late, but so much has been written at second-hand, as well as in the way of original treatment, that further reiteration is uncalled for. The work of Hertz and of his host of followers is familiar to us all. In the study of electrical oscillations even of very high frequency, photography has been used with success, and details of the phenomena of time-elements truly infinitesimal have been secured. By the labours of Wiener 1 waves of a still higher order than those which have occupied the attention of the electrician have been photographed, and a new field of the greatest promise has been thrown open to the optician. The isolation of a single light vibration may indeed still be as far from us as is the inspection of the molecule by means of the microscope, but in the meantime we have in the photography of a system of standing light-waves, an achievement well worth celebrating.

In the investigation of the phenomena of the time-infinitesimal, so far as periodic changes are concerned, we see that the experimenters of the present time are gaining much of detailed knowledge. There is another field equally important, in my opinion, which is as yet for the most part unexplored. The study of the beginnings of changes brought about by abrupt shifting of the conditions of equilibrium is one from which very much may be expected. Already suggestive beginnings have been made, but the researches have not been pushed to the vations of what might be termed "startling phenomena" have have Take for been recorded, but quantitative results are lacking. example the brilliant work of Becquerel (Comptes rendus, 96, pp. 121, 1215, 1853) with the phosphorescope. What a mass of fascinating and suggestive material that savant has gathered into the first volume of his book on light ! (La Lumière, i. pp. 206-422.) What a world of interesting material these preliminary observations present to him who shall undertake to determine quantitatively, wave length by wave-length, the changes which the radiations from the numerous luminescent materials undergo, beginning with the instant of exposure and following the vanishing light until it is gone.

Of a few isolated cases which have been forced upon us by their practical importance we have some complete knowledge already. With the phenomena in cables when current is suddenly introduced or circuit is broken, we are reasonably The case of the charge and discharge of condensers familiar. has been treated analytically under assumptions the precise truth of which is still to be verified. The detailed study by experiments carried to the utmost refinement, of the very cases which seem to have been most completely covered by theory, is especially important ; since in this way only can the assumptions upon which our analysis is based be rigorously determined, and the necessity of modifications be ascertained. For some of this work methods already in use in the study of periodic phenomena will suffice. The curve-writing voltmeter, for example, may be made to give records running to within a thousandth of a second of the instant when a process such as electrolysis, electrolytic polarisation, voltaic action, or the charge and discharge of a condenser begins. Instruments such as the von Helmholtz pendulum, for the isolation of definite small time intervals, may also be applied to a great variety of progressive phenomena, enabling us to approach by successive steps almost to the very beginnings of the changes to be analysed. Concerning known methods let me point out, in conclusion, that photography with the moving plate is a means, the limitations of which have not yet been discovered. It is equally applicable to periodic and to progressive phenomena, often with results of unexpected beauty and significance.²

The remarkable experiments of Mach (Wiener Sitzungsberichte, 95, p. 764, also 97, p. 41) and of Boys ("On Electric Spark Photographs," &c., NATURE, vol. xlvii. p. 415) indicate that the dry plate is still abundantly exposed within intervals so short that the swiftest of modern projectiles give images as of a body at rest.

The laws of electrical resonance have already been so far determined that we can construct condensers, the duration of the discharge of which is a matter of computation, and the precise

¹ "Stehende Lichtwellen und Schwingungsrichtung des polarisirten Lichtes." Annalen der Physik N.F. vol. xl. p. 203. ² In photographing the alternate current arc a single exposure of a con-tinuous current lang upon the moving plate, by way of check, brought out the seat and precise nature of the hissing of the arc in a manner scarcely to be reached in any other way. For the method used, see "A Photographic Study of the Electric Arc," Trans. Am. Inst. Electrical Engineers, vol. viii. 20 at 1860. p. 214, 1891.

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moment of the discharge of which after a given event is quite within control. This single device, consisting of the exposure of the photographic plate by means of a properly timed spark, brings under observation a set of time intervals of a new and higher order of brevity. Much is destined to be learned by means of it concerning the nature of matter, and much more, I think, from other, possibly still more powerful, methods which will doubtless be developed when the importance of the study of the time-infinitesimal is more generally recognised.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.-At a meeting of the Ashmolean Society, held at the Museum on Monday, 27th inst., Prof. Odling was cleeted President for the ensuing year, and Messrs. F. J. Smith and G. C. Bourne were re-elected Secretaries. Mr. F. J. Stone read a paper on the rainfall at Oxford during the last seventyeight years, and Prof. E. Ray Lankester read a paper on fresh-water jelly-fishes.

At the meeting of the Junior Scientific Club, on Friday, 24th inst., papers were read by Dr. Ritchie, on anthrax spores and bacilli; by Mr. G. B. Cronshaw, on explosions in coal-mines; and by Mr. A. L. Still, on plants and their standing army.

CAMBRIDGE .- The Special Board for Physics and Chemistry report that the Cavendish Laboratory, founded and equipped by the munificence of the late Duke of Devonshire, has become incapable of accommodating the large number of students desiring tuition in Physics. In the present ferm no less than 135 students are at work in a disused galvanised iron dissecting-room, which, on its vacation by the Professor of Auatomy, has been placed at the disposal of the Professor of Physics as a temporary laboratory. Its site will, however, soon be required for the Sedgwick Memorial Museum of Geology, and the Board feel that the time has come for the permanent extension of the Cavendish Laboratory. An adjoining site is available between it and the Engineering Laboratory; but the problem of funds for building and equipment is less easy to solve, unless a benefactor as generous as the late Chancellor should make his appearance. The high position deservedly held by the Cavendish Laboratory, entrusted as it is with much work of national importance, makes it reasonable to hope that Prof. J. J. Thomson will be able to obtain the means for the desired extension.

Mr. W. Gardiner and Mr. A. C. Seward have been reappointed University Lecturers in Botany, and Dr. Hill, Master of Downing College, Lecturer in Advanced Human Anatomy, for five years. Dr. Hill has also been appointed Chairman of the Examiners for the Natural Sciences Tripos.

The Local Examinations Syndicate report that the work done in the scientific branches of the Higher Local Examinations during the past year was on the whole satisfactory. Imperfect experimental work in chemistry, and lack of practical instruction in zoology, are among the weaker points revealed.

The Examinations in Sanitary Science seem to be increasingly appreciated by medical men. During the present year eightyseven candidates have presented themselves, and of these fiftyeight received diplomas in Public Health.

THE *Times* correspondent at Paris says that an International University alliance is in course of formation there. Its object is to facilitate the passing of students from one University to another, to promote travelling scholarships and the exchange of information, to multiply periodical celebrations, and to "draw the attention of the Universities to the question of introducing greater justice into international relations.

SCIENTIFIC SERIALS.

Wiedmann's Annalen der Physik und Chemie, No 11.-On e speed of electrolytic ions, by F. Kohlrausch. This is a the speed of electrolytic ions, by F. Kohlrausch. compilation of tables of absolute velocities, of mobilities, and of coefficients of electrolytic friction according to the latest and most reliable data .- Contributions to the knowledge of the absorption and branching of electric oscillations in wires, by Ignaz Klemencic.-The resistance which causes evolution of heat during the passage of very rapid oscillations depends upon the magnetic permeability of the wire, but in a different manner from that in the case of a constant current. The amounts of heat developed in wires of iron, German silver, brass, and copper 6 cm. long and of 0'018 cm. radiuts, were in the proportion of 10'5: 1'75: 1: 1, the last being probably a little too large. The branching of the oscillations is only affected by the self-induction of the wires, not by their resistance. —The emission of hot gases, by F. Paschen (see p. 82).—A simple method of testing the conductivity of dielectric liquids, by K. R. Koch. The apparatus used for this method is a modified Dewar capillary electrometer, in which a drop of the substance to be examined takes the place of the drop of sulphuric acid usually employed for determining differences of potential. Any electrolytic polarisation is indicated by a movement of the drop of liquid, which should not be more than 0'5 mm. long. The conductivity of various dielectrics has thus been studied, and has in many cases been found to be due to impurities. Benzol, carefully:cleaned and freed from moisture, ceased to show any polarisation.—On the magnetic susceptibility of oxygen, by R. Hennig (see Notes).

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SOCIETIES AND ACADEMIES. London.

Chemical Society, November 2.—Dr. Armstrong, President, in the chair.—The following papers were read :—The action of bromine on azobenzene : a correction, by H. E. Armstrong. The colourless bromination product of azobenzene is tetrabromobenzidine, and not a tetrabromazobenzene, as stated by Werigo.—The origin of colour. X. Coloured hydrocarbons, by H. E. Armstrong.—The formation of the hydrocarbons, by H. E. Armstrong.—The formation of the hydrocarbon "truxene" from phenylpropionic acid and from hydrindone, by F. S. Kipping. On heating hydrindone with dehydrating agents, a hydrocarbon of the constitution

$\begin{array}{c} C_6H_4 \ . \ C : C \ . \ CH_2 \\ \dot{C} \ H_2 \ . \ \dot{C} : \dot{C} \ . \ \dot{C}_6H_4 \end{array}$

is formed ; it is identical with truxene, to which the molecular is formed; it is identical with truxene, to which the molecular formula $C_{27}H_{18}$ has been erroneously assigned by Liebermann and Bergami. Further, Gabriel and Michael's "tribenzoylene-benzene" in all probability has the molecular formula $C_{18}H_8O_2$ instead of $C_{27}H_{12}O_3$, as has previously been supposed.— The action of aluminium chloride on heptylic chloride, by F. S. Kipping. A crystalline ketone of the composition $C_{14}H_{20}O_i$ is formed by the interaction of heptylic chloride and aluminium chloride.—The inertness of quicklime. II. The interaction of chlorine and lime, by V. H. Veley. Dry chlorine has no appreciable action on quicklime below 300°; above this temperature. a partial replacement of oxygen by chlorine occurs. temperature, a partial replacement of oxygen by chlorine occurs. -Note on hyponitrites, by D. H. Jackson. No hyponitrite is formed during the reduction of sodium nitrate with aluminium or barium amalgam. Diver's process for preparing hyponitrites gives the best results when a weak sodium amalgam is employed, and when the action proceeds at a low temperature.—The interaction of hydrogen chloride and potassium chlorate, by W. H. Pendlebury and Mrs. McKillop. The authors have determined the amounts of oxidising gases removed, during successive periods of time, from an aqueous solution of hydrogen chloride and potassium chlorate by a current of air. The action of sunlight on the solution materially increases the quantity of oxidising gas carried away by the air current.—The formation of indoxazen derivatives, by W. A. Bone. The author has studied the action of alkalis on orthochloronitrobenzaldoxime with the object of preparing nitrindoxazen; in place of this substance, however, the isomeric 1:2:5 nitrosalicylonitril was isolated, molecular change having occurred during the interaction. A number of new nitro-derivatives were obtained. - The interaction of benzylamine and phenacyl bromide. Synthesis of piazine derivatives, by A. T. Mason and G. Winder. Phenacyl bromide and benzylamine readily interact with formation of the hydrobromides benzylamine readily interact with formation of the hydrodromittes of monophenacylbenzylamine, Ph. CO. CH₂. NH. CH₂Ph and diphenacylbenzylamine (Ph. Co. CH₂)₂N. CH₂. Ph; on liber-ating the bases, molecular changes occur. In the case of the monophenacyl-derivative, 1. 4-dibenzyl-2:5-diphenylpiazine di-hydride is obtained; when this substance is heated to the boiling-point, it yields toluene and 2:5-diphenylpiazine.

CH·N·CPh CPh·N·CH

A number of other piazine derivatives are also described.—The interaction of quinones and metanitraniline and nitroparatolu-

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idine: a preliminary note, by J. Leicester. The author describes a number of condensation products of quinones with *m*-nitraniline and nitro-p-toluidine.—Preparation of α - β -diphenylindoles from benzoin and primary benzenoid amines, by F. R. Japp and T. S. Murray. A mixture of benzoin, aniline, and zinc chloride yields α - β -diphenylindole, in accordance with the following equation

$$Ph \cdot NH_2 + Ph \cdot CO \cdot CH(OH)Ph$$

$$= C_6 H_4 \bigvee_{NH}^{C} CPh_2 + 2H_2O.$$

New substituted indoles may be prepared by the employment of other aromatic amines in place of aniline.

Mathematical Society, November 9.—A. B. Kempe, F.R.S., President, in the chair.—The resolution for the incorporation of the Society, and the list of names as new Council for the session 1893-4 (see NATURE, vol. xlviii. p. 619), were car-ried unanimously.—The President gave a brief account of the life and work of the late W. S. B. Woolhouse, and then accompanied the presentation of the De Morgan medal, which had been awarded by the Council in June last to Prof. F. Klein, of Göttingen, with an outline sketch of the grounds of the award. Prof. Greenhill, F. R. S., and Dr. Forsyth, F. R. S., who had been deputed by Prof. Klein, in his unavoidable absence, to receive the medal, suitably acknowledged the gift. The following communications were made:---A mechanical solution of the problem of tethering a horse to the circumference of a circular field, so as to graze over an nth part of it, by Prof. L. J. Rogers. (The solution turned on a property of the cycloid).—The stability of certain vortex motions, by A. E. H. Love. The paper contains investigations of the steady motion and small oscillations of Kirchhoff's elliptic vortex, which rotates uniformly in the midst of an infinite mass of liquid, and of Hill's elliptic vortex, which rotates uniformly in the midst of a mass of liquid filling a confocal rigid envelope, the enve-lope rotating with the same angular velocity. It is proved that Kirchhoff's vortex is stable for all modes of oscillation in which the boundary ceases to be elliptic, provided the major axis is less than three times the minor axis. It is also proved that if the boundary is any ellipse, the vortex rotates steadily with angular velocity suitable to its eccentricity, and that it is impossible for it to change form and remain elliptic. The characteristics of the various modes of oscillation are made out, viz. it is shown that for each mode there is a definite number of wave-lengths of a simple harmonic disturbance in the circumby the ratio of the normal displacement of a point in the boundary to the central perpendicular on the tangent at the point. The general period equations are obtained, and it is shown in particular that Hill's vortex is always stable for elliptic displacements of the boundary of the vortex, the frequency for such displacements tending to zero when the vortex degenerates into a Kirchhoff's vortex by indefinite expansion of the external boundary of the liquid, thus verifying the results found in the more special case. It is also verified that the vortex sheet, which is another degenerate Hill's vortex, is always unstable for the more complex types of disturbance. Messrs. Hill, Basset, Greenhill, and Bryan spoke upon the paper.—Cyclo-tomic quartics, by Prof. G. B. Mathews.—On the application of elliptic functions to the curve of intersection of two quadrics, by J. E. Campbell.—Note on the theory of groups of finite order, by Prof. W. Burnside, F.R.S. The only quite general (of finite order) is the following, due to Herr Sylow: "If p^{α} is the highest power of a prime p that divides the order of a group, the group contains a single conjugate set of sub-groups of order to group the proventies of the provides the order of a group. p_{σ}^{*} and the number of such sub-groups is congruent to unity, modulus p_{σ}^{*} . In the theory of groups of finite order, and especially in considering the possible structure of a group of given order, this theorem is fundamental. From its enunciation it is clearly independent of the form in which the group may be represented. The only published proofs of it, to the best of the author's knowledge, are the original proof by Herr Sylow (*Math. Ann.* vol. v.), and a proof given by Herr Netto in his "Substitutionentheorie." These both depend essentially on the representation of the group as a group of substitutions, and also on the conception of transitivity in connection with this form of representation. A proof of the theorem is given in the first of these notes, which is as fundamental in conception as