THURSDAY, JULY 27, 1905.

THE AGENTS OF EARTH SCULPTURE.

Geology—Processes and their Results. By Thomas C. Chamberlin and Rollin D. Salisbury. Pp. xix+654. (London: John Murray, 1905.) Price 21*s.* net.

IT is appropriate that this work is written by experienced members of the United States Geological Survey who are likewise heads respectively of the departments of geology and geography in the University of Chicago. The main portion of the volume treats of the earth's physical features and their origin, and thus illustrates the forces and processes which belong to the borderland between past and present in which geologists and geographers are alike concerned. No aspect of geology appeals to a larger circle of interested students and general readers. The preface being dated from the University of Chicago, it may be inferred that the book is published simultaneously in the United States. It is printed in bold type on thick paper, and with such abundant illustrations that it is a veritable picture-book. There are 24 plates and 471 text illustrations; the latter are not listed, however, in the table of contents. In the eyes of a book-lover the appearance of the book is somewhat marred by its being cut down rather too closely; but as the student will pay more attention to the subject-matter he may at once be assured that it is a sound, vigorously written work, abounding in original information and suggestions, and abreast of the ever-expanding knowledge to which American geologists have so largely contributed. Nor is there wanting due acknowledgment of many facts and illustrations drawn from published sources.

In their preliminary remarks the authors make a noteworthy use of statistics. Thus we read that "The total mass of the atmosphere is estimated at five quadrillion tons," that "About 1300 quadrillion tons of water lie upon the surface of the solid earth," and that the volume of the stony portion is about 260,000 million cubic miles. These estimates, incomprehensible by themselves, are rendered useful by comparisons, and the relative mass and extent of atmosphere, hydrosphere, and lithosphere are thereby brought clearly before the reader. It is pointed out that the oceanic depressions rather than the continental masses are the master phenomena of the earth's surface, and that if the surface were graded to a common level by cutting away the land and dumping the matter in the abysmal basins, the average plane would lie somewhere near 9000 feet below sea-level.

In dealing with the atmosphere as a geological agent, dust and blown sand, wind-ripples and wind-erosion, the influence of the colour of rocks on their daily range of temperature, the creep of soils and subsoils, and even the effects of lightning receive attention.

Rain and river erosion are discussed from hypothetical, and more fully from actual, points of view. Various stages in the history of streams and valleys are illustrated, and their distinguishing features in youth, in mature and in old age are described. It is pointed out that the base-level of erosion and sea-level are by no means synonymous, as rivers often erode below sea-level. The development of rivers under different structural conditions is explained, and attention is directed even to the possible influence of the rotation of the earth on the erosive action of streams. The beheading of one stream by another is treated as "piracy," and both "foreign" and "domestic piracy" are explained, the latter phrase being applied to cutting off an ox-bow in a meandering stream. Other terms of a somewhat homely nature are used, such as "scour and fill," in illustration of the fact that a stream in flood degrades its channel and aggrades (builds up) its plain.

There is a notable chapter on ground-water, a subject of great scientific interest as well as practical importance. The movements of ground-water include the fluctuations in its upper surface or "water table," and those dependent on the outflow of water in springs or on its abstraction by pumping, influenced as the movements also are by geological structure.

The work of snow and ice, of continental and alpine glaciers, is treated in an attractive and luminous style. The way of "getting load," the englacial and superglacial drift, the transfers of load from basal to higher portions of the ice, and the movements accompanied by shearing-planes and thrusts, are duly described.

"Hanging valleys" receive attention, and it is remarked that those developed by stream-erosion are not common, except in cases of the recession of a waterfall past the mouth of a tributary. The features are characteristic of regions recently glaciated, where, as in the western mountains of North America and elsewhere, a main valley has been deepened by glacial action below the level of tributary streams.

The work of the ocean is fully discussed and illustrated. The cutting of cliffs in different materials, the formation of arches, stacks, and beaches, and rill-marks on sands that simulate sea-weeds, and other subjects large and small come under consideration. The later chapters are occupied by "the origin and descent of rocks"; minerals and rocks are described, and some account is given of the new, and by no means popular, American petrological classification and nomenclature. Various structural features, cross-bedding, nodules, joints, folds, &c., as well as deformations, volcanic action, and other topics, are illustrated.

The geological functions of life are then dealt with. The consumption and restoration of carbon dioxide and the consequent influence on climate are discussed. The agency of organisms in the disintegration of rocks, and the protection they afford against erosion are pointed out. Attention is also directed to the influence of land vegetation on the character of sediments, due in the first place to the decomposition of different rocks and the formation of soils—materials which may be carried out to sea. On the other hand, "if the surface be bare of vegetation, the crystalline rocks are usually *disaggregated* before they are decomposed." The bearing of these facts on the question of vegetal coverings in the earlier periods is briefly discussed. Observations on organic rocks, and on the distribution and development of the fauna and flora, lead up to the subject of historical geology, which the authors propose to deal with in another volume. H. B. W.

MACHINERY FOR HANDLING RAW MATERIAL.

The Mechanical Handling of Material. By G. F. Zimmer. Pp. xii+521; illustrated. (London: Crosby Lockwood and Son, 1905.) Price 25*s*. net.

IN the preface Mr. Zimmer says that he has been for twenty years professionally engaged in this branch of engineering, and he was recently induced to put together in the form of a treatise—the first in English on the subject—the mass of notes he had gradually accumulated. The importance of the subject is emphasised in the introduction by a few suggestive figures as to the amount of raw materials which has to be dealt with annually, and it may be noted that the wages of an ordinary labourer are equivalent to the interest on 1000*l*. of capital.

The question of the continuous handling of material is treated in the first section of the book; special prominence is given to elevators for the conveyance of corn and flour, and to the important problem of the supply of coke, ore, &c., to the top of blast furnaces; illustrations are given of the latest American furnace hoists. The system of band conveying, due to the inventive skill of Mr. Lyster, engineer to the Liverpool Docks, and the automatic throw-off carriage for such conveyors, also due to Mr. Lyster, are described in detail. Vibrating trough conveyors—the latest type of such machinery, and especially useful with any material which would deteriorate in rough treatment —are then dealt with. Tightening gears, power required, and speed of travel in the different types of convevors are discussed in a special chapter, thus facilitating reference and comparison. The various types of pneumatic elevators, including the successful Duckham system for loading grain which has been extensively used, are next treated. This section of the book is concluded by a series of descriptions, in every case with illustrations, of conveyors which have been designed for special purposes, such as timber conveyors, hot coke conveyors for gas works, and casting machines for use with large blast furnaces.

The intermittent handling of material, mainly by endless chains and ropes, including the many systems of aërial cable-ways, forms the second section of Mr. Zimmer's book. One of the examples selected to illustrate the use of aërial ropeways is that used during the building of the new Beachy Head Lighthouse, and full credit is given to Messrs. Bullivant for the ingenious way in which the many practical difficulties were overcome. We may mention that it is to this system of aërial ropeway that the rapid completion of that remarkable bridge which will convey the Rhodesian railways over the great gorge of the Zambesi, almost within a stone's throw of the famous falls, is due; it not only facilitated the erection of the bridge, but it also enabled the permanent way and rolling stock for the northern continuation of the railway line to be transported to the north bank of the gorge long before the bridge itself was completed. The interesting question of the coaling of ships at sea, a subject of special interest in view of the recent voyage of the famous Baltic Fleet to the East, forms the conclusion to this section.

The third section of the book is devoted to unloading and loading appliances. The discharging of vessels in docks, and the discharging of railway trucks—work requiring so much labour—have been fertile subjects of invention, and a large number of systems of grab-elevators and self-emptying trucks are described. In view of the enormous weight of coal annually shipped at the various coal shipping centres, no branch of the mechanical handling of material has received more attention than that of coal tips for loading colliers, and the chapter which treats of coal tips is a most complete and valuable one. In the last section of the book a number of miscellaneous devices, which the author has found it impossible to group under any of the previous divisions, are described, such as the automatic weighing of material, the coaling of railway engines, &c. Large flour and silo warehouses form an essential feature in the mechanical handling of raw materials such as grain and seed, and a couple of chapters, illustrated with the help of a number of plates, are given up to a detailed account of the main features of their design.

The book will be indispensable to all engineering firms, consulting engineers, and architects who have to deal with this important question either in the way of designing machinery or of erecting warehouses, and it is, though highly technical, a book which will appeal to the general reader anxious to obtain some slight knowledge of the latest advance in the mechanical handling and transport of the immense quantities of raw materials used daily in our industrial life. T. H. B.

THE BUTTERFLIES OF INDIA.

The Fauna of British India, including Ceylon and Burma. Published under the authority of the Secretary of State for India in Council. Edited by W. T. Blanford. *Butterflies.* Vol. i. By Lieut.-Colonel C. T. Bingham. Pp. xxii+511; Figs. 94; Plates 10. (London: Taylor and Francis, 1905.) Price 20*s*.

NINETY years ago, when Kirby and Spence published the first volume of their "Introduction to Entomology," they considered it necessary to devote a whole letter, filling many pages, to refuting popular prejudices against the frivolity and uselessness of the study of entomology; and, no doubt, at that period butterfly-collecting was looked upon as a very silly, childish pursuit; while less than 200 years before, in the time of Charles II., a serious attempt was made to set aside the will of a certain Lady Glanvil, on the ground of insanity, as shown by her fondness for collecting butterflies.

Now, however, instead of butterfly-collecting being ridiculed, it has become almost necessary to discourage it in England in order to prevent the total extermination of all our rare and local species, while abroad it is pursued with enthusiasm by travellers and colonials, some of them belonging to the highest social circles. Again, during the last fifty years, so much light has been thrown on various scientific problems by the study of butterflies that eminent professors are ready to devote a great portion of their lives to such investigations.

Of late years, many Indian officers and civilians have taken up the collection and study of the butterflies of our Indian Empire, which are probably better known at the present time than those of any other part of the world outside Europe, except North America and South Africa. But there exists no complete work on the subject suitable for the use of students. Mr. F. Moore's great works on the butterflies of Ceylon and India are very bulky and costly, and the latter is still in progress, while the regretted death of L. de Nicéville left the work commenced by himself and Col. Marshall, and subsequently carried on by de Nicéville only, complete only as regards the earlier families. Lieut.-Colonel Bingham, a retired Indian officer, who has collected insects assiduously in many parts of India, Burma, &c., and who has already published two volumes on Hymenoptera in the present series, "The Fauna of British India," has been wisely chosen to supply the existing want of a manual of Indian butterflies, and with his previous practical experience behind him, and with sufficient leisure, and access to the collections and library of the Natural History Museum at South Kensington at his disposal, the work could not have been placed in better or more competent hands.

It is expected that three volumes will be required to deal adequately with the subject. Six families are admitted by the author, of which the first two, Nymphalidæ and Nemeobidæ, are discussed in the first volume. The arrangement of the work is similar to that which has been used in previous volumes of this series dealing with insects, which are already well known to all entomologists. The introduction, necessarily brief, contains remarks on classification, metamorphoses and structure, with text-illustrations of the larva and pupa of Vanessa, the head and body of Argynnis and Charaxes, and a very useful selection of figures of labial palpi, antennæ, neuration of wings, and legs. It is worthy of special remark that the author expressly discards the term "species" as liable to mislead, and uses "form" instead, as less objectionable.

Four hundred and seventy-nine species are described in vol. i., belonging to the Nymphalidæ (with six subfamilies, Danainæ, Satyrinæ, Acræinæ, Libytheinæ, Morphinæ, and Nymphalinæ), and Nemeobidæ (five genera only).

The text illustrations are excellent, and among the more interesting ones we may note Figs. 13 and 14, on p. 40, showing the variations in shape and markings of the forewings of seven specimens of *Euploea klugii*, Moore, and Fig. 94, on p. 501, of *Stiboges nymphidia*, Butl., showing its remarkable resemblance to a species of the well-known tropical American genus Nymphidium.

Ten full-page plates (half-figures only) are added, drawn by Mr. Horace Knight and lithographed by the three-colour process by Messrs. Hentschel, and these alone are sufficient to give some idea to outsiders of the variety and beauty of the butterflies of India. If we take the butterflies of Great Britain at 70, those of Europe at 300, and those of British India, within the limits of the present work, at 1500, we shall have a fairly accurate idea of the proportions borne to each other by these three faunas.

In outlying districts, no doubt, many species still remain to be added to the Indian butterfly fauna, but apart from this, nothing is yet known of the transformations, habits, &c., of a great proportion of the insects, which will be sufficient to occupy the attention of numerous observers for many years. The metamorphoses of each butterfly, so far as yet known, are briefly noticed by Lieut.-Colonel Bingham, but it is only occasionally that he has been able to offer his readers any information of this description.

THE STATE AND AGRICULTURE.

The State and Agriculture in Hungary. By Dr. Ignatius Darányi, translated by A. György. Pp. xxii+264. (London: Macmillan and Co., Ltd., 1905.) Price 5*s.* net.

THERE are two fundamentally opposite theories of the duties of a public department dealing with a great industry such as the Board of Agriculture in this country—the one that its function is to foster the industry, the other that it is simply concerned in registering the progress and administering such legislative enactments as may be necessary from time to time.

Our English public offices have all grown up on the latter model, and the Board of Agriculture, which is always being abused for not doing this or that to improve the position of farmers, might legitimately answer that it was never designed to offer any such help to the agriculturist. Of course, the official apologists of the Board cannot put forward such a view nakedly; their plan is rather to divert the unreasonable attack by a show of activity.

To take a concrete case; the Board of Agriculture endeavours to eradicate swine fever—that it recognises as a proper function, true police work for agriculture —but supposing it should be urged to do something to improve the breed of pigs kept in England by introducing new breeds or by distributing boars of the right type in the backward districts, it would probably meet the demand by issuing a leaflet on "points to be aimed at in pig-breeding." The English method is cheap; it is also supposed to be bracing; and the English farmer, being subjected to the State-aided and bounty-fed competition of all other agricultural countries in the only open market, his own, is supposed to be in special need of a bracing *régime.*

So when people ask why the Board of Agriculture does not educate like France, or investigate like

Germany, or introduce new crops and new industries like the United States, or organise its workers like Hungary, the Board has one sufficient and final answer in the fact that such has never been the English theory of the function of a public office.

In the book before us we have an account of the policy of a man who took a different point of view, and created, perhaps, the most paternal ministry of agriculture in the world. Dr. Ignatius Darányi was Minister of Agriculture for seven years (1896–1903) in Hungary, and during his tenure of office he built up an extraordinary system of agricultural education, investigation, and organisation in Hungary. It would be impossible in the limits at our disposal to discuss either the means adopted or the results that have accrued; roughly speaking, Dr. Darányi's method in any industry was to make a start with a State-owned farm or garden, forest or mill, as the case might be. Here proceeded the investigations necessary to establish the conditions requisite for success, and from this centre issued the teachers who carried the new methods to the cultivators. The State then stepped in again, sometimes to lend the cultivator the money necessary for the fresh start, or to organise a co-operative society to enable him to realise the full advantage of the newer methods. Thus, by leaps and bounds, the whole character and quality of Hungarian agriculture has been changed. The reader will find the process set out fully with a wealth of statistical detail in Dr. Darányi's book, which takes the form of a kind of valedictory report on quitting office. It has been excellently translated by Mr. György, who, knowing so well the conditions prevailing in England, adds a preface discussing the value and limits of State interference in such matters. It is a wonderful record; to the English reader, particularly if he be a farmer, it seems difficult to believe that so much can be done for the industry, and also that the distance of a few hundred miles should render impossible in this country methods that have proved so practicable and so fruitful for the Hungarian agriculturist.

OUR BOOK SHELF.

The Treatment of Diseases of the Eye. By Dr. Victor Hanke. Translated by J. Herbert Parsons, F.R.C.S., and George Coats, M.D., F.R.C.S. Pp. vi+222. (London: Hodder and Stoughton, 1905.) Price 3*s.* 6*d.* net.

DR. VICTOR HANKE, the writer of this little book, is principal assistant to Prof. Fuchs in Vienna, and the methods of this famous clinique are those which are here given to a wider public. It naturally follows that it is characterised throughout by a practical sanity which has been sadly lacking in some books on similar subjects which have recently been thought worthy of translation. The author has no special hobby-horse on which to ride to mental destruction. His treatment throughout is practical, scientific in the best sense of the word, what we may call for lack of a more fitting adjective, commonsensical. There is no rash advocacy of new and untried methods of treatment simply because of their novelty. Consequently, it is a book which can be thoroughly recommended to all practitioners of the art of medicine. Reliance on it will not lead to disappointment, for the methods advocated are thoroughly modern and sound.

A careful reading reveals practically no ground for adverse criticism, and many points for active commendation. The warning against the indiscriminate use of cocaine is one that should be unnecessary to any practising ophthalmic surgeon, and yet we have only recently seen prescriptions for lotions and drops given to patients for frequent use containing cocaine. "The immoderate use of cocaine . . . is not only unnecessary but actually harmful to the corneal epithelium"; and again, "Cocaine should in general not be used, for on the one hand its action is only transitory, while on the other it has an injurious influence on the corneal epithelium; moreover the dilatation which follows the temporary contraction of the vessels is harmful."

It would be easy to point out many places in which good results can be obtained by methods of treatment other than those recommended, but as the book does not in any way pretend to be exhaustive, and as the methods given are thoroughly sound, it would be hypercritical to do so. We doubt, however, the advisability of the use of adrenalin in severe inflammatory glaucoma, even if only given to facilitate the operation. Macallan, in a paper in the Ophthalmic Hospital reports some two or three years ago, pointed out the dangers of this drug in glaucoma, and its tendency to set up the hæmorrhagic form.

The chapter on the various forms of inflammation of the cornea and their treatment is quite the most valuable in the book, and generally the earlier chapters dealing with the external diseases of the eye are fuller than the later chapters. The reason of this is that the author does not pretend to give descriptions of operations where only "considerable skill and experience can command success," and in diseases of the deeper parts of the eye the advice of the ophthalmic surgeon is more likely to be called for, and this book is not intended for him. In conclusion, we can only reiterate what we have already stated, that students of medicine will find this a thoroughly safe guide in the treatment of diseases of the eye.

Die Stellung Gassendis zu Deskartes. By Dr. Hermann Schneider. Pp. 67. (Leipzig: Dürr'sche Buchhandlung, 1904.) Price 1.50 marks.

GASSENDI AND DESCARTES were contemporaries and fellow-countrymen, but the relation between them is mainly one of contrast. Gassendi was of peasant origin, a writer encyclopædic in his range, an *Epicurus redivivus* with all Epicurus's distrust of mathematics and all his belief in a material soul, a sceptic who was yet content to remain in the ranks of the Catholic priesthood, his face ever turned to the past whether in philosophy or religion. On the other side there is Descartes, a noble by birth, a student principally of the human understanding, something of a Platonist, with the Platonist's reverence for mathematics and numbers, a dualist who fixed a great gulf between mind and body and between man and the lower animals, an uncompromising doubter of everything but his own doubt and all that is implied by the capacity to doubt, the exponent of *cogito, ergo sum*—in a word, the representative of the distinctively modern tendencies, which mean in religion Protestantism, in science mathematical physics, in philosophy Kantianism new and old. Only in so far as modern thought inclines to atomism and materialism—and how much that is the author points out in his closing paragraph—do we find that its sympathies lie with Gassendi rather than with Descartes.

These contrasts, extended into a detailed discussion of some of the writers' most important works and particularly of their views on psychology, physics, and ethics, are well brought out by this author. His book may be heartily recommended to students of the period described.

A Text-book of Physics, Heat. By Prof. J. H. Poynting, Sc.D., F.R.S., and Prof. J. J. Thomson, M.A., F.R.S. Pp. xvi+354. (London: C. Griffin and Co., Ltd., 1904.) Price 15s.

THE third volume of this well known text-book more than sustains the standard set by its predecessors. The volumes on sound and properties of matter have already appeared. The volumes on light and on electricity and magnetism we hope may follow at a somewhat shorter interval than has intervened between the first three volumes of the series. It is hardly necessary to say that the work is well up to date, and extremely clear and exact throughout, and that it is as complete as it would be possible to make such a text-book within the limits which the authors have laid down for the scope of their work. Among the more original features which should be valuable to the student as filling gaps which are noticeable in similar text-books, we observe that a useful chapter is included on the subject of circulation and convection, with illustrations from meteorology and ventilation. The treatment of the important subject of radiation, especially in relation to temperature and thermodynamics, is unusually complete and clear, and presents in a simple, connected form a number of most important results which the student would have difficulty in finding elsewhere. The experimental spirit is maintained throughout the work in such a manner that the student will feel that he is learning from a practical master of the subject, and will unconsciously imbibe something of the attitude of mind of the original investigator. H. L. C.

The Oxford Atlas of the British Colonies. Part i. British Africa. Seventeen maps. (Oxford Geographical Institute: William Stanford and Co., Ltd., n.d.) Price 2s. 6d. net.

THE first thirteen plates consist of coloured maps, and the remaining four are outlines intended for use as "test" maps or for other class purposes. The first map shows a hemisphere in which Cape Colony occupies the centre, and it is possible from it to see at once the relation of South Africa to the other continents. Map ii. is a political map of the world drawn in accordance with Mollweides's equal area projection, and the student will notice at a glance the apparent distortion in shape, though the relative sizes of land areas in different parts of the map are correctly shown. In addition to meteorological charts, the atlas includes physical and political maps of Africa, and maps of Cape Colony, Natal and Zululand, the Transvaal and Orange River Colony, Rhodesia, and of West, East, and Central Africa.

High Temperature Measurements. By H. Le Chatelier and O. Boudouard. Authorised translation and additions by Dr. G. K. Burgess. Second edition. Pp. xv+341. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 12s. 6d. net.

IN preparing the present edition it was found necessary to make a large number of additions, and the book now gives a useful summary of what is known about pyrometry. The advances in optical pyrometry during the last few years are recognised by the authors, and a useful chapter on the laws of radiation has been inserted. A number of pyrometers are described, but the discussion of the principles involved is in general more adequate than the description of instruments. No mention is made of some of the best of these in use in this country.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Comparison between Two Theories of Radiation.

ON two occasions (NATURE, May 18 and July 13) Lord Rayleigh has asked for a critical comparison of two theories of radiation, the one developed by Prof. Planck (*Drude's Annalen*, i. p. 69, and iv. p. 553) and the other by myself, following the dynamical principles laid down by Maxwell and Lord Rayleigh. It is with the greatest hesitation that I venture to express my disagreement with some points in the work of so distinguished a physicist as Prof. Planck, but Lord Rayleigh's second demand for a comparison of the two methods leads me to offer the following remarks, which would not otherwise have been published, on the theory of Prof. Planck.

Early in his second paper, Planck introduces the conception of the "entropy of a single resonator" S. There are supposed to be N resonators having a total entropy $S_N = NS$, and S_N is supposed to be given by $S_N = k \log W + \text{constant}$, where W is the "probability" that the N resonators shall be as they are. Without discussing the legitimacy of assigning entropy to a single resonator, we may at present suppose S defined by $S = k/N \log W + \text{cons.}$

The function W, as at present defined, seems to me to have no meaning. Planck (in common, I know, with many other physicists) speaks of the "probability" of an event, without specifying the basis according to which the probability is measured. This conception of probability seems to me an inexact conception, and as such to have no place in mathematical analysis. For instance, a mathematician has no right, *quâ* mathematician, to speak of the probability that a tree shall be between six and seven feet in height unless he at the same time specifies from what trees the tree in question is to be selected, and how. If this is not so, may I ask, "What *is* the probability that a tree shall be between six and seven feet high?"

When Prof. Planck calculates the probability function W, he in effect assumes that *a priori* equal small ranges of energy are equally probable. Thus he tacitly introduces as the basis of his probability calculations an ensemble of systems of resonators such that the number of systems in which the energy of any given resonator lies between E and $E+dE$ is proportional simply to dE. This, of course, he has a right to do, only he must continue to measure probability according to this same basis.

The systems of resonators are in motion, their motion being governed by the laws of dynamics. Will they, as the motion progresses, retain the statistical property which has been the cause of their introduction, namely, that the number of systems in which the energy of any given resonator lies between E and $E+dE$ is proportional simply to dE? It is easily found, by the method explained in my "Dynamical Theory of Gases" (§ 211), that in general they will not; the probability function W is not simply a function of the coordinates of the system. Prof. Planck's position is as though he had attempted to calculate the probability that a tree should be between six and seven feet high, taking as his basis of calculation an enclosure of growing trees, and assuming the probability to be a function only of the quantities six and seven feet. His ensemble of systems has not yet reached a statistical "steady state."

Prof. Planck supposes his function S to possess the property of the entropy function, so that $1/T = dS/dU$, where T is the temperature. Combining this with Planck's calculation of S, we find

$$1/T = k/\epsilon \log (1+\epsilon/U) \quad . \quad . \quad . \quad . \quad (1)$$

Here ϵ is a small quantity, a sort of indivisible atom of energy, introduced to simplify the calculations. We may legitimately remove this artificial quantity by passing to the limit in which $\epsilon = 0$. In this way we obtain

$$1/T = k/U \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Thus the mean energy of each resonator, according to this equation, is the same multiple of the temperature, no-matter how many degrees of freedom the resonator possesses, or what the form of its potential energy. Indeed, according to this argument, equation (2) is proved for any dynamical system, *e.g.* the molecules of a gas.

It is, however, known that equation (2), with Planck's meaning of k, is true if, and only if, the energy of each dynamical system is expressible as the sum of two squares. It can, indeed, be shown directly that this latter condition is exactly the condition that Prof. Planck's assumed basis of probability calculations shall be a legitimate basis, *i.e.* shall be independent of the time. Happily, this condition of the energy being a sum of two squares may be supposed to be satisfied by Planck's resonators, so that we may regard equation (1) as true for such resonators. The equation has, however, no physical meaning, owing to the presence of the arbitrary small quantity ϵ, and can acquire a physical meaning only by putting $\epsilon=0$. It then leads merely to equation (2), which can be obtained much more readily from the theorem of equipartition.

Taking $\mathfrak{u}d\nu$ to be the law of radiation, where ν is the reciprocal of the period of vibration, Planck introduces from his first paper the equation

$$\mathfrak{u}=(8\pi\nu^2/c^3)U \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

which in combination with equation (2) would lead to the law of radiation,

$$(8\pi k/c^3)T\nu^2 d\nu \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and this, on replacing ν by c/λ, becomes

$$8\pi kT\lambda^{-4}d\lambda \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

which agrees with my own result. Planck arrives at equation (3) by the help of his assumption of "natürliche Strahlung," but I believe it will be found that this "assumption" is capable of immediate proof by the methods of statistical mechanics. Except for this, and the other differences already stated, the way in which expression (5) has been reached in the present letter is identical, as regards underlying physical conceptions, with the way in which it has been obtained by Lord Rayleigh and myself.

Planck does not reach expression (5) at all, as he does not pass from equation (1) to equation (2). Instead of putting $\epsilon=0$, he puts $\epsilon=h\nu$, where h is a constant, and this leads at once to his well known law of radiation. It will now be clear why Planck's formula reduces to my own when $\lambda=\infty$. For taking $\lambda=\infty$ is the same thing as taking $\nu=0$, or $\epsilon=0$.

The relation $\epsilon=h\nu$ is assumed by Planck in order that the law ultimately obtained may satisfy Wien's "displacement law," *i.e.* may be of the form

$$\nu^3/c^3 f(T/\nu)d\nu \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

This law is obtained by Wien from thermodynamical considerations on the supposition that the energy of the ether is in statistical equilibrium with that of matter at a uniform temperature. The method of statistical mechanics, however, enables us to go further and determine the form of the function $f(T/\nu)$; it is found to be $8\pi k(T/\nu)$, so that Wien's law (6) reduces to the law given by expression (4). In other words, Wien's law directs us to take $\epsilon=h\nu$, but leaves h indeterminate, whereas statistical mechanics gives us the further information that the true value of h is $h=0$. Indeed, this is sufficiently obvious from general principles. The only way of eliminating the arbitrary quantity ϵ is by taking $\epsilon=0$, and this is the same as $h=0$.

Thus it comes about that in Planck's final law

$$\frac{8\pi ch}{\lambda^5}\frac{1}{e^{ch/k\lambda T}-1}d\lambda \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

the value of h is left indeterminate; on putting $h=0$, the value assigned to it by statistical mechanics, we arrive at once at the law (5).

The similarities and differences of Planck's method and my own may perhaps be best summed up by saying that the methods of both are in effect the methods of statistical mechanics and of the theorem of equipartition of energy, but that I carry the method further than Planck, since Planck stops short of the step of putting $h=0$. I venture to express the opinion that it is not legitimate to stop short at this point, as the hypotheses upon which Planck has worked lead to the relation $h=0$ as a necessary consequence.

Of course, I am aware that Planck's law is in good agreement with experiment if h is given a value different from zero, while my own law, obtained by putting $h=0$, cannot possibly agree with experiment. This does not alter my belief that the value $h=0$ is the only value which it is possible to take, my view being that the supposition that the energy of the ether is in equilibrium with that of matter is utterly erroneous in the case of ether vibrations of short wave-length under experimental conditions.

J. H. JEANS.

On the Spontaneous Action of Radium on Gelatin Media.

SINCE my communication to NATURE on the subject of the experiments in which I have been for some time past engaged, my attention has been directed to the fact that M. B. Dubois, in a speech at Lyons last November, stated that he had obtained some microscopic bodies by the action of radium salts on gelatin bouillon which had been rendered "aseptic," but in what manner it is not stated.

I write to direct attention to the fact, as also to add that M. Dubois's experiments were quite unknown to me.

Moreover, the theory that some elementary form of life, far simpler than any hitherto observed, might exist and perhaps be brought about artificially by "molecular and atomic groupings and the groupings of electrons"—in virtue of some inherent property of the atoms of such substances as radium—was pointed out in my article on the "Radio-activity of Matter" in the *Monthly Review*, November, 1903, whilst the experiments which I have been carrying out to verify this view have been for a long time known in Cambridge.

Although I did not make a speech on the subject, I demonstrated the growths to many people at the Cavendish and Pathological laboratories early in the Michaelmas Term last year.

So momentous a result as it seemed required careful confirmation, and much delay was also caused in taking the opinions of various men of science before I ventured to write to you upon the subject.

That M. Dubois's experiments have been made quite independently I do not entertain the slightest doubt.

Some critics have suggested that these forms I have observed may be identified with the curious bodies obtained by Quincke, Lehmann, Schenck, Leduc and others in recent times, and by Rainey and Crosse more than half a century ago; but I do not think, at least so far as I can at present judge, that there is sufficient reason for so classifying them together. They seem to me to have little in common except, perhaps, the scale of being to which as microscopic forms they happen to belong.

JOHN BUTLER BURKE.

The Problem of the Random Walk.

CAN any of your readers refer me to a work wherein I should find a solution of the following problem, or failing the knowledge of any existing solution provide me with an original one? I should be extremely grateful for aid in the matter.

A man starts from a point O and walks l yards in a straight line; he then turns through any angle whatever and walks another l yards in a second straight line. He repeats this process n times. I require the probability that after these n stretches he is at a distance between r and $r+\delta r$ from his starting point, O.

The problem is one of considerable interest, but I have only succeeded in obtaining an integrated solution for *two* stretches. I think, however, that a solution ought to be found, if only in the form of a series in powers of $1/n$, when n is large.

KARL PEARSON.

The Gables, East Ilsley, Berks.

British Archæology and Philistinism.

AT the end of the second week in July two contracted skeletons were found in a nurseryman's grounds near the famous British camp at Leagrave, Luton. Both were greatly contracted; one, on its right side, had both arms straight down, one under the body the other above; the other skeleton lay upon its left side, with the left hand under the face and the right arm straight down. Both were probably female, and upon the breast of one was a fine bronze pin seven inches long with three pendant ornaments, and three discs of bronze, one plated with gold. Other bronzes of great interest were found with the second skeleton.

I do not write to describe the bones and ornaments, but to make public the conduct of the Luton authority. A most intelligent workman lives close to the site of the discovery—one Thomas Cumberland—a man who has studied the antiquities of the district for many years, and to whom antiquaries are indebted for great and freely given assistance. This man was on the spot at once, and clearly and correctly stated the age of the bones and ornaments as British or late Celtic. Notwithstanding this information, the local police insisted on an inquest, although the bones were broken to pieces and in the highest degree friable. I went to the nursery and confirmed Mr. Cumberland's determination, made drawings of the bronzes, and such an examination of the bones as circumstances would permit. The coroner refused to hold an inquest, and so had no authority to make any order, but he wrote and "suggested" that the bones should be buried in the parish churchyard. Armed with this "suggestion," the relieving officer ordered an undertaker to carry off the bones, which he did, in spite of the protest of the nurseryman, who informed him that they had been given to me and were my property. He was ordered to put the bones in coffins and bury them in the churchyard of Biscot. The undertaker took the bones to his shop at Luton. I at once applied to the relieving officer for permission to examine and measure some of the bones. I clearly explained to him the nature and importance of the discovery, and the trifling nature of the favour asked. This official replied in a curt and rude manner, and simply said, "I have no authority; you must apply to the coroner."

I repeatedly wrote to the undertaker to delay the funeral for a few days. I twice wrote to the coroner in an urgent but most respectful manner, and pointed out the importance of the discovery, which, indeed, is quite unique in this district, but all to no purpose. He said he had not given the "order" for burial, and he refused to interfere, but he wrote to the undertaker and said, "I can give no consent or authority in any way, but must leave you to carry out the arrangement which has been come to with you." I wrote letters for six days to the different persons concerned, but to no effect; they would have a funeral, and the police now actually demanded the bronzes from the owner. The property is freehold.

Well, on Wednesday last the two coffins were screwed up at Luton and taken in a hearse to Biscot churchyard, where the vicar, in the presence of a policeman, officiated. Shining breastplates were screwed on to the coffins inscribed, "Bones found at Leagrave, July 1905." Amongst the bones in the coffins were several non-human examples, a rib bone of a sheep, a piece of a rib of beef, a bone of a rabbit, and another of roebuck.

Dunstable. WORTHINGTON G. SMITH.

Graphical Solution of Cubic and Quartic Equations.

SOME years ago you published some interesting communications in regard to the graphical solution of cubic and quartic equations (vol. lxi. p. 55, vol. lxiii. pp. 515 and 609, vol. lxiv. p. 5). The solutions then given give only the real roots of the equation. I therefore take the liberty of directing attention to the following method, which gives the roots of cubic and quartic equations whether the roots are real or complex, and may be applied to equations of higher degree, with more complicated results.

A cubic equation with real coefficients may be reduced by a simple real transformation to the form

$$z^3+qz+1=0,$$

where q is real, and since the sum of the roots of this equation is zero, they may be written in the form

$$-2y$$
$$y+\sqrt{x}$$
$$y-\sqrt{x}.$$

If, now, we form the symmetric functions, we have

$$3y^2+x=-q$$
$$2(y^3-xy)=1.$$

Hence if we draw the fixed curve

$$y^3-xy-\tfrac{1}{2}=0,$$

the coordinates of the points where it is cut by the movable parabola

$$3y^2+x+q=0$$

give the roots of the equation

$$z^3+qz+1=0,$$

i.e. if x_0 and y_0 are the coordinates of any such point, $-2y_0$ and $y_0\pm\sqrt{x_0}$ are the roots of the given equation.

In like manner a quartic equation with real coefficients may be put into the form

$$z^4+qz^2+z+s=0,$$

where q and s are real, and its roots may be put into the form

$$v\pm\sqrt{w_1}$$
$$-v\pm\sqrt{w_2}$$

and, forming the symmetric functions, we have

$$2v^2+w_1+w_2=-q \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$
$$2v(w_1-w_2)=-1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$
$$v^4-(w_1+w_2)v^2+w_1w_2=s \quad . \quad . \quad . \quad . \quad . \quad (3)$$

and if we put

$$4v^2=y$$
$$(w_1-w_2)^2=x$$

we find by simple elimination

$$xy=1,\ (y+q)^2-(x+4s)=0.$$

Hence the intersections of the fixed hyperbola with the movable parabola give values for x and y from which v, w_1, and w_2 may be calculated.

If we eliminate x from the two equations last written, we have

$$y^3+2qy^2+q^2y-4sy-1=0.$$

Hence there is always at least one positive value for y, therefore a real value of v; also, since $xy=1$, a positive value for x, therefore a real value for w_1-w_2; and since from (1) w_1+w_2 is real, real values for w_1 and w_2.

H. IVAH THOMSEN.

1928 Mt. Royal Terrace, Baltimore, Md., June 7.

THE PRESENT POSITION OF THE CANCER PROBLEM.

THE term "cancer" is in common parlance indiscriminately applied to all tumours the growth of which is unlimited and generally rapid, which tend to recur after removal by operation, and particularly which reproduce their like (the secondary or metastatic growths) in parts of the body remote from the original seat of disease. Pathologically there are various forms of "cancer," or malignant disease, but there is no need to deal with these here, and it may be stated that there is no sharp line of demarcation between the so-called benign and the malignant growths; there is a series of connecting links between the two. Malignant disease is an important cause of death. According to the last published report of the Registrar General (1903), the death-rate from this cause per 1000 living was 0·87; for comparison that for pulmonary tuberculosis (consumption) may be quoted; this was 1·2.

Moreover, it is a common belief that cancer is on the increase; people remark how much more frequently it is heard of now than formerly, and apparently the statistics support this view, for the cancer death-rate, which was 0·56 in 1884, has steadily increased, and is now 0·87, as stated above. Competent statisticians, however, doubt whether the increase is real or only apparent, and partly due to more accurate diagnosis and to a greater tendency to seek medical advice. During the last two or three decades surgery has made enormous strides, and it may be said that no region of the body is now beyond surgical interference. Many more obscure conditions, therefore, come under observation than formerly, and the vast majority of tumours removed by the surgeon are in the present day examined microscopically and their nature ascertained without doubt. In the Registrar General's Report for 1903 (p. 63), the various corrections which have to be made to obtain even an approximate corrected rate will be found. It is also to be noted that the deaths classed under "ill-defined causes," which doubtless included many cases of obscure malignant disease, have steadily fallen. Of 49,555 deaths from ill-defined causes in 1903, further inquiry showed that 439 were due to malignant disease. If these inquiries had not been made, which was formerly the case, these 439 deaths would have been omitted, and the cancer death-rate would have been correspondingly diminished. The statement is definitely made in the report of the Imperial Cancer Research Fund just issued that it is not yet possible to determine statistically whether cancer has really increased.

Cancer attacks rich and poor alike, and the manner in which it progresses to a fatal issue, unless early treated by radical operation, has caused it to be regarded with dread by all. It attacks all races of men, though the savage races seem less susceptible than the civilised, and it is met with throughout the vertebrate kingdom. There is no evidence that any form of diet or mode of life conduces to cancer-formation. The origin of cancer has for long exercised the minds of pathologists, and it is in particular the true cancers or epithelial tumours which have been the subject of most research.

The alleged causes of the origin of cancer may be divided into entogenous or intrinsic, spontaneous and anomalous changes within the organism, and ectogenous or extrinsic, derived from outside the body. Of the entogenous theories the most important are those of Thiersch and of Cohnheim. Thiersch suggested that tumour formation consisted in a loss of balance between the epithelial cells and connective tissue, whereby the former take on abnormal and undirected growth. Cohnheim referred the origin of cancer to embryonic cells which had for some unknown reason remained in an undeveloped state and become included in the tissues, and which subsequently proliferate and form the primary growth. Ectogenous theories ascribe the formation of malignant growths to the action of micro-parasites, and bacteria, yeast and other fungi, and protozoa have in turn been regarded as the causative organisms. There are, it is true, some analogies between certain microbic conditions and cancer formation, but the fact that it is a portion of the original growth conveyed by the blood and lymph to distant parts which causes the secondary growths, and that the tissues at the site of the secondary growth take no part in its formation, is quite different from what obtains in microbial affections. Attempts have been made to prove that cancer is contagious, and it is known that the disease is more prevalent in certain districts than in others, which lends some support to the parasitic theory. Auto-infection undoubtedly occurs; a cancer of the breast may infect the neighbouring arm, or of a lip the other lip, and cancer of mice can readily be inoculated into other mice, but these instances of apparent inoculation are rather of the nature of a transplantation; in the mouse it is the tissue introduced which increases and forms the malignant growth, not the tissue of the inoculated animal. Experiments by the staff of the Imperial Cancer Research Fund prove that healthy mice kept in close contact with cancerous mice never contract the disease.

The cancer of one animal is inoculable only into another animal of the same species, and human cancer, therefore, cannot be transmitted to the lower animals. All attempts to isolate a micro-parasite have proved failures, in spite of the vast amount of work done in this direction. The alleged organisms of cancer, such, for example, as certain yeast fungi, have, it is true, been found to produce tumour-like growths, but these have, on critical examination, been proved to be of the nature of granulomatous growths, and not true cancer. A point of which a good deal has been made by the supporters of the parasitic theory is that the so-called "cancer bodies," the alleged parasites, are present only in malignant growths, and not in normal or pathological tissue nor in benign tumours. But the deduction from this fact, that these bodies are therefore parasitic, has little to support it when it is considered that cancer is a unique tissue, and might obviously contain structures not found elsewhere and not necessarily parasitic. On these and other grounds the parasitic theory has of late steadily been losing ground.

The remarkable observations of Prof. Farmer and Messrs. Moore and Walker have recently thrown much light on the possible nature of the cancer process. As detailed in these columns (February 4, 1904, p. 319), it is found that in cancerous tissues many at least of the cells divide in a manner quite different from that of the somatic or body cells generally. This mode of cell-division observed in cancer is that which obtains in gametogenic or sexual reproductive tissue, and is characterised by a difference in the mode of division (transverse instead of longitudinal) and in the number (sixteen instead of thirty-two for man) of the chromatin bands or chromosomes of the nucleus, and is known as "heterotype mitosis." The division succeeding the heterotype, known as the homotype, still retains the reduced number of chromosomes, and is, therefore, sometimes termed "reduction division." Cells with reduction division do not seem to be able to regain the somatic mitosis except by fertilisation. This gametogenic-like tissue of malignant growths has been termed "gametoid." Other irregularities in division of cancerous cells also occur.

Another remarkable fact recently demonstrated by Messrs. Farmer, Moore, and Walker (NATURE, June 15, p. 164) is that in the normal reproductive tissues structures occur which are strikingly similar to the bodies ("cancer bodies") described by Ruffer, Plimmer, and others in cancerous growths, and regarded by many as parasites. These structures in the reproductive tissues are the archoplastic vesicles, and that similar structures should occur in cancerous growths (and not, be it noted, in benign tumours) on the one hand lends additional support to the idea of the gametoid nature of the cancer cells, and on the other further disproves the supposed parasitic nature of the "cancer bodies."

Is it possible from these observations to formulate a suggestion as to the nature of the cancer process? Prof. Farmer himself has stated that he and his co-workers do not profess to explain the relation between the heterotype mitosis of the gametoid cells of cancer and the life-history of cancer. It might be that the gametoid cells of the malignant growth undergo some process of fertilisation giving rise to an aberrant embryo, as it were, which by development forms the primary growth, which would thus be parasitic on the host, the secondary growths arising from a repetition of the primary event. In some plants gametogenic tissue may normally possess parasitic characteristics. There is, however, so far little evidence of fertilisation or fusion of the gametoid cells in cancer, except that, as recently stated by Mr. Moore (*Brit. Med. Journ.*, July 8, p. 104), leucocytes or white blood cells are sometimes found within the body of the cancer cells, with which they appear to be undergoing conjugation.

Messrs. Farmer, Moore, and Walker suggest that it is possible that the malignant elements are the outcome of a phylogenetic reversion, but this would not necessarily explain the *invasiveness* of cancer. In spite of recent work, much remains to be done and to be explained before we shall be in a position clearly to understand the cancer process.

With regard to the causes which lead to the production of the gametoid cells in cancer, it has been found that in plants various stimuli will rapidly bring about heterotype mitosis, and, given the proper stimulus, probably any somatic cell may become changed into this type. The connection between chronic irritation and cancer has long been recognised, but the manner in which this factor acts to produce cancer has not been understood; but in the light of the foregoing, it may be regarded as one of the stimuli which may bring about heterotype mitosis and reduction division.

Does recent work hold out a prospect of the discovery of a curative agent for cancer? It cannot be said that our hopes in this direction have been materially increased as yet. At present almost the only hope of cure lies in early and radical operation, and it is of the greatest moment that the public should realise the importance of early treatment, and that no time should be lost in seeking advice. In superficial cancers, the X-rays and radium emanations seem to effect a cure by causing a retrogression or a necrosis of the cancer elements. Possibly the gametoid tissue of the cancer is more vulnerable than the somatic cells, and hence the former may be caused to degenerate or be destroyed without materially injuring the latter, but probably the rays cause proliferation of the connective tissue elements of the growth and interfere with its nutrition. Is it possible that the stimulus of these rays may also act like fertilisation, and causes the gametoid once more to revert to somatic cells, which then being of the nature of a foreign body are partly removed and partly remain inert?

Clowes and Gaylord (Bulletin of the Johns Hopkins Hospital, April, 1905) have observed that cancer in mice occasionally undergoes spontaneous retrogression and cure, and the same occurs, but, unfortunately, only too rarely, in human cancer. Clowes found that the blood serum of the mice in which this spontaneous cure had occurred exerted a marked curative action on other mice suffering from the disease. This suggests the possibility that work of a similar nature may eventually lead to the discovery of a means of treating human cancer, but the probability is small, for it is extremely unlikely that the serum of any animal would have the slightest effect on the human being. A spontaneously cured human being would almost certainly have to provide the serum!

R. T. HEWLETT.

BRITISH FRUIT GROWING.

THE report to the Board of Agriculture of the departmental committee appointed to consider what measures can be taken for the promotion and encouragement of fruit culture in these islands has been issued. The commissioners recommend that a special department should be formed to deal with matters relating to the fruit industry, and that this department should be subdivided into (*a*) a bureau of information; (*b*) an experimental fruit farm. The desirability of encouraging the practice of gardening in schools in the rural districts is also alluded to, and this recommendation will be generally concurred in. Legal questions connected with the tenancy and rating of land used in fruit culture are of cardinal importance, as also are those relating to the carriage of fruit by rail and to the alleged unfair treatment by the companies of the home-grower as compared with his foreign competitor. The necessity of further market accommodation is likewise insisted on.

These are all matters of importance, but they do not cover the whole of the ground. We find no reference in the report before us of the influence of the weather on the fruit crops, and yet this is a factor the potency of which outweighs all others. In the case of hardy fruits, not grown under glass, the fruit grower is in the main powerless to contend against adverse conditions. The tabulated reports from every county in the British Islands, which have been published annually for the last forty or fifty years in the *Gardeners' Chronicle*, bear ample testimony to this. Spring frosts when the trees are in blossom occur more or less every year, and when they happen to be severe, as they were this year, the results are disastrous. The reports from the cherry-growing districts of Kent this year show remarkable diversity of yield from farms in the same neighbourhood, a diversity due presumably to differences of shelter and aspect. It is difficult to see how the grower can protect himself from these adverse conditions. Experimental farms such as are recommended by the commission, and of which one is in operation at Woburn under the auspices of the Duke of Bedford, are for the most part of local value only; the lessons they teach may not be applicable in the next parish where the conditions are different.

Can nothing, therefore, be done? We should be sorry to assent to such a proposition. We believe that something could be done. But then arises the question whether, in the face of the vast importations first from the American continent, and when supplies from that quarter are exhausted, from Tasmania and Australia, any steps which the British grower could take would be of any use, commercially speaking? Again, no competition on the part of the home-grower is possible with the banana imports from the Canaries and the West Indian islands, which are assuming such vast proportions, or with the still larger importations of oranges. The case is different when what are termed soft fruits are concerned. We can hold our own with strawberries, raspberries, and currants, whilst gooseberries, especially when picked in a green condition, are among the most profitable crops that a farmer or even a cottager can grow. Spring frosts do them relatively little harm, so that a crop of some sort can generally be relied on.

From a commercial standpoint, when we talk of our home fruit-crops we mean apples or plums, and reverting to the subject of spring frosts we may well inquire whether it is not possible for our experts to raise breeds which shall be immune from injury. Our American cousins hoped for great things by the introduction of Russian apples, and some were tried here also, but the results were not encouraging, as the quality of the fruit was so indifferent that the experiment was not continued. Another lesson from the same source seems more promising. When a few years ago a "big freeze" occurred in Florida, the orange plantations suffered exceedingly. What did our friends do? Did they abuse the fickleness of their climate and take their misfortunes with the resignation of the fatalists? Not so. They set to work without loss of time to raise by means of cross-breeding a hardy variety, and they have at least made a good beginning. So, too, have our friends the

French, who by the cross-fertilisation of the hardy *Citrus triptera* and an ordinary orange have succeeded in producing a hardy variety of that fruit. Matters are as yet only in the experimental stage, but the possibility of success has been demonstrated. There is no reason whatever why our own experimentalists should not succeed with apples and plums. Earlier varieties, later varieties, hardier varieties, are all well within the range of possibility, and would be certainly forthcoming if we abandoned our present methods of chance selection and haphazard cross-breeding in favour of careful experiment and rational procedure.

Not only are experimental farms wanted for local purposes, but research stations wherein results might be obtained of universal application.

The Royal Horticultural Society has in its new garden at Wisley, presented by Sir Thomas Hanbury, a splendid opportunity before it, and it is to be hoped that it will not be backward in turning it to account. The fruit farm at Woburn, to which allusion has already been made, sets an example which might be followed and extended with advantage. Already important results with reference to the employment of manures have been obtained there which, though of a negative character, are none the less valuable.

NOTES.

THE annual meeting of the British Medical Association began at Leicester on Monday last. On Tuesday, Dr. G. Cooper Franklin, the president for the year, delivered his address, and the association's gold medal of merit was presented to Sir Constantine Holman and Dr. Andrew Clark. The Stewart prize was presented to Mr. W. H. Power, C.B.

THE British Electro-Therapeutic Society is holding a three days' meeting at Leicester this week. The following subjects are announced for consideration:—the present position of the treatment of carcinoma and sarcoma by electrical methods, neurasthenia, the X-rays in the diagnosis of pulmonary disease, and stereoscopic radiography, while a report will be given on the milliamperemeter as a measure of X-ray production.

THE forty-second annual meeting of the British Pharmaceutical Conference was opened at Brighton on Tuesday last. The organisation, it will be remembered, is distinct from the Pharmaceutical Society, and is solely concerned with "the encouragement of pharmaceutical research, and the promotion of friendly intercourse and union amongst pharmacists." The president, Mr. W. A. H. Naylor, delivered his address, and the reading and consideration of papers took place. The meeting terminates to-day.

SEVERAL earthquake disturbances are reported. According to a Central News telegram from Vienna, the seismograph at the Pola Hydrographic Station registered between 3.55 a.m. and 4.17 a.m. on Sunday last the occurrence of a severe and protracted seismic disturbance at an estimated distance of some 3720 miles, and telegrams from St. Petersburg, through Reuter's Agency, state that earthquakes occurred in Siberia at the following places and times:—at Chita at 10.25 on Sunday morning last; at Marünsk, in the Government of Tomsk, at about 9 a.m. of the same day; and at Kiakhta at 10 o'clock on the morning of Tuesday last. An earthquake is stated also to have taken place at Menstrie and Blair-Logie, and to have been felt in other parts of Scotland, shortly after midnight of Sunday last.

THE committee appointed in April last to consider the advisability or otherwise of confederating the principal London medical societies has now presented its report (one favourable to confederation), which, with certain minor alterations and additions, has been adopted. According to the *British Medical Journal*, it is suggested that the new society should be known as either the Royal Society of Medicine or the Royal Academy of Medicine, and that at first it should comprise the following sixteen sections:—(1) anæsthetic; (2) clinical; (3) dermatological; (4) diseases of children; (5) epidemiological; (6) laryngological, otological, and rhinological; (7) medical; (8) mental medicine (psychiatry); (9) neurological; (10) obstetrical and gynæcological; (11) odontological; (12) ophthalmological; (13) pathological; (14) State medicine; (15) surgical; (16) therapeutical, including general therapeutics, pharmacology, electrotherapeutics, balneology, and climatology. The hope is expressed that in the early future an anatomical and physiological section may be formed.

THE arrangements for the meeting in London of the International Statistical Institute, which is to take place from July 31 to August 4, are now practically complete. The proceedings will be opened at the Imperial Institute by the Prince of Wales, who will deliver an address. Addresses will also be given by the president of the institute, Dr. von Inama-Sternegg, and by the president of the Royal Statistical Society, the Earl of Onslow, after which the following communications will be presented and discussed:—superficie et population du monde; balance économique des nations; mortalité des grandes villes; statistique de la tuberculose; fécondité des mariages; statistique des transports internationaux; accidents du travail; international comparison of workmen's wages; recensements industriels et statistique du chômage; l'enseignement supérieur; import and export statistics; répercussion des droits de douanes; international agricultural statistics; valeurs mobilières; some subjects connected with pauperism; and discours sur l'avenir de la statistique.

PARTICULARS have been issued as to the arrangements which have been made for the autumn meeting of the Iron and Steel Institute. The meeting will be held at Sheffield from September 26 to 29, and the following papers have been offered for reading:—On the metallurgical department of Sheffield University, by Prof. J. O. Arnold; on the thermal transformation of carbon steels, by Prof. J. O. Arnold and A. McWilliam; on the nature of troostite, by Dr. C. Benedicks; on the occurrence of copper, cobalt and nickel in American pig irons, by Prof. E. D. Campbell; on pipe in steel ingots, by J. E. Fletcher; on steel for motor-car construction, by L. Guillet; on the presence of greenish-coloured markings in the fractured surface of test pieces, by Captain H. G. Howorth, R.A.; on overheated steel, by A. W. Richards and J. E. Stead, F.R.S.; on segregation in steel ingots, by B. Talbot; on a manipulator for steel bars, by D. Upton; on machinery for breaking pig iron, by C. Walton; on the influence of carbon on nickel and iron, by G. B. Waterhouse.

THE congress of the International Society of Surgery will this year be held in Brussels. The meetings will take place from Monday, September 18, to Saturday, September 23, and will be under the presidency of Prof. Theodor Kocher, of the University of Berne. Among the subjects to be discussed are:—the value of the examination of the blood in surgery; the treatment of prostatic hypertrophy; surgical intervention in non-cancerous diseases of the stomach; treatment of articular tuberculosis; the treatment of peritonitis; and the diagnosis of surgical diseases of the kidney. The official languages of the congress are English, French, German, and Italian. The English delegate is Mr. R. Harrison, 6 Lower Berkeley Street, W.

Science gives particulars of the sixth International Congress of Applied Chemistry, which is to take place in Rome in the spring of next year. The congress will be divided into eleven sections as follows:—Analytical chemistry, apparatus and instruments; inorganic chemistry and industries related thereto; metallurgy and mining, explosives; organic chemistry and industries related thereto; technology and chemistry of sugar; fermentation and starch; agricultural chemistry; hygiene; photochemistry, photography; electrochemistry, physicochemistry; laws, political economy and legislation in relation to industrial chemistry. The languages to be used in the discussion are Italian, French, German, and English. The minutes of the proceedings of the session will be in Italian. The secretary of the congress is Prof. V. Villavecchia, Central Customs Laboratory, Rome.

It is stated in *La Nature* that the seventh International Congress of Zoology is to be held at Boston, U.S.A., in August, 1907, under the presidency of Prof. Agassiz. The Emperor Nicolas II. prize will be awarded on this occasion for monographs on the subject "Nouvelles recherches expérimentales sur la question des hybrides." The essays, either in manuscript or printed, should be addressed before June 1, 1907, to Prof. R. Blanchard, boulevard Saint-Germain, 226, Paris. The essays should be in French, though those written in German, Italian, or English will be admitted to the competition if accompanied by a summary in French.

It has been decided by the Government of New Zealand to hold during the summer of 1906–7 (*i.e.* from November, 1906, to April, 1907) at Christchurch an international exhibition in which all nations are invited to participate. The object of the exhibition is educational, and to demonstrate the resources of the colony in food production, yield of minerals, the supply of raw materials, &c. Intending exhibitors may obtain full particulars from the secretary of the exhibition at Christchurch, New Zealand.

The report of the special committee appointed by the Government of Bombay to consider the question of a public museum and library for Bombay has been issued. The estimated initial cost of the buildings alone is approximately ten lakhs, four of which are for the building devoted to art and archæology, and three for the science museum and public library respectively.

The Paris correspondent of the *Lancet* states that a permanent committee to deal with the watering places and climatic stations in France has just been established by the Minister of the Interior. The committee, the honorary president of which is the Minister of the Interior, is to examine into the general needs of the places referred to, and to protect and develop them. The mayors and the medical men of the various watering places, the directors and the committees of *sociétés thermales*, are liable each in his turn to be summoned to serve on the committee for a period not exceeding three years.

The sum of 150,000 kroner has been given by Dr. F. G. Gade, of the University of Christiania, to the city of Bergen for the establishment of a laboratory of pathological anatomy.

It is intended to celebrate the jubilee of Prof. D. I. Mendeléeff on August 30, this eminent man of science having completed his fiftieth year of public professional service on June 13 last.

M. J. Dybowski, inspector-general of agriculture in the French colonies, has been elected an officer of the Légion d'honneur, and Dr. Giraud, head of the scientific mission to Martinique, has been raised to the dignity of chevalier.

A portrait medallion, in marble, of Sir William Geddes, the late principal of the University of Aberdeen, has been completed, and will be placed in the Geddes transept of the library at King's College. Its unveiling will probably take place at the beginning of the winter session. A meeting in furtherance of the proposed memorial to the late Prof. James Nicol was held recently in Marischal College, when a number of letters from geologists and old pupils of Prof. Nicol were read, the general tenor of which favoured the placing of a portrait tablet in bronze in the geological museum. There will be, it is hoped, a formal inauguration of the memorial during the centenary celebrations of next year.

The council of the Royal Meteorological Society, being desirous of advancing the general knowledge of meteorology and of promoting an intelligent public interest in the science, has appointed a lecturer who is prepared to deliver lectures to scientific societies, institutions, and schools on payment of a moderate fee and the cost of travelling expenses, the subjects being:—how to observe the weather; weather forecasting; climate; rainfall; thunderstorms; meteorology in relation to agriculture, health, &c. The society is also prepared to lend and fit up a complete climatological station for exhibition, showing the necessary instruments in position and ready for use, and to lend in return for a nominal amount sets of lantern slides illustrating meteorological phenomena. Further particulars as to the scheme can be obtained from the assistant secretary of the society.

In the report for 1904 of the hydrographer of the Admiralty which has just been issued as a Parliamentary paper, reference is made to the retirement, after twenty years' service, of Rear-Admiral Sir W. J. L. Wharton, K.C.B., F.R.S. During the year under review, 482 rocks and shoals dangerous to navigation were reported. Of these 65 were notified by surveying vessels, 31 by other ships in the British Navy, 8 by vessels not in the navy, 26 were struck, and 352 were reported by colonial and foreign Governments; 1139 miles of coast line were charted, and an area of 3993 square miles sounded. During the year the number of charts printed for use in the Royal Navy, the Government departments, and by the public reached the total of 661,590 copies, and 1245 notices to mariners were issued.

The vast deposits of magnetic iron sands in the province of Taranaki, in New Zealand, containing 60 per cent. of iron and 8·14 per cent. of titanic acid, have long attracted the attention of metallurgists, and numerous attempts have been made to smelt the ores by making them into bricks by the admixture of various substances. In 1873 works on which 17,350*l*. were spent proved a failure. A new departure has now been made by the Galbraith Iron and Steel Company, Ltd., of Auckland, by adopting the electric furnace for the direct production of steel from these sands, and by invitation of that company we were afforded an opportunity of witnessing the furnace in operation at the Brush Electrical Engineering Company's works at Loughborough, Leicestershire, on July 19. In the furnace invented by Mr. D. R. S. Galbraith, a constant stream of iron sand mixed with a given quantity of carbon is fed in at the top of the furnace, and travelling downwards by gravitation falls between and upon graphite bars forming resistances in the circuit, and finally leaves the furnace in the form of molten metal. The power is supplied by a single-phase alternator having an output of 100 kilowatts at 300 volts. This pressure is reduced to 18 volts by means of a transformer in close proximity to the furnace. The plant is, of course, an experimental one, and will require to be modified in several ways before it is used on a commercial scale.

DR. J. JOLY, F.R.S. (*Scientific Proceedings of the Royal Dublin Society*, vol. x., No. 34), being struck by the difficulties raised by the silting up of harbours on the south-east Irish coast, suggests the use of floating breakwaters moored to the bottom, but sufficiently deep to prevent response to the rise and fall of waves. They would thus be affected only by the tidal movements, and the dimensions "need not be extravagant where the conditions are not such as to require protection from deep-water waves." Two types are illustrated, the one cylindrical, with a submerged platform below, going down to about four fathoms, and the other more like a flat-bottomed ship, wider below and narrower above, with a hold full of water to increase the inertia. The author believes that in the seas inside the banks of Wicklow and Arklow such a mass might be assumed to be unaffected by wave-motion. The presence of such a breakwater, it is suggested, might even favourably increase the tidal scour.

WE have received from the Home Office part iv. of the general report on mines and quarries for 1903, containing comparative statistics relating to persons employed, output, and accidents at mines and quarries in the British colonies and in foreign countries. A good idea is given of the relative importance of mining in each country. In 1903 the number of persons engaged in mining and quarrying was 4,861,932, of which one-fifth were employed in the United Kingdom and one-third in the British Empire. More than half the total were employed in getting coal, of which the world's production was 881,002,936 tons. The world also produced 609,985 tons of copper, 491,672 kilograms of fine gold, 44,548,962 tons of pig iron, 892,899 tons of lead, 26,232,099 tons of petroleum, 12,818,253 tons of salt, 4,997,491 kilograms of fine silver, 98,295 tons of tin, and 570,440 tons of zinc. The death-rate from accidents throughout the world in 1903 is estimated at 1·83 per 1000, as compared with 1·93 per 1000 in 1902. For coal mines the accident death-rate of the United Kingdom is 1·26, and for the British Empire 1·33; while for France it is 1·02, for Germany 2·00, and for the United States 3·09. The death-rate for foreign countries generally is 2·14. It is evident that mining is conducted in Great Britain with a far smaller risk of accident to the workers than in most other countries.

THE meteorological results deduced from the observations taken at the Liverpool Observatory, Bidston, for the year 1904 have been published by Mr. W. E. Plummer. This observatory is maintained by the Mersey Docks and Harbour Board, and is one of the oldest and best equipped in the United Kingdom. Many years ago, the late Mr. W. W. Rundell prepared an elaborate discussion of the winds of Liverpool, which was published by the Meteorological Office. We notice that at the present time much attention is paid to this subject, which is naturally of the greatest importance for the shipping of the Mersey. Three anemometers of the Osler, Robinson, and Dines patterns are kept in efficient operation, and the maximum velocities and extreme pressures of the wind on the square foot are given for each day of the year, while the monthly and yearly summaries of the principal meteorological elements are expressed in imperial and metric measures. In the astronomical department, the transit instrument has been used continuously for the determination of time, and 2586 stars were observed during the year.

WE have received the annual report of the director of the Royal Alfred Observatory (Mauritius) for 1904; it contains the means and extremes of the meteorological elements and other general information; the actual observations will be published in a separate volume. From a table showing the observations of the direction of the various types of clouds, it is noteworthy that out of 821 observations the cumulus cloud was observed on 397 occasions, the cirrus cloud on only 66 occasions. The mean annual rainfall at ten selected stations was 13 inches below the average. The log-books of ships visiting the island were copied, and a daily journal of the weather over the Indian Ocean kept; it is noticeable that the number of vessels arriving annually between 1882 and 1904 have steadily decreased from 686 to 262. Photographs of the sun were taken daily whenever possible; 638 negatives were forwarded to the Solar Physics Committee. During the year 65 earthquakes were recorded. The observatory is still much troubled by depredations of white ants; numerous poisons have been tried for their extermination, the most efficacious being a solution of sal-ammoniac, turpentine, and methylated spirit, while the bookshelves are insulated with castor oil.

ONE of the scientific results of the annexation of the Philippines by the United States is the study of the ethnography of the group. Mr. W. Allan Reed has published a report on the Negritos of Zambales (vol. ii., part i., Ethnological Survey Publications, Manila, 1904). This is in reality only a sketch, as the author was only two months in the field, but his observations have undoubted value; doubtless a more thorough study will be made of these interesting people. The sixty-two plates which illustrate the paper add very considerably to its value, and by their means one can gain a very good idea of these jungle folk. A very useful album of Philippine types by D. Folkmar has been published by the Philippine Exposition Board, Manila; it contains eighty plates of photographs—full-face and side view of head—of inmates of Bilibid prison. The author has been careful to select typical examples from various districts, and opposite each plate are given certain measurements of the individual photographed, together with the averages of the same measurements taken on a large number of examples of that particular tribe. This is a very useful device, as it gives some sort of clue as to whether the individual figured is a fairly typical example of his tribe.

WRITING to *La Sicilia*, Prof. A. Ricco mentions that the crater of Etna is extending towards the north-west, and along the whole of the circumference, from north to west, is a great continuous fissure emitting steam and heated vapours. As the whole of the ground between this fissure and the margin must fall into the crater, he warns intending visitors of the need of caution in approaching the crater from the westwards, the direction from which it is most easily accessible.

IN the May number of the *Rend. Acc. Lincei* A. Pochettino describes the luminescence emitted by certain crystals under the action of radium and Röntgen rays.

The light given out by the platino-cyanides is, as a rule, vivid and partially polarised; it disappears directly the exciting cause is withdrawn. Crystals of scheelite, phosgenite, &c., show a feeble luminescence lasting several seconds after the removal of the incident rays.

IN part i. of a contribution to the *Scientific Transactions of the Royal Dublin Society,* vol. viii., p. 16, Prof. A. W. Conway discusses the partial differential equations of mathematical physics which in their general form are partial differential equations of the second order with constant coefficients reducible by transformation to three different classes. The problem has been attacked by Whittaker from the point of view of building up singular solutions from plane-wave solutions, but Prof. Conway adopts the reverse course, starting with the singular solution.

AMONG the results of the recent Röntgen congress at Berlin has been the authoritative adoption by a special committee of the following terminology:—Röntgenology = the study of Röntgen rays, Röntgenoscopy = observation by Röntgen rays, Röntgenography = photography by the rays, Orthoröntgenography in place of orthodiagraphy, Röntgenotherapy and the verb to röntgenise in their obvious meanings.

THE question "What is research?" is discussed by Prof. Henry S. Williams in the *Popular Science Monthly.* The author considers that research is not a special faculty possessed by the few, but a common faculty specially trained and systematically exercised by the few, for whom it becomes a tool of the highest value, and the means of opening up new fields of knowledge to mankind. At the same time, he directs attention to the detrimental effects of too much book learning on the power of research, and the need of a vivid imagination such as can be exercised and disciplined by the study of mathematics. Moreover, the man of research must be prepared to sacrifice his prospects in other directions and to work alone, "unappreciated and unapplauded" in most of his work, and Prof. Williams finally cautions teachers against tempting mere enthusiasts to undertake a task which requires for success the toughness of a soldier, the temper of a saint, and the training of a scholar. The subject of the article is one which might be very well discussed further in view of the large amount of "research," falsely so-called, which is now being turned out by persons not possessing any of these qualities, with the great danger of lowering public estimation of the importance of work of real scientific value.

DR. J. HETTINGER, writing from London in the *Physikalische Zeitschrift* for June 15, describes a new electrical connection for intensifying the resonance effects in wireless telegraphy.

THE Mathematical Association has reprinted the report of its committee on the teaching of elementary mathematics. In the same pamphlet are reproduced the "Little Go" regulations in geometry. We observe that Cambridge advocates the "hard pencil," which leads to so many indistinct figures in candidates' answers. A valuable mental training is thus omitted in not requiring candidates to make their drawings, as well as written work, clear and distinct to others. Moreover, even a soft pencil with a thick point has an advantage in showing that in any *constructive* proof lines must necessarily be of a certain thickness, and the conclusion is only established as approximately true. The beginner who learns this will be the better able to appreciate the deductive method at the proper time.

THE surfaces obtainable by the deformation of a hyperboloid of revolution of one sheet are discussed by Prof. Luigi Bianchi in the *Atti* of the Lincei Academy, xiv., 10. The determination of these surfaces is shown to depend on that of a certain class of imaginary pseudospherical surfaces, and the difficulty of the problem is reduced to that of characterising these latter surfaces, and thus presenting the final transformation formulæ in a real and definite form.

THE Institution of Electrical Engineers has published an address delivered to its students in January last by Mr. James Swinburne, M.Inst.C.E., on "The Theory of Electricity and the Value of its Study to Engineers." In it the author emphasises the desirability in many cases of mathematics being learnt through its applications, and points to the theory of electricity as affording a valuable introduction to the study of many of the most important branches of mathematical analysis. In conclusion the author says:—"I feel confident that enough has been said to make it evident that a modern engineer cannot consider his technical equipment complete without some knowledge of the theory of electricity; and if electrical development continues at the present rate it may soon be the most important branch of the science of engineering."

Biologisches Centralblatt of July 1 contains the report of an interesting address on the use and place of hypotheses, suppositions, and problems in biology, delivered by Mr. J. Reinke at the opening session of the International Botanical Congress at Vienna on June 12. That theories and hypotheses have a great and important place in science —indeed, that they are absolutely essential to its proper advance—the lecturer fully admitted; but, he added, it is necessary to remember that they are nothing more than theories, otherwise there is the greatest danger of their proving a hindrance and an illusion. A notable instance of this danger is afforded by the numerous phylogenies of animals and plants which are published from time to time, and are too often accepted as though they were solid facts, instead of being in most cases mere hypotheses, based not unfrequently on the very slenderest of foundations.

A YEAR ago we referred to notices of the occurrence of the striped hawk-moth in this country, and we observe that in the *Entomologist* for June and July several instances of the capture of the same species this season are mentioned. Possibly this handsome moth may become established in the south of England, at least for a time. In the July number Mr. G. W. Kirkaldy continues his popular synopsis of British water-bugs.

To the *Journal of Conchology* for July Mr. A. D. Darbishire contributes a discussion on Prof. Lang's experiments in breeding with the two common garden snails *Helix hortensis* and *H. nemoralis.* The writer denies that these experiments confirm the truth of Mendel's doctrine, *stricto sensu*; that is to say, they do not afford conclusive evidence of the existence in the gonads of *H. hortensis* of definite unit-bearing elements representing either five-banded or unbanded shells. It is added that much interest will attach to the description of the characters of the "dart" in the hybrid between the two species in question.

IN the course of a paper published in the June number of the *American Naturalist* on the advantages presented by the common skate as a subject for demonstration to anatomical classes, Dr. H. W. Rand takes occasion to emphasise the importance of selecting generalised, in place of specialised, species for such demonstrations. A skate or a dog-fish is thus to be preferred to a bony fish, and similarly a salamander to a frog. As regards the choice between a skate and a dog-fish, although the former is a much more specialised type than the latter, it has the advantage of being more easily obtained and of being available for the greater part of the year. Moreover, its very specialisation happens to be an advantage to it as an object for demonstration, for not only does its flattened form render it admirably suited for dissection, but most of its organs are brought more or less nearly into one horizontal plane, so as to be capable of demonstration almost as if drawn in a diagram. Apropos to this article is a second, by Messrs. Rand and Ulrich, on posterior connections of the lateral vein in the skate. To the same issue Mr. E. W. Berry contributes an article on fossil sedges and grasses, with the description of a new Carex; and Mr. J. A. Cushman one on the fossil crabs from the well known Miocene beds of Gay Head, Mass., described long ago by Dr. E. Hitchcock, and subsequently by Sir C. Lyell.

AN interesting paper on the gradual dissociation of mellitic acid is contributed by A. Quartaroli to the current number of the *Gazzetta Chimica Italiana*, vol. xxxv. p. 470. The author has measured the rate at which cane sugar is inverted by mellitic acid and by the corresponding mono-, di-, tri-, tetra-, and penta-sodium salts in one-tenth molecular solution. If the velocity constant for the free acid is represented by 100, the values for the various salts in the order given are respectively 40·5, 14·3, 2·2, 1·5, and 1·04. These numbers may be taken as a measure of the relative tendencies to ionisation of the six successive acid hydrogen atoms. Taking the ratio of the first to the second, of the second to the third, &c., the series 2·47, 2·82, 6·49, 1·47, 1·43 is obtained. These numbers are interesting, and the occurrence of a maximum value in the middle of the series suggests that the dissociation of mellitic acid is of abnormal character.

DURING the past week the Royal College of Surgeons of Edinburgh has been celebrating its four hundredth anniversary. The college, which is the oldest medical or surgical corporation in the United Kingdom, dates from July 1, 1505. The Royal College of Physicians of London, the next in point of age, was officially established some thirteen years later, *i.e.* in 1518. The current number of the *Lancet* contains an interesting account of the older institution.

THE third number of the second volume of the Investigations of the Departments of Psychology and Education of the University of Colorado has reached us. Among other contributions, those in which Prof. Francis Ramaley deals with the teaching of botany and zoology, and Prof. Chas. A. Lory with the teaching of physics, are of special interest.

WE have received a copy of "Southern Rhodesia, Information for Settlers," a small handbook issued by the British South Africa Company. The title sufficiently indicates the nature of the contents of the book, but it is worth noting that many of the numerous illustrations are of considerable geographical interest and value.

THE report of the Royal Cornwall Polytechnic Society for 1904 has just been published, and bears testimony to the continued vitality of the society. One of the chief features of the society's activities during the year was its exhibition, in connection with which addresses and papers were given on electrical research, practical bee-keeping and management, and the geology, minerals and mines of Lelant, St. Ives, and Zennor. The first and last of these communications are to be found in the report before us, as is also an informing paper by Mr. C. C. Bignell on the aphides with their food plants; the volume likewise contains a detailed report of the work accomplished at the Falmouth Observatory.

THE new number of the *Quarterly Review* contains only two papers dealing with scientific subjects, one on the national coal-supply, the other, by Sir Charles N. Eliot, on the Buddhism of Tibet. Both communications are very informative and eminently readable.

MESSRS. R. AND J. BECK, LTD., of Cornhill, have just issued a catalogue of microscopes and apparatus specially suited for metallurgical work.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN AUGUST:—

Aug. 2. 1h. Mercury at greatest elongation (27° 18′ E.).
,, 2. 12h. 28m. to 14h. 6m. Transit of Jupiter's Sat. III. (Ganymede).
,, 4. Pallas in opposition to the sun.
,, 11–13. Epoch of Perseid meteoric shower (Radiant $45° + 57°$).
,, 12. Saturn. Major axis of ring $= 43''·82$, Minor axis $= 7''·47$.
,, 14. 10h. Venus in conjunction with Neptune, Venus 0° 48′ S.
,, 14. Partial eclipse of the moon visible at Greenwich.
14h. 39m. First contact with shadow.
15h. 41m. Middle of the eclipse.
16h. 43m. Last contact with shadow.
Magnitude of eclipse = 0·292. Moon sets 16h. 53m.
,, 15. 9h. Saturn in conjunction with moon, Saturn 1h. 43m. S.
,, 15. Venus. Illuminated portion of disc = 0·680, of Mars = 0·854.
,, 16. 11h. 49m. Minimum of Algol (β Persei).
,, 19. 8h. 38m. Minimum of Algol (β Persei).
,, 22. 21h. 0m. Saturn in opposition to the sun.
,, 23. 12h. 5m. to 12h. 46m. Moon occults σ^2 Tauri (Mag. 4·8).
,, 30. Total eclipse of the sun, partly visible at Greenwich.
11h. 49m. a.m. Beginning of the eclipse.
1h. 3m. p.m. Middle of the eclipse.
2h. 15m. p.m. End of the eclipse.
Magnitude of eclipse = 0·786. Sun's altitude at noon = 48°.

PHOTOGRAPHS OF THE MARTIAN CANALS.—Since the opposition of Mars in 1901, persistent efforts have been made at the Lowell Observatory to secure photographs of the planet on which the canals could be seen definitely. After making a number of exposures with a camera in which the film was continuous, so that a large number of short exposures—as in the bioscope—could be made on the one film, Mr. Lampland succeeded in obtaining negatives which demonstrate indubitably the actual existence of the "canals" Nilosyrtis, Pyramus, Casius, Protonilus, Astaboras S., and Thoth. In addition to these, the "regions" Syrtis Major, Mare Erythræum, Mare Icarium, Hellas and the north polar cap, and the "oasis" Lucus Ismenius are plainly discernible. A photographic print from a negative secured on May 11 at 19h. 44m.–48m. (G.M.T.) on which these features are visible is affixed in the *Lowell Observatory Bulletin*, No. 21, accompanied by a drawing made by Mr. Lowell immediately before the exposure was made. Other photographs secured show other canals, and Mr. Lampland is to be congratulated, in company with Mr. Lowell, upon thus securing unquestionable evidence of the actual existence of these features.

A point of special interest to planet observers is that whilst trying to obtain these photographs the observers found that the restriction of the aperture employed, by its elimination of the evil effects of atmospheric vibrations, more than counterbalanced the inconvenience caused by the diminution of light-gathering power and the consequent increase of the length of the exposures, a result which confirms the conclusion previously arrived at by Mr. Lowell from visual observations.

DUTCH OBSERVATIONS OF THE CORONA.—Parts iii. and iv. of Prof. Julius's report on the observations made by the Dutch expedition in Sumatra during the total solar eclipse of May 18, 1901, minutely describe the apparatus and the methods of procedure employed in examining the coronal radiations for polarisation effects and for the determination of the amount of heat radiated by the eclipsed sun.

A double-image polarimeter of the Cornu pattern, slightly modified, was employed to examine the polarisation at different points of an image of the corona. The points examined were situated at different distances from the sun's limb, and the position of each was carefully recorded. The results showed that the coronal rays were more strongly polarised at some distance from the limb than nearer to it, whilst at greater distances the polarisation again decreased. A discussion of some experiments, performed after the eclipse, on the depolarising effect of haze and clouds showed that this effect was practically negligible.

The observations of the total heat radiated by the eclipsed sun were made with a thermopile pointed directly to the corona, but clouds robbed the observations of any definite result. So far as they go, the resulting figures show that the heat radiated at totality is not so great as that received from the full moon, and that a very striking increase occurred after the third contact.

THE NORTH POLAR SNOW-CAP ON MARS, 1904–5.—Observations of the north polar cap of Mars were made at the Lowell Observatory by Messrs. Lowell and Lampland during the period November, 1904, to May, 1905, and the observers' notes for each night are given in full in No. 20 of the *Lowell Observatory Bulletins*.

One remarkable feature observed was a white collar which surrounded the cap during the latter half of January. Mr. Lowell explains this phenomenon by the conjecture that it is a belt of spring haze which surrounds the cap during the hotter months of the melting, the cap proper being bordered by a blue belt of material (probably water) produced by the melting of the snow. Several subsidiary patches of snow were left behind by the receding polar cap, and became prominent features.

Of these, one in longitude 206° was especially marked, and was recorded in exactly the same longitude by Schiaparelli in 1888, and independently at the Flagstaff Observatory in 1901 and 1903.

VEGETATION AND THE SUN-SPOT PERIOD.—Since 1871 M. Camille Flammarion has each year recorded the dates on which the chestnut trees in the avenue of the Paris Observatory have burst into leaf and flowered. Plotting the results of his observations with the sun-spot curve on the same year-scale, he found that the variation of the dates of the different phases of the annual arboreal phenomena agreed very closely with the latter curve, the leaf-buds bursting and the flowers appearing earlier at those epochs when the sun-spot *maxima* occurred. The details of the observations and the method employed in reducing them are given in the July number of the *Bulletin de la Société astronomique de France*.

VISIBILITY OF THE DARK HEMISPHERE OF VENUS.—In a paper on the influence of the solar-activity variations on the planets, M. Hansky directs attention to the greater visibility of the dark hemisphere of Venus during epochs of maximum solar activity. According to the theory of Arrhenius, electrified ions emitted by the sun cause the phenomena of terrestrial magnetic storms and auroræ. Applying the same theory in the case of Venus, M. Hansky suggests that during the periods of solar maxima the dense atmosphere of that planet is rendered more phosphorescent, and, therefore, more easily visible, by the increased solar activity. He further suggests that, in order to test this theory, astronomers should observe the planet as often as possible during the present sun-spot maximum (*Bulletin de la Société astronomique de France*, July).

DETERMINATIONS OF METEOR RADIANTS.—Some interesting results of meteor observations are recorded in No. 4032 of the *Astronomische Nachrichten* by M. Eginitis, of Athens, and by Prof. A. A. Nijland, of Utrecht.

M. Eginitis observed the Perseid, Leonid, and Andromedid showers of 1903 and the Perseid shower of 1904. He gives the time of observation, the number, colour, magnitude and relative velocity of the meteors recorded, and the position of the determined radiant on each date, directing special attention to any objects which were, for any reason, extraordinary. On August 11, 1904, several meteors were seen to proceed from a radiant near to α Persei, and these were, in general, whiter and brighter than those from η Persei, the latter being fainter and of a reddish-yellow colour, and generally falling in pairs.

Prof. Nijland's results deal with the Lyrid, Perseid, and Leonid showers of 1902, 1903, and 1904, and he gives the results for each night of observation and the positions deduced for the respective radiants.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE summer meeting of the Institution of Naval Architects was held last week in London, the usual sittings for the reading of papers taking place in the theatre of the Society of Arts. The following papers were on the programme for reading and discussion:—Tactics and strategy at the time of Trafalgar, by Admiral Sir Cyprian Bridge; the ships of the Royal Navy as they existed at the time of Trafalgar, by Sir Philip Watts, Director of Naval Construction; the classification of merchant shipping, illustrated by a short history of Lloyd's Register, by H. J. Cornish, chief ship surveyor to Lloyd's Register; experiments with models of constant length and form of cross section, but with varying breadths and draughts, by Lieut.-Colonel B. Rota, Royal Italian Navy; experiments upon the effect of water on speed having special reference to destroyers recently built, by Harold Yarrow; deductions from recent and former experiments on the influence of the depth of water on speed, by W. W. Marriner; the failure of some large boiler plates, by J. T. Milton, chief engineer surveyor to Lloyd's Register; a comparison of the performances of turbines and reciprocating engines in the Midland Railway Company's steamers, by William Gray.

It was also arranged that visits should be paid to the following works:—Siemens Bros. and Co.'s Telegraph and Electrical Instrument Works, near Woolwich; Vickers, Sons and Maxim Ordnance Works, Erith; J. and E. Hall's Refrigerating Machinery Works, Dartford; Yarrow and Co.'s ship-building yard and marine engine works, Poplar; John I. Thornycroft and Co.'s ship-building yard, marine engine works, and motor-car works, Chiswick. Visits were also paid to the P. and O. mail steamer *India*, lying in the Tilbury Docks, and H.M.S. *Black Prince*, built by the Thames Iron Works, and lying in the Victoria Docks. The last day of the meeting, Friday, July 21, was occupied by a visit to Portsmouth Dockyard.

The first sitting during the meeting, when the three first papers on the list were presented, was held on Wednesday, July 19, the president of the institution, the Right Hon. the Earl of Glasgow, occupying the chair. These papers, as will be gathered by the titles, were chiefly of historical interest. In this centennial year of Trafalgar it was, no doubt, appropriate for the institution, which is so largely naval in its composition, to include in its programme papers of the nature of those contributed by Sir Cyprian Bridge and Sir Philip Watts; but how far they have any scientific bearing on naval strategy or tactics of the present day is a question that is evidently open to discussion. It would appear that a large section of naval officers hold that the lessons of the past era of masts and sails should be applied with little modification to the present day. For example, Admiral Sir Edmund Fremantle said that the tactics and strategy at the time of Trafalgar taught lessons which would never die, and Admiral Custance remarked that all the lessons of the past in naval warfare have a bearing on the present day, it being quite immaterial whether vessels were moved by steam or sail. On the other hand, there are some who hold that the disciples of what has been described as the "teachings-of-history" school carry their reverence for the past to an excessive degree, and that a too blind following of the tactics and strategy of the great admirals of the past may lead to disaster. Sir Philip Watts, in the course of his paper, pointed out that "steam propulsion, in all its various forms, shell fire, iron and steel armour, steel hulls, breech-loading and rifled guns, torpedoes, mines, high explosives, electrical appliances, and submarines" have all been introduced since the day of Trafalgar; and though he did not press any moral from these changes, his predecessor at the Admiralty was a little more explicit, as it was possible for one no longer trammelled by the rules or etiquette of office to be. Sir William White said in the discussion that while he agreed with Sir Cyprian Bridge that the teachings of history were valuable, it was necessary to allow for changes brought about by time. He did not think such a course was followed on all occasions.

Mr. Cornish's paper, as a record of the past by a competent authority, is one which should prove of considerable value to the student and historian of ship-building. The author did not urge its reading as time was short, and it was accordingly taken as read.

Colonel Rota's paper was the first taken at the evening sitting of Wednesday, July 19. It formed but a part of a very big subject, and was in the nature of an addition to Mr. R. E. Froude's paper on model experiments, read last year. The experiments briefly described by Colonel Rota were made with five models at the Royal Italian Dockyard, Spezia. It would be difficult to give the results of the inquiry without going into the whole question, but it may be stated that the author, without attempting to draw any general deduction, has practically concluded that in the unlimited series of forms which may be derived from a given form of hull by changing the vertical and horizontal cross sections scale—provided that the area of cross sections remains constant—there is a range of ratio of beam to draught, very close to that corresponding to the least wetted surface, within the limits of which there is not any sensible variation in the value of the resistance constant, that is, the corresponding E.H.P. There was no discussion on this paper, but Sir William White had written to Mr. Dana, the secretary, endorsing the author's plea for the publication of results of a purely scientific nature.

The two papers contributed respectively by Mr. Harold Yarrow and Mr. W. W. Marriner were no doubt the chief attraction during the meeting, and the little theatre of the Society of Arts was crowded to its full capacity by those anxious to benefit by the investigations carried out by Messrs. Yarrow and Co. Both papers referred to the same experiments, the authors having been engaged together on the work. Mr. Marriner, as is well known, is the chief of Messrs. Yarrow's scientific staff, whilst Mr. Harold Yarrow is still a student of the institution, and it is worth noting that his paper is the first contribution to the *Transactions* by a student. The data given possesses the merit of being both of scientific and practical interest. It has for some time past been recognised that depth of water has a considerable influence on the speed of steam ships, and Government contractors have lost considerable sums of money through failure to attain speed on the official measured miles. The scientific interest of the subject is unlimited, the problem involving the study of the natural laws governing wave-making and fluid resistance. It is to be hoped that ship builders and ship owners—now they have had placed before them so striking an example of the value of scientific research upon the practical results at which they aim—will do something tangible to help forward an inquiry into the influence of physical laws upon the resistance of vessels progressing in water. It is not creditable to the ship owners and ship builders that they should be beholden to the generosity of a private firm of torpedo-boat builders for information on these points, especially as such information cannot be obtained without the expenditure of several hundreds of pounds. The exclusive knowledge of the facts set forth in the two papers would prove a valuable asset to Messrs. Yarrow and Co. by giving them a distinct advantage over their competitors, and it is therefore more creditable to them that they have made the details public. It is, however, the greatest reproach of all to us, as the leading maritime nation, that Mr. Yarrow should have been under obligation to a German ship-owning firm for the facilities needed to make the investigation complete. Had it not been for the hospitality of their experimental tank offered by the North German Lloyd Company, the valuable information now at the command of ship designers would not have been forthcoming, for there is no tank of the same nature in this country which could have been used.

The experiments upon which the two papers were founded arose through Messrs. Yarrow and Co. having failed to get the contract speed of 25½ knots with destroyers built for the Royal Navy when they were tried on the Maplin mile off the mouth of the Thames. The builders, anticipating that the limitation in depth of water was accountable for the want of success, surveyed on their own account a mile near Dover, the section posts being placed on the cliffs. Here, in a greater depth of water—50 feet at low tide—the contract speed was reached, the vessels running a great part of the time in quite deep water outside the Goodwins. It should be explained that the trials last over four hours, and only six runs are made on the measured mile. On these six runs is found the number of revolutions needed to cover a mile, and then by counting the revolutions the distance steamed can be known. Although the contract was fulfilled, the results were not altogether satisfactory to the contractors, and Mr. Yarrow determined to have tank experiments made, testing a model of the destroyer at depths corresponding to 20 feet, 30 feet, 45 feet, 60 feet, and 90 feet respectively. The results were shown by diagrams thrown on the screen by the lantern, there being curves for speeds and for effective horse-power at the above depths. The results were somewhat remarkable. Each curve showed a distinct hump, indicating that when a certain speed was reached the power needed for an increased speed rose with enormous rapidity. This, of course, was in accordance with previous experience, and it was also to be expected, as shown by the diagram, that the hump would occur at lower speeds with shallower water; thus at 20 feet depth the top of the hump was at about 16 knots, at 45 feet it was about 20 to 21 knots, and at 90 feet the steepest part was from 20 to 24 knots. As the depth increased the curve became fairer.

The interesting feature brought out, however, was the fact that at a certain speed, depending on the depth of water, for a time the power decreased as the speed advanced. Thus in a depth of 20 feet, at a speed of about 15¾ knots, 2000 horse-power was needed; when the speed had been increased by approximately another knot the power developed was about the same, whilst at 17½ knots the demand for power had fallen off appreciably, and it was not until 18 knots was reached that the 2000 horse-power was again required, and after this the curve rose steadily. With a depth of 30 feet the descent of the curve was even more marked, about 2500 horse-power being needed for approximately 17½ knots and for 20 knots also. Comparing the powers required for speeds at different depths, we find also some remarkable results. At 18 knots 2500 horse-power was needed when the water was 30 feet deep, whilst when it was but 20 feet only 2000 horse-power had to be developed to reach the same speed, thus reversing the popular idea that the deeper the water the easier the boat would run. Again, at 20 knots, and when the water was 20 feet (and also when the depth was about 30 feet—the two curves approximately coinciding here), 2500 horse-power was needed, but to get the same speed with a depth of 45 feet about 315 horse-power was needed. Passing at once to the higher speed of 26 knots, we find that the highest power is needed when the boat is steaming in deepest water. After crossing and re-crossing each other, the curves for four depths (20 feet, 30 feet, 45 feet, and 60 feet) come fairly well together, having got over all the humps at about 25 knots, where there is a range of about 200 horse-power. The curve for 90 feet of water is, however, for 5000 horse-power at 26 feet, or about 500 horse-power above the next highest curve. It would therefore pay better, according to these model experiments, to run a 26-knot trial of a destroyer in a depth of 20 feet to 60 feet rather than at a depth of 90 feet; the saving in power for the given speed due to the use of shallower water would be about 600 to 700 horse-power.

We have been obliged to depart from the text of Mr. Harold Yarrow's paper in order to give the facts contained in his diagram. Limits of space prevent detailed reference to other particulars brought forward by these suggestive trials, but enough has doubtless been said to show their interest and the wide field for further investigation that is afforded by the numerical data now at command. It will be remembered, as Mr. Harold Yarrow pointed out, that the tank experiments were made in the usual way without propellers, and this would doubtless have a considerable influence on the results; but possibly a way may be found, as suggested by Sir William White, to add the propeller, and so bring the tank conditions more nearly akin to actual practice. It will be remembered that the late Mr. Froude proposed to run a propeller, worked by independent mechanism, at a speed of revolutions corresponding to that of actual practice, the model, of course, being towed by the carriage.

Mr. Marriner's investigation of the model results showed that they should, as Mr. Harold Yarrow said, "be accepted with caution." In order to check these tank data progressive trials were made with an actual destroyer on a carefully selected course off the mouth of the Thames. Four tugs were anchored to mark the course, which extended from the East Girdler buoy across the Tongue Sand to a point east of the extreme north-east point of the Tongue Spit. This gave water of depths varying between about 14 to 16 feet over the sand, and 100 to 102 feet in the Queen's Channel. The revolutions of the engines, the fore and aft inclination of the vessel, and the height of the stern wave were noted, indicator diagrams also being taken. The data thus obtained at varying mean speeds were given by means of diagrams thrown on the screen. We have not space to repeat all the records, but will take as an example the run made at a mean speed of about 22·2 knots, the steam pressure being 140 lb. In running from rather less than 50 feet depth into water of 20 feet, the revolutions increased from about 305 to more than 325; the inclination in a length of 20 feet decreased from approximately 5¼ inches to 4¼ or 4½ inches; and the approximate height of the stern wave fell from 20 inches above the deck level to a little more than 10 inches below the deck level, or about 2 feet 6 inches. Naturally any increase or reduction of resistance to the vessel would be accompanied by increase or reduction in the rate of revolutions of the engine, the steam pressure being constant. Increased height of stern wave and greater inclination are also signs of increased resistance and a greater demand for horse-power.

It would be difficult to deal adequately with Mr. Marriner's paper within anything approaching the space we have at our disposal, and without the diagrams by which it was accompanied. We can only hope, therefore, to give an idea of its scope, and refer our readers to the original in the published *Transactions* of the institution. The contribution consisted of a discussion, on a scientific basis, of the results contained in the preceding paper, the size of waves made by a vessel in her passage being a measure of the power absorbed in their formation. As the height of the stern wave was seen to increase when the resistance of the ship increased abnormally, it was to be assumed that anything which tended to retard the formation of waves would reduce the loss from wave making. The author cited the work of W. Froude and his son, R. E. Froude, of Lord Kelvin, D. W. Taylor, of the United States Navy, and Prof. Horace Lamb. The formula for relation of length to speed of ordinary repeating waves in deep water was set forth, and also the more complicated equation for shallow water. The equation showing critical depth for speed and critical speed for depth was given, and the conclusion was drawn (supported by Scott Russell's equation for the solitary wave in canals) that "the wave at the critical speed changes from the repeating to something approaching the solitary type."

The author next considered the waves accompanying the vessel. Transverse waves should tend to become longer and longer for the same speed as the depth diminishes until, at the critical depth, these should be of the isolated type. In shallower water, past the critical depth, there would be no transverse wave corresponding to the critical depth. Actually as the waves became longer if they did not lengthen as rapidly as investigation would lead one to suppose they would be travelling faster than their natural speed, and must be dragged by the boat. The increased resistance on approaching humps in the curve supports this view. The isolated wave is non-repeating, and exists only under certain relations of depth to speed. After passing the critical point the transverse wave disappears, being replaced by confused water. The paper was accompanied by diagrams illustrating these points, and it was considered a fair deduction that the waves formed by a ship closely follow the laws of waves in open water. The effect of the vertical sides of a canal in diminishing the loss of energy was pointed out by the author, and the manner in which the restricted width of a tank might have a similar effect was noted. The interference of the bow-wave system on the stern-wave system was discussed, it being shown that the union of the bow and stern waves (the crests coinciding) resulted in a large resultant wave which would carry away a great deal of energy. The velocity of diverging waves is much less than the speed of the vessel, speeds attained up to the present not being high enough for waves to approach the critical speeds for the depths in which vessels usually run. Diverging waves apparently constitute the principal wave-making resistance at speeds beyond the critical combinations of depths and speeds under consideration. The final conclusions of the author were as follows:—"(1) The critical combinations of depth and speed do not depend on the size of the vessel. (2) Of these critical combinations there is, for every vessel, one more serious than the others, and where this worst combination occurs depends largely on the length of the vessel. (3) The depth to be avoided is given by the equation $d = V^2/10$, and the resistance diminishes in both greater and lesser depths. The further away from this bad depth the better, especially on the deep side."

In the course of the discussion which followed the reading of these papers, Mr. A. F. Yarrow, in conformity with a suggestion made by Sir William White, proposed, and Mr. S. W. Barnaby seconded, a resolution that the Admiralty be urged to erect a measured mile, where ample depth might be found, in proximity to Chatham and the Thames. This resolution was put to the meeting by Sir John Durston, who occupied the chair, and was carried unanimously. It was but the logical outcome of the facts brought forward. The measured mile in the Clyde at Skelmorlie has ample depth of water, and is, as Sir William White said, the only satisfactory mile for high-speed trials; a fact which, it is acknowledged, gives the ship-builders of that district a manifest advantage over those of other centres. Mr. Barnaby stated that when a destroyer built by his firm, John I. Thornycroft and Co., was tried on the Skelmorlie mile an increase of speed of 1 knot was obtained over that reached under the best conditions on the Maplin mile, whilst an increase of 3 knots was reached as compared to running on the Maplin when the state of the tide was most unfavourable. Sir William White, in a letter to the secretary, read at the meeting, heartily endorsed the suggestion of a deep-water measured mile off the Thames. He also pointed out, with great regret, that it was necessary for Messrs. Yarrow to go to Germany for their tank experiments, and trusted that the fact might furnish a fresh incentive towards the establishment of a research tank at the National Physical Laboratory.

In the discussion on the technical details of the two papers, besides those mentioned, Mr. J. H. Narbeth, of the Admiralty, Mr. R. Saxton White, Captain Jackson, R.N., Controller of the Navy, Mr. W. H. Whiting, chief constructor, and Prof. Biles took part. Generally it may be said the views expressed by the authors were not disputed, although Sir William White did not quite agree with Mr. Marriner as to the importance the latter attached to the comparative narrowness of the tank.

On the Thursday's sitting Mr. Milton's paper on fractures in large steel boiler plates was read and briefly discussed. It gave particulars of the failures, the reasons for which could not be explained, of certain plates, and therefore were, naturally, attributed to "heat treatment." It is a term of exceeding comfort to the steel maker and the engineer alike, for the former is able to put the blame on the latter, and the latter to put the blame on the former, as no one can prove where the injudicious heat treatment occurred. The controversy is an old one, dating back, at any rate, to the days of the *Livadia's* boilers. Mr. Milton's paper is a suggestive contribution, and the facts he records may carry us some way towards a solution of the problem in the more or less distant future.

Mr. William Gray in his paper gave particulars of the performances of certain steamers fitted with Parsons' steam turbines. These were set forth in a table, which, as the author said, "treated the matter from a purely commercial standpoint." The discussion was largely of the same character.

The only remaining paper was not on the original programme, but was read at the conversazione which brought the proceedings to a conclusion on the Thursday evening. It was a contribution by Captain R. H. Bacon, R.N., entitled "Notes on the Causes of Accidents to Submarine Boats, and their Salvage." This paper, in harmony with the circumstances in which it was read, was of a popular nature, and was designed to show to the public at large that undue anxiety as to the safety of submarine boats is not warranted by the conditions under which they are employed. Dealing with the probability of water entering the hull through the hatch (the cause of four serious accidents through which these boats have foundered), the author pointed out that the fitting of another water-tight hatch at the base of the tower reduced the chance of accident in the future. The danger from grounding, he said, "was not very great," whilst the risk of the hull being crushed by the boat diving to too great depths argued the failure of the diving rudders, or too much water ballast. As to explosion through leakage of petrol, "in a properly designed system leaks should be practically non-existent." Another possible cause of explosion is due to hydrogen given off when batteries are being charged, but as this operation is carried on only when the boat is opened up for ventilation, "no danger exists." Altogether Captain Bacon's lecture was most reassuring, and it is pleasant to learn that his optimistic views are fully shared by his colleagues in the Service, both officers and men. The risk of sinking—involuntary sinking—being so small, it is of less consequence that only over a limited area near shore is it possible to recover a submarine boat once she has gone to the bottom. For this reason Captain Bacon considers it inadvisable that the Royal Navy should have a salvage plant of its own.

THE CONGRESS OF THE ROYAL INSTITUTE OF PUBLIC HEALTH.

THE congress of the Institute of Public Health, which this year was held in London under the presidency of the Marquis of Londonderry, attracted a large number of visitors, and much good work was done in the various sections which met at the Polytechnic and at King's College.

In a brief space it is impossible to deal adequately with the valuable discussions and papers read.

Sir James Crichton Browne, F.R.S., in his presidential address to the section of preventive medicine, chose as his subject the prevention of senility. It was, he declared, on the reduction of the death-rate that the potency of preventive medicine, as hitherto applied, stood forth conspicuously declared, and that the promise of its future sovereignty might be discerned. Fifty years ago the death-rate of England and Wales stood at 22·5 per 1000 persons; in 1903 it had dropped to 15·4—a fall of 7·1 per 1000, representing, on the estimated population of 1903, a saving of upwards of 223,000 lives per annum. As an exceptionally low rate of infant mortality had been maintained for two successive years, it might be hoped that the warnings uttered as regards infant hygiene, and more particularly infant feeding, were beginning to take effect.

It was, however, during the first half of life that the great fall in the death-rate had taken place. It was a remarkable fact that in men, at all ages from forty-five to seventy-five, there had been a startling rise in the death-rate, and that in women, from fifty-five upwards, it had been practically stationary. At the ages when we should have welcomed a rise in the death-rate, and at which only, in a hygienic Utopia, death ought to occur—eighty-five and upwards—it had fallen. Some of the nerve centres went on evolving until middle life, *e.g.* the hand and arm centres. He had ascertained that among certain classes of operatives in Birmingham the hand and arm centres did not reach their full maturity until about the thirtieth year. Similarly with the weavers of Bradford and the potters of Staffordshire. At about forty-five the productiveness of the manufactory hand generally began to diminish, and after that it contracted in an increasing ratio as time went on. The hand-failure of our operatives after forty-five was premature, and due to excessive wear and tear of the mechanism regulating manual movements. But there were other centres in the brain which, reaching maturity later, retained their power longer. Orators secured their greatest triumphs between forty-five and fifty-five, and it was with musical expression as with oratory.

The best antiseptic against senile decay was an active interest in human affairs, and those kept young longest who loved most. The natural evolution of our nerve centres was largely interfered with and too often arrested by unfavourable environment and deleterious habits of life or methods of work. It was a good working hypothesis that the natural life of man was one hundred, and that so far as it fell short of that it was "curtailed of fair proportion." Every man, he thought, was entitled to his century, and every woman to a century and a little more.

Dr. Francis Galton, F.R.S., in a paper on physical records, suggested that on February 29 in each leap year there should be school reunions at which there might be an opportunity for reviving early friendships, and at which, at the same time, the anthropometric and other records of the pupils might be added to.

Each old boy would be represented by an envelope stored in the school library. This would contain his anthropometric record to date, and he would be given printed forms, containing a few well considered questions—health, profession, preferments, marriage, children, and general remarks—and would be asked to forward the filled-in forms to the school.

Many papers were read on infantile mortality and on municipal milk depôts.

In the unavoidable absence of Sir William Broadbent, a discussion on sanatoria for consumptives was opened by Dr. T. N. Kelynack, physician to the Mount Vernon Hospital for Consumption. To illustrate the enormous economic waste to the community caused by pulmonary tuberculosis, Dr. Kelynack mentioned that in the metropolitan district alone 40,000 people died of the disease every year, and the monetary loss to London had been estimated at 4,000,000*l*.

The provision of adequate assistance for the consumptive poor demanded urgent attention. Sanatoria or hygienic hospitals undoubtedly secured the best conditions for the arrest and alleviation of the disease. At present we were just muddling along, with no satisfactory organisation of our resources and no rational cooperation.

A resolution was unanimously adopted urging the Government to appoint a commission to deal with the subject of the sanatorium treatment of the poor.

The presidential address in the section of chemistry and bacteriology was given by Prof. R. T. Hewlett. It was a plea for the recognition of the place of the specialist in the various departments of public health. Proper administration required a medical officer and his sanitary staff, a bacteriologist, a chemist, and an engineer, all working cordially together to a common end. For the smaller districts such a staff could be secured by grouping. Could they expect effective action if the medical officer was a local practitioner who derived his livelihood by the goodwill of the local landlord?

Prof. Hewlett also denounced the way in which chemists were taking upon themselves the bacteriological examination of pathological material, and emphatically asserted that disease problems should be dealt with only by medical men. He also advocated that a course of biology should be obligatory for candidates for the associateship of the Institute of Chemistry taking the subject of biological chemistry.

An interesting discussion, opened by Dr. Newman, of Finsbury, was on the possibility of establishing a bacteriological standard of purity of milk. Dr. Newman suggested the following standards:—(*a*) not more than 24–25 degrees of total acidity at the time of sale, 1 degree being equivalent to 1 c.c. of deci-normal NaOH solution; (*b*) not an excess of pus or blood; (*c*) no *B. coli, B. enteritidis*, or *B. enteritidis sporogenes*; (*d*) non-virulent to guinea-pigs. All the speakers, including Dr. Allan Macfadyen, Prof. Kenwood, Dr. Savage, Colonel Firth, Mr. Revis and others, agreed that there was little possibility at present of fixing a standard, and Dr. Newman's suggestions did not obtain general acceptance.

Another discussion, on the relative efficiency of chemical and bacteriological methods for the examination of sewage effluents, was opened by Mr. Dibden and by Dr. Savage. There was a general agreement that chemical methods gave a better indication of proper purification than bacteriological ones, though, of course, bacteriological methods alone were of service in detecting species of micro-organisms.

Lieut. Nesfield, I.M.S., gave an interesting demonstration of a method devised by him for the sterilisation of drinking water during a campaign. He had found that chlorine in the proportion of 2 grams per 100 gallons acting for five minutes effectually destroyed the organisms of cholera, typhoid, and dysentery. His method consisted in carrying iron bottles of liquid chlorine, from which, by means of a valve, the requisite amount was liberated into the water. After five minutes a powder of sodium sulphite (2·2 grams) was added to the water, from which a double decomposition ensued, and the water was rendered absolutely tasteless. For the soldier on the march another method was devised, so that he could sterilise for himself a gallon of water. This consisted in adding to the vessel of water a tablet containing iodide and iodate of sodium. This resulted in the liberation of free iodine in the water, which acted in five minutes as an efficient germicide, and was then "killed" so that the water was rendered potable, by the addition of another tablet of sodium sulphite. In both processes the quantities of reagents employed are so small as to have no effect on the human economy; the methods are rapid, and the reagents, &c., portable.

ECLIPSE SHADOW BANDS.

ONE of the most peculiar appearances attending a total eclipse of the sun is that generally known as the "shadow bands." They are long dark bands, separated by white spaces, which are seen on the ground or sides of buildings just before and just after the total phase of an eclipse, moving rapidly. It is probable that they are not real bands, but are composed of dark patches which seem to the eye to make long bands. Their cause is not yet clearly known, as the observations in former eclipses are quite discordant. The undersigned is very desirous of obtaining observations of them at various stations along the line of totality, especially at places near the edge of the shadow, in order to compare with similar observations made by himself and others. The observations require no special instruments, and can be made by any careful person. Information is desired upon the following points:—(1) the direction in which the bands lie; (2) the direction in which they move; (3) the velocity with which they move; (4) the width of the bands; and (5) their distance apart. All of these are likely to be different before and after the total phase, so that two sets of observations are needed. The following suggestions are compiled from various sources.

Spread a white cloth or piece of canvas upon the ground in any convenient open space. It is well to spread *two* cloths or pieces of canvas, one to be used before, the other after, the total phase. Let each observer be furnished with several sticks, 4 feet to 6 feet long.

About three minutes before the time of totality, let the observer stand near the cloth with his back to the sun and watch the cloth intently. If bands or dark patches are seen, place one stick down in the direction in which they lie; after this is done place a second stick in the direction in which they are moving. Both of these operations should be done deliberately, not hurriedly, and the sticks left in position.

During the total phase the observer is free to enjoy the scene or make other observations, but it may be well to note if any bands can be seen during totality, as some have asserted.

At the close of totality the observer should be at the second cloth, or at another part of the single cloth (if he uses but one), and should repeat the observations made before totality, placing one stick down in the direction in which the bands lie, and another in the direction in which they move.

It will be seen that four sticks are needed for these observations. If two persons make the records, one should confine his attention to the direction in which the bands lie, the other to the direction in which they move. The bands are likely to be somewhat faint and poorly defined, so that extreme accuracy may not be possible.

The sticks should not be disturbed until after the eclipse, when their direction should be determined with as much care as possible, either by a compass or, still better, by a surveyor's theodolite if one is available. If neither compass nor theodolite is at hand, an estimate of the directions should be made.

The velocity with which the bands travel is more difficult to determine. The estimates vary from the speed of a man running to that of an express train. Several methods may be suggested:—

(1) Let two persons work together, one having a watch with the seconds marked on the face. Let him mark time by calling out each second. The number of the second is not important, but a simple sound to mark the seconds is sufficient. Let the other observer watch the bands and see how many he can count per second.

(2) With one observer marking time as before, let the second observer note how many seconds elapse while a band is passing between two objects the distance apart of which is known.

(3) Let a person run a short distance with the bands and see if he can keep up with them. If not, let him estimate how much faster the bands are moving than he can run.

(4) A mere guess at the speed is of some value.

The width of the bands and their distance apart can best be determined upon the cloths mentioned above, and it will add to the accuracy of the estimates if the cloths are divided by seams or in some other way into strips of known width. A carpenter's rule will aid the observer in making the estimates. The bands will probably be several inches wide and separated by spaces the width of which is the same or greater.

If the observer notices any other point connected with the bands, such as their colour, whether they are straight or wavy, whether they are continuous bands or made up of dark patches, whether they flicker or not, the information will be valuable. Still more valuable would be photographs of the bands as they pass over the ground or the side of a building or wall.

It is earnestly requested that anyone who will kindly attempt the above, either in whole or in part, will send his records to the undersigned. If for any reason the observation seems unsatisfactory, either because the bands were not as distinct as expected, or for any other reason, or if the record is only fragmentary, it will still be of value. The report should consist of a statement of the methods employed by the observer or observers in making the observations, and the results obtained, with any remarks upon the subject or upon other phenomena noted at the time of the eclipse. A. LAWRENCE ROTCH.

Blue Hill Observatory, Hyde Park, Mass., U.S.A.

The observations may be summarised as follows :—

OBSERVATIONS OF SHADOW BANDS, AUGUST 30, 1905.

Place ....

(Situation and altitude)

Observers ....

....

	Before totality	After totality
1. Direction of bands,	....	....
2. Direction of motion,	....	....
3. Velocity,	....	....
4. Width of bands,	....	....
5. Distance apart,	....	....

Remarks :

Direction of the wind before totality....................., after totality....................., and direction from which upper clouds (if any) came.....................

THE LATENT IMAGE.[1]

MY inclination has led me, in spite of a lively dread of incurring a charge of presumption, to address you principally on that profound and most subtle question, the nature and mode of formation of the photographic image. I am impelled to do so, not only because the subject is full of fascination and hopefulness, but because the wide topics of photographic methods or photographic applications would be quite unfittingly handled by the president you have chosen.

I would first direct your attention to Sir James Dewar's remarkable result that the photographic plate retains considerable power of forming the latent image at temperatures approaching the absolute zero—a result which, as I submit, compels us to regard the fundamental effects progressing in the film under the stimulus of light undulations as other than those of a purely chemical nature. But few, if any, instances of chemical combination or decomposition are known at so low a temperature. Purely chemical actions cease, indeed, at far higher temperatures, fluorine being among the few bodies which still show chemical activity at the comparatively elevated temperature of $-180°$ C. In short, this result of Sir James Dewar's suggests that we must seek for the foundations of photographic action in some physical or intra-atomic effect which, as in the case of radio-activity or fluorescence, is not restricted to intervals of temperature over which active molecular *vis viva* prevails. It compels us to regard with doubt the *rôle* of oxidation or other chemical action as essential, but rather points to the view that such effects must be secondary or subsidiary. We feel, in a word, that we must turn for guidance to some purely photo-physical effect.

Here, in the first place, we naturally recall the views of Mr. Bose. This physicist would refer the formation of the image to a strain of the bromide of silver molecule under the electric force in the light wave, converting it into what might be regarded as an allotropic modification of the normal bromide which subsequently responds specially to the attack of the developer. The function of the sensitiser, according to this view, is to retard the recovery from strain. Bose obtained many suggestive parallels between the strain phenomena he was able to observe in silver and other substances under electromagnetic radiation and the behaviour of the photographic plate when subjected to long-continued exposure to light.

This theory, whatever it may have to recommend it, can hardly be regarded as offering a fundamental explanation. In the first place, we are left in the dark as to what the strain may be. It may mean many and various things. We know nothing as to the inner mechanism of its effects upon subsequent chemical actions—or at least we cannot correlate it with what is known of the physics of chemical activity. Finally, as will be seen later, it is hardly adequate to account for the varying degrees of stability which may apparently characterise the latent image. Still, there is much in Mr. Bose's work deserving of careful consideration. He has by no means exhausted the line of investigation he has originated.

Another theory has doubtless been in the minds of many. I have said we must seek guidance in some photo-physical phenomenon. There is one such which preeminently connects light and chemical phenomena through the intermediary of the effects of the former upon a component part of the atom. I refer to the phenomena of photo-electricity.

It was ascertained by Hertz and his immediate successors that light has a remarkable power of discharging negative electrification from the surface of bodies—especially from certain substances. For long no explanation of the cause of this appeared. But the electron—the ubiquitous electron —is now known with considerable certainty to be responsible. The effect of the electric force in the light wave is to direct or assist the electrons contained in the substance to escape from the surface of the body. Each electron carries away a very small charge of negative electrification. If, then, a body is originally charged negatively, it will be gradually discharged by this convective process. If it is not charged to start with, the electrons will still be liberated at the surface of the body, and this will acquire a positive charge. If the body is positively charged at first, we cannot discharge it by illumination.

It would be superfluous for me to speak here of the nature of electrons or of the various modes in which their presence may be detected. Suffice it to say, in further connection with the Hertz effect, that when projected among gaseous molecules the electron soon attaches itself to one of these. In other words, it ionises a molecule of the gas or confers its electric charge upon it. The gaseous molecule may even be itself disrupted by impact of the electron if this is moving fast enough and left bereft of an electron.

We must note that such ionisation may be regarded as conferring potential chemical properties upon the molecules of the gas and upon the substance whence the electrons are derived. Similar ionisation under electric forces enters, as we now believe, into all the chemical effects progressing in the galvanic cell, and, indeed, generally in ionised solutants.

An experiment will best illustrate the principles I wish to remind you of. A clean aluminium plate, carefully insulated by a sulphur support, is faced by a sheet of copper-wire-gauze placed a couple of centimetres away from it. The gauze is maintained at a high positive potential by this dry pile. A sensitive gold-leaf electroscope is attached to the aluminium plate, and its image thrown upon the screen. I now turn the light from this arc lamp upon the wire gauze, through which it in part passes and shines upon the aluminium plate. The electroscope at once charges up rapidly. There is a liberation of negative electrons at the surface of the aluminium; these, under the attraction of the positive body, are rapidly removed as ions, and the electroscope charges up positively.

Again, if I simply electrify negatively this aluminium plate so that the leaves of the attached electroscope diverge widely, and now expose it to the rays from the arc lamp, the charge, as you see, is very rapidly dissipated. With positive electrification of the aluminium there is no effect attendant on the illumination.

Thus from the work of Hertz and his successors we know that light, and more generally what we call actinic light, is an effective means of freeing the electron from certain substances. In short, our photographic agent, light, has the power of evoking from certain substances the electron which is so potent a factor in most, if not in all, chemical effects. I have not time here to refer to the work of Elster and Geitel whereby they have shown that this action is to be traced to the electric force in the light wave, but must turn to the probable bearing of this phenomenon on the familiar facts of photography. I assume that the experiment I have shown you is the most fundamental photographic experiment which it is now in our power to make.

[1] Address to the Photographic Convention of the United Kingdom, 1905. By J. Joly, F.R.S.

We must first ask from what substances can light liberate the electron. There are many—metals as well as non-metals and liquids. It is a very general phenomenon, and must operate widely throughout nature. But what chiefly concerns the present consideration is the fact that the haloid salts of silver are vigorously photo-electric, and, it is suggested, possess, according to Schmidt, an activity in the descending order bromide, chloride, iodide. This is, in other words, their order of activity as ionisers (under the proper conditions) when exposed to ultra-violet light. Photographers will recognise that this is also the order of their photographic sensitiveness.

Another class of bodies also concerns our subject:—the special sensitisers used by the photographer to modify the spectral distribution of sensibility of the haloid salts, *e.g.* eosine, fuchsine, cyanine. These again are electron-producers under light stimulus. Now it has been shown by Stoletow, Hallwachs, and Elster and Geitel that there is an intimate connection between photo-electric activity and the absorption of light by the substance, and, indeed, that the particular wave-lengths absorbed by the substance are those which are effective in liberating the electrons. Thus we have strong reason for believing that the vigorous photo-electric activity displayed by the special sensitisers must be dependent upon their colour absorption. You will recognise that this is just the connection between their photographic effects and their behaviour towards light.

There is yet another suggestive parallel. I referred to the observation of Sir James Dewar as to the continued sensitiveness of the photographic film at the lowest attained extremes of temperature, and drew the inference that the fundamental photographic action must be of intra-atomic nature, and not dependent upon the *vis viva* of the molecule or atom. In then seeking the origin of photographic action in photo-electric phenomena we naturally ask, Are these latter phenomena also traceable down to low temperatures? If they are, we are entitled to look upon this fact as a qualifying characteristic or as another link in the chain of evidence connecting photographic with photo-electric activity.

I have quite recently, with the aid of liquid air kindly supplied to me by Mr. Moss, and made in the laboratory of this society, tested the photo-sensibility of aluminium and also of silver bromide down to temperatures approaching that of the liquid air. The mode of observation is essentially that of Schmidt—what he terms his static method. The substance undergoing observation is, however, contained at the bottom of a thin copper tube, 5 cm. in diameter, which is immersed to a depth of about 10 cm. in liquid air. The tube is closed above by a paraffin stopper which carries a thin quartz window as well as the sulphur tubes through which the connections pass. The air within is very carefully dried by phosphorus pentoxide before the experiment. The arc light was used as source of illumination. It was found that a vigorous photo-electric effect continued in the case of the clean aluminium. In the case of the silver bromide a distinct photo-electric effect was still observed. I have not had leisure to make, as yet, any trustworthy estimate of the percentage effect at this temperature in the case of either substance. Nor have I determined the temperature accurately. The latter may be taken as roughly about $-150°$ C.

Sir James Dewar's actual measurements afforded twenty per cent. of the normal photographic effect at $-180°$ C. and ten per cent. at the temperature of $-252°.5$ C.

With this much to go upon, and the important additional fact that the electronic discharge—as from the X-ray tube or from radium—generates the latent image, I think we are fully entitled to suggest as a legitimate lead to experiment the hypothesis that the beginnings of photographic action involve an electronic discharge from the light sensitive molecule; in other words that the latent image is built up of ionised atoms or molecules the result of the photo-electric effect on the illuminated silver haloid, upon which ionised atoms the chemical effects of the developer are subsequently directed. It may be that the liberated electrons ionise molecules not directly affected, or it may be that in their liberation they disrupt complex molecules built up in the ripening of the emulsion. With the amount we have to go upon we cannot venture to particularise. It will be said that such an action must be in part of the nature of a chemical effect. This must be admitted, and, in so far as the re-arrangement of molecular fabrics is involved, the result will doubtless be controlled by temperature conditions. The facts observed by Sir James Dewar support this. But there is involved a fundamental process—the liberation of the electron by the electric force in the light wave, which is a physical effect, and which, upon the hypothesis of its reality as a factor in forming the latent image, appears to explain completely the outstanding photographic sensitiveness of the film at temperatures far below those at which chemical actions in general cease.

Again, we may assume that the electron-producing power of the special sensitiser or dye for the particular ray it absorbs is responsible, or responsible in part, for the special sensitiveness it confers upon the film. Sir Wm. Abney has shown that these sensitisers are active even if laid on as a varnish on the sensitive surface and removed before development. It must be remembered, however, that at temperatures of about $-50°$ these sensitisers lose much of their influence on the film. [See a paper by me read before the convention in 1894.]

It appears to me that on these views the curious phenomenon of recurrent reversals does not present a problem hopeless of explanation. The process of photo-ionisation constituting the latent image, where the ion is probably not immediately neutralised by chemical combination, presents features akin to the charging of a capacity—say a leyden jar. There may be a rising potential between the groups of ions until ultimately a point is attained when there is a spontaneous neutralisation. I may observe that the phenomena of reversal appear to indicate that the change upon the silver bromide molecule, whatever be its nature, is one of gradually increasing intensity, and finally attains a maximum when a return to the original condition occurs. The maximum is the point of most intense developable image. It is probable that the sensitiser—in this case the gelatin in which the bromide of silver is immersed—plays a part in the conditions of stability which are involved.

Of great interest in all our considerations and theories is the recent work of Prof. Wood on photographic reversal. The result of this work is—as I take it—to show that the stability of the latent image may be very various according to the mode of its formation. Thus it appears that the sort of latent effect which is produced by pressure or friction is the least stable of any. This may be reversed or wiped out by the application of any other known form of photographic stimulus. Thus an exposure to X-rays will obliterate it, or a very brief exposure to light. The latent image arising from X-rays is next in order of increasing stability. Light action will remove this. Third in order is a very brief light-shock or sudden flash. This cannot be reversed by any of the foregoing modes of stimulation, but a long-continued undulatory stimulus, as from lamp-light, will reverse it. Last and most stable of all is the gradually built-up configuration due to long-continued light exposure. This can only be reversed by overdoing it according to the known facts of recurrent reversal. Prof. Wood takes occasion to remark that these phenomena are in bad agreement with the strain theory of Mr. Bose. We have, in fact, but the one resource—the allotropic modification of the haloid—whereby to explain all these orders of stability. It appears to me that the elasticity of the electronic theory is greater. The state of the ionised system may be very various according as it arises from continued rhythmic effects or from unorganised shocks. The ionisation due to X-rays or to friction will probably be quite unorganised, that due to light more or less stable according to the gradual and gentle nature of the forces at work. I think we are entitled to conclude that on the whole there is nothing in Prof. Wood's beautiful experiments opposed to the photo-electric origin of photographic effects, but that they rather fall in with what might be anticipated.

When we look for further support to the views I have laid before you we are confronted with many difficulties. I have not as yet detected any electronic discharge from the film under light stimulus. This may be due to my defective experiments, or to a fact noted by Elster and Geitel concerning the photo-electric properties of gelatin.

They obtained a vigorous effect from Balmain's luminous paint, but when this was mixed in gelatin there was no external effect. Schmidt's results as to the continuance of photo-electric activity when bodies in general are dissolved in each other lead us to believe that an actual conservative property of the medium and not an effect of this on the luminous paint is here involved. This conservative effect of the gelatin may be concerned with its efficacy as a sensitiser.

In the views I have laid before you I have endeavoured to show that the recent addition to our knowledge of the electron as an entity taking part in many physical and chemical effects may be availed of, and should be kept in sight, in seeking an explanation of the mode of origin of the latent image.

GLACIAL STUDIES IN CANADA.

DR. WILLIAM H. SHERZER has published in the *Smithsonian Miscellaneous Collections* (pp. 453–496) a handsomely illustrated preliminary report entitled "Glacial Studies in the Canadian Rockies and Selkirks." The five glaciers selected are conveniently located in Alberta and British Columbia, and the line of the Canadian Pacific Railway passes near them. Observations have been made on the rate of motion of the Victoria Glacier, which is as low as about 52 feet a year, and on the lowering of its surface by ablation. The front of this glacier shows a shearing movement of one layer over another, as was tested by the pushing forward of iron spikes driven into an upper and a lower stratum. The right lateral moraine receives a certain amount of ground-moraine or subglacial material from a hanging glacier on Mount Lefroy, which breaks away in avalanches on to the main Victoria flow. This incident, which is well illustrated, serves to warn us from assuming that all subglacial material at a glacier's edge results from plucking action on the wall or floor in contact with the local ice.

A brief but useful discussion of "dirt-bands" follows, in which three types are distinguished. Layers of the glacier may vary in the percentage of foreign matter contained in them, and these stratified dirt-bands may be too thick to represent mere temporary variations in snowfall, and probably then correspond with short cycles of variation in the "activity of the glacier-making agencies." A second type of dirt-band is that described by Forbes, conspicuous at a distance, and transverse to the length of the ice-stream; the author traces this appearance to the alternation of depressions and ridges, stones and mud becoming washed into the former, and producing the dark bands, which may be bent forward in the central region as the glacier flows. The explanation given is adopted from Tyndall. The greater rapidity of motion in summer produces a crevasse, or a close-set series of crevasses, where there is a marked increase in the drop of the valley-floor. The sun melts out a depression along the line of the crevasse or crevasses, which remains although the fracture heals. In winter, owing to the slower motion, the ice adapts itself better to its inclines, and the few crevasses that are formed are not emphasised at the top by melting. Hence each dirt-band represents a summer season, and the interval a winter one. The third type of dirt-band depends on the greater resistance to melting offered by blue solid ice, as compared with the intervening layers of vesicular ice. The latter, therefore, form depressions on the melting of the mass, in which detritus gathers, as in the case of the far coarser dirt-bands of the second type. Dr. Sherzer proposes to call a band of the first type a "dirt-zone," and of the third type a "dirt-stripe." The well known blue bands are shown later to have no relation to stratification, and we are left in ignorance as to their origin.

On the lower Lefroy Glacier "ice-dykes" are noted, true mineral veins, as it were, with ice-crystals deposited on their walls and meeting from opposite sides along the central plane. These represent crevasses, which have been healed by the freezing of the water that at one time filled them.

The author's examination of the surfaces of junction of glacier-grains shows that melting opens up a network of delicate tube-like capillaries, which are here photographed —we presume on a natural scale—both before and after injection with potassium permanganate. As melting proceeds, this network disappears, apparently by a general coarsening of the hollows developed between adjacent grains.

FIG. 1.—Formation of Forbes's "dirt-bands," Deville Glacier, Selkirks. From Summit Mt. Fox, looking Eastward. Photographed by Arthur O. Wheeler, 1902. Canadian Topographic Survey.

We shall hope to hear more of the author's views on "block-moraines," since we cannot help thinking that such phenomena are far too common for the invocation of earthquake-action as a cause. The double moraine below Lough Coumshingaun, in the county of Waterford, would seem to come into this category; and in that case the jointed nature of the rocks higher up the mountain accounts for the preponderance of huge and angular blocks. The discovery of ice-cores within the steep lateral embankments of the Asulkan Glacier raises the question of such embankments in general; and here again we hope for further details. The illustrations, one of which is here reproduced, are richly varied, and are of equal value to the geographer and the geologist.

GRENVILLE A. J. COLE.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—It has been announced that the chemical fellowship at Magdalen College, to which an election will be made next term, is open to all persons who have qualified for the degree of B.A. at Oxford, and are not in the receipt of an income of more than 300*l*. per annum. The examination will begin on October 3, and will be mainly in the subjects recognised in the honour school of chemistry. Any candidate may submit any dissertations or papers written by him or any evidence of research work done by him.

THE council of the University of Liverpool has, on the recommendation of the university senate, determined to institute a university lectureship in experimental psychology.

PROF. W. H. WATKINSON, at present professor of engineering in the Glasgow and West of Scotland Technical College, has been appointed to the Harrison chair of engineering in the University of Liverpool formerly filled by Prof. Hele-Shaw, F.R.S.

THE governors of the Merchant Venturers' Technical College, Bristol, have decided to award annually to the most suitable candidate who, being a member of the college, has graduated in science at the University of London or gained a similar distinction, a research scholarship of the value of 50*l*., tenable at the college for one year. The research scholar will be required to undertake some research work either in the department of applied chemistry or in that of engineering. The governors will defray the cost of the apparatus and materials needed for the prosecution of such work.

THE detailed regulations and syllabus for the preliminary examination for the certificate, which will in 1907 take the place of the King's scholarship examination, which pupil teachers have been in the habit of taking at the end of their apprenticeship, have been issued as an appendix to the regulations for the instruction and training of pupil teachers, 1905. The distribution of subjects in the re-cast examination has received the careful consideration of the Board of Education. In order to be successful a candidate must pass a test in the important subjects, including composition and arithmetic, which form part i. of the examination, and also show a reasonable degree of proficiency in English, history, and geography. To quote the circular which has been distributed to local education authorities, training colleges, and pupil teacher centres:—"To these the Board would gladly have added elementary science. They have, however, refrained at present from doing so because, except in fully equipped secondary schools and pupil teacher centres, it is not always possible for candidates to obtain the necessary instruction in practical scientific work, while they are convinced that instruction in science which does not include practical work is of very little value." It is satisfactory to record this frank admission by the Board of Education of the great importance of including elementary science in every scheme of education, whether elementary or secondary. It is to be hoped that every effort will be made by the Board to bring about increased facilities for instruction in elementary science in all schools under their jurisdiction, and not only in those from which pupil teachers proceed to the training college. It is not too much to say that no system of training designed to provide efficient elementary school teachers will prove thoroughly satisfactory which does not subject the teacher in training to a course of practical work in science. Even if it is considered necessary at present to make science an optional subject in this preliminary examination for the certificate, every effort should be made so to improve the equipment of the schools that elementary science may be made obligatory for all candidates at an early date.

A TREASURY Minute upon the recommendations of the university colleges committee has been issued as a Parliamentary paper. The consideration of the final report of Mr. Haldane's committee on the allocation of the grant in aid to university colleges is resumed. The recommendation of the establishment of a permanent committee to advise the Board of Treasury as to the distribution of the grant in aid is accepted, and an endeavour will be made in the autumn to constitute such a body, which will perform the duties hitherto undertaken by the quinquennial committee of inspection. Some of the colleges have pointed out that the intervention of such a committee may interfere unduly with their internal administration, but the Minute lays it down that the main functions of the committee will be to advise the Board of Treasury as to the kind of education which should be assisted out of the grant, and to satisfy themselves by inspection that the money is being properly applied. These objects can be obtained without any undue interference with the responsibility of the college authorities. Ninety per cent. of the grant is in the future to be allocated on the same general principles as have been adopted hitherto, and such sums as may be given will be secured to the colleges for at least five years. The balance of the grant will be reserved partly for special grants towards the provision of books and apparatus and partly for the encouragement of post-graduate work. The colleges will be expected to make proposals to the advisory committee as regards post-graduate work, showing the nature of the work it is desired to undertake and the assistance the college itself intends to contribute to the work. Parliament is being asked to vote 100,000*l*. for university colleges, and if this is agreed to 89,000*l*. will be distributed and 11,000*l*. reserved for allocation in March next. The amount allotted to each college for the year 1905–6 will be as follows:—Manchester, 12,000*l*.; University College, London, 10,000*l*.; Liverpool, 10,000*l*.; Birmingham, 9000*l*.; Leeds, 8000*l*.; King's College, London, 7800*l*.; Newcastle-on-Tyne, 6000*l*.; Nottingham, 5800*l*.; Sheffield, 4600*l*.; Bedford College, London, 4000*l*.; Bristol, 4000*l*.; Reading, 3400*l*.; Southampton, 3400*l*.; Dundee, 1000*l*.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 9.—"Explosions of Mixtures of Coal-Gas and Air in a Closed Vessel." By L. **Bairstow** and A. D. **Alexander**.

Summary.

Mixtures of coal-gas and air are not inflammable until the volume of coal-gas is greater than one-seventeenth of the combined volumes. Only a very small fraction of the gas then burns, the amount burnt rapidly increasing with increased richness of the mixture until the coal-gas is one-twelfth of the total volume. The least inflammable of the constituents then burns, and combustion becomes and remains complete so long as air is in excess. In these latter cases it is still probable that the constituents burn successively and not simultaneously.

The hypothesis of a specific heat increasing with temperature is not supported by direct experiment, and cannot be proved by any work on the pressures produced by explosion, the authors believing that a proof would require the measurement of temperature.

Direct experiments by Deville at temperatures below 1400° C. have shown that both steam and carbon dioxide are partially decomposed, and this dissociation is therefore taken by us as the sole explanation of the difference between the pressures calculated for explosions in a closed vessel and those actually obtained.

PARIS.

Academy of Sciences, July 17.—M. Troost in the chair.—On a new method of direct determination of refraction at all heights: M. **Loewy**. The author describes and explains the theory of his new method by which atmospheric refraction can be measured by the use of a prism the refracting faces of which are at an angle of 45°.—On an apparatus for producing artificial eclipses of the sun: Ch. **André**. By the use of such apparatus many theoretical points can be determined in a way not otherwise possible.—On the infinitesimal properties of non-Eucildean space: C. **Guichard**.—On the distribution of sugary substances in blood between the plasma and the corpuscles: R. **Lépine** and M. **Boulud**. By eliminating certain errors due to glycolysis, the authors find for the corpuscles 22 per cent., and for the serum barely 4 per cent. of sugar.—On the evaluation of errors in the approximate integration of differential equations: Émile **Cotton.**—A contribution to the study of liquid dielectrics: P. Gourée **de Villemontée.** The author's experiments were made with reference to the influence of the duration of charge, and the electric state of the mass after discharge. The results show that the propagation of electric charges across petrol and paraffin is comparable with that observed in crystalline dielectrics.—Experimental researches on the effect of membranes in liquid chains: M. **Chanoz.** The electromotive force developed by the chain of the general nature $MR|H_2O|MR$ depends for sign and intensity upon the nature of the membrane, the nature and concentration of the salt solution MR, and the relative position of the membranes to the liquids.—On fluorescence: C. **Camichel.** Further experiments on the coefficient of absorption in uranium glass when fluorescence is excited.—On the velocity of crystallisation from supersaturated solutions: Charles **Leenhardt.**—On the preparation of binary compounds of metals by means of heating with aluminium: C. **Matignon** and R. **Trannoy.** The great reducing power of aluminium has been utilised to prepare a considerable number of metallic phosphides, arsenides, silicides, and borides.—On the reduction of thorium oxide by amorphous boron, and the preparation of two borides of thorium: Binet **du Jassonneux.**—On the action of chloroacetic esters on the halogen magnesium derivatives of orthotoluidine: F. **Bodroux.**—On the action of ethylamine and *iso*butylamine on cæsium: E. **Rengade.** When ethylamine is condensed on perfectly pure cæsium a blue colour appears in the liquid which does not occur with sodium or calcium. In time the metal becomes a mercury-like substance which evolves gas readily, and is considered by the author to be cæsium-ethyl-ammonium.—Attempts at reduction in the dinitro-diphenyl-methane series of compounds: H. **Duval.**—On the condensation of chloral with aromatic hydrocarbons under the influence of aluminium chloride: Adolphe **Dinesmann.** By the action of chloral on benzene the author obtains in the given conditions excellent yields of trichloro-methyl-phenyl-carbinol,

$$C_6H_5—CHOH—CCl_3.$$

A similar condensation takes place with toluene, paraxylene, and anisol.—On 3:3-dimethyl-butyro-lactone: G. **Blanc.**—On the action of acetylene tetrabromide and aluminium chloride on toluene: James **Lavaux.**—On gentio-picrine: Georges **Tanret.**—On coffees without caffeine: Gabriel **Bertrand.** *Coffea Humblotiana* is noteworthy as containing barely a trace of the alkaloid.—On the development of green plants in light, in the complete absence of carbon dioxide, and in an artificial soil containing amides: Jules **Lefèvre.** The presence of the amides enabled plants to find the carbon necessary for the synthesis of both protoplasm and tissues.—On two cases of grafting (*Ipomea purpurea* with *Quamoclit coccinea* and *Helianthus multiflorus* with *Helianthus annuus*): Lucien **Daniel.**—On the disinfectant properties of smokes; attempts at disinfection with the vapour evolved from burning sugar: A. **Trillat.**—On the identification of the skin of the American admiral Paul Jones, 113 years after his death: MM. **Capitan** and **Papillault.**—On the multiple affinities of the Hoplophoridæ: H. **Coutière.**—On a new exploration of the abyss of the Trou-de-Souci: E. A. **Martel.**—On the mineral constituents of the water supplying Paris: L. **Cayeux.**—The hailstorm of July 16: A. **Berget.** Hailstones were found to weigh as much as 70 grams.

NEW SOUTH WALES.

Linnean Society, May 31.—Mr. T. Steel, president, in the chair.—Notes on the Eucalypts of the Blue Mountains, N.S.W.: J. H. **Maiden** and R. H. **Cambage.** The authors enumerate twenty-seven species and one variety collected by them. One of these, for which they propose the name of *E. Moorei*, is new; it has hitherto been looked upon as a narrow-leaved variety of *E. stellulata*, Sieb., but the juvenile foliage, for example, is very different. The past year was a specially favourable season for natural seedlings of the above genus, and a number of them are described for the first time. Particular notice is devoted to the Blue Mountain form of *E. capitellata*, Sm. Attention is directed to three plants which cannot, in strictness, be referred to any existing species, and which are looked upon as possible hybrids. The Blue Mountains, with their ready accessibility to both plateaux and valleys, considerable range in elevation, and rich Eucalyptus flora, afford special facilities for a study of the genus.—Notes on the native flora of New South Wales, part iii.: R. H. **Cambage.** This paper refers to the flora of the country between Orange, Dubbo, and Gilgandra, and directs attention to the great change that takes place from climatic causes which are regulated by the change in altitude, the fall in the country from Orange to Gilgandra amounting to about 2000 feet. Although much of the true interior flora is to be found at the latter place, it is noted that a number of plants which are typical of the coastal vegetation are also growing there, and the reason may be traced to the fact that a large sandstone area, chiefly Triassic, extends from Sydney across the Blue Mountains, continuing in broken remnants past Gulgong towards Dubbo and Gilgandra; and many of those plants which are able to withstand the cold of the higher levels cross the mountains and continue on the similar geological formation out towards the western plains. Reference is also made to an interesting species of Acacia, known locally as Motherumbung, and having affinities with *A. Gnidium*, Benth., but which in the absence of full material has not yet been identified.—Descriptions of new species of Australian Coleoptera: H. J. **Carter.** Fourteen species are described as new. These are referable to three families and eight genera, namely:—fam. Tenebrionidæ, Pterohelæus, Encara, Menephilus, Otrintus, Adelium (five species), and Coripera (two species); fam. Œdemeridæ, Pseudolychus (two species); fam. Pedilidæ, Egestria.

CONTENTS.