THURSDAY, NOVEMBER 16, 1911.

CELLULOSE DERIVATIVES IN THE SERVICE OF MAN.

Nitrocellulose Industry: a Compendium of the History, Chemistry, Manufacture, Commercial Application, and Analysis of Nitrates, Acetates, and Xanthates of Cellulose as Applied to the Peaceful Arts; with a Chapter on Gun-Cotton, Smokeless Powder, and Explosive Cellulose Nitrates. By Dr. Edward C. Worden. Vol i., pp. xxxiv+565. Vol. ii., pp. xxviii+567–1239. (London: Constable and Co., Ltd., 1911.) Price, two vols., 42*s*. net.

WHEN Schönbein first announced his discovery of gun-cotton little could he have foreseen that he was laying the foundation of so many important industries as those, sixty-five years later, associated with cellulose derivatives, for although the acetates and xanthates of this parent substance are daily growing in importance, their introduction has solely been due to the wide and successful application of the nitrocelluloses. One may safely say that the derivatives of no other single chemical substance (if cellulose in its varied forms may be so termed) have proved of such general use to mankind, assisting in the production at a cheap rate of numbers of articles hitherto made from expensive natural products, developing important branches of photography, rendering valuable service to the man of science and medical man, and finally furnishing the base of all the modern smokeless powders. The author has succeeded in these two comprehensive volumes in admirably treating of all the discoveries and applications of these highly important derivatives. The magnitude of such a work and the thoroughness with which it has been carried out may be realised from the fact that more than 8000 literature references and 5000 patent references have been verified.

The preparation of the nitrocelluloses and their stabilising is of the first importance, and is very clearly dealt with. An important point is the effect of prior treatment of the cotton, before nitration, on the character of the product and its stability. In general cotton treated with bleaching powder solutions or mercerised by alkali gives a lower nitrogen content, a greater ether-alcohol solubility, and renders subsequent stabilisation more difficult.

The successful application of nitrocelluloses in the arts is almost wholly dependent on the use of proper solvents and obtaining solutions of the desired viscosity. The important part which amyl alcohol (*iso*), introduced by Stevens in 1882, has played in the artificial leather, lacquer, and other industries is paralleled by the important property of camphor in forming solid or suitable plastic bodies for other branches of the industry. The author estimates that some 450,000 gallons of amyl acetate are annually employed in the United States, so that he rightly devotes considerable space to its preparation and the chemistry of camphor also receives very full treatment.

Space does not permit of more than a brief reference to the numerous applications of nitrocellulose or the other derivatives; it seems that in one way or another they must have some interest for everyone, but especially for those engaged in any branch of science. The preparation of museum specimens, and particularly of sections for the microscope; for preservation of important writings by saturation of the paper (where Indian ink has been employed, of which shellac is a constituent and soluble in the nitrocellulose solvent—the paper must first be immersed in a 2 per cent. solution of gelatin and allowed to dry); for the production of special tubes for deep-sea soundings, the tubes being coated inside with silver chromate, are amongst the minor but still important applications of nitrocellulose solutions.

In the large industries built up on cellulose derivatives during the last twenty years mention may be made of its application in the manufacture of incandescent mantles, both for coating the mantle to enable it to withstand the shocks of transport and handling, and the production of mantles themselves by the ejection of filaments containing the thoria and ceria, to be afterwards woven into mantles; the production of pyroxylin containing imitation leathers, of which a conservative estimate of the daily output of the United States is 45,000 yards, and for photographic purposes, where the applications of soluble nitrocelluloses are so numerous that considerable space is devoted to the subject. The production of continuous films has undoubtedly contributed more than any other discovery to the popularity of photography, and rendered the kinematograph a possibility. The extreme desirability of using non-inflammable films is emphasised from time to time by the ignition of ordinary films, so that the description of the preparation of cellulose acetate films will prove of value and a useful guide to future inventors.

The production of artificial silk is a triumph of the application of chemical substances to rival one of the most beautiful products of nature. Whilst in the early days it was thought to be a rival to the natural product, its lack of flexibility and strength have precluded this actually being the case; but the beauty of the filaments has given rise to so many new and decorative materials that, although not a rival, the demand for the artificial product was, for a period, so great that its price actually exceeded that of the natural silk. A brief reference can only be made to the early process of Chardonnet (1884), in which, as in most processes, an ether-alcohol solution of nitrocellulose is employed. The fluid was at first squirted through an orifice 0·5 mm. in diameter, the spinnarets falling into cold water which coagulated, their exterior forming a tube with a liquid interior, this coarse thread being then rapidly spun out into a thin filament. Later the orifice was reduced to 0·08 mm. Nitrocellulose silks are usually denitrated by means of an alkaline sulphide, so that finally they are essentially cellulose. It is of interest to compare the diameter of the artificial fibre with the natural. Chardonnet silk is given as 45 to 60 micromillimetres, while the natural silk is only 9 to 15, these figures being for the wet (swollen) fibres.

The chapter on the military applications of cellulose derivatives is limited to eighty-five pages, but these contain a vast amount of information which, although familiar to those associated with this branch of the subject, is an excellent condensation of information.

So wide are the applications of cellulose derivatives and so admirably is the subject treated by the author that his two volumes should find a place in every technical and scientific chemist's library, and, further, will prove an invaluable reference book for the large number who are regularly employing many of these important bodies in their everyday work.

J. S. S. B.

EDUCATION FOR THE COUNTRY LIFE.

The Teaching of Agriculture in the High School. By Garland A. Bricker. Pp. xxv+202. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1911.) Price 4*s.* 6*d.* net.

STUDENTS of rural affairs have long realised that much dissatisfaction exists in country districts with our present system of education. In whatever way it is judged, according to its critics, it has failed; the children sent out from the country schools are not better fitted for work on the land than their fathers were; on the contrary, they are kept at desk work during the period when it is supposed that their receptive faculties are at the best, and when they would, on the land, most rapidly learn the ways of animals, of plants, and of soils. Even the friends of the system will concede that it has been evolved without any special regard for country requirements, and without taking account of the fundamental differences in habits of thought and in points of view between the dwellers in the town and those in the country.

More and more it is being realised that the future development of the rural district, or to put it still more widely, of the country civilisation, must run on different lines from that of the city, and experiments are therefore being made to evolve a system of education that shall train children to lead the life of the country. The experimental scale is largest in the States, as one might expect, and in the book before us Mr. Bricker has collected such of the material as is at present available, thus usefully filling a gap in our education literature. It is, of course, as yet too soon to speak about results, but during the experimental period it is useful for educationists to know what their American *confrères* are doing.

Of the elementary school but little is said. The nature-study idea is for the present the best we have, and has already a copious literature of its own. The work of the elementary schools, according to the author, should confine itself to an elementary study of the common things of the farm, field, and forest. Something of the relative importance of these things to man should be studied and fixed in the mind of the child before he leaves school. It is in the secondary school, or, as it is here called, the high school, that the scholars will take up agriculture as such, but there is no break in the sequence of studies because agriculture will be looked upon as nature-study *plus* utility. But the study of agriculture is to be an education and not simply a manual training.

"If the essence of true culture is to see the fundamental and eternal shining out through the seemingly trivial and transitory, there is no subject better adapted to provide culture than the subject of agriculture."

To be treated in this broad way, agriculture requires a larger place in the school curriculum than the established secondary schools are able or willing to give it; hence the necessity for separate agricultural schools. Two possible dangers are indicated; specialised schools may emphasise class distinctions unworthy of a democratic country; education that makes a strong appeal to economic motives may be harmful if it places its powerful sanction on self-seeking ideals. The purely practical man, of course, will ask: Of what use are culture and adornment if the power to earn a livelihood is lacking? But this must not be the point of view of the agricultural teacher. He must rather insist on the other question: Of what use is the best capacity to make a living without a corresponding power to make life worth while? and make agriculture a cultural as well as a vocational subject. In short, the agricultural secondary school is to be the directive and constructive agent of the new rural civilisation that the best men in the States (and, for that matter, in this country also) are endeavouring to foster.

A chapter is devoted to the description of schools already established. They are, as one would expect, of several types, but in all of them boys and girls are educated together, entering at the age of thirteen or fourteen, and remaining for three or four years. Agriculture for the boys and household science for the girls form the respective centres of the courses, and the education is made as real as possible, *i.e.* the thing itself, whether a horse, a maize seed, or a growing crop, is before the class, and not simply a picture.

The author then proceeds to a discussion of methods. The logical arrangement of subjects followed in a college course is not the best for the boy with his limited experience and his incomplete and unorganised knowledge. It is necessary to adopt a psychological arrangement, *i.e.* a sequence of studies adapted to the changing and developing powers of the scholar. That the subject generally accords with the instincts and the impulses of the average boy is a tremendous help, and yet, unintelligently directed by the teacher, this help may prove a great danger. Into the psychological discussions we need not enter. The author's aim is to show that pedagogic principles can and should be applied to the teaching of agriculture, and that the subject can and should be made cultural as well as vocational.

The book affords a striking illustration of how much further the Americans have got than we ourselves. We are only commencing—if indeed we have seriously commenced—to apply the science of education in our agricultural teaching. Those who propose to essay the task will obtain useful help from this book.

E. J. R.

GLACIERS AND ICE-SHEETS.

Characteristics of Existing Glaciers. By Prof. W. H. Hobbs. Pp. xxv+301. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1911.) Price 13*s*. 6*d*. net.

THE framework of this volume was laid by Prof. Hobbs in three papers, dealing in turn with "Mountain Glaciation," "The Ice of Arctic Regions," and "Antarctic Ice," which were published during 1910 in scientific journals respectively in London, Philadelphia, and Berlin. The author has done good service to the glaciologist and glacial geologist in bringing together his concise description and classification of existing glaciers and ice-sheets in the present convenient form. Especially in the parts devoted to Arctic and Antarctic ice he has made an exhaustive digest of the scattered literature, and has presented a copiously illustrated summary of the available information respecting the distribution and character of the ice of these regions. To the end of each chapter he appends a full list of his authorities, so that the book is in every respect a most useful work of reference. His outlook is throughout that of a physiographer of the modern American school, and he has constantly in view the effect of ice and snow upon the shape of the land beneath it.

In his treatment of mountain glaciers, in the first (and shortest) part of his book, the author asserts himself more prominently than in the later parts, and it may be that some of his readers will consider the value of this part as a digest has, in consequence, been impaired. He reduces the existing Alpine glaciers to their really insignificant position by the aid of comparative diagrams (*e.g.* plate ii.). He will not allow that any of them, with the possible exception of the Great Aletsch, are worthy even of being called valley-glaciers—"In reality the glaciers of the Alps, far from occupying valleys, do not even fill the mother cirques at the valley heads" (p. 52). His rather elaborate classification of mountain glaciers (p. 42), based partly upon comparative alimentation, is not, however, likely to be generally adopted; most of the "types" are necessarily nothing more than phases which merge together indefinitely both in space and time-relation.

With respect to the long controversy as to the potency of ice as an eroding agent, Prof. Hobbs in his preface explicitly disclaims any intention to deal with "the views of that school of British geologists particularly which holds that the denudational effect of glacier ice is negative." So he does not refer to these views in adopting alternative explanations of the critical phenomena; *e.g.* the "Cascade Stairway" and the "Hanging Valley," in chapter iv. In this connection it may be remarked, though not mentioned by the author, that the long trench-like valleys by which the great glaciers pour down to the ice-plain of the Barrier from the high Antarctic plateau can scarcely be assigned to any other cause than ice-erosion.

In discussing the relation of mountain-form to glaciation, Prof. Hobbs dwells with particular emphasis upon cirque-development, which he believes to have a greater importance than has been generally recognised; and in this branch he takes upon himself the *rôle* of special pleader. For the initiation of a cirque through the agency of a snow-bank, he calls in the process of "nivation," *i.e.* selective perishing of contiguous moistened rock, as first suggested by Mr. F. E. Matthes from his observations in the Bighorn Mountains of Wyoming. In the later development of the cirque, the berg-schrund is considered to be a prime factor by the author, who has been duly—possibly even unduly—impressed by results of Mr. W. D. Johnson's celebrated exploration of the berg-schrund of Mount Lyell glacier, California, where the sapping of a perpendicular wall of rock was found to be in progress at the bottom of the fissure. The basis of observation is so limited that it may legitimately be questioned whether this sapping effect is general. However, the author considers that cirque recession is mainly responsible for the residual topographical forms of most high mountains, and he illustrates the progressive stages by good examples from western U.S.A., stating that "in parts of Europe, and in the Alps in particular, one looks in vain for evidences of the earlier and more significant stages," owing to the more prolonged and vigorous glaciation.

In final chapters the meteorological conditions of existing ice-sheets are summarised, and it is considered that the strong radial winds of Greenland and the Antarctic are due to the sliding outward of chilled air along the surface of the ice-dome.

The author fully recognises in other parts of his work the proved aridity of both polar areas, but passages on pp. 42–3 and 100–1 are likely to give the erroneous impression that the ice-caps are areas of heavy precipitation. At p. 238 there is an obvious misprint of Arctic for Antarctic.

Independently of the author's opinions on debatable matters, which may or may not be acceptable, every geographer and geologist interested in ice will appreciate these clear descriptions and excellent illustrations of the earth's great glaciers—they make up into a most presentable book. G. W. L.

PRECESSION AND PARADOX.

Draysonia: being an Attempt to Explain and Popularise the System of the Second Rotation of the Earth, as Discovered by the late Major-General A. W. Drayson; also giving the Probable Date and Duration of the Last Glacial Period, and Furnishing General Drayson's Data, from which any Person of Ordinary Mathematical Ability is Enabled to Calculate the Obliquity of the Ecliptic, the Precession of the Equinoxes, and the Right Ascension and Declination of the Fixed Stars for any Year, Past, Present, or Future. By Admiral Sir A. F. R. de Horsey, K.C.B. Pp. ix+76+diagram. (London: Longmans, Green, and Co., 1911.) Price 3*s*. 6*d*. net.

GENERAL DRAYSON'S book on the "Motion of the Fixed Stars" is not a model of lucidity and generally fails to convince those who endeavour to grasp its argument. It was, therefore, most desirable that in selecting a commentator and literary executor the choice should fall on one who possessed the power of removing what was obscure in the theory and of placing the scheme in the most advantageous light. Admiral de Horsey has nothing to recommend him for the office he has undertaken but an unstinted admiration for the original author and a loyal desire to secure his recognition as a profound thinker. We respect and admire the sincerity of his conviction and his resolute effort to uphold the reputation of his departed friend. The struggle he has made is pathetic, but we regret to say he has only succeeded in darkening the issue.

General Drayson was dissatisfied with the theory of precession. He could not accept the explanation of the change of coordinates as due to the revolution of the earth's pole about that of the ecliptic, while at the same time the obliquity of the ecliptic was continually varying. He did not admit that the circular motion was a close approximation to the truth, and that greater accuracy was obtained by making the radius of the circle vary. Yet the device is a very usual one in the explanation of a recondite subject. It is often found that a broad general truth requires a minute degree of qualification. "The geometrical absurdity of a circle with a movable centre" seems to have presented a difficulty that the gallant General never mastered, and he therefore devised another plan for computing precession. Owing to the slow motion of the earth's pole, there is no difficulty in contriving an arithmetical process, by which the results when confined to a limited number of years shall be similar to those obtained by the ordinary formula. General Drayson's plan was to make the earth's axis revolve in a circle of radius 29° 25′ 47″, about a point 6° from the pole of the ecliptic, and situated near the solstitial colure. The annual motion of the point marking the origin of longitude (apparently not precisely coincident with the first point of Aries) is 40·89″, consequently the cycle of precession is about one-quarter longer than that assigned by astronomers.

Admiral de Horsey's contribution in support of his friend's theory has been to compute the precession of many stars by this method, and to compare the results with the Nautical Almanac values. The agreement is satisfactory, but if this proved anything one would think it proved the Nautical Almanac correct; but that view does not commend itself to the Admiral. Partly perhaps because in Drayson's method the obliquity of the ecliptic will vary in the course of a cycle between 23° and 35°, and thereby the glacial theory, provided that geologists could be satisfied with so short a period as 15,000 years, might be satisfactorily accounted for. The author also claims that some difficulties he imagines to exist in the reckoning of time can be removed by this means of explaining precession. He is not, however, very fortunate when he puts the late Mr. Stone in the witness-box to prove an anomaly in time reckoning. This may be a small matter, but when the author confuses precession with aberration we feel that, with the best intentions of serving the interests of his lost friend, he is scarcely fitted for the task.

THE MEASUREMENT OF ILLUMINATION.

Illumination; its Distribution and Measurement. By A. P. Trotter. Pp. xvii+292. (London: Macmillan and Co., Ltd., 1911.) Price 8*s*. 6*d*. net.

DEDICATED to Pierre Bouguer, the father of photometry, this book is the first really scientific attempt to put illuminating engineering on a proper basis, and is the outcome of the work which has been done in America and England of late years to break away from the haphazard methods of lighting which have so long been in vogue, and to replace them by arrangements of the sources of light which shall lead to a satisfactory distribution of light over the area to be illuminated.

No one more fitted to undertake this work than Mr. A. P. Trotter could have been found, and the experience he has gained since 1879, when he worked out his dioptric system of uniform distribution of light, has enabled him to produce a book which will prove invaluable to those who realise that the mere statement of the candle-power of a light offers no guide to its lighting effect, and that fifteen candles burning in different parts of a room give a very different illumination from one fifteen candle gas-jet burning in the chandelier.

The book very wisely is confined to the methods of distribution and measurement of illumination, and the portions dealing with photometry are more especially amplified in this direction, whilst all descriptions of systems of lighting have very properly been omitted.

The first chapter deals with the units and standards of candle-power, from the much-abused candle to the impracticable Violle melted platinum unit, but surely Mr. Trotter is a little unjust to the former when he says "the so-called English Parliamentary candle of spermaceti was not more scientific and hardly more accurate than the barleycorn of which three went to the inch." There are many photometricians of the old school who could assure him that the sperm standard candle, as made by Miller, when its use was guided by common-sense rather than by departmental directions, fell short of the modern standard in little else than convenience.

In the second chapter the author discusses "illumination and derived units," and it is pleasant to find due credit given to Sir William Preece, who, as early as 1889, recognised the necessity for a measure of illumination, and adopted the carcel-metre, to which unit he gave the name "lux," a name afterwards applied by the Geneva Congress in 1896 to the bougie-metre. The latter part of the chapter is devoted to a clear enunciation of the laws of light, flux of light, brightness, quantity, and reflection.

The distribution of illumination, more especially over a plane, occupies the next two chapters, and in the fifth photometers received full attention, and this chapter is of special value, as Mr. Trotter has introduced into it so much of his own work. It would have been even more interesting if he had criticised the various photometers from the point of view of the personal equation, as many observers would have liked to know his opinion of the Referees' table photometer as compared with the open-bar disc photometer for general gas-testing work.

Several chapters are devoted to the minutiæ of photometric work, whilst in chapter ix. the measurement of illumination is dealt with, and another chapter describes the practical application of the methods employed, the work concluding with a valuable review of the subject of dioptric distribution of light.

The whole work is excellent from all points of view, and will form an addition to the engineer's and architect's library of far more than ordinary value.

MODERN GEOGRAPHY.

(1) *The Nations of the Modern World: an Elementary Study in Geography.* By H. J. Mackinder. Pp. xvi+319. (London: G. Philip and Son, Ltd.; Liverpool: Philip, Son, and Nephew, Ltd., n.d.) Price 2*s.*

(2) *A Geography of Ireland.* By O. J. R. Howarth. Pp. 224. (Oxford: Clarendon Press, 1911.) Price 2*s.* 6*d.*

(3) *Aberdeenshire.* By A. Mackie. Pp. x+198.

(4) *Huntingdonshire.* By the Rev. W. M. Noble. Pp. ix+152.

(5) *Worcestershire.* By L. J. Wills. Pp. ix+154. (Cambridge: University Press, 1911.) Price 1*s.* 6*d.* each.

(1) THE first of these works must not be regarded merely as a reading book for schools. It is, as its author observes, "a book of mingled geography and history," and contains so much matter that it was surely worthy of an index. While it develops the theme of three previous works, and brings out the bearing on human relations of the geographical conditions there described, it forms at the same time an independent treatise, which will stimulate the memory of many readers of full age. It is these, indeed, who will enjoy it thoroughly. A knowledge of modern history, and much of it obtained at first hand, is necessary for the complete appreciation of the changes of the map of Europe. Mr. Mackinder brings the older stages, such as those accompanying the Seven Years' War and the Napoleonic epoch, tersely and vividly before us. The later steps, the freeing of Venice, the partition of Lorraine, the uplifting of Bosnia, belong to our own eventful times. But we are led also to trace the rise of the United States and of Japan, and to take a large and scientific view of the inevitable expansion of Germany (p. 250), where men almost of our own blood are looking out also on the world. It may be somewhat ironic to suppose (p. 257) that the immense progress of Egypt under British organisation incited the Turks to improve their own home government; but the author's treatment of the British Empire as a whole forces a sense of responsibility upon the most insular and reluctant conscience. We may not like the reference nowadays (p. 258) to Japan and Turkey as "two heathen Powers," a phrase that has slipped in somehow from Mr. Mackinder's studies of the early nineteenth century; but his outlook is elsewhere that of the philosophic traveller. Under his direct and closely written sentences, we trace always that fine feeling for duty which is man's highest possession on this strange rotating globe.

(2) Mr. Howarth's "Ireland" is a welcome addition to the Oxford Geographies, a series edited by Prof. Herbertson. Aided by maps and excellent photographic illustrations, it brings the features of the country, grouped in natural regions, well before us. The author makes somewhat little (pp. 44 and 45) of Jukes's classic explanation of the courses of the southern Irish rivers, and seems to think that the Blackwater may have run against the face of an upraised fault-block at Cappoquin. Lamplugh's justly accepted explanation of the Scalp is neglected on p. 64, while the gorge of the Dargle is strangely described as having been deserted by its stream. Fig. 5, showing a drumlin-covered country backed by the Curlew Hills, is not so representative as it should be of "the Central Lowland," and the geological descriptions generally seem to date from the appearance of Hull's "Physical Geology and Geography of Ireland." We thus have Archæan granites (Fig. 3) opposed to large areas of "Cambrian and Silurian" strata in the metamorphosed regions; but the author himself must be held responsible for the insertion on his map of a Silurian district in the extreme south. Chapter xxvi. might be improved by an account of the cooperative organisation of agriculture, which has been largely aided by the fact that Ireland is a convenient and detached geographical unit. The publications of the Irish Department of Agriculture will assist Mr. Howarth in his next edition. The book has so many good points, and so clearly connects the structure of the country with the life of its inhabitants, that we hope it will meet with ready recognition.

(3) The county geographies issued by the Cambridge University Press, with their coloured physical and geological maps, and numerous landscape illustrations, have already taken a high rank. Aberdeenshire is largely a granite county, with solemn ice-worn highlands, and castles as stern as the jutting rocks along its coast. Mr. Mackie is a student of nature with a keen literary taste, and human interests and antiquities are evidently as attractive to him as are the birch-woods and the moors.

(4) The Rev. W. M. Noble's "Huntingdonshire" in the same series presents a very different country, where the fundamental rocks rarely appear from beneath the covering of glacial detritus and alluvial fenland. Too little emphasis seems to be laid (p. 31) on the high interest of the boulder-clay. The agricultural features, the great manor houses, and the stone bridges along the grand old highways are excellently illustrated and described.

(5) In "Worcestershire," Mr. L. J. Wills has a fascinating field. He describes the high ridge of Archæan granite in the Malverns, which rise on the western border like a blue wave against the evening sky. He illustrates the British formations up to the oolites of Bredon, and then directs attention to the upland vegetation of the Lickey Hills and the relics of old forests in the lowlands. The frosts in the hollows of the fruit-growing districts (p. 45) are, we presume, due to the creep of cold air downwards on still nights,

rather than to an increase in the amount of moisture present. A Severn coracle is figured (p. 87), and the antiquities lead us on to the stone houses of the Cotteswolds, and the unrivalled half-timber villages of the Trias plain. The chestnut-tree growing from a tomb in Kempsey Church (p. 140) may puzzle the reader who has not seen it. G. A. J. C.

MATHEMATICAL AND PHYSICAL CHEMISTRY.

(1) *Theoretical Chemistry from the Standpoint of Avogadro's Rule and Thermodynamics.* By Prof. W. Nernst. Revised in accordance with the sixth German edition by H. T. Tizard. (London: Macmillan and Co., Ltd., 1911.) Price 15*s.* net.

(2) *Higher Mathematics for Chemical Students.* By J. R. Partington. Pp. v+272. (London: Methuen and Co., Ltd., 1911.) Price 5*s.*

(3) *Abhandlungen der Deutschen Bunsen-Gesellschaft für angewandte physikalische Chemie.* Zweiter Band, Nr. v., Messungen elektromotorische Krafte galvanischer Ketten, mit wasserigen Elektrolyten. By R. Abegg, Fr. Auerbach, and R. Luther. Pp. x+213. (Halle a. S.: W. Knapp, 1911.) Price 8.40 marks.

(1) PROF. NERNST'S text-book occupies a special position amongst text-books of physical chemistry, written as it is by an author of such eminence as a pioneer and investigator in the science, and of such remarkable powers of exposition. From the chemical point of view no better basis for a work of the kind can be adopted than that of Avogadro's rule, for one of the main practical problems of the chemist is the determination of molecular concentrations. Gas densities, osmotic pressures, freezing and boiling points of solutions, conductivity of electrolytic solutions, and electromotive forces are all measured with this primary object in view, and therefore Avogadro's rule is at the root of them all. On this sound chemical basis, then, with the aid of the two laws of thermodynamics, the author has built. His ideas are always clear cut, his expression of them is always ordered and concise, and his mathematical proofs are of special neatness and brevity. It is no wonder, then, that although the book is scarcely intended for beginners, it should have reached a sixth edition in German and a third in English. The advanced student and teacher will specially welcome in this latest edition a detailed account of Prof. Nernst's new thermodynamical theorem, of which so much has been recently heard.

It is a matter for regret that the original English translation of Prof. Nernst's work was far from satisfactory, and so to a considerable extent spoiled the vogue of the book. The present translation has been revised and partly rewritten, and has without doubt been thereby vastly improved. But nothing short of complete retranslation could do justice to the original. However, an occasional awkwardly turned phrase of a distinctly Teutonic flavour will probably not greatly incommode the average reader, and so to all those who desire acquaintance with the facts and theories of physical chemistry and an indication of the lines of progress of the science, this translation of Prof. Nernst's excellent and unique work can be unreservedly recommended.

(2) Of all the mathematical books intended for the use of chemical students which have come under the notice of the present writer, Mr. Partington's is the most serviceable. The author has had a clear notion of the practical problem to be solved, and has performed his task successfully. He does not attempt to teach too much, and strictly adheres to what will be practically useful to the student of physical chemistry. Brief explanations of the nature of the mathematical processes employed are given, and their application is at once shown by well-selected examples. Thus convergent series are illustrated by the two examples of the washing of precipitates, and extraction from aqueous solution by means of ether; maxima and minima by the rate of catalysis of methyl acetate by water; the compound interest law by the decay of radio-activity; and so on. Alike to the chemical student who has no previous knowledge of the differential and integral calculus, and to the student who has learnt the methods of the calculus, but is at a loss how to apply them, this little book will be of considerable value.

(3) The Bunsen-Gesellschaft deserves the gratitude of those who work on the subject of electromotive force for the issue of the volume under review. It consists of three parts: (1) a complete systematic and chronological bibliography of measurements of electromotive forces; (2) a selection of the most trustworthy measurements reduced to a uniform system; and (3) tables of the most probable values of single electrode potentials.

In the bibliographical section the nature of the electromotive combinations measured is given, but not the numerical values obtained. Only aqueous solutions are considered, and such combinations as involve an agency external to the cell are excluded, *e.g.* thermoelectric and photoelectric combinations, decomposition potentials, and the like. The arrangement is by elements according to the groups of the periodic table, both in the bibliographical and in the tabular sections; the single potentials are referred to the normal hydrogen electrode as zero.

With this book of reference at hand the worker at electromotive force can ascertain in the minimum of time what trustworthy work has already been done in his special branch, and see at a glance the most probable numerical values for any electromotive combination in which he may be interested. J. W.

OUR BOOK SHELF.

Field Note-book of Geological Illustrations. Arranged by Hilda D. Sharpe; containing 86 photographs and maps. Pp. 51. (Manchester: Flatters and Garnett, Ltd., n.d.) Price 3*s.* net.

THE idea of this book is a very happy one. Miss Sharpe has collected a number of photographs illustrating geological features, mainly from places in the British Isles, and Messrs. Flatters and Garnett are prepared to supply lantern-slides of most of them at 1*s.* each, or on hire at 1*s.* 3*d.* a dozen. Even as a supplement to the fine series issued by the British

Association, this selection is very welcome, and the book itself, at its modest price, is distinctly suggestive to the teacher. The illustrations, even when most effective, are rarely chosen from hackneyed subjects. We can scarcely do better than Stare Cove, Lulworth, or the Giant's Causeway, which naturally appear; but we can now avail ourselves of the limestone pinnacle of Pickering Tor, of eight views of the River Artro, near Harlech, from its source among the boulders to the sea, and of the Severn Valley in the Triassic plain of Worcestershire. Broad landscapes like the last have too often been neglected. Miss Sharpe gives us also the Silurian escarpments near Malvern, the rounded forms of the Longmynd, and the ice-worn gneissic floor of Sutherland. Details like an erratic near Harlech and pot-holes on the Gelt have also obvious uses. The subject may easily be extended into future volumes, if the enterprise meets with the success that it deserves.

A neat coloured geological map of the British Isles is given, but no useful purpose appears to be served by the insertion of tables of rock-forming minerals or of the classification of rocks, which cannot be regarded as either adequate or appropriate. The statements, moreover, made in this brief form are not always accurate. Opal is only partially described as "hydrated silica, brilliantly coloured." The term "glassy" applied to sanidine ought to have been long ago abandoned. "Carbonate of calcium" does not necessarily crystallise in rhombohedral crystals, since two forms are described below, one of which, aragonite, is here said to be triclinic. In the classification of the stratified rocks, "silica" and "silicates of alumina" are treated as minerals. These matters might be left with the text-books, to which the preface so properly refers.

Die Anzucht Tropischer Orchideen aus Samen. Neue Methoden auf der Grundlage des symbiotischen Verhältnisses von Pflanze und Wurzelpilz. By Dr. H. Burgeff. Pp. iv+90. (Jena: Gustav Fischer, 1911.) Price 3.50 marks.

IT was announced by the French botanist, Noël Bernard, in 1904 that a symbiotic fungus inhabits the roots of many orchids, and that continued germination of the seed of such orchids is dependent upon the entrance of the fungus mycelium to renew the symbiotic union. This conclusion raised further problems, particularly whether the fungus differs in different orchids and how it may be isolated and inoculated. These are the practical points treated by Dr. Burgeff, who provides full instructions for raising seedlings in accordance with rigidly scientific principles. The methods are laborious. It is necessary to make pure cultures of the fungus, obtain aseptic seeds, mingle the two symbionts, grow them artificially, and transfer finally the young plant to natural conditions. The author also cultivated a number of mycelia taken from different plants with the view of distinguishing different varieties or species of fungus; the general result is indicated in a diagram showing that the mycelium of a given culture may serve for one, two, or rarely for more genera. Having thus shown how pure cultures should be made and described many experiments that he successfully carried out on these lines, he indicates a less troublesome method which consists in sowing the seed on sterilised fungus-infected soil.

It is unlikely that professional orchid growers will adopt either of the methods described, because it is in most cases an easy matter to raise seedlings under ordinary conditions by adding portions of the old roots or even soil from old cultures to the compost in the seed-pan. Nevertheless, the researches of Dr. Burgeff are theoretically and practically of great value, and should be carefully noted by growers, as they may serve to explain unexpected failures.

Elementary Applied Mechanics. By Prof. A. Morley and W. Inchley. Pp. viii+382. (London: Longmans, Green and Co., 1911.) Price 3s. net.

THIS book is intended for beginners of limited mathematical attainments, and, to meet the needs of such, extensive use is made of graphical methods and of numerical illustrations. Many worked-out exercises are included, together with others intended for solution by the student. Simple laboratory experiments are described. The standard is that of Stage I. of the Board of Education, and the method of treatment is quite orthodox. An introductory chapter on mensuration and measuring appliances is followed by chapters on elementary statical principles, leading up to the consideration of simple frames. Work, friction, and machines are then considered. Five very good chapters on the strength and elastic properties of materials are included, and the elementary laws of hydraulics form the subject-matter of the last three chapters.

The illustrations are clearly drawn, and are mostly correct. An exception occurs on p. 115, where a Prony brake is illustrated, having two mistakes in its design. In the chapters dealing with the composition and resolution of forces, it would have been better to omit the arrows shown on the triangles and polygons of forces. These cannot be shown on the force diagrams for frames, and a habit of inserting arrows which have to be omitted in subsequent diagrams is easier acquired than dropped by the beginner. We also observed several diagrams in which the resultant, found from the force diagram, has not been inserted in its proper place. The principal author is well known from his work on the strength of materials, and the present volume should take a good place among the other elementary text-books on the same subject already in existence.

The London University Guide and University Correspondence College Calendar, 1912. *Containing the Regulations for Examinations to be held in* 1912 *and* 1913. (London: University Correspondence College.)

THE private student anxious to graduate at the University of London will find in this volume all the information he needs as to how to proceed. The best plan, in cases where it is possible, is for the student to enter one of the constituent colleges of the University and to follow the suitable course of study arranged for intending graduates; but for young men and women who are compelled to live far away from a college and whose time is occupied during the day, it would be difficult to find more helpful advice than this book contains.

Life in the Sea. By James Johnstone. Pp. vii+150. *New Zealand.* By Sir Robert Stout, K.C.M.G., and J. Logan Stout. Pp. viii+185. (Cambridge University Press, 1911.) Price 1s. net each.

BOTH these volumes belong to "The Cambridge Manuals of Science and Literature," a series which is fast becoming representative of every department of human knowledge. Mr. Johnstone provides a discussion of the general economy of the sea, in which the results of recent investigations of the microscopic life of the ocean are given due prominence. The object of the second book is to show faithfully in a brief way what New Zealand is and what has been done by her people, the treatment being such as is likely to appeal to readers who have not seen the Dominion.

These "Manuals" are not of the nature of primers for young beginners; they are suitable, rather, for educated readers of maturer years, who desire to acquaint themselves with modern advances in the subjects in which they are interested.

L'Assaut du Pole Sud. By l'Abbé Th. Moreux. Pp. 221. (Paris: Jouve et Cie., 1911.) Price 1.50 francs.

THIS popular account of the various expeditions in Antarctic regions, arranged chronologically, will appeal to many readers. In English schools it might serve the double purpose of an interesting French text and leisure-hour reading in geography. The story is brought down to the present day and is illustrated, some of the pictures being views taken by Dr. Charcot on the *Pourquoi-Pas?*

Subject List of Works on Chemical Technology in the Library of the Patent Office. New Series, YN–ZB. Pp. iv+171. (London: The Patent Office, 1911.) Price 6*d.*

THE present list is concerned with oils, fats, soaps, candles, and perfumery; paints, varnishes, gums, resins, and india-rubber; and the paper and leather industries. With the volume, new series YK–YM, it supersedes "Patent Office Library Series, No. 7," published in 1901.

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.*]

The Late Sir Francis Galton.

I AM engaged on a memoir dealing with the life and work of the late Sir Francis Galton. He had a very wide correspondence, the width of which can only be appreciated by those who have seen the replies to his letters. Many of these are of great interest and value, and deal with important scientific problems. The main bulk of the letters start with 1885, although there are isolated letters from de Candolle, Speke, Buckland, Clerk Maxwell, and others from 1860 onwards. The letters from Francis Galton which led to these replies may still exist. May I appeal to any of your readers who have letters from Francis Galton to lend them to me for the preparation of this memoir? I should value especially any letters from 1850 to 1880; but all will be of value. Letters sent to me shall be carefully preserved, and returned if the owner desires it. Any letters which the owners are willing to present to this laboratory will be filed in the Galtoniana, which already contain many Galton manuscripts. KARL PEARSON.

Galton Laboratory for National Eugenics.

The Kaiser-Wilhelm Institut für physikalische Chemie und Elektrochemie at Dahlem, near Berlin.

ON October 1 Prof. F. Haber began his work as director of the new Kaiser-Wilhelm Institut für physikalische Chemie und Elektrochemie at Dahlem, near Berlin. The buildings of the institute, work upon which was begun during the summer of this year, are being erected by the Prussian Government working in conjunction with the "Koppel-Stiftung for the purpose of improving the intellectual relations of Germany with other lands."

The Koppel-Stiftung, which was founded in Berlin some years ago by Geheimer Kommerzienrat Leopold Koppel, and until now has maintained the German School of Medicine in Shanghai and the American Institute in Berlin, will provide the funds for the erection of the new institute, and will also give 35,000 marks annually for its maintenance during a period of ten years. The Prussian Government has provided the site, which is situated at the terminus of the new underground railway from the centre of Berlin to Dahlem, and has endowed the institute with the sum of 50,000 marks annually.

The institute will be controlled by a board consisting of two representatives of the German Government, two representatives of the Koppel-Stiftung, and the director of the institute. The director has an absolutely free hand in the choice of his work, his fellow-workers, and his assistants.

For the admission of investigators who wish to follow their own lines of investigation in the institute with their own means, the director must have the assent of the board of control.

The institute will consist of scientific and technical departments in separate buildings. The building of the scientific department is 600 square metres in ground area, and has a basement, entirely underground, containing constant temperature rooms. On the ground floor are the professor's laboratory and consulting room, the offices, the calibrating room in which are to be kept the necessary laboratory standards, the mechanic's workshop, and a lecture theatre to seat twenty-five persons. Further lecture-rooms are not provided in the building, as *teaching in the ordinary sense is not contemplated in the institute.* The first floor will be devoted to the library, chief assistant's room, glass-blowing room, and a laboratory for eight research men. On the second floor are the living rooms for the mechanic and his family, since the mechanic also acts as caretaker. This floor also contains rooms for photo-chemistry, for scientific collections, and workplaces for several more research workers.

The building is connected by a corridor with the technical department, the most important feature of which is the machinery hall, with a floor space of 200 square metres. This hall is surrounded by smaller rooms for chemical preparations, high-voltage and heavy-current work, and a blacksmith's shop. The ground floor of the technical building contains a consultation room and the laboratory of the assistant in charge of that department. On the first floor is living accommodation for two assistants and an engine-man, and also a room for the serving of refreshments.

The director's house will be erected in the grounds of the institute.

Although there exists no stipulation on the point, *it may be taken as a rule that, on account of the fact that no teaching as such is to be undertaken, only such students will be admitted by the director as have already finished their normal university course and desire a wider experience in scientific research.* There are no restrictions whatever as to the nationality of the men admitted by the director.

The director of the institute, Prof. Haber, was born in Breslau in 1868, and obtained his Ph.D. in Berlin in 1891. After obtaining his degree he spent several years partly in technical work and partly in securing further scientific training. In 1894 he went to Karlsruhe, and was appointed Privat-dozent in chemical technology in 1896 and associate professor in 1898. In 1902 he was sent to America by the Bunsen Society of Applied Physical Chemistry to study the system of chemical instruction and the condition of electrochemical industries in the United States. In 1906 he was appointed to the post of professor in physical and electrochemistry in Karlsruhe, where he built up the best equipped research laboratory of physical chemistry in the world. Students from all parts of the world were attracted to this laboratory to such an extent that its accommodation was insufficient to allow all of them to enter, even although Prof. Haber admitted as many as forty men at one time as research workers. What was most remarkable was that he personally directed the work of all these men, and often aided them in their experimental work. In 1907 he was called to take the place of Lunge in Zürich as professor of chemical technology, and in 1909 he was asked to undertake the control of one of the largest chemical works in Germany, but he declined both these appointments.

Prof. Haber introduced into Germany the rational method of instruction in elementary chemistry as embodied in the laboratory outline written by Prof. Alexander Smith. This book was translated into German by Prof. Haber and Fritz Hiller. The two books, "Lehrbuch der technischen Elektrochemie auf wissenschaftlicher Grundlage" (1898, now out of print) and "Thermodynamik technischer Gasreaktionen" (1905; English edition 1908), together with numerous contributions to the *Zeitschrift für Elektro-*

-chemie, *Wiedemann's Annalen*, and the *Zeitschrift für physikalische Chemie*, constitute his literary activities.

One of Prof. Haber's most important researches was that upon the ammonia gas equilibrium at high temperatures. This work resulted in the development of a commercial method for the manufacture of pure ammonia directly from the elements by the use of osmium or uranium as a catalyser. Another important series of researches was that upon the properties of flames, including the gas equilibria involved, the ionisation and conductivity of the gases, and the action of the ions as catalysers. He has spent much time during the last few years upon the study of the escape of electrons from the reacting surfaces of metals, and the effects of electrons upon gas equilibria and upon the velocity of chemical reactions. His other recent researches have been mostly upon the following subjects:—the electromotive force of the oxyhydrogen cell at high temperatures; the oxidation of nitrogen in the high-potential arc; a gas refractometer for the optical analysis of gases according to Rayleigh's principle; electrical forces at phase boundaries; the corrosion of iron by stray currents from street railways; the reduction of hydroxylamine; the use of solid materials, such as glass and porcelain, as electrolytes; the equilibrium between magnesium chloride and oxygen; electrode potentials and electrolytic reduction; the laboratory preparation of aluminium; the preparation of hydrogen peroxide by electrolysis; experiments on the decomposition and combustion of the hydrocarbons; and autoxidation.

The writer wishes to thank Dr. Fritz Hiller, of Berlin, for the greater part of the information contained in this letter. The statements in regard to the purposes and government of the institute are official.

WILLIAM D. HARKINS.

University of Montana, September 30.

The Weather of 1911.

THAT the year which is now drawing towards its close has been, as regards weather, a true *annus mirabilis* is a commonplace of conversation, and all the more so by reason of the contrast between this and last year. Not only has the summer been remarkable for its length, its heat, its brilliance, but the autumn, even since the weather has broken, has been characterised, unless I am mistaken, by an unusual tendency to relapse into bright sunshine: the storms have cleared up with great rapidity; the sunshine has been peculiarly clear, and mist and fog remarkably rare.

Now for these exceptional phenomena there must be some exceptional cause, or combination of causes. Can any of our meteorologists say what it is? I do not ask for a statement of causes such as the prevalence of anticyclones in a particular direction or the continuance of given winds, for such facts are only part of the phenomena to be explained; but I want to know whether any real cause can be assigned for the general character of the weather.

EDW. FRY.

Failand, November 8.

Dew-ponds in 1911.

THE pond near Chanctonbury, referred to by Mr. J. P. Clatworthy in NATURE of November 2 (p. 8), has generally been regarded as an ancient one; and I may perhaps direct attention to a statement in vol. lvii. of the "Sussex Arch. Collections" to the effect that it was made by the Rev. J. Goring, the father of the present owner. If this be correct, and the word "made" should not read as "re-made," there is, apparently, no ground for attributing the pond and its fortifications to Neolithic or any other ancient people.

A visit to St. Martinsell Hill, Wilts, on September 18 showed how disastrous had been the effects of the long drought. The pond near to the shepherd's cottage was dry except for a small circle of mud at the bottom. When normally full it could not have been more than 2 feet deep; and the whole area was strewn with loose angular flints. The occupier of the cottage stated that the pond had never previously dried up during the seventeen years she had been there. The sheep on the downs had nearly all gone, there being no "feed" for them. In short droughts the dew seems to be sufficient to maintain the "feed"; but this year the absence of rain for so long brought about a remarkable absence of dew, and the dependence of dew upon earlier fallen rain seems to be an established fact.

Another pond is to be seen about a quarter of a mile to the north of the cottage on level ground. It has a large hole in the centre some 5 feet deep. This pond was quite dry. A quantity of puddle had been removed from the depression.

Another pond-depression occurs south-west from the cottage and barn, at the beginning of the spit of down which here juts out over the low-lying land of the Vale of Pewsey. It is grass-grown, and has several Scots pines growing in it. There is no good reason to think it was a "quarry," or even a "tally-house," as has been alleged. It was dry.

Further west along this narrow spit of land, and beyond the great ditch and vallum known as Giants' Graves, is an empty pond-depression about 20 feet across, constructed in a most convenient position if only it had water. It has apparently been grass-grown for many years—another instance of the extraordinary neglect of modern-day farmers.

All these ponds were circular. On descending on the east of St. Martin's Hill towards Wootton Rivers, past a series of mounds like swellings on the side of the hills, called by some authors "pit-dwellings," I noticed a square pond at the edge of a field. This was also dry. But a little nearer Wootton Rivers, at the side of the road, was a pond full of water. This was on the low ground beneath the hills; and the secret of its success lay in the fact that it was almost surrounded by tall trees, some of which completely overhung the pond. Thus evaporation was reduced to a minimum in the heat of the summer sun, whilst it may have been replenished by the condensation on the leaves of the trees.

It was observed that a concrete pond was being built on a slight eminence in a field near at hand, and it was stated in the village that a boring was being made for water.

There is a moral. In the first place, farmers do not make their ponds deep enough. In the next place, they neglect them until they dry up. Finally, when they do repair them, they remove the puddle at the bottom in the process of cleaning, and then wonder why the ponds fail to hold water.

EDWARD A. MARTIN.

285 Holmesdale Road, South Norwood, S.E.

The Research Defence Society and Anti-Vivisection Shops.

WE desire to make a special appeal for the purpose of undoing the harm which is done by anti-vivisection shops and processions. The exhibits in these shops are of a most misleading nature: and the truth as to anæsthetics is carefully concealed. No operation, more than the lancing of a vein just under the skin, is allowed to be done on any animal in this country, unless the animal is under an anæsthetic throughout the whole of the operation.

It will be remembered that one of these shops, on the death of H.M. King Edward VII., distributed a leaflet suggesting that his Majesty's death was due to medical treatment.

We have, of course, received many complaints against these shops. We find that the police have no power to close them: and we can only place men outside them, to give our leaflets to passers-by.

But this constant giving of literature is a heavy expense to our Society. We therefore appeal for special contributions toward this purpose. We make this appeal with confidence, for we are sure that the public recognises the grave harm which is done by these shops, especially to children. All contributions should be sent to the Hon. Treasurer, Research Defence Society, 21 Ladbroke Square, London, W.

We may, perhaps, take this opportunity of mentioning that a letter has just been received from Sir Apolo Kagwa, K.C.M.G., the Prime Minister of Uganda. It is dated from Mengo, Uganda, September 26. "I really think," he says, "that in a few years' time sleeping sickness will be extinct in Uganda, and people will become immune from the disease." If this happy result is obtained it will, without doubt, be due to the work done by the Royal Society Commission, who gained their knowledge on the subject by experimentation on animals.

CROMER, President.
SYDNEY HOLLAND, Chairman of Committee.
F. M. SANDWITH, Hon. Treasurer.
STEPHEN PAGET, Hon. Secretary.

21 Ladbroke Square, London, W., November 1.

The Definition of Mass.

IN NATURE for October 26 your reviewer, in criticising "An Elementary Text-book of Physics," writes:—

"In common with so many other text-books on this subject, this book lacks the fundamental definition of 'mass.' The author introduces the term 'mass' without definition in order to define force, and then uses this definition for the purpose of defining mass. Few writers on mechanics appear to realise that a definition of mass *apart from force* is the essential first step from the point of view of absolute measurement."

I am not concerned to defend this particular text-book, of which I have no knowledge, but I should be grateful, in common with many of your readers, if your reviewer would give us a satisfactory definition of mass *apart from force* (the italics are his own). I presume he would not be content with the fatuous statement that "Mass means quantity of matter"! Apparently Sir Oliver Lodge must be included amongst those censured, for in his "Elementary Mechanics" he writes:—

"We see, then, that mass is measured, and must be held to be defined, by the property of inertness possessed by matter—that is, by its requiring force to move it if at rest, and to stop it if in motion."

The same view is expressed by Clerk Maxwell in his invaluable little book "Matter and Motion," article xlvi.

Let us be frank about this question. The idea of force, like the idea of temperature, is derived from our bodily sensations, and is therefore suspect in some quarters. It is said that our sensations are not trustworthy. Nevertheless, we can form from them by long experience fairly accurate estimations both of force and temperature. To measure temperature we generally observe the expansion of a material body. To measure force we can use the deformation produced by it when acting on some portion of matter—the statical method; or we may measure the acceleration produced in a particular body—the dynamical method. The two methods give concordant results. We observe the effects of changes of temperature; we infer the passage of "heat" from one body to another. We observe the effects of force in producing acceleration. We find that the ratio of force to acceleration (or, what is equivalent, the ratio of impulse to change of velocity) is (approximately) constant for a particular body. We infer the existence of "mass," which is simply the value of this ratio. To say that "mass" is indestructible is to affirm that this ratio remains constant through the range of our experiments. If we extend the range we are led to believe that the ratio is no longer constant when the velocity of the body approaches the velocity of light.

H. S. A.

IT gives me much pleasure to comply with "H. S. A.'s" request expressed in his letter, but, at the same time, I should like to refer him to chapter iii. of Porter's "Intermediate Mechanics" for a clear and exact statement with regard to this question.

In the first place, it should be pointed out that definitions are of two kinds, qualitative and quantitative, and it was in the latter sense that the term was used in that portion of my review which "H. S. A." quotes. To the definition due to Lodge, regarded as purely qualitative, no objection is offered; it is when *quantitative* definitions are required for the purpose of measurement that the difficulties arise. Surely it is obvious that it is meaningless to define unit force as that which produces unit acceleration in unit mass, and then to define unit mass as that which acquires unit acceleration under the action of unit force. Of course, if we are content to define force in terms of the deformation it produces in a given piece of material, mass may then be measured in terms of force and acceleration; but the system of units arrived at will not be absolute. To obtain absolute units, we must be able to compare either two forces or two masses by measurements of space and time alone. The problem of defining mass quantitatively therefore resolves itself into defining the *ratio* of two masses in terms of space and time. This may be done as follows.

Let two masses m_1 and m_2 be isolated (a state of affairs approximately realised in Hicks's balance), and let them interact in any way. Let their accelerations at any instant be a_1 and a_2 respectively. These will be oppositely directed. Then the ratio of the masses is defined as being numerically equal to the inverse ratio of the accelerations, or

$$m_1/m_2 = -a_2/a_1,$$

the negative sign expressing the fact that the accelerations are opposed in direction. We may prove that the definition is valid by extending the experiments to a number of masses taken in pairs, and finding that the results are consistent. The unit of mass may now be fixed, and that of force defined in terms of it. Further, it may be pointed out that as consequences of the experimental verification of the validity of the above mode of definition, the principles of the equality of action and reaction, and that of the conservation of momentum, immediately follow.

From this point of view, therefore, we regard force as being a mass-acceleration rather than mass as the ratio of force to acceleration. The thermal analogy of Dr. Allen, if extended, suits the argument excellently. We do not obtain an *absolute* scale of temperature until we make it independent of any particular substance; neither are we able to measure force absolutely until *its* scale ceases to depend upon the behaviour of any special body under its action.

THE REVIEWER.

Altitude and Animal Development.

SOME time ago I found in the alluvium of a little Derbyshire stream a tubificid of a species and genus new to Britain. It was characterised by its large lymph corpuscles and its Pachydrilus-like form, on which account it was named *Meganympha pachydriloides*, Friend. The description showed that the animal possessed an average of forty-five segments, three or four forked setæ like Limnodrilus, a brain deeply lobed behind, spermathecæ pear-shaped or globular, and a penis-sheath, or large penial seta. While working out some species of Fridericia a few days ago, and turning to Bretscher (*Revue Suisse de Zoologie*, 1901) for some details, my attention was directed to his description of *Rhyacodrilus falciformis*, and it appeared evident that the Derbyshire worm was one with the Swiss.[1] But Bretscher states that the alpine forms have only thirty segments. Issel, de Ribaucourt, and Bretscher have recently given us many facts to show that annelids of the same species are very much smaller when found high up in the Alps than when found in the valleys. The foregoing seems to be an interesting confirmation of these statements.

But I find that other factors are at work. It is many years since Vejdovsky first described the little annelid known as Achæta, on account of the absence of setæ, but it is only within the last few months that specimens have been found in England. Southern found three different species in Ireland two years ago, and I have found the same number, though differing in kind, in England. Now Vejdovsky gives 15 mm. as the length of *Achaeta bohemica*; but Southern says that though the Irish specimens agree with the Bohemian in other respects, they are but 5–6 mm. in length. In August I found *A. bohemica*, Vej., in Kew Gardens, and the length agreed with the Irish forms. On November 7 I took the same species from a little grass plot in the heart of the city of Nottingham, and the specimens again measure 5–6 mm.

It seems easy to account for the difference in size in the case of Rhyacodrilus; but can any zoologist or biologist suggest an explanation of the difference between the Bohemian and British forms of Achæta?

HILDERIC FRIEND.

110 Wilmot Road, Swadlincote, Burton-on-Trent.

[1] Since writing the above I have discovered that Rhyacodrilus was described in 1904 by Ditlevsen as *Ilyodrilus filiformis*. He was familiar with Bretscher's work, but did not observe that the Danish tubificid had already been diagnosed.

RECENT THEORIES OF VOLCANIC ACTION.[1]

FIFTY years ago it appeared as though the volcanic problem had been completely and satisfactorily solved. Granted a cooling globe in which a solid crust covered heated matter, actually or potentially liquid, then the influx of sea-water through fissures in the crust seemed to account for all the phenomena observed during a volcanic outburst. Observations had then been almost wholly confined to the small group of Mediterranean volcanoes; but as our knowledge of volcanic action and terrestrial physics has grown with more continuous study over wider areas, these conclusions, as well as the premises on which they were based, have long since failed to satisfy students of geophysics.

One of the chief factors in bringing about this revolution in opinion has undoubtedly been the systematic study of the remarkable volcanoes of the Hawaiian islands, for which we are especially indebted to the geologists of the United States. In the great "pit-crater," or "sink," of Kilauea, always open to inspection, we find the explosive action and escape of gases reduced to a minimum, such "sinks" presenting the most marked contrast to the explosion-formed craters of Vesuvius and Stromboli (see Figs. 1 and 2). Equally striking is the difference between the great flat Hawaiian domes, rising above the ocean-floor to the height of the Himalayas, with slopes of from 1° to 4°, and the steep conical piles of Chimborazo and Cotopaxi. Another volcano of the same type as the Hawaiian, Matavanu, in the Samoan group, has been recently described by Dr. Tempest Anderson and other observers. In the study of the highly heated lavas of these volcanoes, an explanation has been found of the "slaggy" and "ropy" varieties of lava, as well as of the peculiar types known as "pillow-lavas" formed when they flow into the sea (see Fig. 3).

In addition to the new light thrown on volcanic action by the observations carried out in recent years on these Pacific volcanoes, there have been, during the last thirty years, three great outbursts of igneous activity, attended by phenomena of startling and unexpected character, which have served to awaken geophysicists to the fact that the old and simple theories formerly accepted stand in need of revision or replacement.

In 1883 the tremendous outburst of Krakatoa, in one of the great highways of the world's commerce, supplied opportunities for the study of the *explosive* type of volcanic action, which is so strikingly different from the *effusive* type of Hawaii and Samoa. Without any outflow of lava, fused matter was shot to the height of from sixteen to twenty-five miles into the atmosphere, the shocks producing air-waves that travelled two or three times round the globe. In this great uprush of gases, the molten materials were reduced to such a state of fine division that they were diffused through the whole of the atmosphere of the globe, giving rise to those wonderful sunset glows that will be so long remembered. In this great outburst, the hydrosphere was affected to a much less extent, and the lithosphere scarcely at all—for earthquake shocks, as distinct from air-concussions, were almost, if not entirely unfelt.

Five years later, in 1888, occurred the singular eruption of Bandaisan in northern Japan. In this case the sudden outburst of gases did not carry with

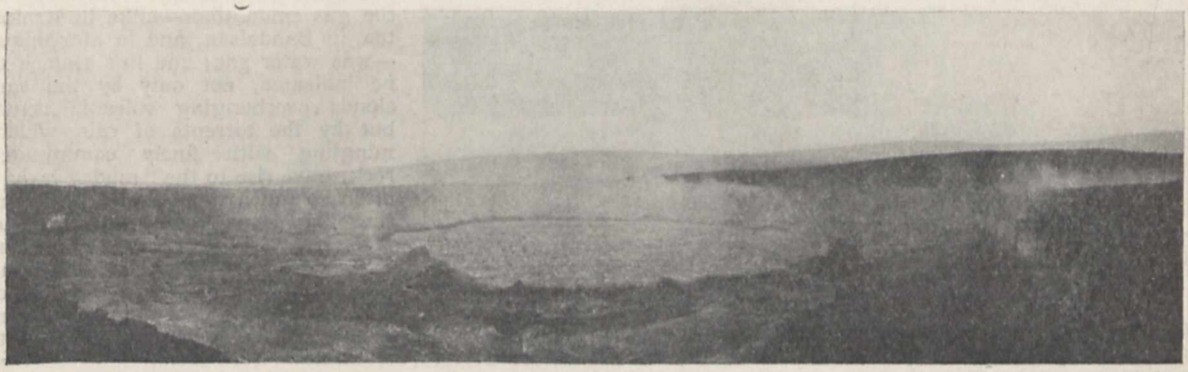

Photo.] [*E. Moses, Hilo.*

FIG. 1.—Panoramic photograph of Halemaumau (the open lake of lava in the crater of Kilauea) on January 13, 1910, with Mauna Loa in the background. The nearly circular lake was about 200 metres in diameter; its surface was estimated to be about 25 metres below the rim of the crater.

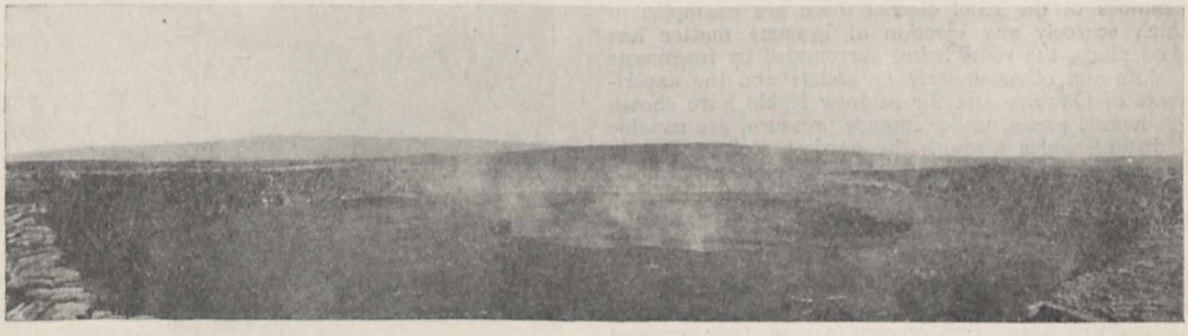

Photo.] [*E. Moses, Hilo.*

FIG. 2.—Panoramic photograph of Halemaumau on February 20, 1910. The lake level fallen about 30 metres below the surface of the "black ledge" of Kilauea in the foreground.

[1] "The Nature of Volcanic Action." By Reginald A. Daly. Proceedings of the American Academy of Arts and Sciences, vol. xlvii., No. 3, pp. 47–122, June, 1911. (Boston, Mass.)

it any molten materials, but was sufficiently violent to throw down one side of a volcano more than 6000 feet high, which had been long in the "Solfatarra stage." The quantity of material thus displaced was calculated by Profs. Sekiya and Kikuchi, the commissioners appointed by the Japanese Government to investigate the phenomena, to be no less than 2782 millions of tons! European geologists had long been familiar with the fact that among the miniature volcanoes of the Eifel district there are examples in which scarcely any ejection of igneous matter has taken place, the vents being surrounded by fragments of slate and other underlying rocks; and the experiments of Daubrée and Sir Andrew Noble have shown that heated gases, under intense pressure, are capable of drilling holes through the hardest rocks. But in the case of Bandaisan, the "hurricane-blasts" hurled along the *débris* at the rate of forty-eight miles an hour, the hurtling masses of which were gradually reduced to the condition of sand, and covered an area of twenty-seven square miles. Although "steam" is said to have been seen rising to the height of 4200 feet above the "crater," the materials overwhelming the country were dry, except where they crossed lakes or rivers. But towards the end of the eruption scalding mud is said to have fallen and destroyed many lives; it is noteworthy, however, that a survivor declared that the gases in which he was enveloped were not of a poisonous character. From the direction in which the materials were thrown, there is some ground for the belief that the outrush of gas was not, as in Krakatoa, vertical in direction, but more or less oblique. The result of the eruption was to produce a great cavity which strikingly resembles the Val del Bove of Etna and the Caldera of Palma.

Photo.] [*T. Anderson.*

FIG. 3.—"Pillow Lava," formed by the molten material coming in contact with sea-water. The chilled surfaces form a scum which is stretched and distended by the still liquid material forced forward behind, into the great pillow-like masses shown above.

In 1902 there occurred, in the West-Indian islands of Martinique and St. Vincent, extraordinary outbursts of volcanic violence, which were carefully studied by English, French, and American geologists. In these cases the great destruction of life and property was caused by enormous volumes of superheated gas, charged with solid particles of all sizes, which rushed down the valleys leading from the mountain summits to the sea. These mixtures of gas and dust behaved like liquid torrents, and travelled at a rate of more than eighty miles an hour, sweeping everything before them. Their destructive action on living beings appears to have been in part due to the heated condition of the gas and in part to its suffocating character. In Martinique another very curious phenomenon was exhibited: the mass of molten rock consolidating in the vent of the volcano was gradually pushed up by forces from below until it formed a great "spine" which attained an elevation of nearly 1200 feet; but after many changes, due to both movement and disintegration, extending over more than a year, this "spine" finally disappeared (see Fig. 4).

It has generally been assumed by geologists that the chief component in the gas emanations—alike in Krakatoa, in Bandaisan, and in Martinique—was water gas; and this seemed to be indicated, not only by the vast clouds overhanging volcanic vents, but by the torrents of rain which, mingling with finely comminuted rock, gave rise to the "muddy lavas" often so much more destructive than the "fiery lavas" of active volcanoes. It is true that deposits of chlorides, sulphur, and other products around volcanic vents indicate the presence of various other gases in the uprising columns, but these have usually been regarded as quite subordinate to the high-pressure steam to which the most important action in volcanic eruptions has usually been attributed.

Photo.] [*E. O. Hovey*

FIG. 4.—The great "spine," composed of andesitic lava, which was forced up during the eruption of 1903 to the height of nearly 1200 feet above the crater-rim of Mont Pelée in Martinique.

It has long been known that lavas after their consolidation are found to contain, occluded in their mass, gaseous matters which are given off when the rock is heated. This is especially true of lavas of a glassy character, which when fused have been shown to swell up into masses of pumice of many times the dimensions of the glass from which it is formed. M. Albert Brun, of Geneva, has collected and analysed the gases given off in such cases, and finds them to be nitrogen, ammonia, chlorine, hydrochloric acid, carbonic acid, and various hydrocarbons. Reasoning from these and other observations, he has been led to the conclusion that steam, instead of playing the most important part in volcanic eruptions, must be regarded, in many cases at least, as only an adventitious and accidental accompaniment of them. He has certainly shown grounds for the more thorough investigation of the nature and composition of these mixed gases, which, as recent studies have shown, play such an all-important part in volcanic outbursts.

But in addition to the more exact and systematic studies which have been made of the great volcanic eruptions in recent years, there is another class of researches which have supplied evidence of at least equal value concerning the nature and origin of these phenomena.

The study of rocks in thin sections under the microscope has shown that the two classes of rocks known as "plutonic" and "volcanic" respectively are essentially identical, and pass into one another by insensible gradations. Great areas of crystalline rocks ("batholites") and lake-like intrusions of similar materials ("laccolites"), lying in the midst of sedimentary and other rocks, were probably the roots of the volcanoes of previous periods in the earth's history. In these cooled reservoirs we may study the changes which have taken place in the magmas that have supplied the old volcanic vents, and—inverting the Lyellian principle—we may reason concerning the processes which must now be going on beneath existing volcanic vents from what we can prove to have taken place beneath those of former geological periods. Nor are there wanting examples of ancient volcanoes, dissected by the scalpel of denudation, which illustrate the intimate connection which exists between the plutonic and volcanic rock-masses.

The author of the memoir before us is well known to geologists by a number of valuable memoirs dealing with the evidence of changes which must have taken place in the great underground reservoirs of igneous rocks. These he has had the opportunities of investigating while engaged as a Canadian member of the International Boundary Surveys. More recently, he has had the opportunity of making a detailed investigation of the phenomena exhibited in the Hawaiian volcanoes. His outline of "a general working theory of vulcanism" is the result, as he tells us, "of the writer's studies in the Hawaiian Islands in 1909, but many of the chief conclusions are founded on his field-work in plutonic geology, as well as on the geology of many ancient volcanic formations."

That the hypotheses he now formulates are of a somewhat speculative character, and that many of his conclusions are more or less tentative, Mr. Daly fully admits; but that, nevertheless, his memoir is an important contribution towards the solution of a very difficult problem everyone will agree. He summarises his suggestions as a "substratum-injection hypothesis," believing that the surface phenomena can best be accounted for by abyssal injections of a deep-seated basaltic magma through an acid substratum of granitic or gneissic rocks everywhere underlying the sedimentary formations. But in elaborating his theory the author is led into a number of discussions of points of extreme interest and importance, and, even if his main conclusions are rejected, these subsidiary discussions retain their suggestiveness and value.

It is admitted by the author that the conditions leading to his "abyssal injections" "form a subject of great theoretical difficulty"; he apparently accepts the view that the high temperatures underground are due to the earth being a cooling globe, although he admits the influence of various chemical reactions in augmenting, locally, these high temperatures. The chief argument in favour of the view that the earth's interior is in a highly heated, if not molten, condition is, of course, derived from the fact that observations made in mines, tunnels, wells, and bore-holes everywhere indicate a progressive rise in temperature as we go downwards. Nevertheless, the most recent observations of underground temperatures have revealed such startling discrepancies between the results obtained in different areas—discrepancies that, it seems, are quite incapable of being explained by differences in the conductivity of rocks and similar causes—that the argument for a "molten globe" based on underground temperatures loses much of its force, and with it must go the estimates of the earth's age that have been based upon it. In these circumstances, the thoughts of geologists turn, not unnaturally, to the great revelation of radio-activity as a source of heat, for here may possibly be found the means of removing, to some extent at least, the "theoretical difficulties" which, the author admits, still beset the explanation of those deep-seated actions for which he argues.

J. W. J.

SPANISH OBSERVATIONS OF BROOKS'S COMET (1911*c*).

BROOKS'S comet has recently been a conspicuous object, and no doubt a great number of valuable observations have been made, both photographically and visually, at most of the observatories in the northern hemisphere.

Some very interesting records have recently been received from Señor F. Iniguez, the director of the Madrid Observatory, and not only do these include photographs of the comet itself, but an excellent spectrum accompanied by a list of the wave-lengths of the bands recorded.

The photograph showing the form of the comet was secured on September 28, with a 6-inch Grubb doublet, during an exposure of one and a quarter hours (9h. 15m. to 10h. 30m.), the comet then being of the second or third magnitude. This photograph is reproduced here (Fig. 1), the scale being 1 mm. to 5 minutes of arc. On this date the tail stretched to a distance of 15 degrees, and consisted of delicately fine interlacing filaments; the nucleus with its surrounding nebulosity measured 21 minutes in diameter. Spectroscopic observations were made visually with a slit spectroscope, and photographs were secured with the Grubb photographic equatorial, having an objective prism of 20 cm. aperture and 20° refracting angle. These have shown the spectrum to consist of seven images of the nucleus. The visible bands are the three situated at the red end of the spectrum, and these form three distinct spectral bands, while the sixth is composed of fine lines. The seventh appears double, although its components are not well defined and were measured as single.

The wave-lengths have been determined by Señor Iniguez from four plates taken on September 19, 20, and 26. The three visual monochromatic images of the nucleus are λ 555, 514, and 472. The fourth band is made up of the lines λ 440, 434, and 432, and the wave-length of the fifth is λ 423. The sixth band he finds to be composed of the lines λ 410, 407, 405, 404, and 402, while 388 he gives as the wave-length of the seventh band. By using a prismatic camera, the spectrum of the comet's tail has also been secured, but because of its faintness only monochromatic images of the tail in the three visible bands were

FIG. 1.—Brooks's Comet as photographed on September 28 at the Madrid Observatory with an exposure of 1¼ hours.

recorded. The whole length of the spectrum indicates the presence of a faint continuous spectrum. This spectrum was secured on the night of September 26 with an exposure of two hours (9h. to 11h. G.M.T.). Besides a paper print of this spectrum, a drawing with a scale of wave-lengths also accompanies the communication. This drawing is reproduced here (Fig. 2), but the violet has been placed on the left-hand side to conform with the general adopted procedure.

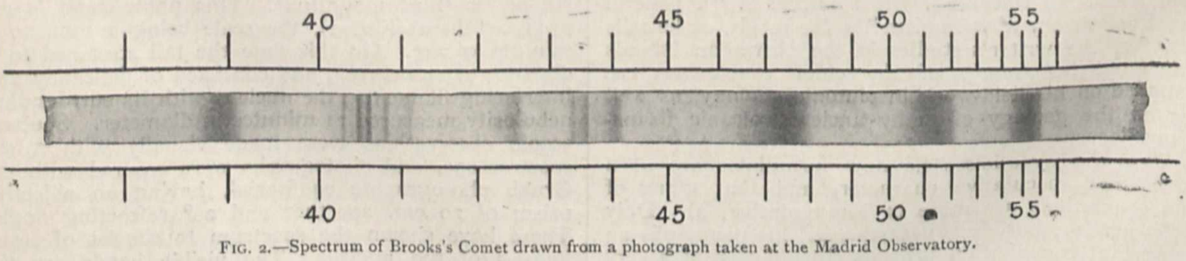

FIG. 2.—Spectrum of Brooks's Comet drawn from a photograph taken at the Madrid Observatory.

The writer has made a comparison of this spectrum with that which was taken of comet 1907*d* (Daniel) by Prof. Campbell. While the latter spectrum is on a very much larger scale and rich in detail, it is seen nevertheless that both are very closely identical when allowance is made for the smaller scale. As Daniel's comet was stated by Campbell to show no radiations other than those due to carbon or carbon compounds, the chief carbon bands being strongly developed, it is very probable that the Madrid spectrum represents bands and lines of the same substances. No doubt in the near future spectrum observations, both photographic and visual, made at other institutions, will be soon forthcoming, so it will be interesting to see if the same explanation of the origin of the bands is corroborated.

W. J. S. LOCKYER.

CONFERENCE ON THE THEORY OF RADIATION.

A VERY successful meeting was held in Brussels from October 29 to November 4, to discuss the present position of the theories of radiation and of molecular theory in general. The following were present at the meeting:—Profs. H. A. Lorentz, Kamerlingh Onnes, W. Nernst, M. Planck, Rubens, Sommerfeld, W. Wien, Warburg, Brillouin, Mme. Curie, Langevin, Perrin, Poincaré, Einstein, Hasenöhrl, Martin Knusden, J. H. Jeans, and Rutherford, while Dr. Goldschmidt, of Brussels, Dr. de Broglie, of Paris, and Dr. Lindemann, of Berlin, acted as secretaries.

The inception of this "conseil scientifique" was due to Mr. Ernest Solvay, of Brussels, who very generously offered to defray the expenses of the conference and the cost of publication of the papers and discussions contributed at the meeting. The members were the guests of Mr. Solvay at the Hotel Metropole, and with the exception of one meeting at the Physiological Institute, founded by Mr. Solvay, the meetings took place in one of the reception-rooms of the hotel. The arrangements of the meeting were under the charge of Dr. Goldschmidt, who was indefatigable in looking after the comfort of the visitors. Prof. H. A. Lorentz was president of the "conseil scientifique," and the success of the meeting was due in large measure to his able management.

The following papers were read before the congress:—Sur l'application au rayonnement du théorème de l'équipartition de l'énergie, by Prof. H. A. Lorentz; a short communication in the form of a letter from Lord Rayleigh; the kinetic theory of specific heats, by Prof. J. H. Jeans; die Gesetze der Wärmestrahlung und die Hypothese der elementaren Wirkungsquanten, by Prof. Max Planck; die Bedeutung des Wirkungsquantums für unperiodische Molekularprozesse in der Physik, by Prof. Sommerfeld; zum gegenwärtigen Stande des Problems der spezifischen Wärme, by Prof. Einstein; Anwendung der Quantentheorie auf eine Reihe physikalisch-chemische Probleme, by Prof. Nernst; les preuves de la Réalité Moléculaire, by Prof. Perrin; die kinetische Theorie der ideale Gase und die Versuchsresultate, by Prof. Knusden.

A vigorous discussion took place on each of these papers, an abstract of which will ultimately be published. Special interest was taken in the papers dealing with the question of specific heats. Prof. Nernst gave an interesting account of the experiments upon the variation of specific heat with temperature down to low temperatures and of their explanation in terms of the "quantum" theory proposed by Prof. Einstein.

The meeting took place under unusually pleasant social conditions, for all the members were staying at the same hotel and dined together. The interchange of views on many problems of modern physics was a feature of the occasion, and led to a much clearer understanding of the points at issue.

At the close of the meetings, Mr. Solvay invited the conference to meet again in Brussels in 1913.

E. RUTHERFORD.

SIR SAMUEL WILKS, BART., F.R.S.

SIR SAMUEL WILKS, at the time of his death, on November 8, the senior fellow of the Royal College of Physicians of London, was born at Camberwell on June 2, 1824. He was the second son of Joseph Barber Wilks, treasurer to the East India Company, who himself had many ancestors in the service of that company. He was educated at Aldenham. In 1840 he was apprenticed to a family doctor at Camberwell, Mr. Richard Prior, whose widow he subsequently married. He began to attend lectures at Guy's Hospital in 1841, and took the M.D. London in 1850. He earned many distinctions at the University. In 1856 he became a fellow of the College of Physicians, and assistant physician to Guy's Hospital, in 1867 full physician; in 1870 he obtained his F.R.S., and in 1897 his baronetcy. He was president of the Royal College of Physicians from 1896 to 1899, and he was a governor of Guy's Hospital.

Wilks began work at a period when most doctors were satisfied with vague words that meant little; hence his desire to know the causes of things was at that time remarkable, and led him to be the first to make systematic post-mortem examinations whenever he could. When he gave up his work in the post-mortem room, he had made more post-mortem examinations than anyone alive except Virchow. In the course of these he found that syphilis could affect internal organs. As now we know that several internal diseases are due to it, this was a most important discovery. The original paper, entitled "On the Syphilitic Affections of Internal Organs," was published in the "Guy's Hospital Reports" for 1863. Of it in later years Wilks wrote, "I regard this as the most noteworthy and original article it has been my good fortune to write."

He was a great observer, and was the first to point out that excess of alcohol causes paralysis of the limbs, and that atrophic lines may form on the skin apart from stretching of it; he described and named the condition of the knuckles called "verruca necrogenica," and under the name of arterial pyæmia he described what is now known as malignant endocarditis; also he did much to establish firmly that Bright's disease, Addison's disease, and Hodgkin's disease were distinct entities. The last he discovered independently, but found that Hodgkin had given an account of some examples of it, and accordingly Wilks gave the name Hodgkin's disease to it.

All Wilks's investigations were done at Guy's Hospital, and he greatly added to the reputation of its medical school. His strong personality and his enthusiasm for the advancement of medical knowledge made him much beloved by students, and by his influence many were stimulated to take an interest in their work as an intellectual pursuit. He was always the champion of investigators, and was one of the most energetic in forming the Society for the Advancement of Medicine by Research. His mind was extraordinarily active even when well advanced in years. He did not retire until he was seventy-seven years of age, and then, when he went to live at Hampstead, he was, at the age of more than eighty, president of the Hampstead Scientific Society, and read papers before it.

His "Pathological Anatomy," first published in 1869, has gone through three editions. It has become one of the medical classics, and is still the best book on the subjects of which it treats. It has been well said that if you think you have discovered a new fact in morbid anatomy, you will find it was observed by Wilks and is mentioned in his book. Students were so much attracted by the matter of his lectures that at their request they were published, and form his two other books, "Diseases of the Nervous System" and "Specific Fevers and Diseases of the Chest."

W. H. W.

MR. JOHN BROWN, F.R.S.

THE death of Mr. John Brown, which, as announced in last week's issue, occurred at Belfast on November 1, removes one who was a scientific amateur in the best sense of that term, and whose enthusiasm bore fruit in much solid work in the department of physics in which he was specially interested.

Born in 1850, the son of a prominent linen merchant, in the north of Ireland, Mr. Brown, after a very short experience of business life, retired from the firm which bears his father's name in order to devote himself entirely to the scientific and engineering pursuits for which his bent had been clearly shown from boyhood. He soon became absorbed in electrical matters, particularly in the question of Volta contact electricity, about which then and since so much controversy has been carried on. His first paper on the subject was published in *The Philosophical Magazine* in 1878, and was followed by a series of others in which he detailed the results of his experiments and lent important support to the chemical theory of these phenomena. The work was done largely by means of home-made apparatus, and gave evidence of experimental ingenuity and carefulness of a high order. He maintained that the effects were due to films of condensed vapour or gas on the surface of the metals, and regarded the pair of metals in contact as equivalent to a voltaic cell, divided in the electrolyte, and having the amount of electrolyte reduced until only an invisible film remains on each plate. In support of this theory he tried the effect of surrounding the metals by different gases, and obtained variations in the value of the potential difference, the proper interpretation of which was a matter of some controversy.

Mr. Brown was elected a fellow of the Royal Society in 1902, and in the following year he published what proved to be his last contribution to the voltaic question. In this he claimed to have got rid of the gaseous films by heating the plates to a high temperature in a bath of petroleum, when the difference of potential was found to disappear. Before his death he had planned to repeat this crucial experiment with additional precautions during the present winter.

His other publications of pure scientific interest were in connection with the allied question of electrolytic conduction. On this he took up a position strongly hostile to the modern developments of the dissociation hypothesis.

Mr. Brown was much interested in mechanical and engineering matters, especially in connection with motor engineering, on which he did some pioneering work. This led him to study the question of road-making and road-testing, and he devised an ingenious instrument, called the viagraph, which gives a trace of the contour of the road-surface and a numerical value for its "bumpiness."

Mr. Brown will be much missed in Belfast, where he did a great deal to kindle and keep alive scientific interests in the community, and where his personality and ability won him much influence and popularity.

W. B. M.

THE SOLAR PHYSICS OBSERVATORY.

THE *Cambridge University Reporter* gives an account of the action taken by the Council of the Senate on this subject. None of the scientific questions we referred to in the article in last week's NATURE are touched upon, including the all-important question of the site, and the dismissal of the staff which for the last thirty years has done work which has received world-wide approval, on a programme which has been followed in the newer institutions.

One of the points insisted upon is how the University is to find the 600*l*. a year, representing a capital sum of 15,000*l*. or 30,000*l*., according as we reckon the interest at 4 or 2 per cent., which the Treasury demands in return for the capital sum of 5500*l*. to be inserted in the estimates for the new installation.

We confess we look with dismay upon the proposal. We trust the Senate will well consider it in all its bearings. It is not the fault of the Senate that Cambridge can never be a fit site for an observatory occupied in the work demanded by modern physical inquiries, but it will be its fault if it acts as a cat's-paw of the Treasury in aiding the detachment of national scientific work from the direct control of a Government spending department with a voice in the Cabinet; in agreeing to administer the needs of a rapidly growing branch of science for a fixed sum based only on the present needs; and in endorsing the view that its future alumni when appointed directors of national observatories are sufficiently remunerated by a stipend of 200*l*. a year.

NOTES.

IN reply to an inquiry as to the award of the Nobel prizes, Prof. Svante Arrhenius has kindly sent us the following information:—(1) *Prize for medicine:* awarded on October 21, the birthday of Dr. Alfr. Nobel, by the Carolinian Institute (faculty of medicine) in Stockholm to Dr. Allvar Gullstrand (born 1862), professor of ophthalmology in the University of Upsala, Sweden, for his investigations in physiological optics. (2) *Prize for physics:* awarded on November 7 by the Royal Academy of Sciences, Stockholm, to Dr. Willy Wien (born 1864), professor of physics at the University of Würzburg, Bavaria, for his discoveries regarding the laws of radiation. (3) *Prize for chemistry:* awarded on November 7 by the Royal Academy of Sciences, Stockholm, to Mme. Marie Curie (born 1867), professor of physics in the University of Paris (Sorbonne), for her discoveries of the chemical elements radium and polonium, and her investigations regarding their chemical properties. Mme. Curie received, together with her husband, the half of the Nobel prize for physics in 1903 for their investigations regarding the Becquerel rays. (4) *Prize for literature:* awarded on November 9 by the Royal Swedish Academy of Literature, Stockholm, to Maurice Maeterlinck (born 1862). The prize for work in the cause of peace will probably not be awarded before December 10, the day of Dr. A. Nobel's death, by the Storthing (Parliament) in Christiania, Norway.

WE notice with regret the announcement that Dr. R. D. Roberts, Registrar of the Board for the Extension of University Teaching, University of London, and secretary and lecturer to the Gilchrist Educational Trust, died suddenly on November 14, at sixty years of age. Dr. Roberts was widely known and esteemed, and his death will come as a great shock to all those who were brought into association with him. An obituary notice in *The Times* gives the following particulars of his career. He was educated at University College, London, and Clare College, Cambridge, of which he was a foundation scholar and later a fellow. He was also a fellow of University College. His university career was a brilliant one. At University College, where he took the D.Sc. degree in 1878, he carried off the university scholarship in geology, and at Cambridge he took a first class in the natural sciences tripos. In 1879 Dr. Roberts was appointed university lecturer in geology at Cambridge, having previously been an examiner in that subject. Six years later he became secretary to the London Society for the Extension of University Teaching, and afterwards secretary for lectures of the Local Examinations and Lectures Syndicate, Cambridge, before taking up his work at the University of London. The fruits of his wide experience were gathered in his book "Eighteen Years of University Extension," and he also wrote "An Introduction to Modern Geology." As secretary to the Congress of the Universities of the Empire, which is to be held in London next year, his work of organisation has been of great value.

THE Royal Scottish Geographical Society has awarded the gold medal of the society to Mr. J. Y. Buchanan, F.R.S., for his distinguished services to geography, especially in connection with oceanographical research.

MR. R. J. GODLEE has been elected president of the Royal College of Surgeons of England, in succession to Sir Henry Butlin, Bart., who has resigned that office on account of ill-health.

THE Paris correspondent of *The Times* reports that the French Government has conferred upon Halil Bey, director of the Imperial Museum at Constantinople, the rank of Commander in the Legion of Honour, and the rank of Officer upon Prof. Lowell, president of Harvard University.

MR. ARTHUR COOPER, of Middlesbrough, has been elected to succeed the Duke of Devonshire in the presidency of the Iron and Steel Institute next May. Mr. Cooper was awarded the Bessemer gold medal of the institute in 1892 for his services to the metallurgy of iron and steel.

THE Berlin correspondent of *The Times* announces the death, at seventy-four years of age, of Dr. Bernhard Fränkel, who enjoyed a European reputation in his own subject of laryngology, both as a practitioner in Berlin and as the author of many scientific works, and the inventor of improved methods and instruments.

A REUTER message from New York states that Mr. Andrew Carnegie has given the Carnegie Corporation, which was organised on November 10, 5,000,000*l*. in gold bonds of the Steel Corporation. The corporation has been founded for the purpose of the advancement and diffusion of knowledge and understanding in the United States, for the formation of a hero fund, and other purposes.

THE Jean Reynaud prize of ten thousand francs, which is awarded by the Paris Academy of Sciences every five years for the work of an eminent savant, has been awarded this year to Prof. Emile Picard, professor at the Sorbonne and at the Ecole Centrale. Previous awards of the prize have been to MM. Lippmann, Henri Poincaré, and Pierre Curie.

THE De Morgan medal of the London Mathematical Society has been awarded to Prof. Horace Lamb, F.R.S., for his researches in mathematical physics. At the annual general meeting of the society, held on November 9, the following were elected to be the council and officers for the session 1911–12:—*President*, Dr. H. F. Baker; *vice-presidents*, Mr. J. E. Campbell and Prof. A. E. H. Love; *treasurer*, Prof. Sir J. Larmor; *secretaries*, Mr. J. H. Grace and Dr. T. J. I'A. Bromwich; *other members of the council*, Mr. G. T. Bennett, Prof. W. Burnside, Mr. E. Cunningham, Mr. A. L. Dixon, Dr. L. N. G. Filon, Mr. J. H. Jeans, Mr. J. E. Littlewood, Prof. H. M. Macdonald, Major P. A. MacMahon, and Mr. A. E. Western.

THE disease known as "infantile paralysis" has recently been added to the list of notifiable infectious diseases in London by an order under the Public Health Act. This disease, known medically as acute anterior polio-myelitis, was referred to in our "Notes" columns of October 12 (p. 494), and, though probably not existing in London at the present time, was epidemic in the Plymouth district this summer. In this epidemic, an account of which was given by Dr. Bertram Soltau in *The British Medical Journal* of November 4, 154 cases were notified between May and September, of which 34 died, a case mortality of 22 per cent. The disease may therefore be an important one, and sanitary authorities will do well to be on the look-out for it and to exercise the option they possess of making it notifiable.

THE death is announced, at the age of eighty-four, of Mr. Daniel F. Drawbaugh, a veteran American inventor. He was a self-taught man, and worked in his early years as a clockmaker in his native village in Pennsylvania. He became an enthusiast on the subject of physics, and made electrical apparatus a special study. In 1860 he devised an instrument for the electrical transmission of speech, and in 1870 claimed to have invented a magneto-transmitter similar to Bell's. In 1881 his claim to be the inventor of the telephone was adversely decided in the courts, his interests being represented by the People's Telephone Co., against which the Bell Co. brought a suit. Mr. Drawbaugh made only a moderate fortune with his inventions, which included an interchangeable telephone and telegraph apparatus, the collapsible lunch-box, the first nail-making machine, higher grade electrical grain-weighing devices, and various pneumatic tools.

THE following announcements have just been made by the Meteorological Office:—Mr. G. I. Taylor, fellow of Trinity College, Cambridge, Smith's prizeman, 1910, has been appointed Schuster reader in dynamical meteorology for three years from January 1, 1912; Mr. L. Southerns, of Emmanuel College, Cambridge, has been appointed special assistant at Eskdale Observatory; Mr. G. Dobson, research student of Gonville and Caius College, Cambridge, has been appointed graduate assistant for research in atmospheric electricity for one year from October 1, 1911. Dr. Arthur Schuster, F.R.S., has presented to the Eskdale Observatory an instrument, made in St. Petersburg from designs by Prince Boris Galitzin, for the registration of the vertical component of seismic movements. Dr. Schuster had previously presented corresponding instruments for registering the horizontal component, so that all three components are now the subject of continuous registration.

THE death is announced, in his seventy-first year, of Mr. Holt S. Hallett, who was widely known as an engineer and traveller. From 1860 to 1868 Mr. Hallett assisted in the construction of railways in Lancashire and Cheshire. In 1868 he entered the Indian Public Works Department, and was employed in the construction of the oldest line in Burma, that from Rangoon to Prome, which was completed in 1877. He retired from the public service in 1880, and was soon engaged in the exploration of the little known country between Moulmein and Kiang Hsen on the Mekong for a railway route into Siam, and made a survey for a branch line to Bangkok. He explored about 2500 miles of country, and discovered the sources of the Menam. The general results of his explorations were laid before the Royal Geographical Society in 1883, and an account of his work is to be found in his "A Thousand Miles on an Elephant." He revisited Siam, Burma, and India in 1885, and at the request of the Foreign Office and the War Office sent in a report, with maps, bearing on the political state of affairs in Indo-China. In 1887 Mr. Hallett received the silver medal of the Socity of Arts for a paper on new markets and the extension of railways of India and Burma.

A POINT which is now agitating the aëronautical industrial world is one that is down for discussion on the agenda of the International Aëronautical Federation, which meets at Turin on November 25. It is, briefly, that it should be made compulsory for aëroplane manufacturers to submit a specimen machine of each type made by them to the representatives of the International Aëronautical Federation, *i.e.* the Aëro Club, in their respective countries in order to receive a certificate of soundness of construction. It will be obvious at once that at the present time such a rule is absurd, for the chief reason that, for instance, in this country only the manufacturers themselves are capable of passing an expert opinion on the merits of any machine submitted. Furthermore, if carried out, it would shift responsibility from the manufacturers to the aëro clubs, which are privately organised bodies, and it would tend to confine the manufacture of machines to certain standard types and close the way to originality and progress. Manufacturers are already up in arms in this country against this extraordinary measure, which, it may be stated, has its origin in France, and it is to be hoped that the delegates of the Royal Aëro Club will receive instructions to oppose it to the utmost. In such attitude they will, no doubt, have the support not only of the club they represent, but also of the German and Italian organisations.

AT the meeting of the Concrete Institute held on November 9, Sir Henry Tanner, C.B., delivered his presidential address. During the course of his remarks he said that the membership of the institute is now about 875, and that during the eighteen months ending in June last the net gain was twenty-one. There is no institution, he pointed out, concerned particularly with structural engineering; and the committee of the institute has been empowered to take steps to foster structural engineering, and thus in future the Concrete Institute will be an institution of structural engineers as well. Sir Henry Tanner went on to say that the Institution of Civil Engineers has taken up the subject of reinforced concrete, and a considerable sum of money has been devoted to experiments which are in process of being carried out. There is no doubt, he said, that experiments are needed in this country to obtain a consistent and complete series based on materials to be obtained here and mixed and tested under similar conditions. At the present time we have to rely on experiments in America, Germany, and France with cement of varying character, and it would be of the greatest advantage if these could be repeated in some cases at intervals, the improvement in strength being so great for some years. Later in the address he referred to the committee appointed by the Board of Education to inquire into the question of economy in building, and as to whether buildings of a more temporary nature could not be brought into use. Reinforced concrete came in for its share of the discussion by the committee; but the estimates of cost varied largely, from 33 per cent. less to 10 per cent. more than for ordinary building. No difference of locality will account for these variations. Witnesses having a more intimate knowledge of the cost of such buildings might have been called. It is little good encouraging specific proposals for the use of novel materials while local by-laws make no provision proper to the use of reinforced concrete. In order, however, to remove this difficulty, it has been suggested that legislation should be promoted to exempt school buildings, the plans of which had been approved by the Board of Education, from the operation of local building by-laws.

A PAPER on a novel and important subject appears in *The Naturalist* for November. The writer, the Rev. Hilderic Friend, has brought together some interesting facts relating to *Octolasium gracile*, Oerley, which is usually found very sparsely, but at Sutton Broad is the dominant Allolobophora; and *Aporrectodea similis*, Friend, a species which is at present known only from the Kew Gardens. An account of the species of Fridericia found at the Eel Hut, where the River Ant enters the Barton Broad, is also very suggestive. Out of twenty-four Euchytræids, belonging to six different species, twenty-two were Fridericias, belonging to five species, of which two have not been observed hitherto in England. One question to be solved is, Does each species do the same work as all the rest, or does one prepare the way for the others?

MR. O. A. RHOUSOPOULOS contributes to vol. ii., No. 5, of *The Museums Journal* an important article on the methods of cleaning and preserving antiquities. The most frequently recurring objects which need preservation are those of copper or copper alloys. For these various methods are considered: soaking in distilled water; saturation with paraffin; reduction treatment by heating in a current of hydrogen, by an electric current in a bath of potassium cyanide or caustic soda. Some of the above methods, which in their present perfection leave little to be desired, may be applied to gold, silver, and their alloys; but the use of a solution of potassium cyanide yields better and more rapid results. Wood and fibres are soaked with antiseptic solutions, and finally receive a coating of celluloid varnish. The article ends with many valuable suggestions for the treatment of objects of iron, lecythi and other coloured earthenware, marble, and porous limestone. The instructions throughout are practical and detailed, and the article may be commended to the attention of all curators of museums.

THE Sutton Broad Biological Laboratory, started in 1902 by Sir Eustace Gurney, and, we believe, still the only fresh-water biological laboratory in this country, has so far well justified its existence. In the current number of the Transactions of the Norfolk and Norwich Naturalists' Society are two papers, emanating from this laboratory, which are of especial interest with reference to the much debated question as to what constitutes "tide" on the Norfolk Broads. For several years past observations, made with a portable recording tide-gauge, have been kept at the laboratory by Mr. Robert Gurney; and in the publication referred to these have been incorporated into a paper, well illustrated with charts. In the same journal Mr. A. G. Innes contributes a paper on the distribution of salt in the River Bure and its tributaries; and, taken together, these two papers are a valuable addition to our knowledge on the subject.

THE report of the Northumberland Sea Fisheries Committee on the scientific investigations conducted under its auspices during the year 1910 and up to June 15, 1911, has now appeared under the editorship of Prof. Alexander Meek, of the Armstrong College, Newcastle-upon-Tyne. It includes some interesting observations on mesmerising lobsters and other crustaceans. It is known that a lobster may be put into a comatose condition by rubbing it along the back of the carapace. The usual way is to hold the lobster head down, with the claws arranged so as to form a support with the rostrum, and to stroke it rapidly with the tips of the fingers. In about a minute the lobster succumbs, and remains without movement in this position for a variable period. With a view to see whether the reversed position, as determining the blood to the head, was essential, a lobster was treated in the horizontal attitude, and so successfully that it remained without movement for three hours. A Norway lobster subjected to a similar treatment was quiescent for fifty-five minutes. A lobster can be put to sleep on its back. The crab goes to sleep usually in the tucked-up condition—and may be left in the natural position or on its back. They all recover when disturbed; but the recovery of the lobster appears to be quicker if the undersurface of the cephalo-thorax is disturbed. Placed in sea water lobsters recover immediately, but in one such case a crab took ten minutes to come round completely. During the sleep the scaphognathite is in action all the time.

MR. E. J. SHEPPARD contributes to the Journal of the Royal Microscopical Society for October observations on the reappearance of the nucleolus in mitosis. He finds that, in the dividing cells of hyacinth and other plants, there appear, at the close of the diaster stage, one or more loops of chromatin in each future daughter nucleus. At a little later stage, when the division of the cell is well marked, the nucleolus makes its appearance, apparently by a streaming, into the area enclosed by the loop, of material from the chromatin. Mr. Sheppard has not been able to trace corresponding changes in the loop-areas of animal cells. He regards the nucleolus as inciting or stimulating the process of mitosis.

DEALING with the subject of alpine gardens in a lecture published in the Journal of the Royal Horticultural Society (vol. xxxvii., part i.), the Swiss botanist M. H. Correvon states that the English climate suits alpine plants better than the continental climate in Switzerland, except such tufted dwarf plants as the species of Eritrichium and Androsace. This statement follows upon a description of the chief features observed in the gardens at Friar Park, Leonardslee, and other notable alpine gardens in Great Britain. Reference is made to the interesting Swiss garden of the Linnaea at Bourg-St.-Pierre in the Valais, where the choicest developments are the masses of *Papaver alpinum*, superb growths of *Eryngium alpinum*, *Heuchera sanguinea*, and *Epilobium latifolium* and abundance of edelweiss. M. Correvon claims for his countrymen the superiority in plant culture on walls, where saxifrages, androsaces, campanulas, and other suitable plants can be induced to make a brilliant show; he also mentions that the walls bordering the mountain railways from Territet to Glyon and Vevey to Pèlerin have been so planted.

IN *The Agricultural Journal of India*, part iii., Mr. Keatinge continues his account of the rural economy of the Bombay Deccan, dealing specially with the livestock.

Great improvements seem to be possible. Ponies, which once had a high reputation, are now poor; goats and sheep do not bring in anything like the profit they might; whilst the cattle also appear to have deteriorated during the past fifty years. These changes are largely attributed to the large increase in cultivated ground and the consequent reduction in the grazing area. An interesting account of grape-growing round Peshawar, accompanied by some good illustrations, is given by Mr. Robertson-Brown.

THE cultivation of cacao is a highly important industry in Trinidad, where also the great bulk of the planters are peasant proprietors. Hence the problem before the staff of the Department of Agriculture is of a dual nature; new methods have to be worked out for improving yields and coping with pests, and these methods have to be brought to the notice of the grower. In a batch of circulars recently to hand instructions are given in the methods of cultivation calculated best to suit a small proprietor. The entomological and mycological notes by Messrs. Guppy and Urich will be found of more general interest. It is stated that leaf-eating beetles were very common last year, particularly *Neobrotica colaspis*; pod-hunters (*Horiola arcuata*) have also been locally numerous.

IN Bulletin No. 7 of the Commonwealth Bureau of Meteorology the climate of the proposed Federal Capital Territory at Yass-Canberra, in New South Wales, is dealt with. Besides a few preliminary paragraphs, the whole Bulletin is devoted to tables of the mean monthly values for twelve stations, and the average maximum and mean rainfall for a considerably larger number. Rainfall and temperature data are also shown for an area of about eight square degrees on a map, which might conveniently have been on a smaller scale, the isotherms being drawn in by interpolation from the twelve observing stations and by employing corrections of 1° F. for each 300 feet of altitude and each degree of latitude. No. 8 Bulletin of the same Bureau deals with the physiography of the same area. Mr. G. Taylor treats by the modern explanatory method the landforms for a radius of about 20 miles round Canberra. Various parts are first described in their present condition, after which the past development of the region is worked out. An ancient peneplain was uplifted for some 800 feet and then maturely eroded, after which a period of unrest set in, during which blocks have been tilted, and the drainage system thereby considerably modified, numerous cases of river-capture occurring. The report is illustrated by sketch-maps and diagrams, and gives a good idea of the area, which would have been improved by a short general description of the main features of this part of New South Wales.

IN Heft No. 9 of the *Mitteilungen der k.k. Geographischen Gesellschaft* of Vienna an account is given of the May cruise of the surveying ship *Najade*. Soundings were taken on the line Brindisi-Durazzo, and the considerable depths which observations in 1877 had indicated were not borne out. In lat. 41° 15′ N. and long. 18° 15′ previous soundings of 1500 and 1600 metres are replaced by more correct values of from 1000 to 1100 metres. The greatest depth of the Adriatic, hitherto given as 1645 metres, is now to be taken as 1132 metres somewhat to the north of the point previously indicated in the basin between Novi and Cattaro or Ragusa. A brief summary of the biological work is also given.

IN the November number of *The Geographical Journal* there appears a map of Africa on which are shown in different grades of colour the portions systematically surveyed, those mapped by good route traverses, and the areas which are but roughly mapped or known only by report. While the second class covers a large area, systematic survey is limited to frontier lines and to areas in Algeria, Egypt, Uganda, South Africa, and a few other points. There still remain vast areas both for exploration in its true sense and for systematic study, and if a corresponding map had been prepared to show our knowledge of the continent from other points of view than its topography the scope for investigation would be seen to be even wider than appears from the present map.

IN the *Zeitschrift der Gesellschaft für Erdkunde* (No. 7) Prof. K. Kretschner completes his survey of the manuscript maps of the National Library at Paris. These date mostly from the sixteenth and seventeenth centuries, and are of the class known as compass charts or portolan maps. While some bear the name of the author, many are anonymous; and maps of both classes are described in the present article, which deals only with those hitherto unknown or which have been very imperfectly treated. The investigation was undertaken in order to improve our knowledge of this portion of early cartography by examining, so far as possible, all the maps preserved in different countries or cities, as has been very completely done for Italy and largely carried out in Germany.

THE October number of *Le Radium* contains a short note by Madame Curie on the variation with time of the activity of some radio-active substances. The measurements have extended over several years, and the results given have been standardised by the use of the piezo-electric charge on quartz. The black oxide of uranium tested for four years in an ionisation chamber in which the whole of the α radiation was absorbed showed no change. Actinium showed a decrease of activity of about 10 per cent. in three years; and Madame Curie assigns to it a mean life of thirty years. Radium, purified from emanation and from traces of radium D, E, and F, was tested by means of its β and γ radiation, and found to increase in activity 5 per cent. in two years. Madame Curie attributes this increase to the formation of radium E. Radium D, purified from radium E and F, appears to have a life of about twenty-five years. The measurements are being continued so that the changes observed in succeeding years may be determined.

IN the July number of the Tokio *Sugaku-Buturigakkwai Kizi* Mr. S. Nakamura describes a panoramic camera by means of which the whole horizon (360°) can be photographed on a stationary film, which is bent into a cylinder and suitably supported inside the camera wall. In order to get the image on the film it is necessary to have two reflecting surfaces parallel to each other and inclined at an angle of 45° with the vertical axis of the camera, the one above the camera to receive the light from the view, and the other within to receive it from the upper mirror and reflect it to the film. The lens may be horizontally in front of either of the reflectors or vertically between them, and in making an exposure the complete optical system revolves on its vertical axis. The chief optical condition necessary in all such apparatus is that the second nodal point of the objective must be at the centre of rotation, and in this case in the centre of the camera. With ordinary photographic objectives, in which the nodal points lie within the objective itself, it is difficult, if not impossible, to fulfil this condition in these circumstances. The author therefore uses a lens which consists of a negative as well as a positive combination, as in telephotographic lenses, so that the nodal points are thrown well outside the objective; it is then only a matter of construction to fulfil every necessary condition. The camera may be compared to a large pill-box, but the lid, which carries the rotating optical system, is as deep as the box within which the film is held by two rings, one notched or marked to indicate on the photograph the azimuths of the objects on the picture. A right-angled prism is preferred for the upper reflector, and the rotation is done by hand by means of a toothed wheel and endless screw.

THE first annual report of the Road Board, established under the powers of the Finance Act of 1909, has been recently published. This Board was formed for the purpose of improving the main roads of this country, rendered necessary by the general adoption of motor vehicles. The funds required for the purposes of the Board are derived from the duties imposed on motor spirit and motor licences levied under the powers of the Act. The applications for aid from local authorities amounted to 7,870,459*l*. Up to the end of June the Board had been able to allocate out of the money placed at its disposal for the first year, 1,161,000*l*., the sum of 270,824*l*. This sum was to be applied to the improvement of main roads and important connecting roads passing through rural areas; also to the improvement of the surface of the roads and the alleviation of the nuisance arising from mud and dust due to motor traffic, and to bringing the road surfaces up to such a standard of construction that the cost of future up-keep to the local authorities may be brought within the means available from local sources. For this purpose the Board has sanctioned the use of bituminous binding material, and has issued general directions and specifications relating to the treatment of road surfaces. The Board has also taken steps to establish at the National Physical Laboratory at Teddington a laboratory for testing the value of different kinds of stone used for road repairs. This work is to be under the direction of the Geological Survey.

A CATALOGUE of gardening books and literature, comprising many early works, has been issued by Messrs. John Wheldon and Co., Great Queen Street, London. The items are arranged under the sections of flower, fruit, kitchen and landscape gardening, trees, conservatory and general treatises.

IN the notice of those volumes of "The Home University Library" published in NATURE of November 9, it was stated that "ten volumes will be issued each year." The publishers, Messrs. Williams and Norgate, ask us to say that the plan of publication is to publish ten volumes in each set at intervals of three or four months. Since April last thirty volumes have been issued, and at least one hundred are planned.

Forthcoming Scientific Books.—In the "Fauna of British India" Series, Canon W. W. Fowler's volume on the Cicindelidæ and Paussidæ, with a general introduction to the Coleoptera, and Mr. E. Brunetti's work on the Nemocera (excluding the Chironomidæ and the Culicidæ), are in the press. The remaining volumes which the editor, Mr. A. E. Shipley, with the assistance of Mr. Guy A. K. Marshall, and with the sanction of the Secretary of State for India, has arranged for in this series are:—volumes on the Orthoptera (Acridiidæ and Locustidæ), by Mr. W. F. Kirby; on butterflies (Lycænidæ and Hesperiidæ), by Mr. H. H. Druce; on the Curculionidæ, by Mr. G. A. K. Marshall; on the Ichneumonidæ, by Mr. Claude Morley; on the longicorn beetles, by Mr. C. J. Gahan; on the Blattidæ, by Mr. R. Shelford; on the Helicidæ, by Lieut.-Colonel H. H. Godwin-Austen; on the Ixodidæ and Argasidæ, by Mr. C. Warburton; on leeches, by Mr. W. A. Harding; on the Meloidæ, by Prof. Creighton Wellman; on the brachyurous Crustacea, by Lieut.-Colonel A. Alcock; and on the Unionidæ, by Mr. H. B. Preston.—Mr. Edward Stanford, official agent for the large-scale Ordnance maps, announces the publication of the first 165 sheets of a new issue on the scale of 50 inches to a mile (1 : 1250). Hitherto, apart from the town plans, the largest scale on which urban districts have been obtainable has been the well-known 25 inches to a mile, and the new issue is based on an enlargement of that map. The larger scale map has been specially prepared for use primarily in connection with land valuation, and the area covered by each sheet is one quarter of that of a 25-inch sheet.—The eighth edition of Fream's "Elements of Agriculture" is to be published by Mr. John Murray. The work of editing has been entrusted to Prof. J. R. Ainsworth Davis, of the Royal Agricultural College, Cirencester, who has considerably extended the scope of the book and brought it up to date.

OUR ASTRONOMICAL COLUMN.

PLANET MT.—The new and interesting minor planet discovered by Dr. Palisa on October 3 has, apparently, been lost again. It will be remembered that Dr. Palisa made observations on October 3 and 4, and Herr Pechüle on the latter date; but bad skies interfered and further observations were prevented. Then the Greenwich observers took a plate on October 25, with the Franklin-Adams camera, which showed apparent images in the supposed position of the planet. However, good plates taken the next night did not confirm this, and there is little doubt that the supposed images are spurious. This is most disappointing, for, as Dr. Crommelin points out in No. 441 of *The Observatory*, the object promised to be of extraordinary interest. The present known data are insufficient for a determination of the orbit, but the observations could be satisfied by assuming an orbit having about the same perihelion distance as Eros, with a slightly greater eccentricity. To explain its apparent disappearance, Dr. Crommelin suggests that, like Eros at some oppositions, this object may be rapidly variable in apparent brightness. Its motion showed it to be very near to the earth, and there is no need to suppose its diameter to be greater than a mile or two. Such small bodies need not be spherical; in fact, they might be discoidal, and would, therefore, suffer considerable changes of apparent brightness. The suggestion that Dr. Palisa's object might be a non-nebulous comet, such as Kopff's, moving in a parabolic orbit, is discounted by its planetary aspect and by the fact that an ellipse would fit the observations.

MARS.—Writing from the Sétif Observatory on November 4, M. Jarry-Desloges announces the appearance of seven fissures, towards M. Acidalium, in the north polar cap of Mars, and states that a bright area was seen on Nerigos.

From the Massegros Observatory, on October 31, it is reported that Juventæ Fons was easily visible, and that Coprates was dull and appeared bifurcated near L. Tithonius; three "lakes" were seen on Coprates, and several small ones on the site of Araxes. The south polar spot is said to be very luminous (*Astronomische Nachrichten*, No. 4534).

EPHEMERIDES FOR VARIOUS COMETS.—Nos. 4533–4 of the *Astronomische Nachrichten* contain ephemerides for Borrelly's (1911*e*), Brooks's (1911*c*), Quénisset's (1911*f*), and Beljawsky's (1911*g*) comets. Borrelly's comet is now just below τ^3 and τ^4 Eridani, and is moving northward at a little more than half a degree per day; it is of about magnitude 13·0. Brooks's comet is now travelling southward through Virgo at nearly a degree a day, and will be near γ Hydræ on November 21; its calculated magnitude now is about 4·5, and it is unlikely to be observed further in these latitudes. Observers in the southern hemisphere should, however, be able to follow it for some time yet.

Quénisset's comet is now near the sun, and practically unobservable; its calculated magnitude is about 7·0, and, travelling southward, it is about half-way between μ and ϵ Serpentis.

Beljawsky's comet is now fainter than the sixth magnitude, according to the ephemeris, and is three or four degrees north-east of Antares; it is practically unobservable, and is apparently travelling southwards, while receding from both the sun and the earth.

THE DISTORTION AND APPARENT DILATATION OF CELESTIAL OBJECTS AT THE HORIZON.—Mdlle. G. Renaudot has an interesting article on this subject in No. 2002 of *La Nature*, where she discusses the numerous explanations which have been put forward since the time of Aristotle. Special attention is paid to the explanation suggested by Alhazen, which calls in an optical flattening of the celestial vault causing the observer to feel that the stars, &c., are nearer to him, *i.e.* they should subtend a greater angle than they really appear to do. The interest of the article is greatly enhanced by some excellent photographs, taken by M. Quénisset, illustrating the distortion of the solar disc near the horizon.

EARLY VISIBILITY OF THE NEW MOON.—Referring again to Mr. Horner's observation of the new moon, Mr. Whitmell, in *The Observatory*, makes one or two minor additions to his previous results, and quotes another case, more remarkable still, inasmuch as the moon's age was only 14·75 hours, which has been brought to his notice. Mr. Hoare, of Faversham, sweeping the horizon with a 4-inch refractor on July 22, 1895, picked up the crescent moon, and after steady gazing was able to hold it with the naked eye. In this case the difference of altitude between the sun and moon was 4° 28′, the former being 2° 19′ below, the latter 2° 7′ above, the horizon, and the difference in azimuth was 7° 5′.

A NEW ASTRONOMICAL SOCIETY AND PUBLICATION.—We have received one or two numbers of the *Revista de la Sociedad Astronómica de España*, the monthly illustrated publication of this newly formed society. The review is well printed on good paper, and, in addition to the notices of the society, ephemerides and phenomena for the month, &c., it contains some excellent illustrated articles.

SOME PAPERS ON SPIDERS AND INSECTS.

TO the Proceedings of the Academy of Natural Sciences of Philadelphia for May Mr. N. E. M'Indoo contributes an article on the lyriform organs and tactile hairs of spiders. The lyriform organs, first observed in 1878, are sensory skin-structures peculiar to arachnids, and consist usually of several more or less nearly parallel slits, generally surrounded by a dark lyre-shaped band. In the simple type there are only two or three slits, with a common border; but in the compound type there are from four to thirty slits, all of which may be enclosed in a common border, or each of which may have a border of its own. The lyriform organs attain their greatest complexity in the hunting-spiders, "and as these usually contain more slits than those of the snarers or tube-dwellers, we must conclude that the method of capturing food has brought about these changes in the number of organs." As regards their precise function, the author is convinced that these organs have nothing to do with the sense of hearing, which appears to be undeveloped among spiders.

Owing to the rapid development and opening up of the country, and the consequent introduction of enormous quantities of seedlings, shrubs, trees, &c., Canada is specially liable to suffer from the accidental introduction of noxious insects. Accordingly, in May, 1910, the Dominion Parliament passed "an Act to prevent the introduction or spreading of insects, pests, and diseases destructive to vegetation." A copy of this Act is published as Bulletin No. 1 of the Entomological Division of the Canadian Department of Agriculture.

Among destructive insects that have reached Canada from Europe, two of the worst are the spruce budworm (*Tortrix fumiferana*) and the larch saw-fly, the ravages of which, coupled with those of other insects, to forests are estimated in a pamphlet by Dr. C. G. Hewitt, the Dominion entomologist, issued by the British Whig Publishing Company, Kingston, Ontario, to be as serious as the losses due to forest fires. Both insects are now spread over large areas in eastern Canada. The former species, which was first observed in force in 1909, defoliates balsam and spruce, and is reported to be doing the same to Douglas pine in British Columbia. Spreading like fire, in the adult stage this insect extends its range in a manner which cannot be controlled by ordinary means. The larch saw-fly, which thrives as well on the American larch as on its European namesake, was first observed in America in 1881, and two years later had spread over the New England States, whence it made its way into Canada by 1882. It attained a great development between that year and 1885, but after that practically disappeared until 1904, when it once more began to increase; at the present time it is spread over an area of 2500 miles. The best hopes of keeping the insect in check are centred on on ichneumon fly (*Mesoleius aulicus*), which appears to have been introduced for this purpose, although it is not quite clear whether the author is referring to its work in England or Canada.

In the September number of *The Entomologist's Monthly Magazine* Messrs. Porritt and Bankes give notes, illustrated by a coloured plate, of nine interesting species of British insects. Among these is the moth *Nonagria neurica*, taken for the first time in this country in the Cuckmere Valley, Sussex, in 1908, the British specimens hitherto referred to this species being shown to belong to an allied form. The caterpillar and pupa are described by Mr. H. M. Edelsten in a separate paper, also illustrated by a plate.

A list of the Macro-Lepidoptera of the Falmouth district, by Mr. W. A. Rollason, is published in the seventy-eighth annual report of the Royal Cornwall Polytechnic Society.

SEISMOLOGICAL NOTES.

IN the *Bulletin de l'Académie Impériale des Sciences de St. Petersbourg*, VI Série, October 1, Prince B. Galitzin adds another valuable contribution to seismometry. In No. 14, 1909, of the same Bulletin he pointed out that the azimuth of an earthquake epicentre can be determined from observations made at a single station. This direction is that of the first longitudinal wave, and is obtained by taking the resultant of amplitudes recorded in two directions at right angles to each other. Because horizontal pendulums are usually oriented north-south and east-west, the displacements are given in these directions. If, for example, one instrument recorded 10 mm. of north-south motion and the other 10 mm. of east-west motion, we see that the direction of motion was N.E.-S.W., but we do not know if it came from the north-east or from the south-west. This is the question that Prince Galitzin answers. If the front of the first wave is dilatational in character this motion is towards and down to the epicentre, but if it is condensational it is away and up from the same. This distinction is made clear by the records of a seismograph recording vertical motion. Observations have shown that sometimes the first movement of this instrument is upwards and sometimes it is downwards. The upward motion indicates a condensation, and the latter a dilatation. Between July 2, 1909, and June 8, 1911, Prince Galitzin has determined the position of forty-two epicentres by methods in which these rules have been followed.

In the issue of the same Bulletin for October 15 we find two more instructive communications from Prince Galitzin. The first deals with observations on the vertical component of earthquake motion. In connection with this, one result, based upon the records of six large earthquakes, is that the ratio of the vertical and horizontal components of movement is not constant, and is less than that which might be expected. Another result is based upon the apparent angle of emergence. Observations of nineteen earthquakes show that those with origins at distances varying between 2260 and 3840 km. have given values for these angles decreasing from 51 degrees to 42 degrees. From this latter distance up to 14,600 km. the values have increased up to 76 degrees. No definite law for the relationship between distance and the angle of emergence can yet be formulated. The second communication, which was brought before the Academy on September 21, deals with the direction of motion of the second or transversal phase of earthquake movement. So far as observations have gone, the inclination of the plane of this movement with the plane passing through the epicentre, an observing station and the centre of the world has wide limits. Its value is probably influenced by the geological character of strata in the neighbourhood of the observing station and the epicentre. These investigations, which are treated from the mathematical and observational sides, are well worthy of attention from all seismologists.

Another interesting note we find in *Rendiconti della R. Accademia dei Lincei*, vol. xx., serie 5ª, 2nd sem., fasc. 1°. This is a short paper on the Latium earthquake of April 10, by Dr. G. Agamennone. The commencement of this disturbance was noted at Rocca di Papa at 10h. 43m. 39s., with a strong reinforcement one second later. At Rome the corresponding times were 10h. 43m. 41s. and 10h. 43m. 44s. These times indicate that the epicentre is nearer to Rocca di Papa than it is to Rome. If it is assumed that the records at each of these places refer to P_1 and P_2, tables like those of Zeissig give a distance of the epicentre from each of these stations. These distances are respectively 10 and 30 km. But as circles with these radii intersect at two points, we are left to choose between two epicentres, and as neither of these falls in with local observations, in this instance, at least, this method of determining origins is found insufficient. To solve the difficulty, Dr. Agamennone shows that the ratio of the differences in time of arrival of the two phases of motion at the two given stations, which we will call A and B, which is a constant, can be expressed in terms of the coordinates of the epicentre x and y and the distance between A and B. To solve this equation with two unknowns three assumptions are made, one, for example, being that the epicentre lies on AB, with the result that three solutions are obtained. The one selected is that which agrees best with local observations. The method is new, but it is hardly applicable to time observations made at only two stations.

EDUCATIONAL SCIENCE AT THE BRITISH ASSOCIATION.

BISHOP WELLDON'S presidential address has already been printed in NATURE, and it is therefore unnecessary to dwell upon it at any length. Teachers will find it animated by a high conception of the dignity and influence of their calling and a sympathetic insight into its characteristic difficulties, as might be expected from a one-time headmaster of a great English public school, though they may consider it lacking in practical suggestion for raising the profession in the general estimation, the public-school headmaster, happily for himself, being exempt from the necessity for considering such mundane matters as tenure, salaries, and pensions. To the general reader the most interesting part of the address will probably be Dr. Welldon's remarks on the relations of the Board of Education with the secondary schools and with the local authorities, which were prompted by his experience as deputy chairman of the Manchester Education Committee. He has learnt that the antagonism between the schools and the rates is a constant quantity, and that, accordingly, new services imposed on the authorities, commendable in themselves, as, for instance, the feeding of necessitous children and medical inspection, will in part be paid for out of funds which are needed for the performance of the older duties, unless, indeed, the Board of Education can induce the Treasury to grant additional help from public funds, a consummation which is likely to remain unrealised so long as the Parliamentary chiefs of the Board are chosen from ex-Treasury officials. In the Board's relations with the schools Dr. Welldon deprecated the tendency to a bureaucratic regulation of details, which is well known to characterise the dealings of the Board with elementary schools. Such methods may be wholesome when applied to unsatisfactory schools, for they assure a minimum of efficiency; but the maximum of efficiency cannot be obtained under a code of regulations—it requires freedom, spontaneity, and individualism for its growth.

The reference to educational topics, which has almost become customary in the presidential addresses to the whole association, was this year concerned with the position of technical education. Sir William Ramsay urged the need for the concentration of higher technical instruction in a few important institutions in place of its dispersal, as at present, through the many struggling technical institutes which have been established up and down the land by the local authorities. In one of the sectional discussions Prof. R. A. Gregory roundly stated that the position of higher technical instruction in England was in a deplorable condition. Official statistics showed, he said, that fewer than 2000 students were taking complete day courses in the whole of the technical institutes of the country.

The initial discussion in the section took place upon the report of the committee on overlapping between secondary schools and universities and other places of higher education. Prof. Smithells, in presenting the report, made it clear that it dealt only with a certain amount of evidence—in some cases conflicting evidence—and that its conclusions must be reserved for a later meeting. The complaint is made in England, and also in America, that the secondary-school course is not properly articulated with the university course, and that on one side the schools are retaining pupils who ought to be at the universities, whilst on the other the universities, owing to the lack of preparation of many of their students, are wasting power upon elementary training. Upon the evidence submitted, and apart from theories as to the position of pass Moderations and the Previous examination in an organised educational course, Oxford and Cambridge appear to have little complaint to make. At London and in some of the provincial universities the overlapping is more serious. The London external system renders it possible for students to pass their Intermediate examination, and even to take their degree, direct from school, while, on the other hand, a large amount of preparation for matriculation takes place in the London colleges. It must be remembered, however, that many of the students enter the university by way of evening classes or even after a short experience of business or professional life, and for these preparatory work must certainly form part of the university course. The overlapping at London is considerable, but to some extent it cannot be avoided; and, as was suggested in the discussion both by Prof. Smithells and by Mr. Daniell, overlapping in the special circumstances of London and of the larger provincial universities is by no means synonymous with waste of educational resources.

As between the technical institutions and secondary schools, no evidence is yet forthcoming to show that the overlapping is serious. Indeed, the facts appear to be the other way. Less than one-fifth of the students in English institutions have passed a university matriculation examination or its equivalent, and nearly one-fourth have been admitted without passing any examination test whatever. The secondary schools and the technical institutions are thus shown to have but little organic connection, and the great bulk of the students of the latter have probably received no secondary education at all. It will be time enough to discuss overlapping when the main stream of pupils in the higher technical institutions have previously laid the foundation of a good general education in the secondary schools, a condition of things, however, which is not likely to be facilitated by the drastic proposal of one speaker that boys should not be allowed to remain at the secondary schools after their sixteenth year, but should be passed straight on to the technical institutes. The evidence from the secondary schools is still incomplete. As might be expected, the public-school masters with one accord proclaim the advantage to be gained by their boys in the last year or two years of school life. In these years they learn self-control, the use of authority, and the most valuable parts of character training; and the schools, with their ample resources, find no difficulty in allowing their boys a reasonable amount of specialisation in the subjects which they will afterwards study at the universities, and in preparing them for the transition in method between school and college.

For the present, and until the committee reports its reasoned conclusions, it may be taken that in the gaps between the different parts of our educational system the real danger lies, and that, as for overlapping, in Principal Griffiths's words, "Time is not lost when the same country is retraversed under a different guide."

The principal item on the programme on the second day of the meeting was a discussion on the place of examinations in education, opened by Mr. P. J. Hartog and Miss Burstall. The papers, and the discussion which followed them, may well be taken as marking a new stage in the treatment of the subject. Hitherto there has been more than a disposition on the part of educationists to anathematise all external examinations. As Mr. Hartog indicated, little good has come of it: the external examining bodies are not one penny the worse. It is now realised that for some purposes, as, for example, the selection of candidates for the State service and the certification of professional skill, the public have a right to demand an examination by some independent body. Sir William Ramsay, who intervened early in the discussion, and was by far the most outspoken opponent of the conventional type of examination, at least agreed that "we must be guarded against professional murder." The problem is thus seen to be, not the abolition of examinations, but their reform, and to this end the section strongly supported Mr. Hartog's suggestion that the time is ripe for a Royal Commission to inquire into the whole subject, but with particular reference to the entry into the Civil Service. All the speakers were agreed that teachers should increasingly cooperate in the "branding of their own herrings." Miss Burstall showed how influential the teacher members had been on the Joint Matriculation Board of the northern universities, not as examiners, but as members equally responsible with their colleagues for the scope and arrangement of the examinations. There are other instances in which the cooperation of teachers has been carried very far, and the committee which was appointed as the result of the discussion might very well devote its time to the preparation of a detailed account of some of these experiments and to a report upon the degree of success which has attended them.

Another aspect of the subject was raised by Mr. Hartog and the president of the section in their remarks upon the suitability of many of the examinations for the purpose they have to serve. It is almost impossible by examination to test the *moral* of the candidate; and there are many gifts of tact, alertness, resourcefulness, and the like required in the State service and in professional life which the present system of examinations completely passes by. Mr. Hartog gave an interesting account of a written test which he had himself applied to a group of candidates to ascertain in what degree they possessed certain of these qualities; but such tests are difficult to devise, and—*sub rosa*, be it said—they demand corresponding qualities in the examiners. Dr. T. P. Nunn was for once *advocatus diaboli*, and gave a thoughtful restatement of the arguments for external examinations which satisfied the generation that founded the University Locals. In essence it was the case for the influence of a master in a subject exerted upon teachers and upon the study of it generally through the annual paper of questions. But even in Dr. Nunn's hands it failed to carry conviction; the general level of teaching in schools is much higher in all subjects than it was in days gone by; an increasing number of teachers come under the personal influence of one or other of the masters of their subject; and among those who do not, the professional periodicals and the numerous associations and conferences which are so marked a feature of educational life in this generation supply opportunities for the spread of right method and sound doctrine superior to any that a mere paper of questions can afford.

It is the practice of the sectional committee to set apart one day for the discussion of recent psycho-physical research as connected with education. This year the central topic was that of defective children. A special committee, of which Prof. J. A. Green is secretary, reported the result of an inquiry into the tests actually used in the diagnosis of feeble-mindedness. The summarised replies received from school medical officers and others show that there is a grave need for some standardisation upon scientific lines in the matter both of diagnosis and subsequent treatment. Dr. Shrubsall gave a detailed account of the methods employed under the London Education Authority for the testing of mental deficiency. Without presuming to criticise these methods in particular, it is very clear that the methods of diagnosis generally employed are frankly empirical and of almost bewildering variety, and that partly in consequence of this and partly owing to the lack of precise knowledge on types of mental deficiency in relation to the general problems of education there is very little connection in most cases between the initial diagnosis and the subsequent treatment.

Dr. A. F. Tredgold presented a careful discussion on the nature of mental defect and its relation to the normal. He suggested that neither from the intellectual point of view nor as a result of psychological analysis or histological examination of brain structure could justification be found for regarding the difference between the normal and the defective as in its essence qualitative, although the quantitative differences may and do result in minds of a very different order. In defining mental defect it was necessary to go much deeper than mere ability to perform certain occupations. He would himself define it as a condition due to arrested or imperfect brain development, in consequence of which the individual is incapable of maintaining an independent existence. Dr. Abelson followed with a description of a series of tests, in some measure comparable with Binet's, which he had employed for the last three years upon backward children. The problem of the mentally deficient is so pressing from the social point of view that it is not surprising that the discussion soon turned rather upon this aspect of the question than upon the report of the committee. Once defective always defective, appears to be the rule. "I have never yet," said Dr. Tredgold, "seen a mentally defective converted into a normal being"; and again, Miss Dendy: "We cannot train the defective child out of his defect; he simply grows into a trained feeble-minded man."

The absolute necessity, in the interests of society, of preventing the multiplication of the unfit, and the inefficacy of the present law, which allows the feeble-minded adolescent at sixteen years of age to go out into the world, none saying him "Nay," dominated the mind of speaker after speaker. Dr. Saleeby, Mrs. Burgwin, Prof. Dendy, and Mr. McLeod Yearsley took part in the discussion. The last named urged especially the importance of segregating the feeble-minded deaf. Miss Dendy showed how much can be accomplished even under present conditions in her description of the feeble-minded colony at Sandlebridge, which, beginning ten years ago as a small residential special school for little children, and resolutely declining to accept any new pupil over thirteen years of age, has grown into a colony with 270 inhabitants, with two farmhouses, with cottages, a laundry, carpenters' and plumbers' shops, and six residential houses, on about 120 acres of land. In the ten years, out of 274 children who have been admitted, only eighteen can be spoken of as failures whose parents have broken their promise to leave them permanently in the school. Very interesting was Miss Dendy's account of how it had been possible to turn to the service of the community those streaks and patches of intelligence which are found in almost all feeble-minded children, and, unfortunately, are often made the basis of a training in tricks which are of no use either to the individual trained or to anyone else.

On the last day of the meeting papers were read on practical education in H.M. dockyard and naval schools, by Mr. Dawe, headmaster of the Dockyard School at Portsmouth, and Mr. W. H. T. Pain, principal instructor of boy artificers on H.M.S. *Fisgard*. The *Fisgard* is quite a recent establishment, but the Dockyard School in one form or another has existed for nearly a hundred years. It was claimed by its supporters in the discussion, among them Sir William White, a former pupil in a dockyard school, Profs. Worthington and Gregory, Dr. Kimmins, and Dr. Varley, that the schools might well be taken as a model by authorities responsible for any form of specialised technical training. Of their success there can be no question. Every professor of naval architecture in the kingdom at the present time has been through one of H.M. dockyard schools; of the principal officers in the constructional branch of his Majesty's Navy the same may be said, and also of the majority of naval architects at the head of private shipbuilding firms, while the lower ranks of his Majesty's dockyards are mainly staffed by ex-pupils. The outlay for which this wonderful return is obtained does not exceed 4000*l*. per annum.

From the beginning the Admiralty has insisted on the faithful observance of two guiding principles. In the first place, the apprentices who attend the school do so partly in Admiralty time. At present the five periods a week are taken, three from the boys' free time and two from Admiralty time, and Admiralty time spent at the school is paid for. In the second place only those pupils are retained who are found to have the requisite ability and industry to profit by the higher instruction; a continuous process of sifting goes on, and the waste of effort is thus reduced to a minimum. Those pupils who go out comparatively early find their position on the wage-earning staff; and, as Sir William White testified, they are altogether different from ordinary workmen, because of the training, short as it may be, which they have had in the school. At the same time, there is sufficient material retained for the training of officers, who will ultimately fill the higher constructional posts. A third principle has been rendered possible of application in recent years, and no candidate is now admitted who has not obtained a sound preliminary education. The number of apprentices in attendance is 180; and the school is arranged in two sections, which attend on alternate days. The full course extends over four years, but there is a weeding-out process at the end of each year. Of those who complete the course a few are selected by examination from all the dockyards for an advanced three-year course at the Royal Naval College, Greenwich, after which they join the Royal Corps of Naval Constructors. The competition for admission to the dockyards as apprentices is severe, and therefore at the outset a careful selection is possible.

The late Lord Spencer, when First Lord of the Admiralty, appointed a committee to consider whether the schools might be abandoned in view of the enormous advances which had been made in the provision for elementary education. Happily for the nation the committee's verdict was unanimously in favour of their retention. The development of to-day in the provision of technical instruction is held by some to justify a fresh proposal for the abolition of the schools, and the transfer of their pupils to the municipal technical schools of the dockyard towns. It is to be hoped history will repeat itself and that the schools will be allowed to continue their unique work. As Prof. Gregory said, they are at least a generation ahead of most of the other technical institutions of this country. Their close association with the dockyard has benefited both. Prof. Worthington pointed out how the problems of the dockyard are brought to the schools for solution, and he also dwelt upon the interest and pride which the rank and file of the yards take in the schools. To sacrifice a century-old tradition for the sake of saving a few thousand pounds would be a deplorable mistake, particularly at this juncture, when the Admiralty's example will be most valuable to administrators and educationists, who have good reason to be dissatisfied with the condition of technical education in the country generally.

SOME ENGINEERING PROBLEMS AND THE EDUCATION OF ENGINEERS.[1]

IT is a consequence of the scientific basis of engineering that it is international, not national. Scientific advances are not restricted within political boundaries. If we gave the world the steam turbine, Germany returned us the gas engine and Diesel engine. Ability to appreciate the value of new discoveries, and readiness to take advantage of them, depend as much on a widespread scientific education as the making of the discoveries themselves.

My distinguished predecessor, out of a long and varied experience in the development of the most modern of the many branches of engineering industry, discussed the economic conditions of production on which successful manufacture depends. It will be more natural to me to deal with some of the technical principles on which the successful design of engineering structures is based.

Strength of Materials.

The object of a study of the strength of materials is to determine the proper dimensions to be given to parts of machines or structures, in order that they may resist the straining actions to which they are subjected without breaking or prejudicial deformation. It is a modern study, for the earlier architects and builders seem to have had no definite knowledge; only it may be noted that the earliest buildings were the most massive. The Egyptian columns were not more than five or six diameters in height, the Greek about nine. Mediæval buildings depend more on considerations of stability than of strength; but there are mediæval columns carrying arches which are twenty-six diameters in height.

So far as we know, however, Galileo (born 1564, died 1642) was the first man of science definitely to consider strength. He found that a rod of copper suspended vertically might have a length of "4800 arms," or, say, yards, before breaking in tension by its own weight—a reasonable result. Having no conception of elasticity or of variation of stress due to variation of deformation, he seems to have assumed that bodies always broke by tension, and that tension was uniform at the surface of fracture. Applying these notions to determine the strength of a cantilever, he supposed the whole cross-section would be in tension uniformly distributed. He arrived at an equation for bending strength which for rectangular sections is right in form, but affected by an erroneous constant; and he acutely deduced the result that, while a model of a structure might be strong enough to carry a load, the structure itself might be so large as to break by its own weight. This is the germ of the law of a limiting span for bridges. On the same false assumptions Grandi, in 1712, published elegant and correct demonstrations of what we know as solids of uniform resistance to bending. It is not the first instance in science of false assumptions leading to partially correct results.

It was not until 1660 that Robert Hooke discovered the fundamental law that stress is proportional to strain in elastic materials. It was not until 1680 that anyone made further experiments on the strength of materials. Then Mariotte made rough tests of very small bars of wood and glass strained in various ways. He first perceived that in flexure part of the cross-section is in compression and part in tension, and placed the neutral axis for a rectangular bar at half the height, correcting Galileo's result. It was not until 1776 that Coulomb determined the position of the neutral axis for simple sections, and not until 1824 that Navier determined it for all sections.

In 1729 Muschenbroek, at Leyden, published the results of what may be considered the first tests of materials made with precision. He made tension and bending tests, and tests of long columns, but on a very small scale. Perronet, occupied with the construction of the Bridge of Neuilly, in 1758 constructed the first comparatively large testing-machine, a machine capable of applying a stress of 18 tons. Rondelet, in 1787, constructed a testing-machine with knife-edges, and with a screw arrangement for taking up the deformation of the test-bar. It was the first machine containing in principle all the essential elements of a modern testing-machine. Labardie, soon after, constructed a 100-ton machine for the Port of Havre, and Girard carried out with it the first tests on a large scale of the elasticity of materials. In 1813 and 1817 Brunton and Company and Captain Sam Brown constructed cable-testing machines.

Theory of Elasticity.

A very great step in the simplification of the mathematical expression of formulæ of strength of materials was taken by that very remarkable English physicist Thomas Young (1773–1829), who defined the coefficient of direct elasticity, or Young's modulus, and first considered shear as an elastic strain. The time had come for the development of a general theory of elasticity. Navier, in 1827, first investigated the general equations of equilibrium of an elastic solid, starting from an assumption as to the molecular constitution of matter. Navier's equations are still accepted, though part of his reasoning is considered to be unsound. At the same time, Cauchy founded the theories of stress and strain, and Lamé and Clapeyron made important developments.

[1] From an address delivered to the Institution of Civil Engineers on November 7 by Dr. W. C. Unwin, F.R.S., president of the Institution.

Reverting to experimental work in this country, early in the last century George Rennie made investigations of the resistance of structural materials, and Peter Barlow made experiments on the strength of timber at the Dockyard and at the Arsenal. This led to his association with engineers; and he assisted Telford in calculations for the Menai Suspension Bridge. His "Essay on the Strength of Timber," in 1817, when developed in later editions, may be regarded as the first general treatise in English on the strength of materials.

Down to about the end of the first quarter of the last century most of the knowledge of strength of materials was due to the work of Continental engineers and physicists. Then an advance was made here. Thomas Tredgold in 1820 published "A Treatise on the Principles of Carpentry." This dealt scientifically and practically with all the then known data of resistance. His book on the steam engine, dealing specially with questions of strength, was published in 1827, and republished down to 1850. It has been rather a fashion amongst elasticians to ignore or depreciate the work of Tredgold. But he had a practical insight into what was important and what was negligible in engineering problems greater than that of writers with more ample mathematical resources, and he rendered essential services to the engineers of his time.

A little later Prof. Eaton Hodgkinson began the researches on strength of materials which give him a foremost place among careful experimenters. He is credited with the discovery of permanent set and of the position of the neutral axis. His paper of 1830 on iron beams, and that of 1840 on columns, were very valuable contributions to practical science.

There is not time to trace further the history of the science of strength of materials. Experimenters and laboratories in the last fifty years have increased enormously, and theoretical investigations have been pushed to great lengths. But I wish to take the opportunity of paying a tribute to one who seems to me the prince of observers in this branch of science. I mean the late Prof. Bauschinger, of Munich, professor of mechanics and graphic statics at the Technical High School at Munich for twenty-five years. There he established a laboratory, rather more for research than instruction, where engineering experiments were carried out with a thoroughness and delicate accuracy never previously equalled. In 1868 he published the result of indicator observations. But his special field of work was that of tests of materials. He created the first public laboratory for this purpose. He first applied Gauss's method of reading by reflection in instruments for measuring the deformation of bodies when strained.

Amongst many researches remarkable for their extent it is only possible just to mention one on cements and cement and lime mortars, demonstrating, amongst other things, the importance of fine grinding, and one on the building stones of Germany. His researches on timber first indicated the precautions necessary for securing comparable results, especially the law of variation of strength with moisture. He carried out many researches on cast iron, wrought iron, and steel, especially some with reference to the variation of the position of the elastic limit under different conditions of straining. Perhaps one of his most important achievements was the foundation of the International Association for Testing Materials.

Testing Materials for Quality.

Down to the middle of the last century the only generally used tests of the quality of iron and steel used in construction were bend-tests, and in certain cases shock-tests. Such other researches as were made were directed to a different object—either to determine the constants in formulæ on which engineers relied or to prove the sufficiency of complete structural members. It was the introduction of Bessemer steel, and cases of unexpected failure of steel structures, which forced on engineers the necessity of systematic tests of quality. An important series of tests carried out by the late Mr. D. Kirkaldy in 1860 led to the adoption of a tension-test as the usual test of quality. Its special merit is that exact figures can be specified for elastic limit, resistance to fracture, and elongation.

With the introduction of definite tests, the importance of accurate and reasonable specifications became urgent. Recently the work of the Engineering Standards Committee has done very much to guide the engineer in securing trustworthy material without imposing conditions too irksome or costly on the producer. Hence it has come about that the testing engineer has been created, having functions partly as an investigator of the properties of materials, partly as adviser of manufacturers, and partly as inspector of material.

Application of the Science of Strength of Materials to Practice.

The general object of the accumulation of experimental and theoretical knowledge of strength of materials has been to determine the minimum amount of material and the best disposition of it in machines and structures to secure safety. Putting it another way, by theory the stress conditions due to any given straining action can be calculated; then it has to be determined what is the greatest permissible working stress, and in what way does it depend on such physical properties of the material as can be ascertained by testing.

The oldest, and still the most common, method of proceeding is to reduce the straining actions to simple tension, thrust or shear, by calculations based on the assumption of Hooke's law, and to provide material enough to limit the intensity of these stresses to a fraction of the breaking strength of test-pieces similarly strained. The ratio of the breaking strength to the working strength is termed the factor of safety. In by far the largest number of cases with which an engineer has to deal, the breaking strength of a structure cannot be calculated, for Hooke's law ceases to be true for stresses much below the breaking stresses. Hence the engineer sometimes proceeds one step further. He tests a scale model of a structure to breaking, and from this deduces the breaking load of the full-size structure by the law of similarity.

In the case of complex structures, the determination of the exact maximum stresses in which are beyond the resources of mathematical analysis, the value of model experiments is unquestioned.

Now it is easy to show that the ratio of the breaking stress to the working stress, or the breaking load of a girder to the working load, is not a real factor of safety; the point at which danger occurs in different cases is not a fixed fraction of either the real or the calculated breaking load. It has even been contended, with some plausibility, that the fashion of dividing the breaking stress by a factor to find the working stress is a barbarous method. The factor must be varied for different conditions, and can only be fixed empirically.

The ductile materials chiefly used in construction *yield* or suffer a large deformation at about half to two-thirds of the breaking stress. The deformations, if the yield stress is exceeded, would be, at least in very many cases, far too large to be tolerated in either machines or structures. If the yield stresses are taken as the limits of safety, then the real factor of safety is only about half the ratio of the breaking to the working stress. Further, the ratio of the yield stress to the breaking stress is not a very constant ratio.

Shall we, then, drop the breaking strength and adopt the yield-point as the measure of the constructive value of a material? Many constructive materials, such as stone, timber, and cast iron, have no yield-point. Besides, even for ductile rolled material, such as mild steel, the point ordinarily determined as the yield-point is not a very fixed point for a given material. It depends a little on the rate of loading. Yielding really begins at the elastic limit, a point below the yield-point, spreading along the bar and becoming general over the bar at the yield-point.

Some writers assume that the elastic limit as determined in a tension test is the real measure of the constructive strength of a material; but I am not sure that this is not, when rigidly examined, the most ambiguous and elusive of all the measures proposed. In what sense, then, is the elastic limit found in a tension-test to be understood?

No doubt there are cases where the primitive tensile elastic limit does fix a superior limit to the stress consistent with safety. But it cannot be taken generally as an exact measure of constructive value, though it certainly is a valuable indication. Further, the elastic limit in compression is seldom observed, and the elastic limit in shear is experimentally almost unknown. Yet resistance to shear is probably for ductile materials the most important element of constructional value. It would be interesting to have the elastic limit in torsion of thin tubes accurately determined.

Hence, whether we take the breaking stress, the yield stress, or the primitive elastic limit, we have not found a satisfactory rational basis for measuring the constructive strength of a material. There is not a fixed ratio between the greatest safe working stress and either of these. But I do not wish to be understood as depreciating the value of the determination of breaking stress, yield-point, and elastic limit in testing materials.

Valuable as are the data of breaking strength, yield-point, and elastic limit determined in a tension test in influencing the judgment of the engineer, they do not furnish any purely rational rule for fixing the working stress for designers. Experience in similar cases must always be the ultimate appeal.

Compound Stress.

So far, all that has been said relates to cases of simple tension, thrust, or shear. But in a very large number of cases two of these stresses are combined. In such cases the theory of elasticity furnishes the principal stresses and the principal strains; but the question, What is the criterion of safety? involves another of the unsolved problems of engineering. Two schools arose amongst theorists, one holding that the maximum stress, the other that the maximum strain, determined fracture. For simple stresses, either assumption leads to the same result. It is not so with compound stress. Very early Coulomb suggested that fractures would be determined by shear, as is the case with cast iron under compression. The subject is now under investigation experimentally, and, speaking generally, it seems that for ductile materials the material gives way at some limit of shearing stress, while for brittle material in tension the principal stress is the best criterion of strength.

Comparative Structural Value of Materials.

It is only when comparing two different materials that an engineer needs to consider relative constructive value, and then he bases his judgment on all the properties of the material. Ordinarily, the safe working stress is fixed by experience in similar cases, theory helping mainly in explaining why in different cases different stresses are suitable. The history of engineering design is a history of experiments in construction, in which by trial and error right proportions have been found; and in the settlement the different relative importance of cost and weight enter into the question, as well as considerations of mechanical strength. The fact that scientific data and rational, or semi-rational, formulæ are conveniently used should not be allowed to conceal the fact that an empirical element always enters into the solution.

New designing is really a process of comparison, in which the engineer extends experience in known cases to new conditions; and the problem is in what proportion dimensions must be varied to allow for differences of size, of material, of loading, of speed, or of form.

Most practical problems in designing for strength reduce themselves, if traced to their foundation, to applications of the law of similarity. At a time when steam engines all worked at about the same steam pressure, it was broadly stated that the drawings of an engine of any size could be used for constructing engines of any other size by merely altering the scale of the drawing. So-called mechanical instinct is, no doubt, really reasoning based on the law of similarity.

In the case of machines, another consideration enters. The weight stresses are not usually important, but the inertia stresses due to variation of velocity or direction of motion are very important. The stresses in a fly-wheel rim due to radial acceleration are proportional to the square of the rim velocity, whatever the cross-section. Hence fly-wheels are equally safe in this respect if the rim velocity is the same, or if the rotations per minute are inversely as the diameters.

Engineering Education.

I turn to another subject, which seems to be appropriate in a year in which the institution has held a conference on the education and training of engineers. An important change is going on in all types of education. In all it is being recognised that they should be such as to afford a training for the duties of life. The term "engineer" is used in such wide and loose senses that it is necessary to be explicit as to one's point of view. There are vocations associated with engineering work for which no special training is absolutely required beyond that of the factory or commercial office, or for which any other training required is different and more limited in scope than that of the professional engineer or director of engineering works. But the conference considered the case of those who aim at becoming ultimately professional engineers, that is, men who advise, design, and direct the execution of works of civil engineering in the wide sense in which that term is used in this institution. If the course of training of such men is provided for, the less complete training of men for lower grades of service is not likely to be wanting. But I do not think that we distinguish sufficiently at present the different type of education required for leaders and subordinates, the heads and the hands.

It must be recognised that the professional or consulting engineer is not solely concerned with technical problems, though as to these he must be an expert. But he is more and more concerned with economic, legal, and commercial problems of much intricacy, and must be prepared to meet men of affairs and of liberal education on an equal footing.

Now the earlier great engineers in this country had no formal technical training; indeed, very little general education either. Brindley, George Stephenson, Fairbairn, had only parish-school education; Smeaton, Telford, and Watt only grammar-school education. They picked up even their practical experience gradually and casually. They differed in this from their contemporaries in France. Perronet, Gauthey, Rondelet, and Navier, for instance, were of a more academically educated type.

It is, no doubt, due in part to such early conditions of English engineering, in part to the narrow and unscientific character of secondary and university education in this country, that until recently the education and training of engineers has been so unacademic and unsystematic.

Preliminary Education.

A very great obstacle to the progress of technical education in this country has been the want of any definite aim —the unsuitable character and poor average quality of our secondary education. Grant whatever can fairly be urged as to the honourable spirit, the pluck, and resourcefulness of boys from the better public schools; grant also the value of dead languages as a means of culture for those who really master them, it must still be recognised that the average boy, to some extent, still leaves school sadly unfitted for any form of higher education. The success of the clever and brilliant few, educated for university prizes, has obscured the poor quality of the intellectual equipment of the average many.

Happily, if the state of things is not yet satisfactory, if secondary education is still unorganised, and the schoolmaster is only partially converted, still science has obtained a footing, and school-leaving and other examinations have secured that the average lad is better taught.

It was partly a cause, partly a consequence, of defective school education that the great universities have not addressed themselves, in a responsible and scientific manner, to securing that candidates for admission to higher courses had reached a reasonable standard. Still less were the engineering schools, with one or two exceptions, able to insist that students were properly prepared for technical instruction. It is only recently, and partly under pressure from the institution, that a fairly satisfactory entrance examination has been prescribed in some English and colonial engineering schools. To admit lads with imperfect preliminary education to advanced instruction lowers the whole standard of work in the classes.

An erroneous opinion has prevailed that technical instruction requires little or no literary and scientific education to prepare the way for it. I noticed the statement in the address of the Chancellor of St. Andrews, on the occasion of the quincentenary of the University, that the test now imposed for entrance would in some respects compare not unfavourably with that for graduation about half a century ago. In the best engineering schools a similar change has occurred, and should, indeed, make further progress. The possibility of effective technical teaching depends on suitable previous preparation; and on this point the committee of the institution in 1906 came to very decided and definite conclusions, and laid down explicitly a scheme of school education for engineering students.

Technical Education.

It is only in modern times that universities came to be regarded as solely concerned with a general liberal and, except as regards medicine, an entirely non-technical education. "The colleges were in their inception," says Mark Pattison, the rector of Lincoln, "endowments not for the elements of a general liberal education, but for the prolonged study of special and professional faculties by men of riper age"; and he lamented that they no longer promoted the researches of science or directed professional study. That state of things is happily changing, especially in the modern provincial universities.

The new vocation or profession of engineering grew up in this country with very little academic encouragement. It is true that after 1840 engineering schools were attached to a few universities. But they were generally unendowed, unequipped, or uninfluential. The most distinguished of them was that at Glasgow, where the Regius professorship was held by Gordon and Rankine.

Meanwhile, in France and Germany there had long existed remarkable engineering schools with distinguished teachers. The Paris Ecole Polytechnique was instituted in 1794, the Ecole des Ponts et Chaussées in 1795, the Ecole des Mines in 1778, the mining school at Freiburg, where many foreigners obtained education in 1765. In the first quarter of the nineteenth century were established the technical high schools of Karlsruhe, Hanover, Berlin, Dresden, Vienna, and the École Centrale at Paris. The great Zürich Polytechnicum dates from 1854.

With one exception, I do not think there were any engineering schools in this country with what could be regarded as a reasonably complete and satisfactory curriculum or equipment before 1870. In giving this date I am passing over the system of education adopted by the Admiralty for naval engineers and architects in 1843. Sir Alexander Kennedy established the first college engineering laboratory in 1878, and from that may be dated the beginning in this country of a necessary equipment of engineering schools. There is now a number of university engineering schools, or schools of university rank, directed by teachers of eminence not only in science, but in practical engineering, with systematic courses of instruction covering broadly all branches of engineering up to the graduate stage, and of a thoroughly practical character. Quite recently a beginning has been made of post-graduate instruction of a specialised character. It is only in a post-graduate course that engineering students can be usefully or efficiently employed in research.

Advanced Education and Practical Training.

I cannot help thinking that there is a tendency amongst some practical engineers to suspect those of us who are interested in formal technical instruction of indifference to the value of practical experience. But surely that is a mistake. Most engineering professors are themselves engineers of considerable practical experience. What, in fact, they do somewhat doubt is the value of so much practical experience as an ordinary apprentice gets who goes straight into works without technical training, and who has to pick up his knowledge as he can. At the best, his experience is a narrow one. Some of the jealousy occasionally shown as to college training seems to arise from the feeling that it interferes with the traditional English system of articled pupilage, which, so far as I know, hardly exists in any other country. It does seem to me that the old apprenticeship system for professional engineers, taken by lads direct from school, was uneconomical, wasteful of time, involving unnecessary drudgery, and in some respects unfair.

There is another consideration as to the pupilage system as it existed forty years ago. It was suitable only for the wealthy. But many of the most hard-working, capable, and even brilliant students are not of the wealthy class. In these days there are ladders from the elementary school to the university and the technical college. It would be a loss to the country and the profession if really able, but comparatively poor, students could find no way to employment. In this competitive time we can least of all afford to neglect or waste intellectual ability.

The institution has by its system of examinations expressed its view of the importance of such theoretical and practical technical education as it is the object of technical schools to give, while at the same time it has done what is possible by its by-laws to encourage or require a term of pupilage or apprenticeship as a means of acquiring experience. Further, in the report of the committee of 1906, while insisting on the value of pupilage or apprenticeship, it has most definitely expressed the opinion that a three years' course in a technical college is equally necessary, and should form an integral part of the training of an engineer; and this conclusion was endorsed by a large majority of the engineers who were consulted by the committee.

The question arises, and I think it is a serious one, how far engineers now are taking any steps to carry out the recommendations of the institution committee as to the requirement of preliminary training antecedent to pupilage. It is clear that young men will not incur the expense, the labour, and the delay of a college course if it gives them no advantage in entering the profession.

Some inquiries were lately made by the institution of more than a hundred engineers in various branches of engineering as to the conditions on which they accepted pupils or apprentices. In a few cases it appears that pupils or apprentices are required to have passed an examination equivalent to the Studentship examination of the institution. In a very few cases the possession of a degree is accepted as a reason for shortening the period of apprenticeship. But what is desirable is that a lad should reach the standard of the Associate Membership examination or the examination for a first degree before entering on pupilage. If he does not he will only be able to reach it by cramming, which, though not quite useless, is much inferior to a systematic course of study. As a matter of fact, however, within my own knowledge the colleges have more influence than these returns seem to show; and, especially in the case of the provincial universities, local patriotism ensures preference to men trained in the local university.

The Transition from College to Practice.

It seems to me that the great efforts made during the last forty years, and the expenditure incurred, largely from private sources, in establishing engineering schools lack in one respect full recognition by the profession. Many engineers have given generously in money and in time; but engineers in general might do more in facilitating the transition from school to works. With an experience of twenty years, I believe that more organised and recognised relations between the schools and offices and works are desirable and possible. The most difficult part of a young engineer's career is the step between college and full capability in some special branch. No engineering school can prepare students completely for any special position in the engineering field without very undesirable narrowing of the scope of the instruction. Two years of pupilage or employment is desirable as a transition period; and the difficulty is that generally engineers expect that someone else should have the task of rounding off the college training. Even in the United States it is perceived that, to make technical education effective, the employer must shoulder a part of the load imposed by the old apprenticeship system, which in the United States has been to a great extent thrown on the schools.

I am therefore much in sympathy with the proposal that there should be an endeavour to produce some coordination between the colleges and employers by making an inquiry as to the conditions under which well-qualified students may be able to get practical training, whether they seek employment later in the mechanical or electrical branches of engineering or in constructional or administrative work. Some scheme might be evolved linking the colleges and the manufacturing, municipal, or other public works, so far that the first stage of practical experience might be gained under conditions less haphazard than at present. No doubt college graduates who want to fit themselves for service in India or for starting in private business are fairly asked to pay for the privilege of entering works or office. But in other cases well-trained students who are quite capable of being useful might very well be taken on easy terms, for a trial of a year or two, in the expectation that they would remain afterwards as valuable assistants. In the engineering departments of municipalities greater facilities for apprenticeship might be given. By choosing technically well-educated lads and directing their practical training, they would form a loyal staff, ultimately more competent and useful than others less educated, but selected as more immediately useful. Further, it is now proved that technically educated lads are very fit, with some experience added, for the commercial branches of an engineering business.

If a university degree or college diploma is to be taken as a qualification for beginning an engineering career, it must not be overlooked that degrees and diplomas are of very varied value, and that one great function of a college is to distinguish the more and the less capable amongst its students.

I believe there are no schools of university rank where the work is more strenuous, the methods more practical, or new ideas more welcome, than in the best of the engineering schools of the day.

I have touched on various subjects, unavoidably in a short address, with some one-sidedness. We have been driven lately to recognise how intimately the very existence of society as now constituted depends on the work of the engineer. It is because I have come to believe in the importance of coherent and systematic instruction and in the value of the play of mind on mind and the influence of generous rivalry, best enjoyed at a plastic and impressionable age during studentship, that I have ventured to urge the claims of engineering schools in preparing the engineer for service in shaping the destinies of the Empire.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—A scholarship of 150*l*. a year for three years has been awarded by the Board of Agriculture and Fisheries to Mr. Gilbert E. Johnson, a student in the department of zoology. This scholarship is one of the number recently founded by the Board with the object of encouraging research in agriculture. Mr. Johnson is at present engaged in research in connection with the subject of eel-worms.

OXFORD.—The statute allowing honour students in mathematics and natural science to dispense with Greek in Responsions passed Congregation on November 7. No canvas had been made on either side, and the division, showing 33 for the statute and 11 against, was without any particular significance. The real struggle will take place when the measure is submitted to Convocation, the ultimate legislative authority of the University. This will probably take place before the end of the present term.

SIR HENRY CRAIK, K.C.B., M.P., has accepted the principalship of Queen's College, London, in succession to Canon G. C. Bell, resigned.

AT a meeting of the governors of the South-Eastern Agricultural College, Wye, held on November 6, it was decided to approach the Board of Agriculture and the Development Commissioners with regard to the foundation of a research institution for fruit-growing, including the practical treatment of plant diseases, in the County of Kent, and also to apply for a grant in aid of the proposed extension of the college buildings.

THE first meeting of the Association of Teachers of Mathematics for the south-eastern part of England will be held at Tonbridge School on Saturday, November 25, at 3 p.m., when the inaugural address will be given by the president, Dr. A. N. Whitehead, F.R.S. This meeting will be open to all who are interested in the teaching of mathematics. Further information can be obtained from the honorary secretary of the association, Tonbridge School, Kent.

WE learn from *Science* that the will of Miss E. C. Woerishoffer leaves 125,000*l*. to the trustees of Bryn Mawr College, of which she was a graduate. From the same source we find that the estate of the late Mr. John S. Kennedy is even larger than has been previously announced. The share of Columbia University is 486,000*l*. New York University and the Presbyterian Board of Aid for Colleges each receive 195,000*l*., and Robert College, Constantinople, 370,000*l*. The specific bequests, not dependent on the size of the estate, include 20,000*l*. each to Yale, Amherst, Dartmouth, Bowdoin, Hamilton, and Glasgow.

AT a Congregation of the University of Wales, held in Bangor on November 10, the following degrees were conferred, *honoris causa*:—For the degree of Doctor of Science, Prof. Conwy Lloyd Morgan, F.R.S., sometime Vice-Chancellor of the University of Bristol, and Sir William H. Preece, K.C.B., F.R.S., sometime electrician to the General Post Office. For the degree of Doctor of Laws, Dr. William Thomas Edwards, J.P., and Sir Isambard Owen, Vice-Chancellor of the University of Bristol, sometime Senior Deputy Chancellor of the University of Wales. For the degree of Master of Arts, Miss Isabella Cleghorn, distinguished for her services in the cause of education.

"THE Moral Influence of a University Pension System" forms the subject of an article in *The Popular Science Monthly* for November by Dr. Henry S. Pritchett. It will be remembered that the author is president of the Carnegie Foundation for the Advancement of Teaching, which has provided for the staffs of American universities and colleges a liberal scale of retiring pensions. Although the system has been organised on a non-contributory basis, Dr. Pritchett seems, on the whole, inclined to favour the contributory system. Probably the conditions are somewhat different in America from those prevailing in this country, where Government old-age pensions have been arranged on a non-contributory basis, and where the main reason for not adopting the same course in our universities has been on financial grounds.

THE present session is the thirtieth during which the City of Bradford Technical College has been at work. The new calendar, which has been received, gives full particulars concerning the very complete provisions which have been made to provide technical instruction in connection with the various industries of the West Riding. The buildings have been greatly extended in recent years. Among other important developments we notice the dye-house is now ready in which the material required for, and produced in, the textile department will be dealt with. The equipment is such that students will have the opportunity of carrying out practical work of an instructive character. The machinery is capable of dealing with loose wool or cotton, slubbing, yarns of all materials, warps, and piece goods. The machines represent the latest practice. In connection with the extension, it was decided to put down a plant for the engineering department which, although primarily intended for educational purposes, would at the same time serve for supplying light and power to the present building, the new extensions, and the school of art. This is probably the most important step in the history of the department which has yet been taken. We notice also that a systematic course in sanitary science, suitable for sanitary and other inspectors in the West Riding, has been arranged to comply with the requirements of the Sanitary Inspectors' Examination Board, and that the college has been placed by the Board of Trade on the list of technical institutions recognised by the Board for the purpose of the regulations relating to the examinations for engineers in the mercantile marine.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 9.—Sir Archibald Geikie K.C.B., president, in the chair.—Sir William **Crookes**: The spectrum of boron. The physical properties of the element boron are almost unknown, notwithstanding the efforts of many chemists who have worked on the subject. Moissan, who came nearest to obtaining the pure element, only succeeded in getting it in the form of an amorphous powder. He said it was not possible to melt or volatilise it in a carbon crucible or arc as it was changed into carbon boride, and concluded that boron passed from the solid to the gaseous state without becoming liquid. Recently Dr. Weintraub, of the General Electric Company, U.S.A., has not only obtained boron in a state of purity, but has prepared it in a fused homogeneous state. His process consists in running an alternating-current arc between water-cooled copper electrodes in a mixture of boron chloride vapour with a large excess of hydrogen. The boron agglomerates on the ends of the electrodes, where it grows in the form of small rods. After a while the arc runs between two boron electrodes; and if the current is of proper value the rods melt down to boron beads, which eventually fall off, whereupon the same process repeats itself. The first specimens received from Dr. Weintraub were deposited from a vaporous state from boron chloride and hydrogen in the manner described. Subsequently he kindly sent the author some lumps of fused boron which had been prepared from magnesium boride. This boride dissociates at a relatively low temperature (1200°), especially *in vacuo*, and with rapidity at 1500°. The fusion is effected between copper electrodes, the affinity of copper for boron being so slight that it can be directly fused on to the electrode without being contaminated with copper. Another way of fusing boron is in what Dr. Weintraub calls a mercury arc furnace, based on the fact that most refractory bodies, such as tungsten, tantalum, boron, &c., have no affinity whatever for mercury. The result of the author's work on boron is to show its photographed spectrum consists essentially of three lines, the wave-lengths of which, according to accurate measurements, are 3451·50, 2497·83, and 2496·89. For more easy comparison the wave-lengths of these lines measured by different observers are given below in a tabular form:—

Hartley (1883)	3450·3	2497·0	2496·2
Rowland (1893)	—	2497·821	2496·867
Eder and Valenta (1893) ...	3451·3	2497·7	2496 8
Exner and Haschek (1897) ..	3451·4	2497·8	2496·88
,, ,, (1902)...	3451·49	2497·79	2496·87
Hagenbach and Konen (1908)	3451	2498	2497
Crookes (1911)	3451·50	2497 83	2496·89

The fourteen other lines given by Eder and Valenta, and the five other lines given by Exner and Haschek, failed to record themselves on the photographs, notwithstanding excessively long exposures given in the attempt to bring out additional boron lines. The most interesting property of solid boron is its extraordinary rise in electric conductivity with a slight increase in temperature. A piece of melted boron measured by Dr. Weintraub, which at the room temperature (27°) had a resistance of 5,620,000 ohms, dropped to 5 ohms at a dull red heat. Another noteworthy property of melted boron is extreme hardness. It comes next to the diamond in hardness, a splinter easily scratching corundum. Its fracture is conchoidal, and no decided crystalline structure is seen under the microscope. The agglomerated boron deposited in the arc from boron chloride and hydrogen is, on the contrary, highly crystalline.—Hon. R. J. **Strutt**: A chemically active modification of nitrogen produced by the electric discharge: II. (1) Oxygen destroys active nitrogen, but does not combine with it. Hydrogen has no action. (2) Active nitrogen, in reacting with nitric oxide to form the peroxide, gives the same greenish-yellow flame with continuous spectrum which may be obtained by stimulating oxides of nitrogen in other ways. (3) The reaction just mentioned is used to determine the percentage of active nitrogen present in ordinary nitrogen as it leaves the discharge. The result found is about 2·5 per cent., much higher than was formerly supposed. (4) When dilute phosphorus vapour is introduced into glowing nitrogen it does not react at once. It is not until some time after the glow has completely disappeared that the nitrogen gets into a state in which it can react with phosphorus. (5) The glow has a large electrical conductivity, comparable with that of a salted Bunsen flame. The ions are liberated in the glow, not merely carried forward from the original discharge. This ionisation is, as a rule, not very greatly affected when the spectra of other substances, such as metals or cyanogen, are developed by the active nitrogen in the space between the testing electrodes. (6) None of these spectra are visibly diminished in intensity when large electromotive forces are applied to remove the ions. (7) Ozone can in some cases develop metallic spectra when mixed at comparatively low temperatures with the metallic vapour.—Sir J. **Dewar**: Production of solid oxygen by the evaporation of the liquid.—Sir J. **Dewar** and Dr. H. O. **Jones**: The gaseous condensable compound, explosive at low temperatures, produced from carbon disulphide vapour by the action of the silent electric discharge: II.—Dr. T. H. **Havelock**: Optical dispersion: a comparison of the maxima of absorption and selective reflection for certain substances. This paper contains a discussion of various wave-lengths associated with each dominant region in a general type of dispersion formula. It is shown how the maxima of absorption and of selective reflection are, in general, separated from each other and from the wave-length corresponding to the natural vibrations in the molecule. Formulæ are obtained for some of these maxima in terms of the constants of the dispersion formula, and are confirmed by comparison with available experimental results. To estimate the magnitude of the differences in question, a numerical study is made of regions of selective absorption and reflection for carbon disulphide, rock salt, and sodium vapour; in particular, for rock salt it appears that the maximum of selective reflection in the infra-red is displaced considerably from the maximum of absorption and from the dominant wave-length of the dispersion formula. —Dr. T. H. **Havelock**: The influence of the solvent on the position of absorption bands in solutions. According to Kundt's rule, the effect of the solvent is to displace the absorption bands further to the longer wave-lengths the greater the refractive or dispersive power of the solvent. By using a suitable type of dispersion formula this rule is given a definite theoretical expression, and various experimental results are examined from this point of view. Although effects are complicated, in general, by molecular changes, it is possible to estimate in some cases how much can be ascribed to the operation of Kundt's rule.—Prof. F. G. **Donnan** and Dr. J. T. **Barker**: An experimental investigation of Gibbs's thermodynamic theory of interfacial concentration in the case of an air-water interface. The "surface" concentration of a dissolved substance in excess over that in the bulk of the solution is given by Gibbs's equation $\Gamma = -d\sigma/d\mu$, where Γ=excess of solute per unit of interface, σ=interfacial tension, μ=chemical potential of solute. Assuming the simple osmotic law of van 't Hoff for the solution, the above equation can be written in the form $\Gamma = -\frac{c}{RT}\frac{d\sigma}{dc}$, where c=bulk concentration of solute. The authors have tested this equation by measuring independently Γ, c, and $d\sigma/dc$ for the case of an air-water interface. The substances examined were pelargonic acid and saponin. The value of Γ was determined by finding the change in concentration of a given volume of solution caused by bubbling through it a known volume of air in the form of a known number of very small air bubbles. Steady streaming of the liquid was prevented by breaking up the column of liquid into a number of eddy chambers. The extremely small changes of concentration thus produced in excessively dilute solutions were measured by means of a dropping pipette, the same apparatus being also employed to measure $d\sigma/dc$. The values of the two members of Gibbs's equation were found to be in fairly good agreement, considering the difficulty of the experiments. In the case of aqueous solutions of pelargonic acid of concentrations varying between 0·008 and 0·0024 gram per 100 grams of water, the average value of Γ found experimentally was in round numbers one ten-millionth of a gram per square centimetre of interface at 15° C. In the case of saponin the values found were somewhat greater.

Zoological Society, October 24. — Sir John Rose Bradford, K.C.M.G., F.R.S., vice-president, in the chair. —Bruce F. **Cummings**: Distant orientation in Batrachia, based on observations and experiments made by the author in North Devon. Two species of newts had been used for the experiments, and the results obtained lent support to the hypothesis that these batrachians possessed a homing faculty, but no very definite instinct for detecting water, even from a short distance. Of the factors discussed in connection with amphibian migration, it was suggested that in regard to newts a combination of their homing faculty and their marked tendency to walk downhill was chiefly of assistance to them in finding water in which to breed.—Oldfield **Thomas**: Mammals collected in the provinces of Sze-chwan and Yunnan, western China, by Mr. Malcolm Anderson, for the Duke of Bedford's exploration of eastern Asia. The paper formed No. xv. of the series, and would be the last on Mr. Anderson's specimens, as he was now returning finally to America. During his work on the exploration he had obtained 2700 specimens, besides many birds, and had quite revolutionised our knowledge of the area explored. The present collection, given, as before, to the National Museum by the society's president, consisted of 160 specimens, belonging to thirty-three species.—E. P. **Stebbing**: Game sanctuaries and game protection in India. The author discussed the question of the formation of game sanctuaries and what had been already done in this direction in various parts of the country. Suggested additions to the proposed New Indian Game Act were given, and "close seasons" for certain species recommended as being necessary for the preservation of the game of the country.

Challenger Society, October 25.—Dr. G. H. Fowler in the chair.—Prof. D'Arcy W. **Thompson**: The scales of the herring as an index to age. In the herring, the rings or zones borne by the scales, which are constant in number for the same individual, and are undoubtedly correlated in some way with the size and age of the fish, are not, in the writer's opinion, so simply related to the years of life that the age of an individual fish can be determined with accuracy from an inspection of the scales. In any random sample of herring the frequencies of individuals at centimetre lengths and of numbers of rings each forms a probability curve grouped about a single mode. Either, then, the shoal is composed of herrings of uniform age and number of rings, or of various ages and ring numbers mixed in a definite and remarkable manner. While, on the usual hypothesis of each scale ring indicating a year of life, the facts may conceivably be explained as due to selective action of the net, the writer considers that it is more probable that the members of a herring shoal are of the same age.—Dr. W. T. **Calman**: Phototropism and the distribution of marine organisms (opening of discussion).

British Psychological Society, November 4. — Dr. Beatrice **Edgell** and W. Legge **Symes**: A preliminary note on visual flicker.—Dr. F. **Golla**: The vestibule and the concept of space.—J. **Kay**: (1) Apparatus for McDougall's dotting test; (2) apparatus for weight discrimination.

Mathematical Society, November 9.—Dr. H. F. Baker, president, in the chair.—J. E. **Campbell**: The invariants of the linear partial differential equation of the second order in two independent variables.—Colonel R. L. **Hippisley**: Closed linkages.—H. **Hilton**: Invariants of a canonical substitution.—G. T. **Bennett**: The system of lines of a cubic surface.—G. H. **Hardy** and J. E. **Littlewood**: The relations between Borel's and Cesàro's methods of summation.

CAMBRIDGE.

Philosophical Society, October 30.—Sir George Darwin, K.C.B., F.R.S., president, in the chair.—G. R. **Mines**: Note on the mode of discharge of the Cuverian organs of *Holothuria nigra*. The sea-cucumber, *H. nigra*, when irritated emits white conical bodies, the Cuverian organs, which rapidly elongate, shooting through the water while remaining attached at their bases to the animal, and forming long, intensely sticky tubes. These are then disconnected from the animal. The elongation of the Cuverian organs has been attributed to internal water pressure by some, but by others to an intrinsic activity of the tubes. The former view is strongly supported by the facts presented in this communication. Undischarged Cuverian organs removed from the body cavity of Holothuria can be made to elongate in a manner exactly resembling the normal discharge by injecting them with sea water or other fluid. The natural discharge of the Cuverian organs is always preceded and accompanied by a rise in the pressure within the body of the animal, and this pressure reaches the value needed to elongate an excised Cuverian organ. The arguments which have been adduced in favour of the intrinsic activity of the Cuverian organs are shown, by further experiments, to lack cogency. An account of this work will appear shortly in *The Quarterly Journal of Microscopical Science*.—Oswald H. **Latter**: The discharge of spermatozoa by *Unio pictorum*.

PARIS.

Academy of Sciences, November 6.—M. Armand Gautier in the chair.—E. H. **Amagat**: The internal pressure of fluids and the determination of the absolute zero. In a previous paper the author has defined a function π as $\left(T\frac{dp}{dt}-p\right)$. It is now shown that the values of π for hydrogen, taken for pressures of 1 and 3 atmospheres, and taking 273 as the temperature of melting ice on the absolute scale, obey perfectly the law of the square of the volume, and this is not the case if 273·1 or 272·9 be assumed. It is possible to look at the problem from a different point of view, and determine the absolute zero from the condition that, starting with well-determined coefficients of pressure under 1 and 3 atmospheres, the values of π should rigorously satisfy the law of the square of the volume. This gives from the data for hydrogen 272·983, for nitrogen 272·999, and for oxygen 272·996 for the absolute zero.—C. **Guichard**: A very extended class of triple orthogonal systems.—J. **Meunier**: The conditions of production of the Swan spectrum, and on conclusions which may be drawn relating to comets which possess this spectrum. The Swan spectrum is regarded as essentially a spectrum of oxidation and explosive combustion, and additional experiments on this point are described. The Swan spectrum denotes not only the presence of a hydrocarbon, but also that of oxygen, and hence oxygen must be present in comets showing this spectrum.—A. **Guillet**: An induction-coil interrupter formed of a primary arc.—J. **Guyot**: The differences of contact potential apparent between a metal and electrolytic solutions.—Jacques **Danne** and Victor **Crémieu**: The quantity of radium emanation disengaged by one of the springs at Colombières-sur-Orb, Hérault. The amounts of emanation per 10 litres of gas have been determined for three springs. One of these, the Crémieu spring, is remarkable on account of the large quantity of gas spontaneously evolved—43,000 litres in twenty-four hours. The amount of emanation disengaged in twenty-four hours from this spring is more than double that of Ax (Viguerie); and, moreover, since 95 per cent. of the gas from the Crémieu spring is carbon dioxide, the concentration in the radium emanation is readily increased twenty times by simple treatment with alkaline solutions. —G. Ter. **Gazarian**: A general relation between the physical properties of bodies: application to densities. The comparison of physical properties, either at 0° C, or at the boiling point, or at corresponding temperatures according to Van der Waals's formula, is not altogether satisfactory; and in place of these the author proposes the following: at temperatures equally removed from the critical temperatures, the quotients of the numbers representing a property for any two bodies whatever are a linear function of the temperature. This holds for densities, viscosity coefficients, surface tension, the rectilinear diameter of Cailletet and Mathias, and the latent heat of vaporisation. The densities were compared at analogous temperatures (defined as above) of ammonia and pentane, carbon monoxide and pentane, benzene and pentane, acetic acid and pentane.—H. **Duval**: The molecular refraction of azo-compounds. The molecular refraction of solutions of azo-benzene was found to depend to a certain extent on the solvent. The ortho- or meta-position of a substituting group causes too slight a variation in the refraction to conclude that these compounds have a different constitution.—A. **Boutaric**: Cryoscopy in fused sodium thiosulphate. $Na_2S_2O_3.5H_2O$ melts at 48·5° C. The temperature of equilibrium between the solid hydrates with $5H_2O$ and $2H_2O$ and the solution is 48·2° C. Various organic substances and salts of sodium give a molecular lowering in this solvent of 44°; salts of other metals produce about double this lowering.—A. **Besson**: The formation of hydrogen peroxide under the silent electric discharge. It is proved that H_2O_2 can be formed by the silent discharge acting on moist rarefied air at a moderately low temperature, conditions realised in the upper regions of the atmosphere. Although ultra-violet light may be one cause of the presence of hydrogen peroxide in rain water, these experiments prove that electrical phenomena may also be a contributory cause.—J. **Bougault** and C. **Charaux**: Lactarinic acid. This acid has been shown in a previous paper to be a ketostearic acid. The application of the Beckmann reaction proves the ketonic group to be in the position 6, the formula being

$$CH_3—(CH_2)_{11}—CO—(CH_2)_4—CO_2H.$$

—J. B. **Senderens** and J. **Aboulenc**: The catalytic esterification of the dibasic acids in the wet way. Quantitative studies of the formation of esters of malonic, succinic, oxalic, and phthalic acids in presence of small quantities of sulphuric acid, aluminium sulphate, or potassium bisulphate as catalysts.—A. **Roussy**: The life of fungi in the fatty acids. It is shown that moulds which grow well in a medium containing a certain quantity of fat owe their development rather to the fatty acids than to the glycerol. It is only in rare cases, in particular for Aspergillus and Penicillium, that glycerol is as good a medium as the fatty acids.—Raoul **Combes**: Researches on the formation of the anthocyanic pigments.—J. **Dumont**: A new method for the physical analysis of soil.—Louis **Gaucher**: The digestion of casein. Milk is only coagulated in the stomach, and the clots reduced to a fine state of division by the contractions of this organ. The peptonisation occurs in the intestine, and may even be continued in the duodenum. The coagulation of the milk in the stomach is not a necessary condition of its digestion.—F. **Houssay** and A. **Magnan**: The wing surface, the weight of the pectoral muscles, and the feeding process in certain birds.—A. **Desgrez**: The influence of the chemical constitution on the toxicity of nitriles and amides. Unsaturated nitriles are more toxic than saturated nitriles containing the same number of carbon atoms.—E. **Voisenet**: New considerations on the disease of bitterness in wines in its relations with the acrylic fermentation of glycerol. The acrylic fermentation of glycerol is at least one of the essential processes undergone by wine when it develops bitterness.—A. **Daniel-Brunet** and C. **Rolland**: Contribution to the chemical and physiological study of the hepatic gland in cattle.—P. **Mazé**: Experimental chlorosis in maize.—Raphaël **Dubois**: Microbioids.—M. **Fournier**: The existence of coal at Franche-Comté, at Saint Germain near Lure (Haute-Saône). Details are given of the strata found in three trial borings; the coal found is similar to the Ronchamp coals.—L. **Cayeux**: The existence of organic remains in the ferruginous rocks associated with the Huronian iron minerals in the United States.

BOOKS RECEIVED.

Account of the Operations of the Great Trigonometrical Survey of India. Vol. xix. Levelling of Precision in India (1858–1909). By Col. S. G. Burrard, F.R.S. Pp. xiii+484+xviii plates. (Dehra Dun: Office of the Trigonometrical Survey of India.) Rs. 10.8.

An Introductory Course of Mechanics and Physics for Technical Students. By W. M. Hooton and A. Mathias. Pp. vii+148. (London: W. B. Clive.) 1*s.* 6*d.*

Kulturpflanzen und Haustiere in ihrem Übergang aus Asien nach Griechenland und Italien sowie in das übrige Europa. Historisch-Linguistiche Skizzen von V. Hehn. Achte auflage neu herausgegeben von O. Schrader. Mit Botanischen beiträgen von A. Engler und F. Pax. Pp. xxviii+665. (Berlin: Gebrüder Borntraeger.) 17 marks.

The Home-life of the Osprey. Photographed and described by C. G. Abbott; with some photographs by H. H. Cleaves. Pp. 54 and 32 mounted plates. (London: Witherby and Co.) 6*s.* net.

Treatise on Practical Light. By Dr. R. S. Clay. Pp. xv+519. (London: Macmillan and Co., Ltd.) 10*s.* 6*d.* net.

The Rubber-planter's Notebook. Compiled from the most reliable and modern sources by F. Braham. Pp. viii+108. (London: Crosby Lockwood and Son.) 2*s.* 6*d.* net.

The Story of the Zulus. By J. Y. Gibson. New edition, revised and extended. Pp. vii+338. (London: Longmans and Co.) 7*s.* 6*d.*

The Life of Paracelsus, Theophrastus von Hohenheim, 1493–1541. By A. M. Stoddart. Pp. xv+309. (London: Murray.) 10*s.* 6*d.* net.

Land and Peoples of the Kasai: being a Narrative of a Two Years' Journey among the Cannibals of the Equatorial Forest and other Savage Tribes of the South-western Congo. By M. W. Hilton-Simpson. Pp. xx+356. (London: Constable and Co., Ltd.) 16*s.* net.

Pflanzengeographische Wandlungen der deutschen Landschaft. By Prof. H. Hausrath. Pp. vi+274. (Leipzig: Teubner.) 5 marks.

Chemisch-technisches Praktikum. By Dr. W. Moldenhauer. Pp. vii+206. (Berlin: Gebrüder Borntraeger.) 6.80 marks.

Handbuch der vergleichenden Physiologie, herausgegeben von H. Winterstein. Sechzehnte Lieferung. Band iv. Erste Hälfte. Pp. 321–480. (Jena: Fischer.) 5 marks.

Physiology. By Prof. W. D. Halliburton, F.R.S. Pp. xi+176. (London: J. M. Dent and Sons, Ltd.) 1*s.* net.

Roses. By H. R. Darlington. Pp. xiii+193. (London: T. C. and E. C. Jack.) 2*s.* 6*d.* net.

Gardens Shown to the Children. By J. H. Kelman and O. Allen. Described by J. A. Henderson. Pp. xii+100. (London: T. C. and E. C. Jack.) 2*s.* 6*d.* net.

The British Bird Book. Edited by F. B. Kirkman. Section vi. Pp. 379–540. (London: T. C. and E. C. Jack.) 10*s.* 6*d.* net.

In Northern Mists. Arctic Exploration in Early Times. By Prof. F. Nansen, G.C.V.O. Translated by A. G. Chater. Vol. i. Pp. xi+384. Vol. ii. Pp. iii+416. (London: Heinemann.) Two vols. 30*s.* net.

Through Trackless Labrador. By H. H. Prichard. With a chapter on Fishing by G. M. Gathorne-Hardy. Pp. xv+254. (London: Heinemann.) 15*s.* net.

Pictures of British History. By E. L. Hoskyn. Pp. 64. (London: A. and C. Black.) 1*s.* 6*d.*

Year Book of the Indian Guild of Science and Technology, 1911. Pp. 135. (Letchworth: The Letchworth Printers, Ltd.)

The Canadian Rockies: New and Old Trails. By Prof. A. P. Coleman, F.R.S. Pp. 383. (London: T. Fisher Unwin.) 12*s.* 6*d.* net.

A Text-book of Physiological Chemistry. By Prof. O. Hammarsten. Authorised translation from the author's enlarged and revised seventh German edition by Prof. J. A. Mandel. Sixth American edition. Pp. viii+964. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd.) 17*s.* net.

Tables of Physical and Chemical Constants and some Mathematical Functions. By Dr. G. W. C. Kaye and Prof. T. H. Laby. Pp. vi+153. (London: Longmans and Co.) 4*s.* 6*d.* net.

Rifle, Rod, and Spear in the East, being Sporting Reminiscences. By Sir E. Durand, Bart. Pp. xi+200. (London: Murray.) 8*s.* net.

Fourth Scientific Report on the Investigations of the Imperial Cancer Research Fund. By Dr. E. F. Bashford. Pp. xxi+223. (London: Taylor and Francis.)

The Elements of Plane and Spherical Trigonometry. By J. G. Hunt and C. R. MacInnes. Pp. vii+205. (London: Macmillan and Co., Ltd.) 6*s.* net.

Dairy Cattle and Milk Production. By Prof. C. H. Eckles. Pp. xii+342. (London: Macmillan and Co., Ltd.) 7*s.* net.

Beginnings in Agriculture. By A. R. Mann. Pp. xii+341. (London: Macmillan and Co., Ltd.) 3*s.* 6*d.* net.

The Conquest of Nerves. By Dr. J. W. Courtney. Pp. v+209. (London: Macmillan and Co., Ltd.) 5*s.* 6*d.* net.

The Learning Process. By Prof. S. S. Colvin. Pp.

xxv+336. (London: Macmillan and Co., Ltd.) 5s. 6d. net.

Experiments in Educational Psychology. By Dr. D. Starch. Pp. vii+183. (London: Macmillan and Co., Ltd.) 4s. net.

The Theory and Practice of Technical Writing. By Prof. S. C. Earle. Pp. vii+301. (London: Macmillan and Co., Ltd.) 5s. 6d. net.

The Elements of Electrical Transmission. By Prof. O. J. Ferguson. Pp. vii+457. (London: Macmillan and Co., Ltd.) 15s. net.

A Text-book of Inorganic Chemistry. By Dr. G. Senter. Pp. xi+583. (London: Methuen and Co., Ltd.) 6s. 6d.

Outlines of Biology. By Dr. P. C. Mitchell, F.R.S. Third edition. Revised and supplemented by G. P. Mudge. Pp. xv+348. (London: Methuen and Co., Ltd.) 6s. net.

L'Équation de Fredholm et ses Applications à la Physique Mathématique. By Profs. H. B. Heywood and M. Fréchet. Pp. vi+165. (Paris: A. Hermann & Fils.) 5 francs.

Introduction à la Théorie des Équations Intégrales. By Prof. T. Lalesco. Pp. vii+152. (Paris: A. Hermann & Fils.) 4 francs.

Traité de Chimie Générale. By Prof. W. Nernst. Ouvrage traduit sur la 6e édition allemande by Prof. A. Corvisy. Deuxième Partie. Pp. 422. (Paris: A. Hermann & Fils.) 10 francs.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 16.

ROYAL SOCIETY, at 4.30.—On the Discovery of a Novel Type of Flint Implements below the Base of the Red Crag of Suffolk, proving the Existence of Skilled Workers of Flint in the Pliocene Age: Sir Ray Lankester, K.C.B., F.RS.—Studies in Heredity. I. The Effects of Crossing the Sea-urchins (*Echinus esculentus* and *Echinocardium cordatum*): Prof. E. W. MacBride, F.R.S.—The Influence of Ionised Air on Bacteria: Prof. W. M. Thornton.—The Intrinsic Factors in the Act of Progression in the Mammal: Dr. T. G. Brown.—The Refractive Indices of the Eye Media of some Australian Animals: Dr. J. L. Jona.—The Permeability of the Yeast Cell: S. G. Paine.—Ventilation of the Lung during Chloroform Narcosis: G. A. Buckmaster and J. A. Gardner.—(1) On the Boiling Point of Water; and (2) on the Boiling Points of some saturated Aqueous Solutions: Lord Berkeley, F.R.S., and M. P. Appleby. (*Published.*)—The Heating Effect of the Currents in Precise Measurements of Electrical Resistance: Dr. R. T. Glazebrook, F.R.S., W. R. Bousfield, and F. E. Smith. (*Published.*)

INSTITUTION OF MINING AND METALLURGY, at 8.—*Adjourned Discussions:* (1) Fallacies in the Theory of the Organic Origin of Petroleums: Eugene Coste; (2) The Economics of Tube-milling: H. Standish Ball. —*Paper:* The Whim Well Copper Mine, West Pilbara, North-west Australia: H. R. Sleeman.

LINNEAN SOCIETY, at 8.—Recent Researches on Œnothera: Dr. R. R. Gates.

FRIDAY, NOVEMBER 17.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Endurance of Metals: Experiments on Rotating Beams at University College, London: E. M. Eden, W. N. Rose, and F. L. Cunningham. (*Adjourned Discussion.*) —*Probable Paper:* Double-cutting and High-speed Planing Machines: J. Hartley Wicksteed.

ILLUMINATING ENGINEERING SOCIETY, at 8.—Notes on the Design of Motor-car Headlights: Dr. H. R. B. Hickman.

MONDAY, NOVEMBER 20.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Volcanic Craters and Explosives: Dr. Tempest Anderson.

TUESDAY, NOVEMBER 21.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further Discussion:* The Loch Leven Water-power Works: A. H. Roberts.—The Hydro-electric Plant in the British Aluminium Company's Factory at Kinlochleven: F. B. Sonnenschein.

ZOOLOGICAL SOCIETY, at 8.30.—The Fresh-water Crayfishes of Australia: Dr. Geoffrey Smith.—Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. III. On a New Genus of Tapeworms from the Bustard (*Eupodotis kori*): F. E. Beddard, F.R.S.—Structure of the Alimentary Canal of the Stick Insect (*Bacillus rossii*, Fabr.), with a Note on the Parthenogenesis of this Species: A. E. Cameron.—Some Remarks on the Habits of British Frogs and Toads, with reference to Mr. Cummings's recent communication on "Distant Orientation in Amphibia": G. A. Boulenger, F.R.S.—Diagnoses of New Species of Terrestrial and Fluviatile Snells from British and German East Africa: H. B. Preston On the Milk-Dentition of the Ratel: R. Lydekker, F.R.S.

ROYAL STATISTICAL SOCIETY, at 5.—The Course of Prices at Home and Abroad, 1890–1910: R. H. Hooker.

WEDNESDAY, NOVEMBER 22.

ROYAL SOCIETY OF ARTS, at 8.—The Industrial Progress of the United States of America: Dr. James Douglas.

GEOLOGICAL SOCIETY, at 8.—Petrological Notes on Guernsey, Herm, Sark, and Alderney: Prof. T. G. Bonney, F.R.S., and the Rev. Edwin Hill. —The Evolution of Inoceramus in the Cretaceous Period: H. Woods.

THURSDAY, NOVEMBER 23.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* On the Iron Flame Spectrum and those of Sun-spots and Lower-type Stars: Sir N. Lockyer, K.C.B. F.R.S.—Sinhalese Iron and Steel of Ancient Origin: Sir R. A. Hadfield, F.R.S.—On the Conductivity of a Gas between Parallel Plate Electrodes when the Current approaches the Maximum Value: Prof. J. S. Townsend, F.R.S.—Spectroscopic Investigations in connection with the Active Modification of Nitrogen. II. Spectra of Elements and Compounds excited by the Nitrogen: Hon. R. J. Strutt, F.R.S., and Prof. A. Fowler, F.R.S.—The Less Refrangible Spectrum of Cyanogen, and its Occurrence in the Carbon Arc: Prof. A. Fowler, F.R.S., and H. Shaw.—Note on the Monatomicity of Neon, Krypton, and Xenon: Sir W. Ramsay, K.C.B., F.R.S.—The Adherence of Plain Surfaces: H. M. Budgett.—On the Resistance to the Motion of a Thread of Mercury in a Glass Tube: G. D. West.—The Distillation of Binary Mixtures of Metals in vacuo. Part I. Isolation of a Compound of Magnesium and Zinc: A. J. Berry.—Analysis of Tidal Records for Brisbane for the Year 1908: F. J. Selby.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Automatic Reversible Battery Boosters: R. Rankin.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Huxley Memorial Lecture.—The Early Inhabitants of Western Asia: Prof. F. von Luschan.

INSTITUTION OF MINING AND METALLURGY, at 8.—The Development of the Copper Queen and the Warren Mining District: Dr. James Douglas.

CHEMICAL SOCIETY, at 8.30.—*Extra Meeting.*—Prof. Harold B. Dixon, F.R.S., will deliver the Berthelot Memorial Lecture.

FRIDAY, NOVEMBER 24.

PHYSICAL SOCIETY, at 5.—The Maximum Value of the Electric Stress between Two Unequal Spherical Electrodes: Dr. A. Russell.—The Cubical Expansion of Fused Silica: F. J. Harlow.—On the Temperature Coefficient of Diffusion: B. W. Clack.—The *a* Particles emitted by the Active Deposits of Thorium and Actinium: E. Marsden and T. Barratt. —The Magnetic Transition Point of Cementite: S. W. J. Smith, W. White, and S. G. Barker.

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