be raised if, when travelling at this speed, it were instantly brought to rest and the whole of its energy converted into heat in the atom itself, we have the result that the rise in temperature is no less than the stupendous figure of approximately 50,000,000,000 degrees Centigrade. This is upon the assumption that the specific heat remains constant; but allowing for this, and even allowing for the merest fraction of the energy being converted into heat in the atom itself, there is obviously an ample margin to admit of a temperature being actually obtained enormously transcending anything of which man has any knowledge. Perhaps it may be objected that it is only when we come to deal with aggregations of atoms that we can speak of heat, and that a hot atom is a physical absurdity. If, however, we look upon heat as a rhythmic dance of the atoms, perhaps we may also contemplate the possibility of a single atom executing a *pas seul*, and giving pulses to the ether at each of its movements. In any case, this difficulty disappears if we imagine the travelling particles each to consist of an aggregation of atoms. The fact that substances of high atomic weight form the most efficient anti-kathodes, lends force to the suggestion that the Rontgen rays are produced in some way by the sudden removal of velocity from the atoms that form the kathode stream, owing to the collision of these latter with the comparatively stationary atoms of which the anti-kathode is composed; while the effect observed with the pin-hole photographs of the anti-kathode, in which, as has been seen, the kathode rays that strike the anti-kathode most normally are the most effective in producing Rontgen rays, is also in accordance with this view. At the same time, the fact that in Röntgen ray photographs of Birkeland's kathode ray spectrum it is always the least deflected ray that produced the greatest photographic action, goes to show that the higher the velocity of the kathode ray atoms the more effective these latter are in generating the Röntgen rays.

More than two years have now elapsed since the date of Röntgen's discovery, and nearly twenty years since the commencement of the researches of Crookes. Here, as always, we find that "Art is long, opportunity fleeting, experiment uncertain, judgment difficult." Thus wrote the Greek Hippocrates some twenty-three centuries ago, and time has not impaired the truth of the ancient aphorism.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Junior Scientific Club met at the Museum on Wednesday, May 18. After private business, Rev. G. D. Allen exhibited his collection of European Cicindelidæ and Carabidæ. Mr. N. V. Sidgwick (Ch. Ch.) read a paper on "Tautomerism," which gave rise to a short discussion, and Dr. Gustav Mann gave an account of Miss L. Hulè's further researches on changes produced in Drosera by feeding. The foods recently investigated include peptone, milk, globulin, and urea. The results previously obtained with egg albumin are confirmed by the three former foods, with important modifications. Urea acts as a poison.

CAMBRIDGE.—On June 15, honorary degrees are to be conferred on General Ferrero (Italian Ambassador), the Master of the Rolls, Mr. Leonard Courtney, Mr. James Bryce, Prof. Dicey, Sir Edward Poynter, Sir William Turner, F.R.S., the Master of Balliol, Mr. F. C. Penrose, F.R.S., Prof. S. R. Gardiner, Sir Henry Irving, and Mr. Charles Booth, author of the valuable inquiry into East-end life and poverty.

The honorary degree of M.A. is to be conferred also on Dr. Arthur Willey, Balfour student, for his excellent researches on *Nautilus*.

The General Board of Studies recommend the establishment of a University Lectureship in Chemical Physiology, but in view of the present state of the University finances the post will be without stipend from the Chest.

Dr. Joseph Griffiths has been appointed to the new Readership in Surgery, which takes the place of the suspended Professorship.

THE Report of the Council of the City and Guilds of London Institute upon the work of the Institute during last year has just been published. Before referring in detail to the several branches of the Institute's work, the Council point out that the percentage of expenditure on the teaching staff is 61·9 per cent. at the Central Technical College, and 58·2 per cent. at the Finsbury Technical College, while the average of fourteen University Colleges is 64·9 per cent. The comparison relieves the Council of any suspicion of excessive expenditure. The Research Fellowship at the Central Technical College, founded by the Leathersellers' Company during the mastership of Dr. W. H. Perkin, F.R.S., was awarded at the commencement of the summer term, with the sanction of the Company, to Mr. W. S. Gilles and Mr. F. F. Renwick, who were together engaged in investigating the oxidation products of the so-called artificial camphor. Dr. Williamson, the holder of the Salters' Company's Fellowship, has continued his investigations at the College on the actual composition of the wheat grain grown on Sir John B. Lawes's experimental farm at Rothamsted, and that of the Royal Agricultural Society at Woburn. A number of other investigations have been carried out in the engineering, physics, and chemical laboratories, and the results in many cases have been published in the technical and scientific journals. Prof. Ayrton rightly points out that the assignment of space for an electro-chemical laboratory merits attention in consequence of the rapidly growing importance of the electro-chemical industry. It is certainly time that a well-equipped laboratory was established to provide facilities for investigations in electro-chemistry.

SCIENTIFIC SERIALS.

American Journal of Science, April.—On the temperature coefficients of certain seasoned hard steel magnets, by Arthur Durward. The author examined the temperature coefficients of a large number of stout magnets seasoned according to the method of Barus and Strouhal. If the temperatures are plotted as abscissæ, and the percentage losses of magnetic moment as ordinates, the curves obtained show a slight concavity upwards in most cases, which implies that the loss of moment becomes accelerated at the higher temperatures. Some specimens show an anomalous behaviour, which can be traced to local softening of the steel, and a temperature coefficient considerably augmented in consequence.—The skull of Amphictis, by E. S. Riggs. Describes an almost complete skull in the Princeton collection from the phosphorites. It is unusually small, the length from the incisors to the condyles being ·074 m. The cranium is well expanded, showing a large and well-convoluted brain. The nasals are narrow and slender as in the civets. The genus forms a connecting link between the Mustelidæ and the Vineridæ, and supports Schlosser's theory as to their common origin.—New form of make and break, by C. T. Knipp. The ordinary form of make and break for a seconds pendulum consists of a platinum tip brushing through a mercury drop. This is subject to oxidation and other troubles. The author uses a simple spring device which is always in order, and gives a sharply defined tick for transmission. A T-shaped lever of thin sheet brass is attached to the pendulum. As it swings, each end alternately comes into contact with a fine steel spring. In the middle position, the springs are both in contact, and the circuit is established and transmits the signal.—Rhodolite, a new variety of garnet, by W. E. Hidden. During the past fifteen years there has been found from time to time, over a very limited area in western North Carolina, a variety of garnet called rose garnet. It is distinguished by the variety of its tints, by its transparency, and by its freedom from inclusions and other imperfections. Its specific gravity is 3·838. The ratio of MgO to FeO is almost exactly 2 : 1. The detailed formula is $2Mg_3Al_2(SiO_4)_3 \cdot Fe_3Al_2(SiO_4)_3$.

Bulletin of the American Mathematical Society, April.—The February meeting, in accordance with the rule lately set up by the Society, was an all-day one. This arrangement gives opportunity for not only scientific, but also social intercourse. There was a good attendance of members, and many papers were read.—The theorems of oscillation of Sturm and Klein (first paper), by Prof. Bôcher. The author states that Sturm's work (*Liouville's Journal*, 1836) has been regarded by some writers as not sufficiently rigorous, and that other methods must be substituted for his; for instance, the method of successive approximations recently employed by Picard for establishing some of the theorems. Prof. Bôcher considers that Sturm's work can be made perfectly rigorous without serious trouble and with no real modification of method. This is what

he proposes to do in the present paper; in a subsequent paper he hopes to discuss the cases in which certain functions are discontinuous either within or at an extremity of the intervals within which they are considered. The paper was read at the December meeting, and within its limits appears to be a thorough discussion of the matter.—Another paper read at the December meeting is by C. L. Bouton, on some examples of differential invariants. It is founded on Lie's methods. The invariants are those occurring in projective transformations, and the treatment for the plane is given in full; the method for the corresponding solid problem is sketched in, and the results given. In the author's opinion all the invariants are new.—Papers read at the February meeting are on an extension of Sylow's theorem, by Dr. G. A. Miller.—Note on the tetrahedroid, by Dr. J. L. Hutchinson. The writer points out the connection between a certain quartic surface, discussed by him in the *Annals of Mathematics* (vol. ii. p. 158), and the above-named surface.—Note on integrating factors, by P. Sarel.—Early history of Galois' theory of equations, by Prof. J. Pierpont. This is a very interesting bibliographical paper, which treats of (1) Galois' relations to Lagrange, and (2) how Galois' algebraic theories became public. Galois' estimate of his discoveries is thus stated: "J'ai fait des recherches qui arrêteront bien des savants dans les leurs."—Reviews follow of Love's theoretical mechanics, of Schell's tortuous curves, and of Page's differential equations.—There are a few slight notes, and the useful list of mathematical publications.

Wiedemann's Annalen der Physik und Chemie, No. 3.—Conductivities of electrolytes, by F. Kohlrausch, L. Holborn, and H. Diesselhorst. The authors point out that the modern advances in the measurement of temperatures and resistances have made it necessary to redetermine the conductivities of electrolytes in terms of the units now adopted. As standard electrolytes they take solutions of sulphuric acid of density 1·223, magnesium sulphate of density 1·190, and sodium chloride saturated at 18°. The resistance of 1 cc. as a cube is 0·7398, 0·04922, and 0·21605 in the three cases, which represent the maximum conductivities of those salts at the temperature mentioned.—The foundations of the electric unit of resistance, by W. Jaeger and K. Kahle. The authors describe the methods adopted in the Physikalisch-Technische Reichsanstalt for purifying the mercury and calibrating the tubes of standard resistances. The tubes must be filled in a vacuum. The resistances show a secular diminution of about 0·00003 ohms in five years.—Absorption and emission of steam and carbonic acid in the infra-red spectrum, by H. Rubens and E. Aschkinass. The infra-red rays separated out by five successive reflections at fluospar surfaces are absorbed by carbonic acid and water vapour in thick layers. Their wave-length is about 24 μ. Their absorption by the atmosphere accounts for their absence in the solar spectrum.—On the transparency of some liquids for rays of great wave-length, by the same authors. Water shows considerable absorption, but benzol is more transparent even than silver chloride.—On light nodes in a kathode ray bundle under the influence of a magnetic field, by E. Wiedemann and A. Wehnelt. When the lines of force are parallel to the axis of the tube, the kathode rays are twisted into a bundle having successive nodes. The phenomenon is completely in accordance with the projected-particle theory of kathode rays.—Visibility of Röntgen rays, by E. Dorn. Proves that the light effects seen are not due to an accommodation-strain or to electrical discharges in the neighbourhood of the observer's head.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 5.—"Observations on the Action of Anæsthetics on Vegetable and Animal Protoplasm." By J. B. Farmer, M.A., and A. D. Waller, M.D., F.R.S. Received March 9.

The object of the investigation was to observe simultaneously and comparatively the effects of certain anæsthetics (carbon dioxide, ether, and chloroform) upon vegetable and upon animal protoplasm.

Two gas chambers in series, through which anæsthetic and other vapours can be passed, contain: the first, a leaf of *Elodea Canadensis* under the microscope (× 300); the second, a sciatic nerve of *Rana temporaria* connected with an inductorium and galvanometer (or upon occasion a galvanograph).

The actual movements of chlorophyll bodies in a cell of the leaf were observed and measured by one observer, while the other took readings of the galvanometric deflections in response to excitation of the nerve. To establish comparison between the two classes of effects we took as measures:—the number of chlorophyll bodies that crossed a cobweb in the eye-piece during each successive minute, and the magnitude of galvanometric deflections at intervals of one minute, before, during, and after the action of the vapour. The number of bodies passing per minute gives measure of the rate of movement in the vegetable protoplasm, while the magnitude of successive galvanometric deflections gives measure of the mobility of the animal protoplasm.

The results obtained from a study of *Chara*, *Elodea*, and plasmodium of *Badhamia* were quite consistent, but owing to the greater ease in making a quantitative determination, *Elodea* was used for the more exact comparative experiments.

The action of carbon dioxide was to produce an initial slight acceleration, followed speedily by a complete cessation of movement. On disconnecting the CO_2 apparatus and aspirating air through the chamber the protoplasm, after the lapse of two or three minutes, began to show signs of recovery. Fitful movements of the granules first occurred, and then they soon resumed their processional motion around the cell; at first very slowly. The movement rapidly became accelerated and considerably exceeded the normal rate. This acceleration was not of long duration, and was followed by a slowing down to the ordinary speed.

The results of experiments with chloroform and ether were also given.

May 12.—"On the Connection of Algebraic Functions with Automorphic Functions." By E. T. Whittaker, B.A., Fellow of Trinity College, Cambridge. Communicated by Prof. A. R. Forsyth, Sc.D., F.R.S.

If u and z are variables connected by an algebraic equation, they are, in general, multiform functions of each other; the multiformity can be represented by a Riemann surface; to each point of which corresponds a pair of values of u and

Poincare and Klein have proved that a variable t exists, of which u and z are uniform automorphic functions; the existence-theorem, however, does not connect t analytically with u and z. When the genus (*genre*, *Geschlecht*) of the algebraic relation is zero or unity, t can be found by known methods; the automorphic functions required are rational functions, and doubly periodic functions, in the two cases respectively. But no class of automorphic functions with simply connected fundamental polygons has been known hitherto, which is applicable to the uniformisation of algebraic functions whose genus is greater than unity.

The present memoir discusses a new class of groups of projective substitutions, such that the functions rational on a Riemann surface of any genus can be expressed as uniform automorphic functions of a group of this class. Groups are first considered which can be generated by a number of real substitutions of period two, whose double points are not on the real axis, and whose product in a definite order is the identical substitution. A method is given for dividing the plane into curvilinear polygons corresponding to such a group; these polygons are simply-connected, and cover completely the half of the plane which is above the real axis. Sub-groups of these groups are found, whose genus is greater than unity, and which are appropriate for the uniformisation of any algebraic curves.

The sides of the polygons, into which the half-plane is divided, are formed of arcs of circles orthogonal to the real axis.

The analytical connection between the variables of the algebraic form and the uniformising variables is given by a differential equation of the third order. A certain number of the constants in this equation have to be determined by the condition that the group of substitutions associated with the equation leaves unchanged a certain circle. When any arbitrary values are given to these constants the solution of the differential equation is termed a quasi-uniformising variable. The properties of quasi-uniformising variables, and their relation to the uniformising variable, are discussed in the last section of the paper.

Physical Society, May 13.—Mr. Shelford Bidwell, President, in the chair.—A paper by Prof. W. E. Ayrton and Mr. T. Mather, on galvanometers, was read by Prof. Ayrton. It is a sequel to *Proc. Physical Soc.*, vol. xi. p. 393,