulphate caused the surface of the weathered rock to present a fretted surface, with the thin veins of sulphate projecting from the surface; while when the sulphate had bound together spherical or oval masses in the substance of the sand, these were left in pebble-like forms as soon as the loose sand had been washed out from between them.

Dr. Bedson had shown (*J.S.C.I.*, vol. vi. p. 712) that barium chloride was present to the extent of 137·2 parts per 100,000 in some of the colliery waters of the Durham coal-field, and the ferrous sulphate and sulphuric acid derived from the iron pyrites in the beds of coal and shale caused the frequent deposition of barium sulphate from such water. The author of the present paper described some of these deposits (*Roy. Soc. Proc.*, June 1889), and suggested that the calcium sulphate present in the waters of the Nottingham district would in a similar way cause barium sulphate deposits from barium chloride spring water. But in the Nottingham district all evidence of barium chloride in solution was wanting.

Such a barium chloride water, derived from an artesian boring at Ilkeston, has recently been found by Mr. John White (*The Analyst*, February 1899). The Ilkeston boring has been made in the immediate neighbourhood of the Bramcote and Stapleford sandstone which contains the large proportion of barium sulphate. Since the barium chloride is found to the extent of 40·7 parts per 100,000 in the water from this boring, and seems to be a normal constituent of the water, it would appear that soluble barium salts are present in the district, and may therefore have given rise to the deposition of the barium sulphate in the original sand beds. The crystallisation of the sulphate around the sand grains would then cause it to act as a compact, insoluble cementing material.

Since the publication of his original paper on the occurrence of barium sulphate in the Bramcote sandstone, the author has continued his examination of samples of sandstone from the basement of the pebble beds of the Bunter, with the object of ascertaining whether the occurrence of barium, either as sulphate or in other forms of combination, was characteristic of the sandstones of that geological period. He had thus far failed to find any similar rock to that at Bramcote, and it therefore seems probable that the occurrence of barium sulphate, although it extends over a very extensive area at Bramcote and Stapleford, must be looked upon as being due to purely local causes. Such local causes, however, appear to have occurred in certain other districts, since Messrs. J. Lomas and C. C. Moore stated to the Liverpool Geological Society, on February 8, 1898, that large proportions of crystallised barium sulphate occurred in triassic sandstones at Prenton and Bidston. In different specimens of the sandstone the percentage of the sulphate varied from 12·4 to 33·8 per cent. It was described as being colourless and highly crystalline, and adherent to the sand grains in such a way as to show that it has been deposited *in situ* subsequently to the sand grains. Mr. Lomas stated that the occurrence of barytes in the trias was fairly common, and mentioned the following localities, in which its presence is well known: Beeston, Alderley Edge, Oxton, Storeton, and Peakstones Rock, Alton.

"Some Experiments bearing on the Theory of Voltaic Action." By J. Brown. Communicated by Prof. Everett, F.R.S.

The experiments were intended to test the theory which attributes the difference of potential observed near metals in contact to the chemical action of films condensed on their surfaces, from the atmosphere or gas in which they are immersed, by investigating the effect of removing the chemically active matters from this atmosphere. On the hypotheses the difference of potential should be reduced thereby to zero, and regain a value near its original, when air was re-admitted. Previous experimenters had not found this to be the case, but it was hoped that elaborate precautions in details might give more definite results than had been hitherto obtained.

A copper-zinc volta condenser with plates 101 mm. by 47 mm. was sealed up in a glass tube in an atmosphere of nitrogen exhausted to a few millimetres pressure, together with metallic potassium and sodium, to absorb any oxygen or other chemically active matters that might have remained in the nitrogen. The zinc plate of the condenser was carried on a glass support hinged to a prolongation of the copper plate, so that on tilting the tube the plates could be separated, in order to measure the difference of potential by a well-known zero method. Platinum wires sealed into the tube made connections for this purpose. Three experiments were made.

In No. 1, lasting six months, the difference of potential fell gradually from 0·74 volt at starting to 0·33 volt. On admitting air it rose to 0·48 volt.

In No. 2, lasting eighteen months, the fall was from 0·7 volt to 0·52 volt, and on opening the tube this value did not sensibly change. The fall was therefore probably due to the well-known effect of tarnishing of the zinc surface.

In No. 3, potassium and sodium were fused together to form the alloy liquid at ordinary temperatures. The difference of potential was 0·75 volt at starting, and fell in the course of seven and a half years to 0·49 volt. On opening the tube there was little appreciable change in this value. The fall in this case also was therefore no doubt due to tarnishing of the zinc surface.

Experiment 1 is the only one of the three which lends some degree of support to the hypothesis which, however, from evidence in other directions, seems nevertheless to be the true theory. If so, the negative results here obtained are no doubt due to the difficulty of removing the last traces of active matter from the gas employed.

Experiments by C. Christiansen (*Wied. Ann.*, vol. lvi. p. 644), confirm this view. He shows that, if the metals be exposed for only a minute fraction of a second in hydrogen the difference of potential is very much lower than when the exposure is continuous in air. Here the active matters have not time to diffuse through the hydrogen to the metal in sufficient quantity to produce the full effect.

Physical Society, March 10.—Prof. Oliver Lodge, F.R.S., President, in the chair.—Mr. A. A. Campbell Swinton described and exhibited the Wehnelt current-interrupter. A glass cell contains a large cylindrical negative electrode of lead, and a small positive electrode consisting of a platinum wire about 1/16 inch or ⅛ inch in length, in a solution of one part sulphuric acid to about five parts water. The platinum wire may project from the top of the shorter arm of a J-shaped ebonite tube, so that it can point upwards immersed in the solution. Or it may be fused into a similar glass tube; but glass is apt to crack in the subsequent heating. Wehnelt's interrupter replaces the make-and-break apparatus of an induction coil; it also replaces the ordinary condenser of that apparatus. In its present form it requires rather a strong current. The resulting spark at the secondary terminals differs in character from the ordinary spark of an induction coil: it is almost unidirectional, and in air takes a V-form, bright, continuous, and inverted—somewhat like a pair of flaming swords rapidly crossing and recrossing one another at their points. By blowing upon the V it breaks up, and then more nearly resembles the customary discharge of a coil. The sound emitted by the spark has a pitch that varies with the conditions of the circuit. As the self-induction of the circuit is diminished, the spark-pitch rises; it becomes infinite when the self-induction vanishes, *i.e.* the Wehnelt interrupter will not work in a circuit devoid of self-induction. As the applied potential-difference diminishes, the spark-pitch diminishes. In Mr. Campbell Swinton's experiments, twenty-five volts was the minimum primary voltage at which his apparatus would work. The spark-pitch also varies with the length of the platinum wire electrode in the solution. If the circuit is closed by dipping this electrode into the solution, the apparatus will not work; the wire must be dipped in before closing the circuit. After working for about a quarter of an hour the action often ceases; this fatigue-effect is not due to heating of the solution, for it is not obviated by keeping the temperature constant by a water-bath. It is supposed that the oxygen generated at the platinum electrode forms a more or less insulating film which interrupts the current until absorbed by the surrounding water. The fact that oxygen is more easily absorbed than hydrogen may explain why it is necessary to connect the platinum electrode to the positive pole of the battery or dynamo. When the platinum electrode is dipped gradually into the solution, the wire gets red-hot, and the interruptions do not take place. Again, when the apparatus stops, from fatigue, the platinum gets red-hot. The action is further complicated by a series of small explosions, and by the formation of a kind of electric arc at the platinum electrode. The coil exhibited was connected to the 100-volt electric-light mains at Burlington House; in this case the potential difference at the terminals of the primary was 30 volts, and that across the interrupter 150 volts—a total of 180 volts, showing the effect of impedance. For Röntgen-ray work the apparatus would be very effective, but unfortunately the sparks produce great heating, so that the kathodes of tubes are melted. Mr. Campbell Swinton suggested that as the sparks were more nearly continuous than ordinary discharges, they might produce Hertz waves less rapidly attenuated than those now applied to wireless telegraphy; the trains of waves would also follow one another at shorter intervals than those from the sparks at present employed. The President said he was rather surprised that the self-induction of the primary coil was not sufficient of itself to form the induction factor in the impedance necessary for perfect working. He would like to know how the apparatus behaved when an alternating current was used. Did the secondary coil become damaged by over-heating? Did reversal of the current assist the recovery from the fatigued condition of the apparatus? The natural period of the circuit depended upon its capacity and its self-induction. There was undoubtedly capacity at the surface of the platinum electrode in the liquid; this capacity acted together with the auxiliary self-induction, and the self-induction of the rest of the circuit, in the orthodox way, and there was automatic adjustment of resonance to the frequency of the interruptions, probably by variations of the capacity at the electrode. The heating effect, when a wire was made to close a circuit with a liquid, was discovered many years ago. Prof. G. M. Minchin thought that the usefulness of the apparatus would be greatly increased if it could be made to work with less current. He had himself succeeded with 12 applied volts, but not with 10 volts. As a tentative experiment he had used a horizontal lead plate, with disastrous effect, for the apparatus went suddenly to pieces. Explosions were frequently obtained, but they were not attended with much real danger. In a later and safer apparatus he used a platinum wire about ¾ inch long, projecting from a glass tube around which the lead plate was bent. There appeared to be a definite depth of immersion of this wire, at which the apparatus worked with minimum current. In his apparatus this critical position was when half the wire was below the surface of the liquid, the other half projecting into the air. He attributed the fatigue to the presence of gas about the electrodes, for he observed that a mechanical tap to the base of the apparatus restored the working condition. Mr. Rollo Appleyard pointed out that the improved result at half immersion, observed by Prof. Minchin, taken together with the phenomena described by Mr. Campbell Swinton as to the effect of dipping the electrodes into the solution, suggested that the liquid immediately around the submerged part of the wire was at some instants in the spheroidal state. The breaking-down of the spheroidal state would be facilitated by heat lost by the immersed part to the non-immersed part of the wire. The capacity for heat of the non-immersed part, and the degree of roughness or smoothness of the immersed part, would thus appear as factors in the explanation. No doubt the evolved gases were the primary cause of the interruption of current, but the wire having once become red-hot the spheroidal condition would introduce a further cause of electrical separation between the wire and the liquid. Prof. Vernon Boys asked whether it was the liquid or the electrodes that became fatigued. Experiments should be made to determine the effect of variations in the hydrostatic pressure around the platinum electrode. Mr. T. H. Blakesley said that the rise of potential at the terminals of the interrupter proved that the arrangement possessed capacity. Such a rise of potential could not occur without there being capacity, any more than it could without self-induction. Mr. D. K. Morris described experiments he had made with a Wehnelt interrupter, using a 1 kilowatt transformer with a transformation of 4 to 5, intended for 10 amperes at 100 volts. The anode of the interrupter was designed to have an adjustable surface to correspond with the load on the secondary—a platinum wire at the end of a copper wire could be projected more or less through the drawn-out lower end of a glass tube containing oil. The best results with the interrupter were obtained with about 45 volts on the primary circuit. At this pressure, an average current of 1 ampere sufficed to give 125 (alternating) volts very steadily on the secondary. As measured by an electrostatic instrument, the "no-load" loss was only 45 watts. The secondary could then be loaded up with lamps, provided that the exposed surface of platinum wire was proportionately increased. The energy delivered to the lamps, however, was not at any load much greater than 45 per cent. of that taken from the mains. By connecting the interrupter with a condenser of ½ microfarad, the efficiency at small loads was increased to nearly 60 per cent. He had observed that the fatigue of the interrupter could be temporarily remedied by reversing the current. Mr. C. E. S. Phillips asked whether Mr. Campbell Swinton had tried other liquids than dilute sulphuric acid. So far as his own experiments went, he had only obtained good results with that electrolyte. Mr. Campbell Swinton, in reply, said that with the apparatus arranged in a simple circuit, an alternating current applied to the primary of an induction coil through a Wehnelt interrupter produced only about half the effect of the corresponding direct current—apparently, only half the alternations got through. But if two interrupters were connected in parallel circuits it was possible so to arrange them that one took one-half and the other the second half of the alternations. It might, therefore, be possible to design an induction coil with two primary windings to correspond to the two interrupters, so as to give an additive effect. The induction coil he had used had suffered no damage from the currents employed in the experiments exhibited; there was extremely little heating of the secondary. He could not with his apparatus restore the working condition by any mechanical disturbance of the interrupter. Hydrochloric acid failed, but a saturated solution of potassic bichromate gave fair results. The President, in proposing thanks, said he did not agree with Mr. Campbell Swinton's remarks as to the chances of improving Hertzian telegraphy by the use of these interrupters. The rate of interruption with this apparatus was something like 1000 per second, but the vibrations corresponding to Hertz waves were of the order 100,000 per second. The wave-trains from oscillators excited by the new interrupter would still be a series of damped vibrations; the amplitudes would not be maintained. It might be advantageous to have sparks following one another so rapidly, but he doubted it. For Hertzian telegraphy, the spark at the oscillator should "crackle"; to produce the best effect, the air about the oscillator should be in a non-electric condition.—A paper by Mr. A. Griffiths, on an apparatus for the determination of the rate of diffusion of solids dissolved in liquids, was then read. The apparatus consists of a cylindrical glass vessel subdivided about midway by a horizontal non-porous partition, into which are fitted a number of vertical tubes. The lower section of the vessel is filled with a liquid, such as an aqueous solution of cupric sulphate, and the upper one contains pure water. The method consists in determining by chemical analysis the quantity of cupric sulphate transmitted up the tubes. The paper gives the theory of the method, with very few experimental results. Ordinary diffusion observations are affected by the flow of liquid in the tubes due (1) to changes of temperature of the apparatus as a whole; (2) to differences of temperature throughout the liquid; (3) to local variations in volume produced by the process of diffusion; (4) to inequalities in the lengths of the tubes. Equations are given for determining the magnitudes of the sources of error, and certain numerical cases are worked out.—The same author also contributed a note on the source of energy in diffusive convection. Diffusion tends to produce local changes of density, causing gravitational currents, which currents can be made to do work. By "diffusive convection," the author means these gravitational currents. The heat equivalent of the work done is determined in a particular case, *i.e.* for a subdivided vessel, as in the above paper, having two tubes of unequal length. He points out that the heat absorbed, owing to diffusion through one of the tubes, is independent of the mechanical motion of the liquid in that tube, and it is also independent of the length of the tube.—The President proposed a vote of thanks, and in doing so described an apparatus he had used for a thermostat. A double-walled cylinder of copper sheet, with a little water in the inter-space, is exhausted at atmospheric temperature until the water boils. It is then sealed. Water-vapour is a powerful equaliser of temperature, and a vapour-jacket of this kind is very efficient when it is required to maintain uniform temperature—not constant temperature. Mr. Watson described the method of Mr. E. H. Griffiths, who used tap-water as a negative source, and a gas-flame as a positive source, with extremely good results as a thermostat for constant and for uniform temperature.—The meeting then adjourned until March 24.

Entomological Society, March 1.—Mr. G. H. Verrall, President, in the chair.—Mr. J. J. Walker exhibited a specimen of a rare British beetle, *Quedius longicornis*, Ktz., recently taken at Cobham Park, Kent. Mr. M. Jacoby exhibited a Halticid beetle from Sumatra, of the genus *Chaloenus*, Westw., and called attention to the remarkable position of its eyes, these organs being placed at the end of two very distinct lateral processes of the head, somewhat resembling the stalked eyes of crabs and other Crustacea. He said this character was peculiar to the male sex, and was very exceptional in Coleoptera, not being met with in any other genus of Phytophaga, and only occurring in a few Anthribidæ, and in isolated cases in one or two other families. He also showed a beetle from Peru, which was sent to him in a collection of Phytophaga, and, superficially, was very like certain members of that group; but from the structure of the antennæ and other characters, it appeared to be out of place in the Phytophaga, and probably belonged to some other family. Mr. Gahan remarked that this beetle, to whatever family it might prove to belong, was very interesting, not only from its structural peculiarities, but also from the fact that it had the colour and markings characteristic of certain species of Galerucidæ, a family to which it undoubtedly was not in any way closely related. This fact seemed to show that it was a mimetic form, and thus helped to explain the present obscurity surrounding its affinities.—Mr. G. J. Arrow contributed a paper "On Sexual Dimorphism in beetles of the family *Rutelidae*," and sent for exhibition a series, including both sexes, of six species of *Anomala*, selected to illustrate the subject of his paper.

Chemical Society, March 2.—Prof. Dewar, President, in the chair.—The following papers were read:—Bromomethylfurfuraldehyde, by H. J. H. Fenton and M. Gostling. The substance which gives rise to the purple coloration when ketohexoses are treated with hydrogen bromide in ethereal solution is a bromomethylfurfuraldehyde of the constitution

$$\begin{array}{l} CH : C - CHO \\ | \quad\quad\quad > O \quad ; \\ CH : C < CH_2Br \end{array}$$

it has a golden yellow colour and seems only to be produced from ketohexoses or substances capable of yielding them by hydrolysis.—The reaction of alkyl iodides with hydroxylamine. Formation of alkylated hydroxylamines and oxamines, by W. R. Dunstan and E. Goulding. The hydriodide of trimethyloxamine $(CH_3)_3N : O$, is obtained by the action of methyl iodide on hydroxylamine; the base yields the iodide of trimethylmethoxy-ammonium by treatment with methyl iodide. The reactions of these substances are described, and also the products of the interaction of hydroxylamine with other alkyl iodides.—Derivatives of $\alpha\alpha'$-dibromocamphorsulphonic acid, by A. Lapworth. On heating ammonium α-bromocamphorsulphonate with bromine and water an $\alpha\alpha'$-dibromocamphorsulphonic acid, $C_{10}H_{13}Br_2O . SO_3H$, is formed; its acid bromide loses sulphur dioxide on heating, yielding $\alpha\alpha'\pi$-tribromocamphor, $C_{10}H_{13}Br_3O$.—Ethylic $\beta\beta$-dimethylpropanetetracarboxylate, by W. T. Lawrence. Ethylic $\beta\beta$-dimethylpropanetetracarboxylate, $CMe_2[CH(COOEt)_2]_2$, is obtained by the interaction of ethylic isopropylenemalonate with ethylic sodiomalonate; on hydrolysis with potash it yields $\beta\beta$-dimethylpropanetricarboxylic acid.—The action of metallic thiocyanates on certain substituted carbamic and oxamic chlorides; and a new method for the production of thiobiurets, by A. E. Dixon.—A reaction of some phenolic colouring matters, by A. G. Perkin. A number of metallic derivatives of colouring matters containing hydroxyl groups in relatively ortho-positions are described.—Note on the optical activity of gallotannic acid, by O. Rosenheim and P. Schidrowitz.

Royal Microscopical Society, February 15.—Mr. E. M. Nelson, President, in the chair.—The President called the attention of the Fellows to a beautifully made microscope by the late Andrew Ross, which had been presented to the Society by Messrs. Watson and Sons. It had a rotating foot, into which the standard was fixed eccentrically; this was not, however, an original idea, having been used by Cuff in 1760.—Mr. Beck exhibited a very ingenious and compact reversible compressorium designed by Mr. H. R. Davis. Dr. Tatham said that being made chiefly of ebonite, it was comparatively light, and in his opinion would be found a useful accessory by the naturalist.—Messrs. Watson and Sons exhibited a new model of their Van Heurck microscope, designed to give complete rotation to the stage, a feature which the President described as a step in the right direction, the great desirability of which he said had been insisted upon by Dr. Dallinger and Mr. Michael. Messrs. Watson also exhibited a new cover-glass clip devised by Mr. Pakes, of Guy's Hospital, for making blood films. Dr. Hebb thought it likely to be of use, especially as the technique of the blood was coming more and more into notice.—The President referred to the Martin microscope presented to the Society last year; he had come to the conclusion that it was not made by Benjamin Martin, but it was a very good imitation, probable date about 1850.—The President read a letter he had received from Mr. Keeley, of Philadelphia, with a slide of diatoms mounted on edge, and some photographs of the latter. The President said he had examined the slide, and could corroborate Mr. Keeley's description of the structure of the diatoms. With regard to the coscinodiscus and triceratium, he believed Mr. Morland was the first to work out and correctly describe these structures, and Mr. Keeley's observations confirmed those results; but he believed the account of the structures of heliopelta and auliscus now given was original. While he was on the subject of diatoms he wished to mention a very interesting discovery made by Mr. Morland, who found that the bracket which strengthened the "plate" in arachnoidiscus was neither more nor less than what an engineer would call a bead-headed girder, in the invention of which the engineer had only copied what nature had already accomplished in the strengthening girders of this diatom.—Dr. Hebb said the fourth part of Mr. Millett's paper on the Foraminifera of the Malay Archipelago had been received, but, owing to its technical character, he proposed that it should be taken as read.—The President read a paper descriptive of the Powell iron microscope, constructed by Hugh Powell in 1840; the instrument, which was exhibited in the room, was still in constant use by the President. Mr. Vezey suggested that an exhibition should be held of historic microscopes, showing the various stages of the development of the instrument; and the president said he hoped the Society would see its way to arrange for an exhibition of the character proposed by Mr. Vezey.—Mr. Rheinberg read a paper in explanation of the chief features of the exhibition of objects shown under multi-colour illumination, arranged under twenty-seven microscopes. The President said he believed one of the chief values of this method of illumination was that it might make it possible to use a larger axial cone than heretofore, and that if they could only combine the Gifford screen with this new method, he thought an advantage would be secured, but caution would be necessary in the selection of the colours. In photomicrography Mr. Rheinberg's method would prove useful.

CAMBRIDGE.

Philosophical Society, February 20.—Prof. H. Lamb, F.R.S. (Trin.), Victoria University, was elected a Fellow of the Society.—The following papers were communicated to the Society:—A semi-inverse method of solution of the equations of elasticity, by Dr. C. Chree. The usual procedure in attacking an elastic solid problem is first to determine expressions for the displacements involving arbitrary constants, thence to deduce expressions for the strains and stresses, and finally to determine the values of the arbitrary constants by the aid of the surface stress equations. In two papers published in 1895 the author obtained a complete solution for an isotropic elastic solid ellipsoid under certain important force systems, employing a semi-inverse method in which expressions for the stresses formed the basis of departure. Some little time ago the author noticed that not only was this method applicable to the corresponding problems in aeolotropy, but that the first stages of the work were absolutely the same for all kinds of homogeneous elastic material. The semi-inverse method thus leads at once to the solution of such a problem as that of an ellipsoid of any shape and any degree of aeolotropy rotating about a principal axis and self-gravitating. The procedure is perfectly straightforward, the only practical difficulty being the complication of the expressions for the three fundamental arbitrary constants which appear in the general formulæ for the stresses. In the present paper the aim has been to illustrate the method by applying it to a variety of the more interesting special cases, and not to chronicle general results of forbidding length and complication. For comparison with results found for rotating elongated or flat ellipsoids, the corresponding problems have been solved by a similar method for long cylinders and thin discs. Some of the results may interest those who are concerned with speculations about the structure of the earth, while others may prove of value to engineers.—On change of independent variables and the theory of cyclicants and reciprocants, by Mr. E. G. Gallop. The problem considered is the change of a system of n independent variables in a partial differential coefficient. The solution was given in a fully expanded form by Sylvester, and deduced by Cayley from a theorem due to Jacobi on the reversion of series. In this communication Jacobi's formula is developed in a manner somewhat different from Cayley's method, and a result obtained which leads on the one hand to Sylvester's expanded form, and on the other to a symbolical formula which is also applicable to any function of differential coefficients. This form involves n^2 quadro-linear partial differential operators analogous to the annihilator of ordinary pure reciprocants, and $n(n-1)$ lineo-linear operators of the type occurring in the theory of invariants. The formula can also be applied to the differentiation of implicit functions, and it is shown how a solution of the general equation of infinite degree, or of a set of such equations, can be exhibited in symbolical form. The method is then applied to the case of the general linear transformation and to the theory of cyclicants as developed by Prof. Elliott. Attention is also drawn to another class of reciprocants in n variables which, perhaps more naturally than cyclicants, may be regarded as generalisations of Sylvester's reciprocants in one variable. Conditions are obtained which ensure that a function of differential coefficients may be a reciprocant in this sense of the term.—On the combustion of carbon in electrolysis, by Mr. S. Skinner. A cell consisting of a carbon electrode in potassium permanganate and a lead peroxide electrode in dilute sulphuric acid produces a current flowing in the external circuit from the lead peroxide to the carbon. The permanganate ion is therefore brought against the carbon plate and becomes reduced, forming mainly carbon dioxide gas and permanganic acid. Such a cell has an electro-motive force of 0·33 volt. To find the relation between the carbon dioxide set free and the current, a voltameter containing potassium permanganate solution with a carbon anode and platinum kathode, was connected in series with a water voltameter and a current passed through them. With certain precautions it was found that one volume of carbon dioxide was set free for two volumes of hydrogen, and the author gives reasons for considering this result as determining the electro-chemical equivalent of carbon. The carbon dioxide produced in this way is not quite pure; it contains small percentages of oxygen and carbon monoxide.—On the ionisation of a gas by "Entladungsstrahlen," by Prof. J. J. Thomson. The paper contains an account of a series of experiments which show that the "Entladungsstrahlen" discovered by Prof. E. Wiedemann cause a gas through which they pass to become a conductor of electricity. The experiments show that with the discharge through a gas at a low pressure the region near the kathode produces more "Entladungsstrahlen" than the positive column, while none could be detected from the dark space between the positive column and the negative glow.

PARIS.

Academy of Sciences, March 6.—M. van Tieghem in the chair.—On some peculiarities of the theory of shooting-stars. Possibility of repetition of activity of certain radiant points. Existence of so-called stationary radiant points, by M. O. Callandreau. The observations of Mr. Denning on the existence of families of shooting-stars which diverge from the same point in the sky, with a maximum every three months, have been called in question by M. Tisserand, but in the author's opinion these observations cannot but be regarded as accurate, and their theory is discussed by the formulæ of Tisserand. The conditions necessary for the formation of the so-called stationary foci are also discussed mathematically, with application to the Orionids; shooting-stars from a fixed point near ν-Orionis having been observed by Denning over a period of twelve days.—M. Helmert was elected a Correspondant for the Section of Geography and Navigation in the place of the late Sir George Henry Richards.—Measurement of the diameters of the satellites of Jupiter and of Vesta by interference methods, carried out with the large equatorial of the Observatory of Paris, by M. Maurice Hamy. The numbers obtained were in general agreement with those of Michelson, the latter being slightly higher for satellites I., II., and III. The value for the minor planet Vesta ($0''\cdot54$) agrees exactly with the micrometric observations of M. Barnard.—Absolute determination of directions making an angle of 45° with the horizon. Application to the measurement of latitudes, by MM. J. Perchot and W. Ebert. A mirror is floated upon an annular ring of mercury, and making an angle of $(45+x)°$ with the horizontal, x being the small error of setting. The method described allows of an exact determination of x. For most European observatories, not far removed from latitude 45°, the method has important advantages, the error due to flexure, in particular, being practically eliminated.—On the fundamental problems of mathematical physics, by M. W. Stekloff.—On analytical prolongation, by M. E. Goursat.—On an extension of the calculus of linear substitutions, by M. Cyparissos Stéphanos.—On the arithmetical nature of the number e, by M. Emile Borel.—On conjugate bundles, of which a system of curves are geodesics, by M. C. Guichard.—On certain systems of equations of

Laplace, by M. Tzitzéica.—On Green's and Cauchy's theorems, by M. Chessin.—On a simple relation giving the molecular weight of liquids as a function of their densities and their critical constants, by M. Daniel Berthelot. By combining two laws found experimentally by S. Young and Mathias respectively, the author deduces the expression

$$M = 11 \cdot 4 d T_c / p_c \left(2 - \frac{T}{T_c}\right),$$

where M is the molecular weight, d the density at any temperature T, T_c and p_c the critical temperature and pressure respectively. This formula is applied to a considerable number of substances, and a comparison of the molecular weights determined in this way with those obtained from the gaseous density shows that in general the molecular weights in liquids and gases are identical, water, acids, and alcohols being exceptions. The deviations found are probably due to the difficulties of ascertaining the correct critical pressures.—On tungsten bisulphide, by M. Ed. Defacqz. Two methods of preparation are described, the action of hydrogen sulphide upon the hexachloride, and that of sulphur upon tungsten trioxide at a high temperature. The physical and chemical properties are given.—Action of formaldehyde upon menthol and borneol, by M. André Brochet.—Estimation of copper and mercury in grapes, wines, lees, and grape skins, by MM. Léo Vignon and Barrillot. As a consequence of the application of salts of various metals for the destruction of parasitic diseases of the vine, it is necessary to examine the fruit products for traces of these metals. Suitable methods for estimating these minimal quantities are described, and satisfactory test analyses given.—Contribution to the study of the forms and conditions under which the chlorine of the soil usually enters into vegetables, by M. P. Pichard.—On the fermentation of galactose, by M. Dienert.—On some peculiar deformations of the blood corpuscles of fishes, by MM. J. Kunstler and A. Gruvel.—On the casting of the skin in insects, considered as a means of defence against animal and vegetable parasites. Special functions of the casting of the trachea and intestine, by M. Künckel d'Herculais.—Researches on the defensive glands of the Carabides, by M. Fr. Dierckx.—On some new Madagascan fossils, by M. Marcellin Boule.

DIARY OF SOCIETIES.

THURSDAY, MARCH 16.

ROYAL SOCIETY, at 4.30.—The Croonian Lecture: On the Relation of Motion in Animals and Plants to the Electrical Phenomena which are associated with it: Prof. J. Burdon Sanderson, F.R.S.—Experiments in Micro-metallurgy: Effects of Strain: Prof. Ewing, F.R.S., and W. Rosenhain.

LINNEAN SOCIETY, at 8.—A Further Contribution to the Freshwater Algæ of the West Indies: W. West and G. S. West.—On So-called "Quintocubitalism" in the Wing of Birds: P. Chalmers-Mitchell.—Some Facts concerning the so-called "Aquintocubitalism" in the Bird's Wing: W. P. Pycraft.

CHEMICAL SOCIETY, at 8.—Influence of Substitution on Specific Rotation in the Bornylamine Series: Dr. M. O. Forster.—Rotatory Power of Optically Active Methoxy- and Ethoxy-propionic Acids prepared from Active Lactic Acid: Prof. Thomas Purdie, F.R.S., and James C. Irvine.

FRIDAY, MARCH 17.

ROYAL INSTITUTION, at 9.—The Electric Fish of the Nile: Prof. F. Gotch, F.R.S.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Backwater or Hæmoglobinuric Fever: Dr. W. H. Crosse.

QUEKETT MICROSCOPICAL CLUB, at 8.

SATURDAY, MARCH 18.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh, F.R.S.

MONDAY, MARCH 20.

VICTORIA INSTITUTE, at 4.30.—Marks of Mind in Nature: Prof. Duns.

TUESDAY, MARCH 21.

ROYAL INSTITUTION, at 3.—The Morphology of the Mollusca: Prof. E. Ray Lankester, F.R.S.

SOCIETY OF ARTS, at 4.30.—The Commercial Development of Germany: C. Rozenraad.

ZOOLOGICAL SOCIETY, at 8.30.—Contributions to the Osteology of Birds. Part III. Tubinares: W. P. Pycraft—On the Marine Copepoda of New Zealand: G. Stewardson Brady.—On the Breeding of the Weka Rail and Snow-Goose in Captivity: F. E. Blaauw.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Papers to be further discussed: Water-Tube Boilers for Marine Engines: J. T. Milton.—Recent Trials of the Machinery of War-Ships: Sir. John Durston, K.C.B., and H. J. Oram, R.N.——Paper to be read, time permitting: Alloys of Iron and Nickel: Robert Abbott Hadfield.

ROYAL STATISTICAL SOCIETY, at 5.—Causes of Changes in Pauperism in England, chiefly during the last Two Intercensal Decades: G. Udny Yule.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Automatic Adjustment of the Half-Tone Screen: W. Gamble.

WEDNESDAY, MARCH 22.

SOCIETY OF ARTS, at 8.—Electric Traction: Philip Dawson.

GEOLOGICAL SOCIETY, at 8.—Relations of the Chalk and Drift in Möen and Rügen: Prof. T. G. Bonney, F.R.S., and Rev. Edwin Hill.—A Critical Junction in the County of Tyrone: Prof. Grenville A. J. Cole.

THURSDAY, MARCH 23

SOCIETY OF ARTS, at 8.—London Water Supply: Walter Hunter.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Hissing of the Electric Arc: Mrs. Ayrton. (Illustrated by Experiments.)

FRIDAY, MARCH 24.

ROYAL INSTITUTION, at 9.—Transparency and Opacity: Lord Rayleigh, F.R.S.

PHYSICAL SOCIETY, at 5.—On the Criterion for the Oscillatory Discharge of a Condenser: Dr. Barton and Prof. Morton.—The Minor Variations of the Clark Cell: A. P. Trotter.

SATURDAY, MARCH 25.

ROYAL INSTITUTION, at 3.—The Mechanical Properties of Matter: Lord Rayleigh, F.R.S.

BOOKS, PAMPHLET, and SERIALS RECEIVED

BOOKS.—The Principles of Bacteriology: Dr. F. Hoeppe, translated by Dr. E. O. Jordan (Paul).—Electricity in Town and Country Houses: P. E. Scrutton (Constable).—Lectures on the Evolution of Plants: Dr. D. H. Campbell (Macmillan).—Measurement and Weighing: E. Edser (Chapman).—Les Plantes Utiles du Sénégal: R. P. A. Sebire (Paris, Baillière).—Naturalist's Directory, 1899 (U. Gill).—Iron-making in Alabama: Dr W. B. Phillips, 2nd edition (Montgomery, Ala.).—The Resources of the Sea: Prof. W. C. McIntosh (Clay).—Experimental Morphology: Dr. C. B. Davenport, Part 2 (Macmillan).—A History of Physics: Prof. F. Cajori (Macmillan).—Unités Electriques Absolues: G. Lippmann (Paris, Carré).—Théorie du Potentiel Newtonian: N. Poincaré (Paris, Carré).—Observations taken at Dumraon, Behar, India, during the Eclipse of January 22, 1898: Rev. V. de C. Campigneulles (Longmans).—Loup-Garou!: E. Phillpotts (Sands).—Bergens Museums Aarbog for 1898 (Bergen).—Universal Electrical Directory, 1899 (Alabaster).—Handbook of Physiology: Prof. W. D. Halliburton, 15th edition (Murray).—The Wild Fowl of the United States, &c.: D. G. Elliot (Suckling).—The Internal Wiring of Buildings: H. M. Leaf (Constable).—An Introduction to Stellar Astronomy: W. H. S. Monck (Hutchinson).—Twenty-four Test-Papers in Practical Plane and Solid Geometry (Science Subject 1), Elementary Stage: G. Grace (Macmillan).

PAMPHLET.—The Geology of the Borders of the Wash: W. Whitaker and J. Jukes-Browne (London).

SERIALS.—Observatory, March (Taylor).—Astrophysical Journal, February (Chicago).—Geographical Journal, March (Stanford).—Zeitschrift für Physikalische Chemie, xxviii. Band, 2 Heft (Leipzig).—Schriften der Naturforschenden Gesellschaft in Danzig, Neunter Band, Drittes und Viertes Heft (Danzig).—Mines and Quarries: General Report and Statistics for 1897, Part 4 (London).—Bulletin of the American Mathematical Society, February (New York).—National Geographic Magazine, February (Washington).—Quarterly Journal of Microscopical Science, February (Churchill).—Journal of the Institution of Electrical Engineers, February (Spon).—Middlesex Hospital Journal, February (London).—Engineering Magazine, March (222 Strand).——Atlantic Monthly, March Gav).

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