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The Langley Flying Machine.

AT a recent meeting of the Royal Aeronautical Society a paper was read by Mr. Griffith Brewer on "The Langley Machine and the Hammondsport Trials," which has for its theme "the attempt to rob the Wright brothers of the credit of inventing the aeroplane."

The argument of the paper turns on a usual interpretation of the word "inventing," and it is not suggested that the credit of establishing the principles of aeroplane design is in doubt. The dispute as to the relative importance of the pioneers S. P. Langley and the Wright brothers arose in the course of certain legal actions as to the validity of patents taken out by the latter. In connection with the defence of the Curtiss Aeroplane Co. against a charge of infringement, arrangements were made with the Smithsonian Institution for the loan of the original man-carrying aeroplane designed and constructed by Langley. The design was modified in certain ways before it was taken into the air at Hammondsport, and the contention of Mr. Brewer in putting the case for the Wright brothers is that the modifications were such as to invalidate the claim that the original Langley aeroplane had been flown.

The trials of the modified aeroplane were made late in the development of the subject, the loan by the Smithsonian Institution being dated April, 1914. The public European flights of the Wright brothers had taken place some six years prior to this, whilst the date of the first successful flight of about one minute's duration is stated to be December, 1903. It is perhaps worth while to clear up the historical facts of the trials, but the paper tends to give an erroneous impression of the importance of the part played by the Wright brothers in spite of Mr. Brewer's note to the effect that Langley himself did not make the claims to which exception is taken, nor would he have been likely to do so had he been alive to hear of the controversy.

The difficulty appears to arise from a not uncommon type of mental blindness which is readily produced by the contact of financial interests with development. It is rather like making the assumption that, because an arch cannot be used as an engineering structure until the keystone is in place, the keystone is therefore the most important element in it; the rest of the structure appears to be unseen. Applied to Mr. Brewer's paper, the simile suggests that the keystone was provided by the Wright brothers, and that the much more laborious work of preparing for its reception is to be found in the scientific experiments of Langley. Readers of NATURE will find in its volumes references which indicate, in a calmer atmosphere, the part played by Langley in the development of aviation. So far back as July 23, 1891, a paper on his experimental researches is to be found in NATURE showing that the flight of a man-carrying aeroplane was possible, and enunciating the fundamental principles for obtaining a design. Matters were so much advanced in 1896 that on May 28 of that year NATURE was able to give a description of the flight of the Langley model aeroplane under its own power. This was a remarkable achievement, since it required a solution of the problem of inherent stability, a quality almost certainly not possessed by the Wright aeroplanes of 1908. The great addition to aeronautical knowledge and practice made by the Wright brothers was the introduction of the system of wing warping which gave adequate lateral control even to an unstable aeroplane.

Langley's researches have been described on many occasions, and their relation to the problem of dynamic flight is shown in Sir Richard Gregory's book, "Discovery," from which a couple of extracts may be appropriately cited as bearing directly upon the subject under discussion. On p. 288 Langley is quoted as saying, in relation to his experiments before 1897:—

"I have brought to a close the portion of the work which seemed specially mine—the demonstration of the practicability of mechanical flight —and for the next stage, which is the commercial and practical development of the idea, it is probable that the world may look to others. The world, indeed, would be supine if it does not realise that a new possibility has come to it, and that the great universal highway overhead is now soon to be opened."

The Wright brothers are equally clear in their acknowledgment of Langley's work :—

"The knowledge that the head of the most prominent scientific institution of America believed in the possibility of human flight was one of the influences which led us to undertake the preliminary investigations that preceded our active work. He recommended to us the books which enabled us to form sane ideas at the outset. It was a helping hand at a critical time, and we shall always be grateful."

One feels that in relation to such remarks by the two great American pioneers of aviation the matter under discussion in "The Langley Machine and the Hammondsport Trials" is unimportant. The transactions appear to have been rather sordid and to reflect discredit on those commercial systems of the world which exalt "patentability" at the expense of solid service which is not patentable.

The Impurity of Pure Substances.

Die Theorie der Allotropie. By Prof. A. Smits. Pp. xvi + 500. (Leipzig: Johann Ambrosius Barth, 1921.) 100 marks.

AT one time the term allotropy or allotropism was confined mainly to the chemical elements, such as oxygen, carbon, phosphorus, etc. In one of these cases—that of oxygen and ozone—the explanation of the allotropic forms was found in the existence of different molecular species, whereas in the case of diamond and graphite, for example, this could not be definitely proved. Another more striking case of the latter sort is presented by the rhombic and monoclinic forms of sulphur. As our knowledge increased concerning the different crystalline forms, in which both elements and compounds could occur, the idea of crystalline polymorphism was developed. In these cases it was supposed that one and the same molecular species only was involved, that the polymorphism was due to different crystalline arrangements of the same units, and that the vapours or solutions derived from the different polymorphic forms would, for the same values of pressure, temperature, and concentration, be chemically and physically identical. This explanation certainly gave a satisfactory account of the main facts involved—that is to say, the various substances appeared to behave as *one-component* systems. The curious facts relating to the behaviour of water suggested, however, to chemists that this substance was in reality *complex,* water consisting at any given temperature and pressure of a mixture of molecular species differing in the degree of *association* of the simplest (Avogadrian) molecular type.

This idea of an inner complexity, or inner equilibrium of simple and associated molecules, was gradually extended to other classes of "pure" substances—that is to say, substances the thermodynamical behaviour of which was that of a one-component system. In spite of this inner complexity, it was realised that such substances would behave as one-component systems so long as, with variation of the "external" parameters (pressure, temperature, etc.), the inner equilibria were readjusted with a speed incomparably greater than the rate of variation of the parameters referred to. Cases gradually became known, however, where certain one-component systems exhibited a *pseudo-binary* character. Thus the researches of Alexander Smith, Aten, Kruyt, etc., on sulphur showed that liquid sulphur must be a mixture of different molecular species, for if the inner equilibrium existing at any given temperature were "frozen" (or partly so) by the use of certain inhibiting agents (so-called negative catalysts), liquid sulphur showed a marked pseudo-binary behaviour.

Such phenomena were easily understood owing to the knowledge possessed by chemists of the behaviour of nitrogen peroxide. Here there is a well-known inner equilibrium (of a simple and an associated form) existing not only in the pure liquid state, but also in the states of vapour and solution. The researches of Prof. H. B. Baker showed that the speed of readjustment of this inner equilibrium is positively catalysed by very minute traces of water, and that it may be "frozen" by very prolonged and intensive dehydration. We may, in fact, have at a given temperature and pressure an infinite number of different liquid or gaseous "nitrogen peroxides," the former one-component system passing thus into an infinite number of states corresponding to a two-component system.

About fourteen years ago Prof. Smits, on the basis of certain experimental results which he had obtained, took a very daring and interesting step. It occurred to him that perhaps all known cases of allotropy, phase-polymorphism, etc., were due to the existence of different inner equilibria of two or more different molecular species, *and that this applied not only to liquids, but also to solids.* Thus the different crystalline forms were to be viewed as *solid crystalline solutions of two or more molecular species.* Bancroft had already shown that many curious phenomena in the behaviour of "pure" organic substances—such as the dependence of the melting-point on the rate of heating, in cases where no "ordinary" decomposition occurred—could be explained only by the existence of two different molecular species in the liquid, these species existing in inner equilibrium in the "natural" liquid, and the stable or "natural" melting-point corresponding to the point of intersection of the (T, x)-equilibrium curve of the liquid with one of the saturation-curves of the pseudo-binary system. Researches on the tautomeric equilibria of enol-keto systems have greatly extended these results. Prof. Smits's theory amounts to extending Bancroft's views to the solid crystalline as well as to the liquid state.

During the last fourteen years Prof. Smits has gradually elaborated his theory on the basis of the thermodynamic treatment of homogeneous and heterogeneous equilibria, and he and his collaborators have published a very large number of exceedingly interesting researches bearing on the question. One might refer particularly to the very thorough investigation of the phosphorus system. He has also extended his theory in recent years to the electrochemical equilibria existing between atoms, ions, and electrons in both solids and solutions, and has obtained new formulæ for the potential differences existing between metals and solutions, etc., and new explanations of such phenomena as polarisation (cathodic and anodic), over-voltage, passivation and activation, etc.

In the present volume Prof. Smits has given a full account of his theory, of the tests to which he has subjected it, and of its application to many phenomena observed or examined by himself and others.

In recent years a difficulty has arisen with regard to the newer views of crystal structure obtained by X-ray methods, which may be put briefly thus: If the older view of a crystal as a molecular structure is to be replaced by one where the structural units are atoms, how can we regard a crystalline phase as a solid solution of two different molecular species in inner equilibrium? Prof. Smits deals with this difficulty in a special chapter of his book. He points out that the differences which characterise his molecular species may be often of a rather fine or subtle type, and that these differences may very well persist in a crystal structure in spite of the close juxtaposition and intimate inter-relationship of the atoms of different molecules. The present reviewer would suggest that possibly it may be a question of the number and distribution of energy quanta in and amongst the various atoms and atomic groupings. In other words, we may have to do with a kinetic equilibrium of energy-contents rather than with molecular species differentiated by structure in the ordinary sense of this term.

Prof. Smits is clearly a man who is not afraid of daring generalisations. He has developed his theory fully from the graphical thermodynamic side, and applied it to the explanation of a large number of phenomena not otherwise easily explicable. Some critics may think he has pushed his theoretical views too far, but undoubtedly his theory has cast a flood of light on many obscure phenomena. It has led, and is constantly leading, himself and his collaborators to numerous quantitative experimental researches, and what more can one ask of any theory? And how many true Baconians are there who can experiment well without a theory to stimulate interest?

For the present well-written and clear account of his work all chemists owe Prof. Smits a great debt of thanks.

F. G. DONNAN.

The Birds of Australia.

A Manual of the Birds of Australia. By G. M. Mathews and T. Iredale. Vol. 1: *Orders Casuarii to Columbae.* Pp. xxiv + 279 + plates. (London: H. F. and G. Witherby, 1921.) 3 guineas net.

AUSTRALIA, the birds of which have a foremost place among those of the world for their variety of form and beauty of plumage, has been fortunate in having two splendid treatises devoted to its avifauna, namely, John Gould's magnificent volumes, published between the years 1840–48, which are pictorially unrivalled among ornithological works; and the recent valuable and beautiful work by Mr. Mathews. Apart from these great and costly books, there has long been a want of a modern handbook on the subject at a moderate price, not only by those who are specially concerned with the Australian ornis, but also by students interested in bird-life generally. Gould realised this, and in 1865 published his excellent and useful "Handbook of the Birds of Australia" in two octavo volumes. From 1865 to the present time our knowledge relating to the birds of Australia, as of all other countries, has advanced prodigiously, and the old handbook is now quite out of date. Very fortunately, however, Mr. Mathews, like his eminent predecessor, has realised that an up-to-date work, within the reach of most, was greatly needed, and with Mr. Iredale has undertaken to supply the desideratum—hence this first volume of the four which are to complete the work.

In the neat and handy volume under notice the authors deal with 188 species and their numerous racial forms, comprised in the orders Casuarii, Sphenisci, Procellariæ, Fregati, Pelecani, Lari (including the Limicolæ), Ralli (including the Colymbidæ and Podicipidæ), Galli, and Columbæ. These orders and their component sub-orders, families, and genera, together with their diagnostic characters, are fully described. Under species the necessary synonymy, plumages from nestling to adult, nests and eggs, distribution and sub-species —including the range and diagnostic definitions of nearly 700 racial forms—are given. As a further help to identification, a series of illustrations is furnished in the form of ten coloured plates depicting more especially hitherto unfigured species, immature birds, and nestlings in down; while thirty-six plates in monochrome contain some 300 figures devoted to the elucidation of the characters upon which the various species treated of in the volume are based. These plates and drawings have been prepared by Lilian Medland and are excellent, but in some of the coloured plates the reproductions, though good and very useful, have not done full justice to the artistic merits of the originals.

We may not always be in sympathy with the views of the authors on the vexed question of nomenclature, and on the recognition of racial forms which are sometimes based upon too trivial characters; nor are we aware that the curlew sandpiper breeds in "Arctic Europe." These, however, are small matters, and it is a pleasure to recommend the book as one which, being the product of consummate personal knowledge, admirably fulfils its purpose, is excellent in all respects, and will doubtless be much appreciated by ornithologists. W. E. C.

Climatic Factors in Agriculture.

Agricultural Meteorology: The Effect of Weather on Crops. By J. Warren Smith. (The Rural Text-book Series.) Pp. xxiv+304+8 plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1920.) 13*s*. net.

IT has been said—and the statement is very generally true—that in most soils the crop yield is more affected by the weather than by manuring and cultivation. For this reason it is necessary to repeat most field trials for a number of years in order that the variations due to climate may be averaged out; and if at the same time meteorological records are taken it is possible to trace out some of the relations between weather fluctuations and the variations in yield. The infinite variety in meteorological conditions and in the factors concerned in plant growth makes statistical examination of the results essential if trustworthy information is to be obtained. The great value of long-continued experiments in this connection is clearly pointed out in the book under notice, and a large number of exceedingly interesting correlations are given between the yields of various crops and the weather characteristics—rainfall and temperature—not only over the whole year, but also over limited portions of the growing season. As more data become available it will be possible to specify the most critical periods of plant growth, and the economic value of forecasts of crop yields will be considerably increased.

The effect of climate is not confined to the final yield of the plant; it operates throughout its whole life, not only directly, but also indirectly through the soil conditions, insect and other pests, and so on. The relations must be considered, therefore, from many aspects—ecological, physical, physiological, to mention only a few. The difficulty of presenting such diverse material in a continuous and logical manner is obvious, and the author is to be congratulated on the success he has achieved.

Most readers of the work will be greatly interested in the methods adopted by the U.S. Weather Bureau in preparing and issuing weather forecasts and warnings. Full advantage is taken of these warnings, not only by the growers of specialised crops, who employ various forms of heaters to prevent damage from frost, but also by the general farmer, especially in the important harvesting periods.

In one or two minor aspects the book might be improved. The explanation of the method of working out correlation coefficients could be shortened; the student should be expected to know the way to solve simultaneous equations. Further, the section on physiological indices should adequately include the work of F. F. Blackman and V. H. Blackman, and a discussion of the views of Matisse would not be out of place.

The suggested laboratory exercises at the end of each chapter are excellent. They are intended primarily for university students, but many of them contain stimulating suggestions which could profitably be followed up by experienced research workers.

Agricultural meteorology must inevitably attract more workers in the future. It is to be hoped that the literature of the subject will maintain the high standard set up in this book.

B. A. KEEN.

Our Bookshelf.

Hiroshige. By Yone Noguchi. Pp. ix+38+19 plates. (New York: Orientalia; London: Elkin Mathews, 1921.) 25*s.* net.

WE thank Mr. Elkin Mathews for sending us this charming volume. We have admired once more the delicate art of Hiroshige, and we have read Mr. Noguchi's criticism with interest (Mr. Noguchi is always interesting); but we are left wondering why a work of such purely artistic content was submitted for review in a scientific journal. And, as we muse, the question takes form. Is there, after all, so great a difference between the artistic and the scientific approach to Nature? The multitudinous facts and ideas that make up the manifold variety of the world must flood and overwhelm any mind that attempts to grasp the whole. Most of us are saved from seeing too much, if not by native blindness, then by the blinkers of custom and education; but the penetrating eye of the artist or the philosopher looks for safety to the guidance of selection. He is, to quote Mr. Noguchi, "like Hiroshige himself who paid no attention to the small inessential details, when he grasped firmly the most important point of Nature which he had wished before to see, hold and draw." Perhaps the man of science may learn from the great artist, Hiroshige or another, that the searcher after Nature's secrets must frame a clear idea of what he wants to know; that he must not be led astray by facts, useful enough in their time and place, but irrelevant to his quest; that he must make himself the master and not the slave of his facts, so as, without falsifying Nature, to transcend her. It is the fearless vision, the intelligent choice, and the controlling imagination that produce alike the inspiring picture, the supreme poem, and the conquering theory of science.

Do you not agree? Well then, let us simply yield to the fascination of Hiroshige's balanced colour and of Mr. Noguchi's curiously expressive prose.

The Way of a Trout with a Fly, and some Further Studies in Minor Tactics. By G. E. M. Skues. Pp. xvi+259. (London: A. and C. Black, Ltd., 1921.) 18*s.* net.

THOSE who fish for trout with a fly will find that this book raises most of those problems which anglers debate so earnestly, if sleepily, after a day by the river. Mr. Skues claims no finality in his solutions, but that is not the only or the chief objective. His work is in the true line of descent from Izaak Walton and the Dame—that of one who loves and observes most patiently the secret processes of fish-life in our chalk-streams.

Some pages are devoted to the advocacy of what, on a "dry fly" water, is usually regarded as heresy. When a trout is feeding under the surface Mr. Skues will suit his taste with a sunk fly. Omar Khayyám held drunkenness and sobriety in equal abhorrence. Mr. Skues scorns the insobriety of the mere "lure" angler, who will play on any fishy weakness, as much as the asceticism of the "dry-fly purist." If your trout be only feeding on larvæ or nymphs, then have at him under water with a "legitimate" imitation and our author's blessing. And if Viscount Grey or the shade of F. M. Halford shake a deprecating finger, Mr. Skues merely taps his basket, full of fat two-pounders.

The Study of Geological Maps. By Dr. Gertrude L. Elles. (Cambridge Geological Series.) Pp. viii+74+7 plates. (Cambridge: At the University Press, 1921.) 12*s.* net.

DR. ELLES has lectured for several years past on this subject to women students at the University of Cambridge, and the well-printed and fully illustrated book under notice is based upon the course of instruction that she adopted. The relations of outcrop to contour-lines are shown in a series of boldly drawn maps, each with a section of the selected bed below. The details in these are intended to lead students to construct similar exercises on their own account. The shaded drawings of outcrops in relation to topography are excellent. British examples are used as types, and include the cauldron-subsidence of Glen Coe and the reversed fault in the Clifton gorge. Evidently the travels of the author throughout our islands have been aptly utilised. Some account might have been added of the methods adopted by the Geological Surveys of various countries for recording geological features on maps, especially in regard to the differentiation of superficial (surficial) deposits, since the range and variety of geological maps of our own islands are still unknown to many workers. G. A. J. C.

The Land and its Problems. By Christopher Turnor. (A New Series on Economics.) Pp. 254. (London: Methuen and Co., Ltd., 1921.) 7*s.* 6*d.* net.

MR. TURNOR is well known as an enthusiast in agricultural matters, and in this small book he sets out his ideas in a clear and moderate manner. His purpose is to lay stress on the vast importance of the land as the greatest imperial and national asset, and to show that if a permanent consolidation of the Empire is to be achieved this can be effected only by giving the necessary care and thought to the development of our land resources.

The author is a great believer in small holdings. He does not, however, suggest that the United Kingdom should be devoted entirely to this purpose, but he emphasises the national and social importance of maintaining a number of these holdings—*i.e.* farms of about 50 acres and under—and on the need of improving living and business conditions of the small-holders. He further insists on the necessity for increasing the area of ploughed land. The book is illustrated by charts showing the changes in British agriculture during recent years.

M

Letters to the Editor.

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Metallic Coloration of Chrysalids.

THE chrysalids of many butterflies have the appearance of being gilded. The area covered by the gilding is variable even in the produce of the same batch of eggs, in some cases showing only round the prominences on the back, and in others diffused over the greater part of the surface.

Modern naturalists seem inclined to explain animal coloration as being either protective, warning, mimetic, or the result of sexual selection, but the ornamental gilding above referred to can scarcely fall into any of these classes. Protective resemblance, *i.e.* the similarity between an animal and its usual surroundings, is met with everywhere, and natural selection would, or might, act continuously, to promote this resemblance. The opportunities, however, for selection to cause members of different genera to assume the same appearance would be much fewer.

I do not know of any evidence which would point to the models as being of older types than the supposed copyists, but even if such evidence existed, the probability that the similarities are due to selection is of a different, and lower, order than that which connects selection and congruity of colouring with environment.

Considering that, apart from the latter tendency, nothing whatever is known as to the origin of the various types of markings and colour patterns, it would seem justifiable to put down many cases, at least, of what is called mimicry to the action of the same unknown cause.

Chrysalids are often protectively coloured (amongst the Pieridæ, for instance, if the pupa is placed on a wall or paling it is greyish with dark specks, but if on a leaf the colour is a uniform green); there are very few positions, however, in which a bright metallic object would not be more conspicuous than a duller surface similar in tint to its background.

The nature of the metallic colours, of which there are such abundant instances in the animal world, has always been a matter of interest, and during the last twenty years I have examined many hundreds of examples of the kind, and have found in every case that the metallic appearance was due to some form of "interference."

Colour, in general, is the result of a selective action of matter on the light which reaches it, and may arise either from a relation between the wave period of the light and the molecular periods of the matter, or from a relation between the wave-lengths of the light and some structural dimension in the substance built up of numbers of molecules.

The first of these alternatives includes all pigmentary colours, while the action of the second is properly described as "interference."

Pigmentary colours are analogous to the phenomena of resonance in sound, and interference effects to those of combined echoes.

The interference colours of birds and insects take so many forms that it is not always easy, at first sight, to distinguish them from pigments, but a decisive test may be found by subjecting the coloured material to pressure.

If the application of pressure causes the colour to disappear, interference may be safely inferred. If the colour changes, but does not vanish, interference is probable, but not certain.

Fig. 1 shows the apparatus which I made for carrying out this test. It consists of a quartz plate A and a plano-convex quartz lens B, which can be pressed into contact or withdrawn from A by the adjusting screw C. Other adjustments are provided for traversing A in its own plane and for clamping the apparatus in its correct position on the stage of the microscope.

In use, B is first brought into contact with A, and the series of Newton's rings thus formed is centred in the field of view. B is then withdrawn and a small piece of the material to be tested is placed on A, and A is moved by its own adjustment screws so as to bring the test-piece into the same position as was occupied by the centre of the ring system.

Various other tests, such as immersion in various fluids, may be applied to determine the character of the interference, and some of these are mentioned in the paper on "Iridescent Colours" (Proc. Roy. Soc., A, vol. 85, pp. 598 *et seq.*).

In the majority of the cases which I have examined the colours seem to be analogous to those of Lipmann films, but it is almost impossible to cut sections thin enough to show this by direct evidence. It may be stated, however, that in the case of birds and insects they are not due to diffraction (an explanation which has often been put forward in books on natural history). I have not yet examined the iridescent colours of fishes and reptiles. From their appearance I should expect that of the former to be interference phenomena, but that the splendid iridescence shown by the scales of some pythons may be the result of diffraction.

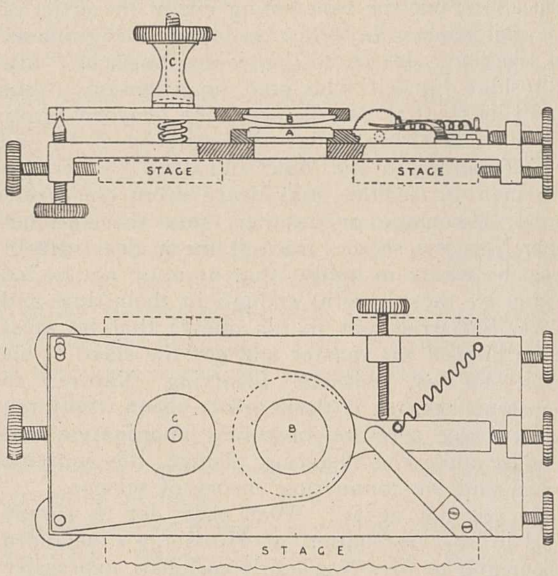

FIG. 1.—Section and plan of apparatus for applying pressure to coloured test-pieces.

It is true that the scales of many Lepidoptera are traversed by fine and regularly spaced lines, and I have used a single scale from a Morpho as a diffraction grating, but the diffraction spectra have no relation to the colour which is directly reflected.

To return to the gold of the chrysalids, I find (1) that the gilding disappears completely when pressure is applied; (2) no immediate change occurs on immersion in water, alcohol, or xylol, but in the course of a few days the gold tends to become more orange; (3) the metallic appearance vanishes when the specimens are dry, and this happens also (probably for the same reason) about a day before the imago escapes; (4) when the chrysalis is examined with a low power, the gold is seen to be made up of small patches of colour ranging from red to green, with yellow predominating; and (5) all these colours shift towards the blue as the angle of incidence increases.

An enlarged sketch from a photograph of a thin section of the wall of the chrysalis is shown in Fig. 2. Photographs of subjects such as these are generally unsatisfactory owing to the impossibility of getting all the significant features in focus at the same time.

The section shows an inner membrane (*a*), which stains readily, and is traversed by closely spaced fine lines (about 30,000 per in.), covered by a thin chitinous coat (*b*) having many corrugations on the outer side.

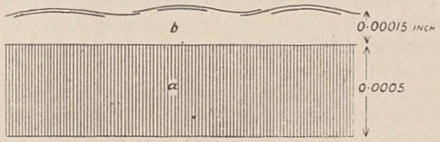

FIG. 2.—Section of a portion of a chrysalis of *V. urticae*. (From a photograph.)

Of the foregoing observations, which were made on a series of chrysalids of *V. urticae*, (1) proves the colour to be the result of interference, and (5) is in agreement with this; (2) shows that the interference is not a surface effect, but is due to some internal structure in the chitin; and (2) and (3) together indicate that the periodic structure changes its properties and dimensions by wetting and drying.

In some very thin sections I have thought I could recognise separate layers at the borders of the chitinous coat, but it is difficult to distinguish with certainty this apparent stratification from the diffraction bands which are often seen at the boundary between two substances of different refractive index.

A. MALLOCK.

9 Baring Crescent, Exeter.

Sex-manifestations and Motion in Molluscs.

IN NATURE of October 13, p. 212, Mr. G. C. Robson discusses the application to molluscs of the present writer's suggestion that bisexuality in animals may be a direct physical result of a freely moving habit of life, and that hermaphroditism may be a direct physical result of a sedentary or sluggish mode of life. It was also suggested that it follows from this hypothesis that all sedentary or sluggish animals may be suspected of hermaphroditism where they are now supposed to be bisexual, especially in view of the fact that sex-change may be obscured by a rapid changeover of sex-characters such as we know takes place in the oyster.

Mr. Robson's discussion brings out some of the difficulties experienced in applying the generalisation to molluscs, but at the same time illustrates some facts in its favour. It is suggested that the marine Euthyneura, which are hermaphrodite, are as "active" as the Streptoneura, which, except for some sedentary and parasitic forms, are bisexual. This difficulty is a real one if a comparison be made merely of the behaviour of the animals in captivity; but if "activity" be defined in relation to muscular development, it will at once be seen that there is a great difference between the Streptoneura and the marine Euthyneura. An Aplysia, or even a Scaphander, as a type of marine Euthyneura is a flabby and feeble animal in comparison with the strong, powerful, muscular Buccinum as an equivalent type of Streptoneura. Indeed, the difference in muscularity between the two groups might very well be regarded as of fundamental importance by a biophysicist.

It is considered undesirable to attempt to define closely such terms as "sluggish" and "active," since if there is any underlying truth in the hypothesis proposed, definitions would soon begin to crystallise out when the problem begins to be seriously attacked. The degree of muscular development will, however, probably enter largely into the definition of "activity" from this point of view. In this respect the following quotation—warm from the press—("Mechanism of Life," by J. Johnstone, 1921, p. 218) is of great interest:—"The animal[1] is characteristically a machine for the conversion of potential chemical energy into movement of body and limbs, and the movement inevitably leads to friction." As an illustration of another apparent contradiction of the hypothesis, the Ctenophora may be mentioned. These forms (excepting the Berœ group) are "active"—that is, they move about quickly; but there are also at least many of them hermaphrodite. The Ctenophores (except the Berœ group), however, move about, not by means of muscular movements, but by the rhythmic action of compound flagella, and this, it is submitted, may be regarded from a biophysical point of view as a mode of locomotion fundamentally different from that brought about by muscular action.

The illustration from Mr. Robson's letter in favour of the hypothesis relates to the fact that among the Streptoneura, which are typically bisexual, are a few sedentary and parasitic forms. Now these parasitic forms are hermaphrodite, and so also are those sedentary forms, namely, Crepidula and Calyptræa, which have been critically examined. Moreover, it may be observed that such simple cases of hermaphroditism as occur in Crepidula and Calyptræa have been described only recently, and that, therefore, more difficult cases may very easily have been overlooked; further, it is not at all incompatible with possible hermaphroditism in a species for a hundred specimens of that species (not to mention a mixture of several species) to be examined unsuccessfully for products of both sexes; even in the oyster Hoek ("Rapport over de oorzaken van den achteruitgang in Hoedanigheid van de Zeeuwsche oester," p. 174, Uitgegeven door het Ministerie van Waterstaat Handel en Nijverheid, s' Gravenhage, 1902) found only 11 hermaphrodite forms out of 130 examined microscopically, and we now know that sex-change occurs seasonally in this species. In other species—where sex-change may occur only once in a lifetime—it would be easy to predict a case where less than 1 per cent. of a random sample would be hermaphrodite, especially as both sex-products may not be produced simultaneously.

It is not a difficult matter to raise objections to the general hypothesis in relation to doubtfully active animals; therefore, results of practical applications of the suggestion are more interesting. For instance, are all the sedentary Streptoneura, the Scaphopoda, and the Polyplacophora really hermaphrodite, although they appear to be bisexual? It must be remembered that Nature can attain the same end in all kinds of ingenious ways, as though delighting in obscuring the application of any underlying principles, if such do, indeed, really exist. For example, the present writer applied the hypothesis stated above to an inves-

[1] Prof. Johnstone is of course referring to the metabolism of undoubtedly active animals.

tigation of the sex-phenomena in the pea-crab, the female of which is known to be sedentary, spending its life imprisoned within bivalves such as mussels, cockles, and occasionally oysters. It was found that the female fulfils its mating functions probably once and for all (see NATURE, December 23, 1920, p. 533) when quite a tiny mite, and probably not more than a month or two old. It is unlikely afterwards that the female has any more need of a male. Now the same result—excepting for any advantage there may be in cross-fertilisation—might be obtained by the pea-crab being born as a male and changing into a female, and at the outset of the investigation such a change was suspected. It is, indeed, possible, that evolution in sex-characters in a similar species carried a stage further would end in cutting out the males of that species altogether—as has taken place in some Cirripedes—and leaving a hermaphrodite form which starts life as a male and changes into a female. In the case of the pea-crab, therefore, bisexuality is maintained by a very precocious association of the sexes, while the males still retain their active mode of life.

A similar dodge on the part of Nature has been applied in a large number of other cases, such as in some parasitic Copepods, some Echiuroids, some Cirripedes, some parasitic Isopods, and no doubt in many other cases. But in these cases the male is often minute and permanently attached to the female. It is clear, therefore, that it is necessary to be on the look-out for adaptations which retain in a species an appearance of bisexuality, but which bring about a close resemblance to the hermaphrodite state. The conditions which determine whether both sexual products shall ripen together in an individual or only successively are entirely unknown, but it is hoped that the suggestions put forward in this letter may help towards securing some information bearing on the problem.

J. H. ORTON.

The Laboratory, The Hoe, Plymouth,
October 20.

The Presence of Perennial Mycelium in Peronospora Schleideni, Unger.

SINCE *Peronospora Schleideni*, Unger, the onion mildew fungus, is known to produce its sexual organs in the leaves of the host-plant, the assumption has been made that the parasite is dependent on its oospores for perpetuation from year to year. It has now been proved, however, that the mycelium is capable of a perennial existence in onion bulbs, and that the shoots produced if such bulbs are planted are infected *ab initio*.

The presence of non-septate mycelium permeating the bulbs of the potato- and common onion, sent in from several parts of Ireland in the late spring of 1920, first directed attention to the subject. All attempts to induce this fungus to fruit on the bulb-scales, to infect other onions, or to grow on artificial media, met with failure. In some cases, however, where green leaves were present, the mycelium was traced from the bulb to the apical portion of a leaf on which conidiophores of *P. Schleideni* were being produced. All the infected bulbs shrivelled and died during the course of the autumn or winter, as did further infected specimens gathered in the autumn from badly diseased plots. Practically 66 per cent. of the smaller-sized onions from one particular plot which was badly mildewed in 1920 contained non-septate mycelium. Such infected bulbs sprouted prematurely, but although the mycelium grew up within some of the new shoots, it failed to develop conidiophores on the surface under winter conditions in the greenhouse.

Further material became available in the spring which proved the relationship of this fungus to *P. Schleideni*. Bulbs of the common onion (*Allium Cepa*) and of the shallot (*A. ascalonicum*) which contained the same non-septate mycelium were grown in the early spring under conditions which excluded the possibility of external infection, as proved by the fact that numerous control plants which were initially free from mycelium remained free from mildew, even when kept for a week under conditions favourable to the disease. The infected plants, on the other hand, when placed under a bell-jar for one night were found practically covered with mildew next day. In some cases the original infected leaves, which had not developed any mildew, were cut away. The new shoots which replaced them again came up permeated with mycelium and again became mildewed under favourable conditions, while similarly treated control plants remained healthy.

There is a time in the early spring, generally in the month of April, when the mildew is found only on onions the bulbs and leaves of which are permeated with mycelium. These plants appear to act as important centres of infection. For a long period no apparent harm results to the host, but the tips of the leaves ultimately turn yellow and droop. Under favourable weather conditions mildew then breaks out, at first just below the withered portion of the older leaves, and then on all the leaves except the youngest. There appears to be a nice balance between host and parasite, seeing that both can go on flourishing so long together, and that it is apparently only at a certain stage of maturity of the leaves that the internal mycelium breaks out into conidiophores. Even when this happens, the host-tissue is not killed for a considerable time.

Non-septate mycelium, apparently that of *P. Schleideni*, has been found in the bulbs of the common onion, in those of the potato- or underground-onion, and of the shallot. In the case of the common onion and shallot this mycelium has been definitely connected with the mildew fungus. It has also been proved that the mycelium survives when infected bulbs are left in the soil during the winter. This is possibly an important point in the case of Tripoli onions, which are sown in the autumn. The *rôle* of perennial mycelium in the shallot, potato-onion, and in onions grown from "sets" is obvious.

Plainly visible mycelium was observed in infected bulbs every time they were examined in spring, autumn, and winter. In these circumstances, it appears unnecessary to suggest the presence of mycoplasmic infection. It may be added that the mycelium is so obvious, the hyphæ being stout and well differentiated from the cells of the host-plant, into some of which large convoluted haustoria extend, that no better subject for demonstrating intercellular mycelium and haustoria is known to the present writer. No staining is required.

The effect of the fungus on the keeping qualities of infected bulbs requires further study, as do some other points in this strangely overlooked phase in the life-history of such a common and destructive parasite.

PAUL A. MURPHY.

Royal College of Science, Upper Merrion
Street, Dublin, October 15.

The Development of Optical Industries.

IN NATURE of October 20, p. 238, Messrs. Zeiss's publicity manager questions a particular period of British supremacy in the manufacture of optical glass, and in doing so he minifies the value of Faraday and Harcourt's work. Of Harcourt he says: "The result at that time (between 1834 and 1844) was scarcely of any practical importance."

Now what does Dr. Zschimmer, who until the Revolution was chemist to Messrs. Schott, of Jena, say? I shall translate from his book, "Die Glasindustrie in Jena" (p. 22), and throughout I shall limit myself to quotations from German sources: "With Harcourt's experiments there began in the year 1834 the systematic 'scientific melting' of glass in the laboratory. He was the discoverer of the first research furnace for fusion at high temperatures, the first who was able to complete numerous small experimental melts, and thence to determine by spectrometer measurement the optical properties—refraction and dispersion—of various extreme glass substances."

On p. 23 he continues: "Harcourt . . . discovered the power of molten phosphoric acid and boric acid to form glass with almost all the elements, and on account of their fluidity he substituted them for the more viscous silica. Already in 1844 he was able to communicate to the British Association the happy success of his first experimental melts, the further object of which was to compare the chemical constitution with the optical properties of different glasses. . . ."

Dr. Zschimmer is generous, but not unduly so. A genuine man of science himself, he has recognised the great, far-reaching practical results of Harcourt's work, but Dr. Zschimmer has embarrassed us. In accepting his opinion we must doubt that of Messrs. Zeiss's representative, whose declared object it is to "furnish some trustworthy historical data."

Messrs. Zeiss's spokesman questions to-day the statement in NATURE that: "If the British optical industry is to be maintained and to develop so as to turn out products equal at least to the best products of other nations, it must not be dependent on foreign sources for the supply of optical glass, but must have an adequate home supply, equal, again, at least to the best available anywhere." "History," he says, "does not point to the existence of such a very close relation between the welfare of the glass-founder and of the optical instrument-maker in the same country."

Does it not? Is Messrs. Zeiss's publicity manager so unfamiliar with the history of the Jena establishments? If in the above statement from NATURE the word "German" be substituted for "British," we have the essence of the original appeals for a subsidy made to the Prussian Government. In this connection I shall translate part of a vigorous statement made by Rudolf Virchow: "It concerns itself, indeed, with a national undertaking, the object of which is to produce in Germany in an independent way the glass necessary for all scientific purposes, and also to provide for the population what is necessary for the production of spectacle glasses, opera glasses, and the like. Nevertheless the latter is not the principal object. It concerns itself, moreover, to the highest degree with the production of glass for telescopes, microscopes, and such like scientific instruments. This question is of very special importance as regards the construction of instruments for military and naval purposes, in which connection we have hitherto been entirely dependent upon foreign countries. In the previous year it was proven to the Budget Commission that only by a particular accident was it possible to obtain the necessary quantity of glass for the construction of optical instruments essential for the army."

"The close relationship between the welfare of the glass-founder and of the optical instrument-maker in the same country," thus forcibly advocated, was already recognised by the Prussian Government, which "granted to the Jena undertaking for two years a sum of 60,000 marks." JAMES WEIR FRENCH.

Anniesland, Glasgow, October 24.

THE letter published in NATURE of October 20 from the Carl Zeiss organisation in Jena through Messrs. J. W. Atha and Co. is interesting, but not very convincing, for Messrs. Zeiss seem to wish to convey a totally different impression from that of thirty-five years ago. Their present attitude is that although they did receive a small subsidy, a mere 3000*l.*, from the Prussian Government, it was an isolated instance and really quite unnecessary. In view of this the following extract from the preface to the catalogue of optical glasses issued by Schott and Gen in 1886 is interesting:—"We have to express our sincere thanks to the Prussian Bureau of Education and to the Diet of the kingdom for the *very liberal and repeated subsidies* by which we were enabled to carry out the costly experiments on a manufacturing scale." The italics in the quotation are mine.

An analysis of the various optical glasses offered in this 1886 catalogue gives food for thought. Forty-four glasses were offered, of which it was claimed that nineteen were essentially new, and so were printed in heavier type. Fourteen of these were entirely withdrawn from the market within a year or two, as they were absolutely unstable, and were never replaced. Of the remaining glasses five had the following significant remark printed against them, presumably as a recommendation: "Exactly corresponds to the hard crown (soft crown, dense flint, etc.) of Chance Bros." Of the remaining glasses it may be said that they were merely slight modifications of the ordinary old-fashioned crowns and flints, having slightly lower or higher refractive indices than ordinary hard crown, light flint, or dense flint, and a correspondingly lower or higher dispersion, many of which had been produced by Chance years before.

MANSELL P. SWIFT.

81 Tottenham Court Road, London, W.1, October 25.

IN their letter to NATURE of October 20 (p. 238), Messrs. Zeiss suggest, by implication, that British optical instruments are inferior to those of German manufacture. The following may be of interest:

I possess three photographic lenses. One a pre-war Goerz, double-anastigmat, 7-in. focal length, working at f/6·8, and two post-war Cooke lenses, one of 8¼-in. focal length, working at f/4·5, and the other of 15-in. focal length, working at f/5·8.

All three lenses have recently been tested at the National Physical Laboratory. The full reports are too lengthy for publication, but it suffices to quote that the Goerz lens had to be stopped down to f/16 to give "satisfactory definition over the entire plate," whereas the Cooke lenses did this at *full aperture*.

The Goerz lens, I was informed, was specially selected for me by Messrs. Goerz's agency in London, whereas both Cooke lenses were bought from stock at the Army and Navy Stores.

Possibly one important factor in the success of the German optical industry is the skilled way in which their products are advertised. The delusion that they are unequalled is widespread. K. C. BROWNING.

16 Bridge Avenue Mansions, Hammersmith, W.6.

Qualities of Valency.

IN a letter under the above heading in NATURE for October 13, p. 210, Dr. R. M. Caven directs attention to the difficulty felt by chemists in accepting Dr. Langmuir's view that the sodium and chlorine in sodium chloride are not united by a chemical bond, being always ionised, although molecules of sodium chloride actually exist in a state of vapour at 2000° C. Perhaps the following considerations may help to remove the difficulty.

In the first place it is necessary to distinguish between the two separate processes of intramolecular ionisation and electrolytic dissociation. Intramolecular ionisation is the expression introduced by Sir J. J. Thomson to describe the transfer of an electron from one atom to another *within* the molecule, an "ionic molecule" being thereby produced. Electrolytic dissociation is the breaking up of such an ionic molecule into separate ions.

Sodium chloride is therefore an intramolecularly ionised compound, and the chemist's difficulty is the question of how the ions are united in the molecule.

Now the conception of the valency bond can be retained if we accept the convention first suggested by Sir Oliver Lodge (NATURE, vol. 70, p. 176, 1904), according to which the electron and positive charge are united by a very large number of lines of force when in combination. In the chloride ion we have a kernel with seven positive charges surrounded by eight electrons. The electrons will, therefore, be unsaturated, and in a molecule of sodium chloride we shall have a bundle of lines of force passing from the electrons of the chloride ion to the nucleus of the sodium ion. This is a typical instance of a strong electrolyte.

In non-electrolytes two or more electrons are shared between two atoms, giving Dr. Langmuir's covalency bond. In this case, without specifying the particular electrons involved, we may assume a double bond consisting of two equal bundles of lines of force passing in opposite directions, that is to say, in a molecule AB, one bundle will pass from the electrons of A to the nucleus of B, and the other one from the electrons of B to the nucleus of A. All intermediate stages of combination between these two extremes are possible, as I have pointed out in a series of papers, in which the subject is discussed in detail (Trans. Chem. Soc., vol. 111, p. 253, 1917; vol. 115, p. 278, 1919; *Phil. Mag.*, vol. 42, p. 448, 1921).

Full consideration of the question, as shown in the papers referred to, leads to the conclusion that a simple and all-embracing theory of valency is not possible, but that different theories of valency must be devised for different types of compounds, such as electrolytes, non-electrolytes, and molecular compounds. In view of this difficulty I have used affinity formulæ only, and it would appear that the time is approaching when the chemist will have to decide whether the conception of valency can be retained for general purposes, or whether it would not be better to restrict its use to certain special branches of the science, such as the chemistry of carbon compounds, in which it has proved of supreme value.

To the inorganic chemist the valency conception has been of doubtful value. This is particularly noticeable if we compare the rapid development of inorganic chemistry since Werner introduced the co-ordination theory less than thirty years ago with the slow rate of progress in the previous thirty years under the valency theory.

In any case the restricted use of the valency bond to the particular type of combination termed covalency by Dr. Langmuir will scarcely be accepted by chemists if the conception of valency is to be retained for general purposes.

The other facts mentioned by Dr. Caven all indicate that there is no clear-cut distinction between electrovalency and covalency, but that they represent extreme types of combination with an indefinite number of intermediate grades. S. H. C. BRIGGS.

October 24.

Relation of the Hydrogen-ion Concentration of the Soil to Plant Distribution.

WITH reference to Dr. W. R. G. Atkins's interesting communication in NATURE of September 15, may I be allowed to submit the following comments? The importance of the study of hydrogen-ion concentration in physiology and biochemistry, soil science, and other branches of research cannot be over-emphasised, and is rapidly becoming appreciated by workers. There appears, however, to be a tendency to apply methods of measurement that have been standardised in one branch of study to other departments—soils, for example—with a minimum change of technique. With the exception of Gillespie's pioneer, but by no means exhaustive, work in America, the colorimetric method of measuring the hydrogen-ion concentration of soils has never been critically examined. After considerable preliminary work with this method—an account of which has been published elsewhere—the present writer feels that the conditions under which it can be applied in soil work so as to yield accurate and reproducible results have not yet been fully worked out. As an example may be cited the fineness of division of the soil sample which is often a factor influencing the apparent *p*H as determined colorimetrically. Until much more work has been done from this point of view the data being accumulated by ecologists can scarcely have the strict quantitative significance often attached to them, although when regarded as provisional only they are undoubtedly of great interest and no little importance.

A further point is perhaps worthy of attention: it may possibly happen that in some soils the actual *p*H at the moment of measurement is of less importance than the *rate of change* of the *p*H under natural conditions. The "buffer effects" imposed by the nature of the soil on its reaction vary enormously in magnitude from soil to soil; a dressing of basic slag may alter considerably the *p*H of a light sand while having no appreciable effect on that of a heavy loam; and the *p*H of a light soil may vary regularly or erratically with fluctuations in local conditions. Such variations may be important in many cases, and would well repay study. The whole problem of the nature of soil reaction is complicated, but some light would undoubtedly be thrown upon it by measuring, not merely the *p*H of soils, but the variations in *p*H with additions of acids and alkalis, *i.e.* by plotting titration curves the slopes of which can be correlated with the magnitude of the buffer action of the soil. Very little work along these lines has so far been done in this country—or, indeed, in any country—but that little has afforded indications that such work would be fruitful of result if attacked systematically and with due appreciation of all the difficulties.

E. A. FISHER.

The University, Leeds, September 28.

Absorption of X-rays.

AT the suggestion of Prof. Richardson, we have for some time been engaged in an investigation of the connection between X-ray absorption coefficients and critical frequencies. In this work we have met with considerable experimental difficulties, which so far have not been completely overcome. It appears, however, that one of the questions we had set ourselves can be answered, partially at any rate, from some data recently published by Richtmeyer (*Phys. Rev.*, July, 1921, p. 13), who has given the absorption curves of molybdenum and silver for homogeneous X-rays on both sides of their respective critical (κ) absorption frequencies, and for lead on the longer wave-length side. Data on lead have been previously given by Hull and Rice (*Phys. Rev.*, vol. 8, p. 326, 1916), who have also determined one point on the shorter wave-length side. The values of Richtmeyer for lead are proportionately higher than those of Hull and Rice, apparently indicating that the latter have inaccurately determined the thickness of their thin absorbing screen.

By plotting $\log(\tau/\rho)$ against $\log\lambda$, the double values of the mass absorption (fluorescent) coefficients of molybdenum and silver at their respective critical frequencies can be accurately determined. In the case of lead the accuracy of the upper value (for the shorter wave-length side) is governed by the accuracy of the single determination of Hull and Rice as corrected from the Richtmeyer data. The following results are obtained for the ratio of the values $\frac{(\tau/\rho)_{\nu_\kappa+\delta\nu}}{(\tau/\rho)_{\nu_\kappa-\delta\nu}}$ when ν_κ is the κ critical absorption frequency of an element and $\delta\nu$ is infinitely small.

Element	Lead	Silver	Molybdenum
$R=\frac{(\tau/\rho)_{\nu_\kappa+\delta\nu}}{(\tau/\rho)_{\nu_\kappa-\delta\nu}}$	3·5	6·76	7·06
Critical frequency ν_κ	$21{\cdot}58\times10^{18}$ sec^{-1}	$6{\cdot}186\times10^{18}$ sec^{-1}	$4{\cdot}854\times10^{18}$ sec^{-1}

The relation between R and the critical frequency is linear, and is expressed by the equation

$$R=0{\cdot}212\times10^{-18}(38{\cdot}1\times10^{18}-\nu_\kappa).$$

The relation between R and the atomic number has been tested, but it does not appear to be nearly as linear as the one given above. The data from which this generalisation has been made are admittedly incomplete, and the experiments are being continued in the hope of testing the extent of its validity.

W. EWART WILLIAMS.
B. L. WORSNOP.

Wheatstone Laboratory, King's College,
Strand, W.C.2, October 15.

The Film-photophone.

IT may be of interest to readers of the Note in NATURE of September 29, p. 161, to learn that the photo-electrical equipment of the "speaking-film" is quite new. It consists of an antimonite cell, and was constructed especially for this purpose by the present writer. A fragment of a single crystal of the mineral antimonite (found in Japan and Borneo) is connected to electrodes (of very large surface) in such a manner that air and humidity are excluded. An even flow of current is thus attained and the sudden, unexpected jerks which formerly destroyed the acoustic effect are avoided.

The photo-electrical properties of antimonite have been known for a comparatively short time. The discovery was made by F. M. Jaeger (of Zaandam) in 1907. The exceptionally high resistance of the first cells was at that time, before the advent of the amplifier, a serious obstacle to technical uses. In 1911 I succeeded in constructing a cell of lower resistance which enabled Prof. B. Glatzel in 1912 to demonstrate graphically by the oscillograph the surprising rapidity with which the antimonite adjusts itself to varying intensities of light.

That synthetic antimonite, made by melting together antimony and sulphur in suitable proportions, is sometimes very sensitive was shown by Olie and Kruyt in 1912.

The investigations of F. C. Brown seem to indicate that single crystals of selenium might also be used with advantage. But they are difficult to make, and the problem of affixing the electrodes is not yet solved. although solutions may be said to be in sight.

W. S. GRIPENBERG.

Helsingfors, Finland, October 13.

THE first two sentences in Dr. Gripenberg's letter are misleading in the sense that they suggest that the only photo-electrical equipment capable of being used with "speaking-films" is the antimonite cell. It is well known, of course, that other substances besides selenium respond to fluctuations of light intensity, and antimonite is, apparently, one of them. Another is the "thalofide cell," which has recently been advertised extensively, and was invented by T. W. Case. I believe I am correct in saying that the sensitive substance in this cell is thallium sulphide. The comparative merits of these various substances will, no doubt, ultimately decide which is best to use with speaking-films. For the present, at any rate, selenium has been by no means completely ousted—a fact which is made evident by its adoption and use in connection with the film-photophone of Mr. Bergland, to the efficient performance of which attention has been directed by the *Times* correspondent.

THE WRITER OF THE NOTE.

Rainfall Records at Rothamsted.

THE following rainfall figures from Rothamsted are worth noting. The records date back to 1852 for the large rain-gauge (1/1000 acre), but for the purpose of comparison the figures for the last fifty years are taken, since the three percolation gauges (also 1/1000 acre) were not built until 1870. They relate to the harvest-year, September 1–August 31:—

Harvest Year.

		Percolation		
	Rain. Inches.	Through 20-in. soil. Inches.	Through 40-in. soil. Inches.	Through 60-in. soil. Inches.
Average for last 50 years	29·500	14·834	15·482	14·659
September 1, 1920, to August 31, 1921...	16·282	6·921	7·161	6·812

For the past eight months (February 1–September 30) the figures are:—

1921	8·511	1·125	1·230	1·176
Average	18·239	6·525	6·910	6·528

The rainfall for the period September 1, 1920, to August 31, 1921, is the lowest since the records started in 1852, the previous lowest being 19·504 in. in 1897–98. The highest figures for the period are 41·048 in. in 1878–79.

W. D. CHRISTMAS.

Rothamsted Experimental Station,
Harpenden, October 27.

Edinburgh and the Rise of Oceanography.[1]

By PROF. W. A. HERDMAN, C.B.E., F.R.S.

EDINBURGH may be regarded as the birthplace and the early home of modern oceanography, and Edinburgh men and Edinburgh ideas played a leading part during the nineteenth century in establishing this comprehensive science of the sea. Oceanography, if of modern development, is of ancient origin. The foundations upon which it has been recently built can be traced back to very early times, to the records of naturalists and the observations of seamen from the voyages of the Phœnicians onwards, and maps have been constructed to show the growth of our knowledge of the oceans from the shores of the Mediterranean in the time, say, of Homer, and later of Aristotle, on to the Atlantic voyages of the fifteenth and sixteenth centuries, and the circumnavigation of Magellan in 1522, when the first attempt, so far as we know, was made to sound the Pacific with a 200-fathom line at a spot we now know to be about 2000 fathoms deep. Pytheas, who first passed the Pillars of Hercules into the unknown Atlantic, and penetrated to British seas and brought back reports of Ultima Thule and of a sea to the north thick and sluggish, like a jelly-fish, was an early oceanographer in the fourth century B.C.; and so, coming to later times, was that truly scientific navigator, Capt. James Cook, who sailed to the South Pacific on a transit of Venus expedition in 1769, with Sir Joseph Banks as naturalist on board, and later circumnavigated the Southern Ocean about lat. 60° S., and so finally disproved the existence of a great southern continent.

It is impossible in one short lecture to trace all stages and mention all worthy names, but a list of the more notable voyages of exploration in the nineteenth century recalls the names of the great men such as Darwin, Hooker, and Huxley, who went with the ships as naturalists, and all of whom contributed in their turn to our knowledge of the sea and its contents.

Information as to the bottom of the sea and the animals living there is obtained chiefly by dredging and trawling, and we find that the naturalist's dredge, a modification of the fisherman's oyster dredge, came into common use about 1830, and was the chief implement employed by the marine biologists of the nineteenth century, who made known the riches of the British seas.

In tracing the development of the science of the sea, we may take as examples the work of three Edinburgh men, who are types of periods of investigation in the nineteenth century—Edward Forbes, the pioneer of shallow-water dredging during the earlier half of the century; Wyville Thomson, the explorer of the deep sea and scientific leader of the *Challenger* expedition; and John Murray, who continued the work of Wyville Thomson and guided research in the last quarter-century into deeper and more fundamental problems of the ocean, and brought the science practically to its present position and outlook.

Edward Forbes, though of Scottish descent, was born in the Isle of Man about 100 years ago, but much of his short life and his remarkable work was connected with Edinburgh. His long and erratic career as a student of medicine and science was spent here, and he died a professor in the university of the city. As a mere boy in the Isle of Man he commenced his marine biological studies and the accumulation of those collections and observations which afterwards formed the basis of his classic works on "British Starfishes" and "British Mollusca." He left home at the age of seventeen, and from that time onwards the whole of his short, strenuous life was devoted to science and mainly to the science of the sea. He was a many-sided genius, who produced an extraordinary volume of first-rate original work in marine biology and inspired advances in oceanography which he did not live to see carried out.

After a short period of art study in London Forbes arrived in Edinburgh in 1831 as a medical student, and here he remained a student for nine years. It is interesting to note that our three selected leaders in science were all students of medicine in this university, and not one of them graduated. Forbes was the centre of a brilliant group of young medicals, about half a dozen of whom were afterwards fellow professors with him in the same university. The chief of these was perhaps John Goodsir, the famous anatomist, and in 1839 we find Forbes and Goodsir dredging in the Shetland seas, with results which Forbes made known to the meeting of the British Association at Birmingham that summer with such good effect that the celebrated "Dredging Committee" of the association was formed to continue the good work. Forbes and his British Association Dredging Committee may be said truly to have led on, step by step, to the *Challenger* and other expeditions of modern oceanography.

One very curious animal which Forbes and Goodsir made known from Hebridean seas is the bright-green compound Ascidian called *Syntethys hebridica,* which has since been shown to be the same as a Mediterranean animal of a lovely violet colour named by the French naturalist, Savigny, *Diazona violacea.* The animal in our seas is green when alive, but when it dies undergoes a chemical change and becomes violet. As an example of the constancy of Nature, I may add that nearly seventy years after this rare animal had been found by Forbes and Goodsir I went to the Hebridean seas to search for it, and in exactly the same spot, to the north of the Croulin Islands, came upon it in quantity sufficient to supply various museums and give material to my chemical friends who were investigating the pigment.

[1] Abridged from an evening discourse to the British Association at Edinburgh on September 13.

Forbes's great opportunity to make marine investigations outside the British seas came in 1841, when he was appointed naturalist on the surveying ship *Beacon* engaged on hydrographic work in the eastern Mediterranean. His dredgings in the Ægean gave great results and led to the well-known and much-discussed views on zones of life in the sea which are always associated with his name. He defined in the Ægean eight zones of depth, characterised by peculiar assemblages of animals, and he conjectured that the zero of animal life would probably be found somewhere about 300 fathoms—the "azoic" zone—a conclusion which has since been found to be erroneous. His Ægean report was laid before the British Association in 1843, and, we are told, at once raised the author to a high rank amongst living naturalists.

But perhaps Forbes's most important work of an oceanographic nature is the Geological Survey Memoir, in which he traces the origins of the British fauna and flora and their relations to geological changes in the past. He accounted, for example, for the five sub-floras which he defined as due to successive migrations from neighbouring lands previous to the isolation of the British Islands from the mainland of Europe. He showed the northern and southern relations of the fauna of our seas, as exemplified by the fishes and the molluscs, and the presence of "Boreal outliers," assemblages of northern species occupying deeper areas of 80 to 100 fathoms on the west of Scotland. These he regarded as portions of the original northern fauna which formerly occupied our seas and had retreated northwards when the climate became more genial subsequent to the Glacial epoch, leaving these colonies isolated in the deeper holes. Forbes's theories on distribution and on the origin of the British fauna and flora, even if in part erroneous, were a notable contribution to knowledge, and far in advance of anything known at the time, and had an important influence on the history of further investigation. His theories, along with his descriptive work, form a wonderful output both in quantity and quality for a man to have produced who died before reaching the age of forty, only six months after he had attained to the goal of his ambition, the chair of natural history in the University of Edinburgh.

Forbes was the most original, brilliant, and inspiring naturalist of his day, with a broad, philosophic outlook over Nature, and a capacity for investigating border-line problems involving several branches of science—he was, in a word, a pioneer of oceanography and the spiritual ancestor of men like Sir Wyville Thomson and Sir John Murray.

We now pass from this period of the early marine naturalists to that of the later oceanographers of the nineteenth century. If Forbes was the pioneer of shallow-water dredging, Wyville Thomson played a similar part in regard to the exploration of the depths of the ocean. His name will go down through the ages as the leader of the famous *Challenger* expedition, by far the most important scientific deep-sea exploring expedition of all times. Wyville Thomson's work was in direct continuity with that of Forbes. It was Forbes who, on a basis of observations then thought to be sufficient, but now known to have been exceptional, placed the zero of life in the sea at 300 fathoms, and it was Wyville Thomson more than any man who proved that Forbes's views were in this respect erroneous, and that many and varied living things inhabit the greatest depths of the ocean.

Charles Wyville Thomson was born in 1830 at Bonsyde, near Linlithgow, and was in every sense, by ancestry and by education, a son of Edinburgh. Like Edward Forbes, he started as a medical student, but, fortunately for oceanography, after about three years of study, his health gave way, and he left medicine for what was then supposed to be the less strenuous pursuit of science. It is interesting to trace how Thomson's earliest investigations on fossils led on by successive steps to the novel and fruitful field of deep-sea exploration. Palæontological observations on Crinoids suggested work on the living Antedon, and that led to the investigation of the stalked larval stages of that Rosy Feather Star. Then the news that a strange new stalked Crinoid (*Rhizocrinus lofotensis*), related to the fossil Apiocrinidæ, and resembling the larval forms of Antedon, had been found living in northern seas induced him in 1866 to visit Prof. M. Sars at Christiania and examine for himself the remarkable collection of rare animals that the son, G. O. Sars, had brought up from more than 300 fathoms in the Lofoten fiords. Thomson was naturally much struck by their novelty and interest and their resemblance to extinct animals of former geological periods. Thus inspired, he urged his friend, Dr. W. B. Carpenter, with whom he was then working, to join him in endeavouring to promote an expedition to explore the deeper water of the Atlantic. Carpenter's powerful advocacy induced the council of the Royal Society to use their influence with the Hydrographer with such success that the Admiralty placed first one and then another small surveying steamer at the disposal of a scientific committee. Thus came about the cruises of the *Lightning* in 1868 (when they dredged down to 650 fathoms) and the *Porcupine* in 1869 and 1870 (when they reached the great depth of 2435 fathoms) which are described in detail in Wyville Thomson's book, "The Depths of the Sea," the first general text-book of oceanography, published just after the *Challenger* had sailed in 1872. These explorations showed an abundance of life at all depths.

Incidentally we may note that another Edinburgh professor—Fleeming Jenkin, the engineer—when repairing a cable in the Mediterranean in 1860 brought up some sessile animals attached to the broken cable from more than 1000 fathoms.

Wyville Thomson succeeded Allman as professor of natural history in Edinburgh in 1870, and from that time Edinburgh became the active centre of deep-sea exploration. The undoubted success of the preliminary expeditions in the *Lightning* and *Porcupine* encouraged Carpenter and Thomson, again through the council of the Royal Society, in co-operation with a committee of the Council of the British Association, to induce the Government to equip a deep-sea expedition on a really grand scale to explore the conditions of life in the great oceans. This resulted in the famous circumnavigating expedition of the *Challenger*, with Sir Wyville Thomson as director of the scientific staff. On that staff were also two other Edinburgh men, J. Y. Buchanan, the chemist, and John Murray.

The *Challenger* sailed in December, 1872, and returned in May, 1876, and during that three and a half years traversed 70,000 miles of sea, dredging or trawling at 362 stations, and bringing back enormous collections, such as the scientific world had never seen. It is impossible in a few minutes to give any adequate idea of the discoveries of the *Challenger* expedition. Never did an expedition, which cost so little, produce such momentous results for human knowledge, and Edinburgh may fairly claim a share of the glory reflected from the expedition led by her famous Regius professor of natural history.

All naturalists know how great were the additions to the scientific knowledge of the oceans and their inhabitants made either during the voyage or later in the working out of the collections, which was carried on during the following twenty years, to a very large extent in Edinburgh, partly in the *Challenger* office in Queen Street, and partly in some of the laboratories of the university.

Sir Wyville Thomson did not live to see the results of his great expedition worked out and published. Soon after the return home his health broke, and he died in 1882. During the last years of his life Thomson arranged for two supplementary expeditions under Murray and Tizard to explore the Faroe Channel between the north of Scotland and the Faroe Isles. All three of our pioneers are connected with this region. Forbes long ago, in 1850, pointed out that it ought to be explored, as on the boundary of two faunas, the Arctic and the Atlantic, Thomson, in the *Porcupine*, discovered "cold" and "warm" areas at the bottom only an hour's sail apart and differing by 15° F.; and from *Challenger* temperature observations in the Pacific, etc., he predicted that a barrier would be found rising to 200 or 300 fathoms. Hence the *Knight-Errant* and *Triton* expeditions, in which Murray and Tizard discovered the "Wyville-Thomson" ridge separating cold Arctic water from warmer Atlantic.

For a quarter of a century after the *Challenger* expedition Edinburgh was the chief centre of oceanographic research, and the Mecca towards which marine biologists from all over the world turned to inspect the novelties of the wonderful collections and to discuss results, and in all this work many well-known Edinburgh men of science—Turner, Tait, Crum Brown, Geikie, Chrystal, Buchan, and others—played a leading part—outside the biological group of workers at the *Challenger* office.

After Sir Wyville Thomson's death it was fortunate for science and for the continuance of the influence of Edinburgh upon oceanographic research that Dr. John Murray, who had been chief assistant at the *Challenger* office since the return of the expedition, was able and willing to take up the directorship and bring the whole work to a most successful issue twenty years later. These two Scots share the honour of having guided the destinies of what is still the greatest oceanic exploration.

John Murray, though born in Canada, was of Scottish descent, and came as a boy to Scotland to complete his education. He also started as a student of medicine at the University of Edinburgh, and, again like his two forerunners, gave up medicine for science, and left without graduating. His first oceanographic expedition was to Spitsbergen and other parts of the Arctic regions on board a Peterhead whaler, on which, on the strength of having been once a medical student, he was shipped as surgeon. It was only an odd chance that led to Murray's connection with the *Challenger*. The scientific staff had already been definitely appointed when at the last moment one of the assistant naturalists dropped out, and on the recommendation of Prof. Tait, Murray was offered the vacant post.

On the expedition Murray devoted special attention to coral reefs, bottom deposits, and plankton, all of which have led to important results.

Murray's investigation of deposits led, moreover, to one of the romances of science when he discovered and exploited a very valuable phosphatic deposit on Christmas Island in the Indian Ocean. He was able to show, after some years' working of the deposit, that the British Treasury had received in taxes and royalties considerably more than the total cost of the *Challenger* expedition. Even in his busiest years at the *Challenger* office Murray never gave up work at sea. In his little yacht, *Medusa* (38 tons), between 1884 and 1892 he explored the sea-lochs of the west of Scotland, made great collections and many observations, and found "Boreal outliers" in Loch Etive and Upper Loch Fyne.

It is curious that Edinburgh, so favourably situated on the Firth of Forth, and provided with such a succession of eminent professors as her university has had since the days of Jameson, has never had a permanent marine biological station. Murray at least made an attempt. In 1884 he acquired Granton quarry and moored in it the *Ark* with biological and chemical laboratories. Murray and Irvine carried on chemical work while the *Ark* was at Granton on the secretion of carbonate of lime, on the solution of carbonate of lime in sea-water, and on chemical changes in muds, etc.

Murray's last oceanographic expedition was a four-months' cruise in 1910 in the North Atlantic with Dr. Hjort in the *Michael Sars* when in his seventieth year. He was killed in a motor accident in March, 1914.

There is, no doubt, other Edinburgh work in connection with oceanography, such as that of the Fishery Board for Scotland, which should be mentioned, and other names of those who are still happily with us and at work, such as the indefatigable arctic and antarctic explorer, Dr. W. S. Bruce, the leader of the *Scotia* expedition, and the founder of the Edinburgh Oceanographic Laboratory; but in this brief record of the past it has been possible only to deal simply with the historically connected work of the three great pioneers of the nineteenth century—Edward Forbes, the dredger of the shallow waters; Wyville Thomson, the explorer of the deep seas; and John Murray, who may be regarded as the founder of modern post-*Challenger* oceanography—in demonstrating the effect of Edinburgh men and ideas and work in advancing our knowledge of the science of the sea.

Absorption Spectra.

By PROF. E. C. C. BALY, C.B.E., F.R.S.

WITHOUT doubt the study of absorption spectra, more particularly those of organic compounds, has given rise to great interest, owing to the possible connection between absorption and chemical constitution. The work of Hartley, Dobbie, and others showed that in certain cases it was possible to determine the constitution of substances from observations of their absorption spectra. It is not surprising that, as the result of this work, a school of thought was founded on the basis of a direct correlation between the atomic structure of a molecule and its absorption spectrum. On the other hand, Hantzsch, who in a great number of papers has maintained the opinion that the absorption curve is an index to constitution, has travelled far beyond the original point of view. He found that changes in the absorption spectrum of a compound are observed when no change is possible in its primary valency structure, and in interpreting his results Hantzsch has invoked the aid of the secondary valencies of the atoms.

It is now known beyond any question of doubt that one and the same substance under different conditions can show different absorption spectra in the visible and ultra-violet. It is also known that, whilst a change in the primary structure of the molecule might possibly be accepted as an explanation of this in a few instances, the large majority of these variations in absorption cannot in any way be thus accounted for. Attempts were also made to interpret absorption spectra by oscillating linkages, such, for instance, as the equilibrium between the enolic and ketonic forms of ethyl acetoacetate or the oscillation that may be accepted as taking place within the benzene ring. This suggestion was very soon negatived when it was found that many substances in which no such oscillation is taking place exhibit well-marked absorption bands. For example, it might be possible to explain the ultra-violet absorption band of acetone by attributing it to the equilibrium $CH_3—CO—CH_3 \rightleftharpoons CH_3—C(OH)=CH_2$; but hexamethylacetone, in which no such change is possible, exhibits the same absorption band as acetone.

The only other possible variable from the point of view of the chemist is the secondary valency, and this has been advanced by Hantzsch and others as the explanation of absorption in the visible and ultra-violet, the well-established differences in absorption being accounted for by different distributions of the secondary valencies. No physical explanation, however, has been offered of the assumed correlation between the secondary valency and absorptive power, a matter of great importance, since a theory cannot hold good unless some physical basis can be found for the phenomenon of the absorption of radiant energy.

In all this work the study of absorption spectra of organic compounds has been restricted to the visible and ultra-violet regions of the spectrum, and, indeed, only to that portion of the ultra-violet which is transmitted by a quartz spectrograph working in air. This is unfortunate, since the absorption bands exhibited by the compounds in that vast region known as the infra-red and in the extreme ultra-violet are ignored. Then, again, many inorganic substances show absorption bands which are exactly similar to those on which Hantzsch founds his valency formulæ of organic compounds, and obviously an identical explanation must be found for each class of compound. It is not too much to say that all the above theories have been based on insufficient data.

If the complete system of absorption bands shown by a compound over the whole spectrum is examined, it is found that the central frequency—namely, the frequency for which the absorptive power is the greatest—in any visible or ultra-violet band is always an exact multiple of the frequency of an important absorption band in the short-wave infra-red. Then, again, this infra-red frequency is itself an exact multiple of the central frequencies of well-marked bands in the long-wave infra-red. This integral relationship is of great importance, since it can readily be proved that the central frequencies are truly characteristic of the molecules, the subsidiary frequencies associated with them being probably due to the atoms and groups of atoms composing the molecules. Again, the changes in absorption exhibited by one and the same substance under different conditions are restricted to the visible and ultra-violet, the fundamental short-wave infra-red frequency remaining the same.

There is one point about absorption spectra which has been strangely neglected in all theories —namely, the ultimate destination of the energy that is absorbed. It is obvious that when a substance exhibits an absorption band energy is being absorbed, and if no photochemical change is thereby produced the whole of the absorbed energy is again radiated in the infra-red. The integral relationship between the frequencies is in harmony with an energy quantum theory, since, if the quantum of energy is the product of the frequency into a constant, one single quantum absorbed at one frequency can be radiated as an exact number of quanta at a smaller frequency if the first frequency is an integral multiple of the second.

The usually accepted basis of all theories of absorption is the assumption that a molecule is characterised by certain definite frequencies or free periods of vibration, and that absorption of energy takes place as the result of these. There are, however, certain objections to this assumption, such, for instance, as the fact that the frequencies of a molecule are far larger than those of the atoms which it contains. These objections can at once be met by making an entirely different assumption—namely, that a molecule is characterised by an amount of energy which determines its frequency. The cardinal assumption may be made that each elementary atom is characterised by a fixed amount of energy or elementary quantum which is associated with a definite physical process such as the shift of an electron from one stationary orbit to another. These elementary quanta are related together in that they are multiples of a fundamental unit, possibly the elementary quantum of the hydrogen atom. On this hypothesis an atom can only absorb or radiate one or more of its elementary quanta.

It may readily be shown, on the grounds that when two or more atoms combine they each lose an equal amount of energy, that the resulting molecule is endowed with a molecular quantum which is a multiple of the least common integral multiple of the elementary atomic quanta of its atoms. If the physical process in the atom occupies a definite time, assumed the same for all atoms, then all atoms and molecules will have the power of absorbing or radiating energy of a definite frequency. In all probability the molecular quantum establishes the fundamental molecular frequency in the short-wave infra-red of which the visible and ultra-violet frequencies are exact multiples. On this theory, therefore, a molecule, like an atom, can lose or gain energy as a whole only in terms of its molecular quantum.

There is little doubt that the origin of the affinity between atoms which causes them to combine is to be found in their electromagnetic-force fields, and when the combination has taken place the external faces of the atoms must come into play. These cannot exist in any molecule without mutual influence, and, indeed, the force lines must condense with the escape of energy to form a molecular-force field on which the reactivity of the molecule will depend. Obviously, this energy loss is a process in which the molecule as a whole takes part, and consequently the energy will be lost in molecular quanta. A freshly synthesised molecule, therefore, must pass into one of a number of possible phases according to the number of quanta that have been lost. It is a matter of simple proof that when a freshly synthesised molecule loses x molecular quanta in this way it becomes endowed with a new quantum which is $x+1$ times the molecular quantum. The molecular phase, therefore, will exhibit its characteristic frequency together with a phase frequency which is an integral multiple of the molecular frequency.

The total number of molecular quanta that are evolved in the force-field condensation will depend on the nature of the external fields of the atoms. The more nearly balanced these are, the greater the number of molecular quanta that will be lost. The great majority of organic compounds have a molecular frequency of the order of 1×10^{14}, so that if four quanta are lost in the force-field condensation, the phase frequency will be 5×10^{14}, which is situated in the red; but if 10 quanta are lost, the phase frequency will be $1{\cdot}1 \times 10^{15}$, which is in the ultra-violet. Again, if 17 quanta are lost, the phase frequency will be $1{\cdot}8 \times 10^{15}$, which is situated in the extreme ultra-violet beyond the limit of the quartz spectrograph.

It is perfectly possible to change the phase in which a molecule exists by supplying to it or taking from it energy in an amount equal to one or more molecular quanta. This can be done in many cases by use of a suitable solvent, or even by a change of physical state, such as from liquid to gas. The change in phase is indicated by a change in the position of the absorption band in the visible or ultra-violet, and this phenomenon is frequently observed when different solvents are used. The change of molecular phase with change in physical state is well instanced by piperidine and pyridine. Liquid piperidine is diactinic to all the visible and ultra-violet rays transmitted by a quartz spectrograph, because its absorption band lies in the very extreme ultra-violet. Piperidine vapour, on the other hand, exhibits a strong absorption band in the near ultra-violet. The absorption bands of liquid and gaseous pyridine are also quite different.

The molecular-phase hypothesis clearly has a quantitative basis, since the molecular quantum evolved in the phase change is given in ergs by the product of the frequency into the time constant $6{\cdot}57 \times 10^{-27}$. It applies, moreover, to inorganic substances as well as to organic, and of this a typical instance is given by sulphur. It is now accepted that the allotropes of sulphur are equilibrium mixtures of four different molecular species of sulphur, S_λ, S_π, S_ϕ, S_μ, and there is little doubt that these are in reality four molecular phases, for they exhibit absorption frequencies which are multiples of the fundamental molecular frequency of sulphur. It is well known, too, that coloured forms can be obtained of many simple salts which normally are colourless, such as sodium chloride, by supplying energy to them.

The phenomena of fluorescence and phosphorescence are also due to molecular phases. If a molecule absorbs a phase quantum which, for instance, is ten times the molecular quantum, this energy can be radiated in two ways. It may either be radiated as 10 molecular quanta, when the fluorescence will be in the infra-red, or it may be radiated partly as one quantum characteristic of a lower phase—say, that phase with frequency five times the molecular frequency—and partly as molecular quanta. In the second case the fluorescence will be visible.

Since the essential characteristic of the phases of a molecule from the chemical point of view is their force fields, the variation in which causes their different reactivities, it might be argued that this theory is only a re-statement of the secondary valency hypothesis. Such an argument would not, however, be sound, for the secondary valency hypothesis does not explain absorption. At best it only succeeds in showing that different distributions of secondary valency can generally be written where the same molecule has been found to exhibit different absorption under different conditions. The present theory establishes the existence of different phases of any inorganic or organic molecule, each of which has its own energy content, its own reactivity, its own frequency and power of absorbing light. The theory attempts to correlate all the phenomena of absorption and to place them on a quantitative basis, and in this attempt it would seem to meet with some success. Although in this article we are not concerned with the chemical aspect of the differences in the force fields of the phases, it may also be claimed that this theory offers a quantitative explanation of the phenomena of reaction and reactivity.

Artificial Production of Rain.

By DR. HAROLD JEFFREYS.

IN an article in the *Times* of October 17 an account is given of the achievements of Mr. Charles M. Hatfield in producing rain. The method used is not described in any detail. A tank filled with certain unspecified "chemicals" was exposed at a height of 25 ft. above the ground, and it is claimed that this had the effect of producing 8 in. of rain in three months at Medicine Hat, 22 miles away. The theory of the method is that the apparatus draws clouds from other parts to the Medicine Hat district and causes them to precipitate their moisture there. No direct observations of the motions of clouds are mentioned in confirmation of this theory, though they should not have been difficult to obtain.

The official raingauge at Medicine Hat during May, June, and July, the period of the contract, recorded 4·8 in., which was 1·3 in. below the normal for the station for those months. Further comment on the success of the experiments is unnecessary.

The financial side of Mr. Hatfield's contract with the United States Agricultural Association of Medicine Hat is interesting, for the association was apparently prepared to pay Mr. Hatfield as if 8 in. of rain had fallen. Still more interesting is the fact that he was promised 4000 dollars for 4 in., and 6000 dollars for 6 in. Since the normal rainfall is 6·1 in., Mr. Hatfield would have been much more likely than not to make a substantial profit even if he had done nothing at all.

It may be mentioned that at Calgary, Alberta, the rainfall was 3·0 in. below normal; at Edmonton it was 3·1 in. above; and at Qu'Appelle (Sask.), 300 miles to the east, it was 3·85 in. above normal.

It is also stated that at Los Angeles, in the first four months of 1905, Mr. Hatfield guaranteed 18 in. of rain, and that his own raingauge showed 29·49 in. If this is correct the rainfall must have been extremely local, for the official raingauge at Los Angeles in those months showed only 14·98 in. Still, this was 4·4 in. above normal. At San Diego, however, which is 200 miles away, the excess was 4·6 in., and it appears likely that the abnormality at both stations was due to more widespread causes than Mr. Hatfield's chemicals.

Attempts have on many previous occasions been made to produce rain by artificial means, but the results have been uniformly unsuccessful. The reason is not difficult to see. To make the water vapour in the air condense it is necessary to cool the air in some way to a temperature below the dew point. This may be done in two ways. One may cool the air directly, for instance by the evaporation of liquid carbon dioxide or liquid air. This certainly would produce a little condensation; the fatal objection to it is that it would be thousands of times cheaper to distil sea water. The other method is to raise the air. The pressure decreases with height, and to reduce the pressure on a particular mass of air is known to cool it. The difficulty is to raise it enough. To produce an inch of rain over an area of 100 square miles requires the condensation of 6 million tons of vapour, and to achieve this some hundreds of millions of tons of air must be lifted up. The distance it must be raised depends on how nearly saturated it was originally, but it could not be less than a kilometre in ordinary fine weather conditions. We have no source of energy at our command great enough to achieve this.

It is often suggested that rain may be produced by exploding shells or otherwise agitating the air. The action is compared with that of a trigger, a large amount of energy being released by a small effort. An essential feature is, however, overlooked. For a trigger to work, there must be a large supply of potential energy only awaiting release. Precipitation from partially saturated air would require an actual supply of new energy. Therefore a trigger action cannot produce precipitation.

Obituary.

PROF. CH. FRANÇOIS-FRANCK.

CH. FRANÇOIS-FRANCK, the distinguished physiologist, and officer of the Legion of Honour, who passed away in September last at the age of seventy, was the successor, at the Collège de France, of Marey, whose assistant he had been from the time of his arrival from Bordeaux to work for the degree of Doctor of Medicine. The acquaintance was most fortunate. Marey, always in more or less delicate health and naturally desirous of saving his strength, seldom delivered the annual course of forty lectures which necessitated so much original work—for the lectures of the Collège de France are not given for the instruction of students in preparation for examinations, but to further the advancement of science. Marey continued in his own laboratory that admirable series of experiments on the flight of birds, the motions of the horse and man, and the compilation of his book, "La Méthode Graphique," of universal renown.

François-Franck was therefore appointed by Marey to lecture in his stead, and thus he gained the opportunity of doing original work for the foundation of the lectures. His subject was the physiology of the circulation in general and of the heart and lungs in particular; and for more than thirty years François-Franck delivered the course of lectures annually. The number of experiments he made must have been enormous, for all the lectures were illustrated on the board in the room by means of most ingenious apparatus and registering instruments. The talent for exposition he possessed and the extreme precision of the details and results he showed were never forgotten by those who attended the lectures.

It was in another department of physiology that François-Franck accomplished his *magnum opus*, "La Physiologie du Cerveau," published in 1887. He was on intimate terms of friendship with Pitres, afterwards the distinguished professor of neurology at Bordeaux, who, coming with François-Franck to take the degree of Doctor of Medicine in Paris, had gone direct to Charcot at the Salpêtrière. At that time Charcot was working very hard to establish what he called "la belle doctrine" of cerebral localisation, and Pitres became his most enthusiastic and useful assistant. He engaged the interest of François-Franck in this field of work, and they began a series of experiments which ultimately was continued and terminated by François-Franck alone. The work is a remarkable production, as physiologists know, both for the originality of treatment and the extreme precision of the experiments. François-Franck also published a number of articles in the "Dictionnaire des Sciences Médicales" of Dechambre that are models of lucidity and sound learning, on the sympathetic nervous system, besides more than eighty papers or notes in the "Comptes rendus de la Société de Biologie," the meetings of which he seldom missed; he had also been a vice-president of this society. The reputation he had gained amongst physicians was such that he had become a much-sought consultant for heart and circulatory disorders and diseases, although he was never connected with any hospital.

François-Franck lived in retirement for the last few years owing to failing health, and was much missed by his scientific friends. Some twenty years ago the Academy of Medicine had most justly elected him to take a seat near the masters, Marey and Channeau, for he was the one man in France who was able to demonstrate in detail the great work of these physiologists who established the unalterable foundations of our knowledge of the functions of the heart and the circulatory organs.

E. J. BEVAN.

MR. EDWARD JOHN BEVAN, who died suddenly on October 17, in his sixty-fifth year, was educated at private schools, and at the age of seventeen entered the laboratory of the Runcorn Soap and Alkali Co. Thence, in 1877, he proceeded to Owens College, Manchester, where he met Mr. C. F. Cross, and the student friendship continued after the college career, each entering upon research work in connection with cellulose industries, upon which they kept up an active correspondence and a certain amount of collaboration. This resulted in a definite joint adventure, and the work was continued at the Jodrell Laboratory, Kew Gardens.

The publication of results in the Journal of the Chemical Society (1882–83) led to a research appointment with the firm of Thomson, Bonar and Co., actively engaged in the pioneer development of the "Ekman" wood pulp (cellulose) process; the work was undertaken under the formal partnership "Cross and Bevan." They were next engaged in technical research work in connection with textile bleaching processes—the "Thompson" process, the "Hermite" electrolytic process—and as a necessary incident prosecuted investigations of the alkali-boiling treatments by which the textiles are prepared. These investigations were the chemical basis of the invention of the well-known "Mather" Kier and process. In 1885 "Cross and Bevan" was established at 4 New Court, Lincoln's Inn, where the scientific-technical research work has been carried on ever since. The invention of the well-known "Viscose" process in 1892 resulted from the systematic investigations of the antecedent period.

The development of this matter becoming a pressing question of "ways and means," Mr. Bevan decided to enter the field of professional chemistry, and obtained the appointment of County Analyst for Middlesex. In this field he made his particular personal reputation. The long tenure of this important position (1892–1921) is evidence of Mr. Bevan's exceptional qualifications, and in addition to those of chemist his qualities of character, brought to bear on activities associated with his office, were honoured by influential positions in the Institute of Chemistry (vice-president) and Society of Public Analysts (president).

Mr. Bevan's life-work is a many-sided constructive contribution to chemical science, and his career may be an encouragement to young students of this generation who are inclined to despise the day of small beginnings.

THE third EARL OF DUCIE, who died on October 28, aged ninety-four, was much interested in natural science, and was for many years an active geologist. He joined the Geological Society in 1853, and was a member of council from 1856 to 1858. He collected fossils, and between 1864 and 1891 made many valuable gifts of specimens to the British Museum. He also made important observations on the geology of the region round Tortworth, Gloucestershire, his country seat. He was elected a fellow of the Royal Society in 1855.

THE death occurred on Friday, October 28, at the age of forty-two years, of PROF. F. E. ARMSTRONG, professor of mining at the University of Sheffield.

WE regret to announce the death, on Thursday, October 27, at the age of forty-seven years, of PROF. F. A. BAINBRIDGE, professor of physiology in the University of London.

WE much regret to see the announcement of the death on October 29, at the age of fifty-four years, of DR. W. S. BRUCE, the well-known Polar explorer and naturalist.

Notes.

ON Monday last, October 31, twenty-five years had elapsed since Prof. P. Zeeman's first observations of the decomposition of spectral lines by a magnetic field were communicated to the Amsterdam Academy of Sciences in a paper that appeared shortly afterwards in the *Philosophical Magazine* under the title "On the Influence of Magnetism on the Nature of the Light emitted by a Substance." By this important advance in magneto-optics, the first made since the days of Faraday and Kerr, a new and vast field of research of uncommon interest was opened. In commemoration of this development a reprint of Prof. Zeeman's original papers has now been published by the physicists of the Netherlands, conjointly with many scientific men of other countries. Prof. Zeeman has also been honoured by a special issue of the Dutch journal *Physica*, containing contributions by C. Cotton, G. E. Hale, Ph. Kohnstamm, T. van Lohnizen, H. A. Lorentz, A. van Maanen, E. E. Mogendorff, H. Kamerlingh Onnes, F. Paschen, and C. Runge. Some of these articles are devoted to an appreciation of Zeeman and his work or to the history of his discovery. In others the present state of magneto-optical theory and the latest results in the experimental investigation of the Zeeman effect are discussed. The bearing of the phenomenon on solar physics and the conclusions that have already been drawn concerning the magnetic field of sun-spots and the sun's general magnetic field are explained by Prof. Hale and Mr. van Maanen. Finally, Prof. Paschen describes a new phenomenon lately discovered by him, and consisting in the appearance, under the influence of a magnetic field, of certain spectral lines that cannot otherwise be produced. We are glad to avail ourselves of this opportunity of expressing our high appreciation of Prof. Zeeman's brilliant work, by which he has contributed most effectively to the development of modern physics.

"IS it advisable that every clinical thermometer offered for sale in Great Britain should be tested at the National Physical Laboratory?" This is the question asked and answered affirmatively in a circular issued by the British Lampblown Scientific Glassware Manufacturers Association and circulated amongst members of Parliament, the medical profession, etc. It is pointed out that from the consumer's point of view it is as important to be assured that the clinical thermometer he buys is accurate within two-tenths of a degree Fahrenheit as it is to have a guarantee, such as the law provides, that when he purchases butter it is pure butter that he gets. From the maker's point of view it is to the good of the trade in this country that there should be such a standard of accuracy of clinical thermometers that everyone will know the British article to be above suspicion. When the Government made testing compulsory, at least 25 per cent. of the first batches tested were rejected as inaccurate; but there was steady improvement until, at the time of the abolition of the compulsory test, the rejections were of the order of only $1\frac{1}{2}$ per cent. The quantities under test, which in November, 1919, when testing was compulsory, were 135,000 per month, dropped to 55,000 per month in June, 1921, when the compulsory test was abolished. In view of these results the British Lampblown Scientific Glassware Manufacturers Association invite support of the Clinical Thermometer Bill, which was submitted to Parliament in July last to replace the lapsed Order in Council, but which, owing to the objections of six members, was deferred by the Government to the next session. That in the interests of consumers and manufacturers alike there should be some guarantee of accuracy seems to be indisputable. The circular does not discuss the question whether clinical thermometers imported from abroad and tested by a foreign institution of recognised standing should also be re-tested by the National Physical Laboratory before being sold in this country.

THE Church of St. Martin's-in-the-Fields, the bicentenary of which is about to be celebrated, was rebuilt in 1721, but, as was pointed out by Sir William Tilden in NATURE of October 6, p. 176, it was not in the present church that Boyle was buried. It was, however, in the vaults of the new church that the great anatomist, John Hunter, was first interred. Hunter's burial took place in October, 1793, and the transference of his remains to Westminster Abbey sixty-six years later was entirely due to the extraordinary exertions of Frank Buckland, the naturalist. Buckland's resolution to do honour to Hunter's remains was made at a dinner held in 1856 to celebrate the centenary of Hunter's studentship. Three years later, on February 7, 1859, he began to search the vaults of St. Martin's for Hunter's coffin, and in his diary writes :—"Moving coffins all day long; turned out about thirty coffins. . . The stink was awful; rather faint towards the end of the business." His search went on for fourteen days, until on February 22 he records :—"At work all the morning, and about three o'clock in the afternoon found it, the bottom coffin in the last tier but one." The removal of the coffin to the Abbey took place about a month later.

THE *British Medical Journal* announces that the Municipal Council of Paris has decided to establish at a cost of 1,185,000 francs a municipal institute of electrotherapy.

SIR ARTHUR GRIFFITH-BOSCAWEN, Minister of Agriculture and Fisheries, has appointed the Earl of Ancaster to act on his behalf as Deputy Minister of Fisheries in addition to his duties as Parliamentary Secretary to the Ministry.

THE *Times* of November 1 announces that Mrs. Rosita Forbes (Mrs. McGrath) was presented with the gold medal of the Antwerp Royal Geographical Society on Saturday last after she had given a lecture to the society on her expedition to Kufara.

DR. M. GRABHAM, of Madeira, will deliver the Bradshaw lecture at the Royal College of Physicians on November 3 on "Sub-tropical Esculents" and Dr. R. O. Moon the FitzPatrick lectures on November 8 and 10 on "Hippocrates in Relation to the Philosophy of his Time."

THE Swiney lectures on geology for the present year will be delivered by Dr. J. D. Falconer at the Imperial College of Science and Technology (Royal College of Science, Old Building) on Mondays, Wednesdays, and Fridays, beginning on November 7, at 5.30. There will be twelve lectures in all on the subject of "The Wonders of Geology." Admission will be free.

PROF. J. W. HINCHLEY, of the Imperial College of Science and Technology, South Kensington, has issued invitations to a meeting to be held on Wednesday, November 9, at the Engineers' Club, 39 Coventry Street, London, W.C., to discuss the best method of forming an Institution of Chemical Engineers. Sir Arthur Duckham will preside, and will be supported by representatives of various branches of industrial activity cognate with the profession of chemical engineering.

THE sixth meeting of the Optical Society of America was held at Rochester, N.Y., on October 24, 25, and 26, and was constituted an Helmholtz memorial meeting. On the first day the president, Prof. J. P. C. Southall, gave a brief survey of the development of optics, Prof. H. Crew gave an account of Helmholtz's work on the conservation of energy, Dr. L. T. Troland of his contributions to physiological optics, and Prof. M. I. Pupin gave some personal recollections of him. Under the chairmanship of Mr. P. G. Nutting, the reports of sixteen subcommittees on nomenclature and standards were read and discussed. Up to the present time these reports have not been received, but from the abstracts of some of them which are available it is evident that they will be of importance to optical workers in this country.

IN the third interim report of the Departmental Committee on Lights on Vehicles it is remarked that complete elimination of dazzle from motor headlights is impracticable, but glare may be materially restricted below the eye-level of an adult observer approaching a car. The main beam should accordingly be restricted as regards height above ground and a maximum and minimum intensity specified. Secondary diffused light should be also available. No lamp entirely complying with the desired conditions has been found. Suitable regulations permitting the use of existing lamps adapted to restrict light below a height of 4 ft. from the ground and diffuse the light are proposed, but would require statutory authority. Compliance would involve co-operation on the part of manufacturers and owners of headlights, which should be submitted to an approved authority which might issue certificates. No legal requirement of minimum intensity exists, and the Committee consider that this should not be made compulsory, but that in any proceedings in regard to dangerous driving due regard should be paid to adequacy of lights. Swivelling headlights should not be permitted, but devices enabling the beam to be tilted downwards to avoid dazzle are permissible provided all headlights execute the same movement. Inspection lamps, for use only when the vehicle is at rest, should also be permitted.

THE Journal of the American Society of Naval Engineers for August last contains an interesting and well-illustrated article by Comdr. Stanford C.

Hooper, U.S.N., on the Lafayette super-high power radio station. The station is situated at the small village of Croix d'Hins, sixteen miles south-west of Bordeaux, and the memorial tablet states that it was "conceived for the purpose of ensuring adequate and uninterrupted Transatlantic communication facilities between the American Expeditionary Forces engaged in the world-war and the Government of the United States of America." The greater part of the structural material, amounting to some 15,000 tons, was prepared in America. Work was started at Croix d'Hins on May 28, 1918, and the station was completed on August 21, 1920. Among the principal items of interest are the eight self-supporting steel towers 820 ft. in height, triangular in plan, placed in two rows, the rows and towers being 1320 ft. apart. Weighing about 550 tons, each tower is designed to withstand a horizontal pull at the top of 11 tons, while the dead-weight of the whole antennæ system supported is about 3½ tons. The transmitting equipment consists of two 1000-kilowatt arc radio transmitters complete in duplicate throughout. During the trials, signals were copied without difficulty at Cavité, San Francisco, and Darien, and it was demonstrated that Lafayette's signals could be heard at suitably equipped radio receiving stations all over the world.

THE report of the council of the North-East Coast Institution of Engineers and Shipbuilders contains the awards made for papers read during the session 1920–21. The engineering gold medal is awarded to Eng.-Comdr. C. J. Hawkes for his paper on Diesel engines. In the graduates' section awards have been made to Mr. W. S. Burn for a paper on Diesel-engine flexibility, to Mr. F. McAlister for his paper on the design of ship-form of the modern cargo-vessel type, to Mr. E. V. Telfer for a paper on the strength of ships, and to Mr. C. S. Darling for a paper on internal-combustion engines for marine purposes. Standardisation work was energetically pursued during the past session by the North-East Coast Institution Panels. The committees of the associations concerned still endorse their decision not to proceed with the formation of an engineering and shipbuilding research association, in view of the unfavourable industrial conditions. Among other gifts to the institution may be mentioned one of 250*l.* from Mr. T. A. Reed to establish a fund for the provision of an annual medal or prize in memory of his father; the details of the competition in this connection have not yet been decided upon. It is of interest to note that of the twelve entrants for the 1921 scholarship, one only has not yet matriculated; this supplies evidence of the better standard of education attained by candidates. The institution has broken new ground this session by electing a shipowner to the presidential chair, and the new president, Sir William J. Noble, in his address delivered on October 14, indicated the need for co-operation between shipowners, shipbuilders, and employees; our only light in the darkness—and it is not a very illuminating one—is that other countries are apparently just as badly off as ourselves.

IN his preface to Bulletin No. 1, of the Department of Industries, Bombay, Mr. R. D. Bell states that this is the first of a series which it is proposed to publish in order to make the public acquainted with the activities of the Department, and to place information in a convenient form at the disposal of those who can make practical use of it. This is obviously a step in the right direction, and the Department is to be congratulated on the bulletins which have already appeared. Bulletins Nos. 1 and 4 contain parts 1 and 2 of a series of papers on Indian casein, initiated and carried out by Dr. A. N. Meldrum in collaboration with Mr. D. M. Gangoli. The results obtained are clearly stated, and it is evident that this kind of work is typical of that which must be undertaken in India by competent investigators if the great natural resources of the country are to be applied to industrial purposes. It is of the greatest interest to note that the Department has recently opened a small demonstration factory at Anand, in which the manufacture of casein in accordance with the results of these investigators will be carried out on the commercial scale. Bulletin No. 2 contains an account of work by A. J. Turner on the utilisation of bitterns, in which it is shown that the whole of the magnesium chloride required for cotton weaving, etc., can, if desired, be obtained from Indian sources, and need not be imported, as is at present the case. Moreover, it appears that the price of Indian salt would be considerably less than that of the foreign article. Hitherto the vast salt deposits at Kharaghoda, with which this paper deals, have received little attention, although recent analyses seem to show that they are comparable with the Strassfurt deposits in wealth of material, and that, if properly worked, they could render India self-supporting so far as potash, bromine, and magnesium salts are concerned. It is therefore welcome news to hear that this mine of wealth is at length being investigated, and that some, at least, of the recommendations of the Chemical Services Committee are receiving attention.

OF special interest to students of plant physiology is the recently issued instalment of the section on methods of investigation of the functions of the plant-organism forming Abteilung 11, Teil 2, Heft 1, of the "Handbuch der biologischen Arbeitsmethoden," edited by Dr. E. Abderhalden, of Halle University. The author, Viktor Grafe, of Vienna, deals with the following subjects:—The physico-chemical analysis of the plant-cell; the determination of permeability in plant-cells; use of adsorption and capillarity for biochemical analysis; and measurement of the processes of movement of gas and water in the plant-organism. Various methods of experiment are described and illustrations are given of the apparatus employed.

MR. W. JUNK, of Berlin, has issued a list of a remarkable collection of botanical works, containing altogether 12,900 hand-coloured plates, which he offers for sale as a whole to the highest bidder. Should no satisfactory offer for the whole be received, offers for single works may be considered. The collection includes some of the finest and rarest illustrated works on botany. Some of them are unique, the plates being copies of the original issues, executed by R. Simkó, an Hungarian painter, while the text is neatly typewritten. This is the case with Sibthorp's "Flora Græca," the 966 plates of which have been redrawn, apparently with extraordinary success, for they are described as being more artistic than those of the original issue, the merits of which are well known. Several of Jacquin's rare works are included in the collection, amongst them being his "Hortus Botanicus Vindobonensis," "Flora Austriaca," and "Icones Plantarum Rariorum." There is also a complete set of W. Griffith's "Posthumous Papers," Waldstein and Kitaibel's "Descriptiones et Icones Plantarum Rariorum Hungariæ," Reichenbach's "Iconographia Botanica," and "Icones Floræ Germanicæ et Helveticæ," Lapeyrouse's "Figures de la Flore des Pyrénées," and Weinmann's "Phytanthozaiconographia."

IN *Science Progress* (No. 62) Mr. F. W. Flattely, in an article on "Some Biological Effects of the Tides," discusses the consequences which tides and tidal action have had on the life of the sea-shores. The abundance of sedentary or fixed forms and the widespread occurrence of the phenomenon of stereotaxis among free-swimming species are traced to the direct action of wave impact. Reference to such semi-marine animals as Ligia, certain species of Littorina, Birgus, and Periophthalmus, is made to show that the population of the land from the sea took place *via* the shore as well as by way of the rivers, and it is suggested that the daily and monthly changes in tidal level, by producing alternating aquatic and terrestrial conditions, made the shore zone an effective bridge between the land and the sea, and provided the opportunity for marine animals to attempt the conquest of the land. The case of Convoluta is quoted to show that the daily rhythm of the tides has imposed a periodicity upon the behaviour of shore forms which tends to become impressed on the animals and to persist after their removal from tidal influence. The far-reaching consequences of such an effect on animal behaviour are suggested rather than insisted on.

IN a paper in the *Philosophical Magazine* for September Drs. Dorothy Wrinch and Harold Jeffreys discuss some of the fundamental principles of scientific inference. They assume that scientific arguments must conform to the rules of pure logic—an assumption which, of course, is by no means universally admitted. They then inquire what conditions must be fulfilled in order that a proposition shall have a finite probability of truth as the result of empirical verification, the term "probability" being used in a sense which they have expounded in a previous paper (*Phil. Mag.*, December, 1919). They conclude that if all possible forms of the law are equally probable *a priori*, then no amount of empirical verification can establish a finite probability in favour of one law rather than another. In order that a finite probability may be established it is necessary that the class of possible laws should form a well-ordered series in which each term is more probable *a priori* than its predecessor, and that the probabilities of this class form a convergent series. The supposition that this necessary condition for valid scientific inference is fulfilled is equivalent to the admission of some principle of "simplicity." Thus, like most of those who discuss the foundations of science, they arrive at very familiar conclusions as a result of very complicated arguments, but that result does not detract from the value or the interest of their inquiries.

THE Greenwich observations for the twelve months from October, 1920, to September, 1921, give 12·43 in. as the total rainfall, which is only 51 per cent. of the normal for the last hundred years. This is the smallest amount on record for the corresponding period, the next smallest being apparently from October, 1897, to September, 1898, when the fall was 14·75 in., or 60 per cent. of the normal. For deficiency this was followed by 16·74 in. from October, 1863, to September, 1864, which is 69 per cent. of the hundred-year normal. The rainfall has been below the average in each of the last thirteen months. This is the longest dry period in the last hundred years with the single exception of fifteen months from November, 1846, to January, 1848, during which time the rainfall for the twelve months from November, 1846, to October, 1847, registered only 16·26 in. October is usually the wettest month of the year, but this year it had a deficiency of more than $1\frac{1}{2}$ in. Different weather conditions prevailed in the early and latter halves of October; the first half of the month experienced summer weather, while in the latter half the weather was cooler and less sunny. Each day from October 1 to 15 was abnormally warm; the mean daily excess over the normal was 10·7° F., the greatest excess being 17° F. on October 6, and there were eight days with an excess of 13·7° F. or more. The duration of sunshine at Greenwich from October 1 to 15 was 101 hours, which is 4 hours more than the normal for the whole month.

THE Department of Commerce, Bureau of Standards, Washington, has issued Scientific Paper No. 416, entitled, "Preparation of Galactose." Owing to the demand made by bacteriologists for galactose and its derivatives, a convenient method is described for preparing this compound from lactose. One kilogram of lactose is hydrolysed by boiling for two hours with 2·5 litres of water and 50 grams of sulphuric acid. The solution is neutralised with barium carbonate, filtered, and concentrated. The galactose is crystallised from the resulting syrup by the addition of a mixture of one part of ethyl and two parts of methyl alcohol. The yield of crude sugar is about 27 per cent. of the lactose taken. The galactose is purified by concentrating to 75 per cent. of total solids, under diminished pressures, a 25 per cent. solution to which a little glacial acetic acid is added. The material is warmed to 60–70°, transferred to a beaker, and 95 per cent. alcohol added to saturation. After standing overnight the crystals are filtered, washed, and dried.

THE presidential address delivered by Mr. G. W. Watson on October 12 last, at the Institution of

Automobile Engineers deals with the subject of industrial standardisation. A little standardisation had been accomplished subsequent to 1910, but the year 1914 found us in a condition of partial impotence, and gave the "component assemblers" in America their opportunity for reaping a rich harvest. Co-operation in this and other matters with a view to the re-establishment of trade is urgent at the present time. Hitherto British industry has been more or less indifferent to the question of standardisation; many directors have been, and still are, apathetic in the matter, and vote money for standardisation more in the spirit of charity donations than as matters of important business. Mr. Watson considers it would be best for British makers to concentrate on the standardisation of commonly applicable details rather than to attempt to produce vehicles alike in all particulars. Abroad there will always be found an appreciable percentage of distinctive British-built cars owned by discriminating users. Standardisation in foreign countries is making great strides; indeed, there are now standards committees in thirteen different countries. A Standards Committee of German Industry was formed three years ago, and in two years had issued 160 standard sheets and had more than 400 in progress.

MESSRS. H. K. LEWIS AND CO., LTD., have just issued a list of additions to their Medical and Scientific Circulating Library for the months July–September. The catalogue should be of service to all students of science, whether subscribers to the library or not.

MESSRS. GURNEY AND JACKSON will shortly publish "The Natural History and Physical Features of the Canary Islands: Their Fauna, Flora, and Geological Formation." The work, which will be illustrated by reproductions of photographs and maps, will deal especially with the ornithology of the islands.

WE have received a copy of a short paper "On Correlation," by Alf Guldberg, from the Norsk Matematisk Forenings Skrifter. The paper (written in English) criticises the divergent definitions of correlation that have been given, and suggests cautions as to interpretation, but there does not appear to be much novelty in the views of which an exposition is given.

Our Astronomical Column.

THE NOVEMBER METEORS.—Mr. W. F. Denning writes:—The shower of Leonids is due at the middle of November, and though the parent comet of the stream is now at a great distance from the earth (approaching us from near the orbit of Uranus) there will probably be a tolerably active exhibition of meteors.

Observations in past years have proved that certain sections of the ellipse are more rich in meteors than others, so that if we assume a period of about thirty-three years for all portions of the stream, the display of November 14, 1888, ought now to be repeated. The shower of that year was not of very special character, but it was fairly conspicuous, and furnished some large fireballs. It was, in fact, considerably more striking than an ordinary return of Leonids when Tempel's comet is far removed from perihelion.

The best time for observation this year will be the morning of the 15th, but unfortunately there will be a full moon in the sky, so that only the brighter meteors will be visible. However, the members of the Leonid stream usually supply a number of splendid objects, and tolerably bright meteors are quite a common feature. Though the conditions affecting this year's return are not therefore favourable, the event should be carefully watched, for it is important to accumulate evidence as to the visible character of the annual displays.

LIGHT OF THE NIGHT SKY.—*Scientia* of October 1 contains an article by Prof. Charles Fabry on the luminosity of the night sky. Prof. Fabry discusses whether or not this luminosity can be attributed to an unresolved background of faint stars. In this connection he insists on the importance of concentrating attention on some small selected area and determining how many stars of each magnitude are present, with a view of extrapolation to stars below the 20th magnitude, which cannot be detected by existing telescopes. The luminosity of the general background of this area should be observed concurrently. If, as appears probable, we cannot plausibly attribute the general illumination to unresolved stars, it would be natural to fall back on the hypothesis of scattered light. That the light can be due to scattering by gaseous matter appears improbable in view of Lord Rayleigh's recent observations on the colour and state of polarisation of the light of the night sky. It may, however, be scattered by meteoritic matter. The article concludes by reference to the aurora as contributing in some cases to the light of the night sky.

DELINEATIONS OF THE MILKY WAY.—Dr. F. Goos, of Hamburg University, has produced a useful series of representations of the Milky Way as delineated by various astronomers, partly from visual study and partly from photographs. The work of Heis, Gould, Easton, Boeddicker, and Houzeau has all been reduced by photography to a common scale, which is somewhat small, but sufficient to show all the important features. There is also a new delineation made by Dr. Goos himself from photographs by Prof. Max Wolf, who contributes an introduction in which he points out that photography is incomparably more rapid and convenient than visual work, but that it has difficulties of its own, as no lens covering a large field will give images of the same character on all parts of the plate; it is thus easy to draw fallacious conclusions as to the relative brightness of different regions. The exposures lasted from three to four hours, and stars down to the thirteenth magnitude are shown on the negatives. The reproductions were made by hand from the negatives and then reduced by photography. They show a large amount of complicated structure, including many of the dark rifts which may be due to opaque matter. Comparison of the different authorities reveals many differences. Boeddicker shows some faint outlying streamers, which are absent from Houzeau and shorter and fainter on the Wolf pictures. Dr. Goos suggests that colour-differences may explain some of these discordances.

The Danish Arctic Station.

By PROF. A. C. SEWARD, F.R.S.

THE Danish Arctic Station at Godhavn, on the south coast of Disco Island, off the west coast of North Greenland (lat. 69° 14′ N.), is not so well known, at least to British scientific workers, as it deserves to be. It is the only station in the world within the Arctic Circle where it is possible under very favourable conditions and with adequate facilities to carry out experimental scientific investigations.

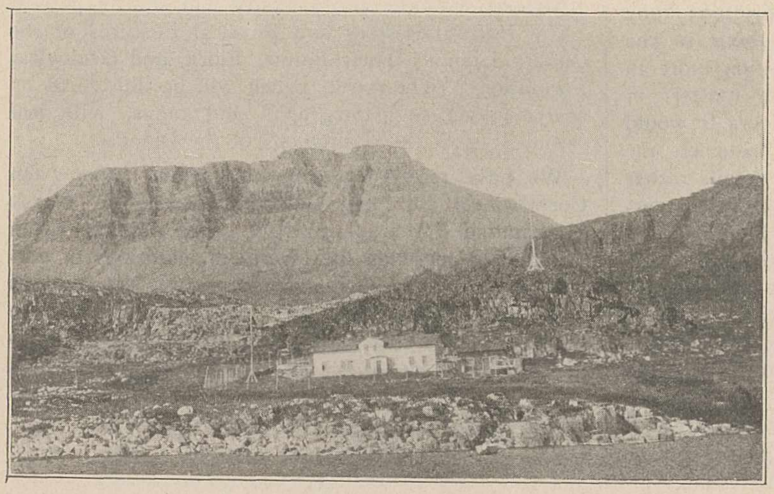

FIG. 1.—The Arctic station, showing Archæan gneiss in the foreground and, behind, one of the mountains carved out of the plateau of Tertiary basalt sheets and beds of tuff.

In 1898 the present director, Mr. Morten P. Porsild, on his return from an expedition under the late Dr. K. J. V. Steenstrup, to which he was attached as botanist, made an unsuccessful attempt to induce the Danish Government to establish a station in Greenland. Some years later funds were obtained from private sources, chiefly from Mr. A. Holck, of Copenhagen, and Mr. Porsild, with the assistance of two Danish carpenters and some native labourers, but largely with his own hands, built the present station and established himself there in 1906. The Government at once took over the station, with Mr. Porsild as director, and made an annual grant of 10,000 kronen to cover all expenses, including the director's stipend. The director for Greenland, at present Mr. Daugaard-Jensen, an official who, under the Minister of the Interior, is responsible for Greenland affairs, has the assistance of a Commission composed of a few scientific men to advise him on all matters connected with the station.

The station is about 1 km. from Godhavn harbour, and is reached by a road, probably the best road in Greenland, made by Mr. Porsild. The station consists of a well-built and exceptionally warm wooden house of two stories approximately 20 by 10 metres in plan. On the ground floor there is a well-equipped laboratory and a dark room, a library containing about 5500 books and pamphlets, and an excellent herbarium of Arctic and some Alpine plants, and living rooms; on the first floor are two good bedrooms for visitors and a workroom. The library receives contributions from foreign institutions and from individuals in return for papers published at the station or for specimens. British authors whose work deals with subjects bearing upon Arctic problems will do good service to science by sending reprints to the director.

Near the main building is a large workshop, and an adjacent stream provides an abundant supply of excellent water. The station is built on glacial sand at the foot of the rounded hummocks of gneiss which on this part of the coast form the foothills in front of the terraced basaltic cliffs rising to a height of more than 2000 ft. (Fig. 1). On the seaward side the station faces Disco Bay, with the Crown Prince Islands in the distance, and in the foreground there are always several icebergs (Fig. 2) which have stranded on the shore after drifting across the bay from the large Jakobshavn ice-fjord.

The main objects Mr. Porsild had in view in founding the station were to provide a base for a geographical and geological survey of the country, a centre from which to investigate the fauna and flora of a particularly rich Arctic region, and means for experimental work, both biological and chemical. It would be difficult to find a more suitable place as a training school for men who wish to qualify themselves for Arctic exploration, as in winter the locality is particularly well situated for sledging and ski-ing. The station's motor-boat is available for expeditions and for marine investigations, while for shorter trips, especially to places where the anchorage is bad, visitors can hire a umyak (a long flat-bottomed skin boat).

Since 1908 there have been fourteen visitors to the station from Denmark, Sweden, Germany, Switzerland, and America, who have resided there several weeks or months, and many others for shorter periods. Forty scientific papers on work done at the station or dealing with material collected in the neighbourhood have been published, and of these twenty-five are by the director.

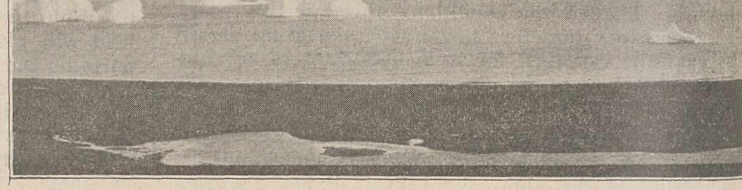

FIG. 2.—View from the Arctic station. Icebergs stranded on the beach of Disco Bay.

As Greenland occupies an exceptional position as a "closed" country, it is necessary for all foreigners, also for Danes not officially connected with Greenland, to obtain permission from the Danish Government to go there. British applicants should submit recommendations through the Foreign Office and specify the purpose of their visit. There is at present no fee for working at the station, and for board and lodging the charge is at present only 8 kronen a day. The North Greenland district is accessible to ships from the latter part of May to the end of September, but during that time there are usually only two opportunities of direct connection with Copenhagen.

The director is an ideal man for the position; he is generally acknowledged to be the leading authority not only on the natural history of West Greenland, but on the history of Eskimo culture, and he is always willing unreservedly to place his knowledge and the results of his wide experience at the disposal of fellow-workers.

It was my privilege this summer, in company with Mr. R. E. Holttum, of St. John's College, Cambridge, to spend some weeks at the Arctic station, and I cannot speak too highly of the hospitality and scientific assistance which we received. Unfortunately for the cause of research, the director has no paid assistant to relieve him of much of the routine work of the station which makes serious inroads into the time available for investigations in his own special fields. One of the director's sons, Mr. Erling Porsild, who is not only a keen naturalist, but also is able to speak the Eskimo's language with ease, took us for a week's trip in the station's motor-boat to some localities where we wished to collect fossil plants. Our intention was to return to Godhavn in time for the King's visit before visiting more remote places, but the breaking of the boat's shaft and a spell of bad weather rendered this impossible, and threatened seriously to interfere with our subsequent plans. Mr. Porsild at once approached the Director for Greenland who accompanied the Royal party, and he very kindly placed at our disposal for a month's trip his official motor-boat—an act of generosity for which it is difficult adequately to express my gratitude.

The particularly favourable climatic conditions in the Godhavn district have produced an exceptionally rich and varied flora, including several southern types not found elsewhere in North Greenland. There is a legend that Disco Island once lay much further south, and as it was an obstacle to navigation a hunter towed it behind his kayak to its present position.

Mr. Porsild has taken steps to protect the vegetation in the immediate neighbourhood of the station and at Englishman's Harbour, near the warm springs, of which there are several on the south coast of Disco, by putting up notices in the Eskimo language asking the natives to abstain from gathering fuel or collecting plants for food within certain protected areas—a request which is almost invariably respected.

The Danish Government by officially adopting the Arctic station showed its appreciation of the foresight and determination of Mr. Porsild, and set an example to other nations possessing territory within the Arctic Circle. One may venture to express the hope that the State will see its way to increase the value of this pioneer station by augmenting the annual grant sufficiently to provide an adequate stipend for the director and for a trained assistant, by the provision of an additional and larger motor-boat, and by expending the comparatively small sum required to make certain much-needed extensions of the building to relieve the present congestion in the rapidly growing library, and to accommodate the very valuable collection of Eskimo implements and weapons obtained by the director in the course of excavations made by him during several years on the mainland.

Psychological Tests for Vocational Guidance.[1]

THE newly-formed section of Psychology had, at its first meeting in Edinburgh, a large and enthusiastic attendance. It opened its sittings on the morning of Thursday, September 8, being joined by the sections of Education and Economics, under the chairmanship of Sir Henry Hadow (president of the Education Section), with a discussion upon "Vocational Tests and Vocational Training." It appeared in the course of the several speeches, that economists, educationists, and psychologists alike were agreed upon one general and practical conclusion, namely, the feasibility and the importance of diagnosing during early childhood, whether by tests or other means, each individual's special vocational aptitudes.

Sir William Beveridge (director of the London School of Economics), who spoke late in the discussion, summed up the arguments for this conclusion most clearly. With other speakers he welcomed cordially the progress of industrial psychology, and maintained that if boys could be selected with greater care for the vocations they had to take up, three distinct economic consequences might be predicted. In the first place, unemployment would be appreciably diminished; although it was impossible to expect that lack of work would be altogether abolished simply by right vocational selection, it would beyond question be very much reduced. Secondly, the tenure of employment would be more nearly permanent: one of the chief causes that prevented people from sticking to the jobs they had obtained would be largely eliminated. Lastly, productivity would be greatly increased. Besides these more limited effects, economic in their special nature, there would be a wider benefit to the public at large—a general decrease in human misery, and a general increase in human welfare.

He proceeded with some severity to criticise the method, or lack of method, now obtaining among employers in their choice of persons for different kinds of occupation. There were few things, he said, which employers handled more inefficiently than the selection of their employees. It is true that the president of the Economics Section later on disagreed with these criticisms of the employers' method of choice. Mr. Hichens considered that employers exercised an extraordinary amount of care in choosing workers, both for higher and for lower positions. Indeed, they showed some advance upon the methods hitherto adopted by educationists. Instead of setting examination papers in which candidates were asked to name the kings of Israel, they asked questions and used trial tasks which had a definite bearing upon the trade process concerned.

In face of this slight disagreement among the economists, the psychologists replied that, even if the employers' methods were superior to the old-fashioned methods of the educationists, they were still highly unscientific and quite unstandardised. As an instance of the work possible and necessary in this direction, Dr. C. S. Myers (director of the Cambridge Psychological Laboratories) described the work of the new

[1] Discussion at a joint meeting of the Sections of Psychology, Fducation and Economics of the British Association at Edinburgh on September 8

National Institute of Industrial Psychology in London. Here attempts were being made at the request of large firms not only to improve the psychological conditions in their industries, but also to send scientifically trained psychologists to test applicants for particular kinds of work. Other psychologists, who spoke later, emphasised the value of the vocational testing already carried out in America, and dwelt especially upon the success of recent tests for general ability or intelligence.

There seemed a general feeling, announced particularly by the educationists, that the process of vocational guidance and testing should begin while the child was still at school; and it was even suggested that the general kind of education imparted at school should be very largely determined by the results of such tests.

This, indeed, was the position taken up in the opening speech by Dr. C. W. Kimmins (Chief Inspector of the Education Department of the London County Council). London, he claimed, offered the finest field for psychological research in the whole world. Here, under one authority, were accumulated 800,000 children and 20,000 teachers. He pointed out that the London County Council had, just before the outbreak of the war, added to the officers of the education department a psychologist, whose business it was to investigate both individual cases and general problems in the schools; and he described in detail certain aspects of the psychological work under the Council, work (he added) that only the recent demand for economy had prevented from rapid expansion. Since psychology had taken an important and an official part in investigations among school children, there had been, in London at any rate, large changes. In days gone by the children sent to special schools for the mentally deficient were often merely backward; and, thus stigmatised as mentally defective, their vocational future was often seriously prejudiced. But it was now possible by means of psychological tests to ascertain at the outset whether a child was genuinely and innately defective in native ability, or whether he was merely retarded through accidental causes in his educational attainments alone. His own experience of special schools now was that the children sent to them at the present day were really mentally deficient; and here, in schools of this type, the elder boys receive special industrial training suited to their capacities and future prospects. At the other end of the scale intelligence tests were now also being used in connection with the transference of brighter children to the secondary schools. Certain children, he said, might, up to a certain stage, do well in routine school work, and even pass their scholarship examinations, and yet it might prove that they had not sufficient inborn intelligence to profit by the higher instruction.

Dr. Kimmins, however, urged not merely the employment of the better known tests of intelligence, but also the elaboration of tests specifically devised for different occupations. In this reference he stated that some time ago he had made an investigation into the after-employment of children in the London district. He described the state of affairs that he found as tragic. In their first appointments an enormous proportion of the children gained unsuitable jobs; when they found themselves unsuitable they threw them up and drifted from one position to another. In many cases he found that boys of the greatest promise had eventually become mere van boys. And, generally, he concluded, although we spend an enormous amount of money upon education, we fail to give sufficient attention to the marketing of our products. He, therefore, advocated the adoption of a system by which the child, upon leaving school, would receive a carefully drawn up statement, based upon psychological tests and prolonged observation, showing the line of employment for which he or she was best fitted. If this were done, he argued, the number of misfits would be much fewer than that observable to-day.

Mr. D. Kennedy Fraser (lecturer in education at the University of Edinburgh) spoke upon similar lines. He described from personal experience the use of intelligence tests in America. The result of these had been to show that an appreciable proportion of the population, something like one in forty, did not even during adult life attain a mental level beyond that of the average ten-year-old child. He strongly urged the execution of similar researches in this country. He concluded that, as a result of the newer discoveries made by the application of psychological methods to school children, the use of intelligence tests would eliminate—and was, indeed, the only possible way to eliminate—an enormous waste of time and effort on the part of teachers. Thus vocational testing and vocational training were now needed as an essential part of a system of general education.

Mr. Frank Watts, formerly lecturer on psychology in the University of Manchester, agreed with the foregoing speakers upon the importance of vocational testing, but he emphasised the fact that the tests were as yet still somewhat imperfect. The problem was usually stated too simply. It was depicted purely as a question of fitting pegs, round or square, into holes of an appropriate shape. He pointed out that the pegs were plastic and malleable, and the holes were constantly changing their shape; and both, as a rule, were neither absolutely square nor absolutely round. Further psychological investigation was, therefore, needed not only into the capabilities of the applicant, but also upon the requirements of the different kinds of job for which he might apply. Just as Sir William Beveridge had urged that firms should take a more intelligent interest in testing and training, so Mr. Watts urged that educationists must bring the schools into more vital contact with the industrial firms. One of the chief difficulties was that not only did the employer know nothing about the applicant, but the applicant when he left school knew nothing about industry.

This latter point was also emphasised in the speech of Dr. Myers, who made the very valuable suggestion that the kinematograph should be used to show the responsibilities, the prospects, the advantages, and the dangers of various occupations. Dr. Myers insisted that the choice of the occupation must be made by the individual himself; but the boy needed advice; and, helpful as they might be, neither teachers nor parents were entirely adequate to supply that advice because they themselves were without detailed knowledge of industrial requirements. Expert advice, therefore, was essential. Here once more was evident the need for a national institute of vocational psychology, though, even in the work of such an institute, the co-operation of the teacher and of the education authority still remained indispensable.

Miss L. Grier (principal-elect of Lady Margaret Hall, Oxford) was one of the few speakers who explicitly urged the importance of direct vocational training in addition to general vocational testing. It was apparently her view that, after we had discovered what the boy was suitable for, we should attempt to teach him and train him somewhat more specifically upon those lines. In giving this training, the question as between the factory and the school, she believed, was no longer confused by the old distinction between useful and useless knowledge. The idea that knowledge that was useful ceased to be educational was now exploded. The special institutions that existed for giving training in particular subjects should now be able to supply excellent apparatus and specialised teachers for the purpose. Unfortunately, however, too often these institutions were crippled in their finances.

Prof. Reid, of Aberdeen, urged that the responsibility of training was at present thrown too exclusively upon the schools. Speakers had argued for industrialising education. He wished to argue for educationalising industry. And he thought that a hopeful change in this direction might be anticipated if the spirit of the older and smaller industries could be got into the big industrial concerns to-day. Other speeches, following somewhat upon these lines, seemed to indicate that the general opinion of the three united sections had reached this interesting, and, on the surface, somewhat paradoxical, conclusion: at present the industries left training to the school, and kept vocational selection to themselves; it was urged the industries should take upon themselves more and more of the responsibilities of training, and the schools should take on more and more of the work of the testing and selecting with a view to ultimate vocational guidance. But it seemed universally agreed that, whether in the matter of training or in that of selection, neither school nor industry could shift the responsibilities entirely on to the shoulders of the other.

Mechanical Engineering Education in Bengal.

SOME months ago a committee was appointed by the Government of Bengal to investigate the training of mechanical engineers in the Province, with special reference to the improvement of the education of apprentices in the State railway workshops at Kancharapara. The committee consists of Sir Rajendra Nath Mookerjee, Mr. A. T. Weston (Director of Industries), Mr. B. Heaton (principal, Bengal Engineering College), Prof. R. Wolfenden (professor of mechanical engineering, Bengal Engineering College), Mr. W. H. Everett (Director of Technical Education, Bengal), Mr. A. Cochran, Mr. H. Spalding, Mr. S. A. Skinner, Mr. Miller King, Mr. H. S. Strachey (representing the railway workshops and various well-known engineering firms in Calcutta), and Dutt Subrawardy, of the Bengal Legislative Council.

This committee is to be known as the "Board of Control for Apprenticeship Training in Bengal." It has had several meetings and has drawn up a scheme of apprenticeship training which, it is hoped, will greatly improve mechanical engineering education in Bengal. The scheme, which will be put into operation at Kancharapara immediately, consists of an admission examination (similar to the graduate examination of the Institution of Mechanical Engineers), followed by four years' training in workshops with compulsory attendance at a technical school to be built at Kancharapara. All the apprentices will live in barracks to be provided by the railway. It is hoped that by the end of the four years of training the brighter students will have reached such a standard of proficiency in mechanical engineering subjects as will enable them to proceed to a two years' course in the mechanical engineering department of the Bengal Engineering College. Those who are not sufficiently well qualified to be admitted to the college will remain at the works for a further two years of training. The course will, therefore, in all cases be a six years' course. The scheme, at present, will be compulsory only in the workshops of the East Bengal Railway at Kancharapara, but it is hoped that other State workshops—such as the ordnance factories and the large engineering firms in Calcutta—will join in the scheme.

The new Board of Control is also supervising the courses and examinations in mechanical engineering at the Bengal Engineering College. These courses have to provide, at present, for students admitted directly to the college after having passed the matriculation, or the intermediate science examinations of Calcutta University. They comprise (*a*) a three years' course at the college, together with three years' practical training in approved workshops, leading to a college diploma; and (*b*) a four years' course at the college followed by two years' practical training in workshops leading to the associateship of the college. Course (*b*) is for the exceptionally good men who, in the opinion of the examiners and of the professor of mechanical engineering, would profit by a year of more advanced training.

The courses are arranged to suit the conditions prevailing in India, and will include training in modern workshop methods and measurements, and in workshop management and accounts. It is hoped that these courses will succeed in producing a regular supply of thoroughly trained mechanical engineers for service in the Province.

University and Educational Intelligence.

EDINBURGH.—There comes into operation this year the new Science Ordinance, under which a student may study either for a pass or for an honours B.Sc. degree. Four years is the minimum time in which either degree may be completed. The main difference between the two classes of degree is that a student aiming at the honours degree in any science devotes in general the third and fourth years to a specialised study of the subject he is professing, cognate sciences being studied up to a somewhat lower standard. In the pass degree several branches of science are carried forward simultaneously to an intermediate standard. With the exception of the first year chemistry the lectures and laboratory work are now being conducted in the new King's Buildings on the southern margin of greater Edinburgh. Next year all the work will be transferred there.

The University Court has approved generally of a draft Ordinance founding an independent professorship in the department of natural philosophy, to be called the Tait chair of natural philosophy.

The following new courses have been instituted:—(1) A course in Indian geology for forestry students who have been selected as probationers for the Indian Forest Service, and (2) two half courses in economic geology, the first to deal with ore deposits.

In terms of an Act of Parliament recently passed the income of the John Newland Endowment (capital 22,500*l.*) will in future be applied in bursaries, the award to be determined on the results of the University examination for entrance bursaries.

Negotiations have been completed for the purchase of about ten acres of ground for the extension of the University athletic field.

MANCHESTER.—Prof. F. E. Weiss has been appointed Pro-Vice-Chancellor.

The resignation of Mr. P. A. Cooper, assistant lecturer in physics, is announced.

Mr. C. G. Core and Miss Lucy Higginbotham have been re-appointed Schunk research assistants.

PROF. W. A. BONE will deliver a lecture on "The late W. A. Haward's Experiments upon the Combustion of Hydrogen-Carbon Monoxide at High Pressures" before the Royal College of Science Chemical Society on Friday, November 11. The lecture is intended as a memorial to Mr. Haward, who lost his life in December last through an accident while carrying on research on the subject of the lecture.

THE MARQUESS OF CREWE will preside at the annual dinner of the Old Students' Associations of the Imperial College of Science and Technology, London, to be held on Thursday, November 24, at the Trocadero Restaurant, London, W.1. He will be supported by distinguished guests, the governors, and by past and present professors and staff of the college and its constituent colleges.

THE usual winter courses of the Ecole d'Anthropologie will begin at Paris on November 4. The ten professors all continue their teaching on the branches of anthropology with which they are concerned, and their number has been augmented by the appointment of M. Paul Boncour as professor of criminal anthropology. Conferences will be held by M. G. Courty on the petroglyphs of the region round Paris, by M. Dubreuil-Chambardel on the geography and anthropological history of the basin of the Loire, and by M. Saintyves on the origin of *contes*, and the *contes* of Perrault considered in the light of anthropology and ethnography.

THAT Battersea Polytechnic, like most other institutions for higher education, is hampered by lack of accommodation is apparent from a perusal of the Principal's report for the session 1920–21. The entries for the day courses are shown for a number of past sessions, of which it is sufficient for purposes of comparison to take the figures for the session 1913–14. An increase of, roughly, 30 per cent. is shown by the entries for the 1920–21 session, although there are now very few in training who may be regarded as students whose training was interrupted by war service. Unfortunately, a similar comparison of numbers of evening students is not possible. The figures for 1914–15 are, however, given, and an equally striking increase, in this case of nearly 55 per cent., is shown. These numbers are an ample confirmation of the Principal's plea for increased accommodation. In spite of the strain which this increase of numbers has placed on the teaching staff, a certain amount of research has been undertaken by the Principal and his colleagues, and, in addition, a few research students have been at work in the chemical and engineering departments.

THE Rhodes Trust has issued a statement for the academic year 1920–21 dealing with the scholarships it administers. From the pamphlet it appears that no less than 277 Rhodes scholars were in residence during that period, 129 from the United States, and 148 from the British Empire; 120 took up their scholarship for the first time during the year. The figures giving the distribution according to subjects show that law, with 91 scholars, claimed the greatest number, while natural science, in which medicine is included, came next with 62; mathematics had six Rhodes scholars, forestry three, agriculture and geography two each, and one took anthropology. The value of the scholarship has now been increased by 50*l.* per annum, but the Trust warns prospective scholars that even thus the emoluments will not ordinarily cover the expenses of a full year. Appointments will be made to the 1923 scholarships during the course of next year, and further information can be obtained from the Secretary, Seymour House, Waterloo Place, S.W.1.

Calendar of Scientific Pioneers.

November 3, 1643. Habakkuk Guldin died.—A convert to the Roman Catholic faith, Guldin, or Guldinus, held the chairs of mathematics in the Jesuit colleges at Rome and Gratz. His "Centrobarytica," 1635–42, contained his well-known theorems.

November 3, 1832. Sir John Leslie died.—The successor of Playfair in the chairs of mathematics and natural philosophy at Edinburgh, Leslie made researches in radiation, photometry and hygroscopy in connection with which he devised the differential thermometer. He was the first to freeze water by rapid evaporation in a vacuum.

November 4, 1698. Erasme Bartholin died.—Bartholin, or Berthelsen, a member of a Danish scientific family, was first professor of mathematics, and then professor of medicine at Copenhagen. He is remembered for his discovery in 1669 of the double refraction in Iceland spar.

November 5, 1879. James Clerk Maxwell died.—Born in Edinburgh in 1831, Maxwell was educated at Edinburgh and Cambridge, and in 1854 was Smith's prizeman. He later held the chairs of natural philosophy at Marischal College, Aberdeen, and King's College, London, and in 1871 became the first Cavendish professor of experimental physics at Cambridge, where he died. His principal investigations referred to the kinetic theory of gases, the perception of colour, the theory of the electromagnetic field, and the electromagnetic theory of light. His great treatise on electricity and magnetism, called the Principia of the nineteenth century, appeared in 1873, and in 1879 he published the "Electrical Researches of the Hon. Henry Cavendish." Maxwell was the successor of Faraday, from whom he drew much inspiration, and his electrical work has revolutionised the whole aspect of science.

November 6, 1777. Bernard de Jussieu died.—The brother of Antoine de Jussieu (1686–1758), Bernard de Jussieu also was celebrated as a botanist, and for many years was connected with the Jardin du Roi. He was the first to prove that fresh-water polypi are animals and not plants.

November 6, 1822. Claude Louis Berthollet died.—The contemporary of Lavoisier, de Morveau, and Chaptal, Berthollet contributed greatly to the advance of chemistry, and among his discoveries was that of the bleaching power of chlorine. His "Essai de Statique Chimique," the first attempt to deal with chemical physics, apeared in 1803.

November 7, 1817. Jean André Deluc died.—A native of Geneva, Deluc engaged in business for some years, but in 1773 came to England and was made reader to Queen Charlotte. He made valuable observations on meteorology, and to him is due the scientific use of the word geology.

November 7, 1872. Rudolph Friedrich Alfred Clebsch died.—Professor of mathematics at Karlsrühe, Giessen, and Göttingen, Clebsch wrote on elasticity, Abelian functions, and on binary algebraical forms.

November 9, 1871. Adolph Strecker died.—Trained under Liebig at Giessen, Strecker was afterwards professor at Christiania, Tübingen, and Wurzburg, and was known for his researches in organic chemistry.

November 9, 1896. Johan August Hugo Gylden died.—A distinguished Swedish astronomer, Gylden was trained by Hansen, served under Struve at Pulkowa, and in 1871 became director of the observatory at Stockholm. The theory of the motion of the planets and comets, stellar parallax, proper motions, cosmogony, and photometry are among the subjects dealt with in his numerous memoirs. E. C. S.

Societies and Academies.

LONDON.

Association of Economic Biologists, October 14.—Sir David Prain, president, in the chair.—Dr. W. **Brown**: The physiology of the infection process. The lecturer gave an account of recent work carried out in the Imperial College of Science on the physiology of parasitism, dealing chiefly with the fungus *Botrytis cinerea.* Evidence was brought forward showing that the actual penetration of the host-tissue took place by mechanical means. The most careful examination, both by chemical and cytological methods, failed to show evidence of a cutin-dissolving enzyme. The mechanical theory of penetration was further supported by the fact that fungi could penetrate membranes, such as gold-leaf, paraffin-wax, etc., on which they could not possibly exert any chemical action whatsoever. The well-known "action in advance" subsequent to penetration was shown to be due to a toxic enzyme, the properties of which had been studied in detail. Previous to penetration the fungus exerted no action on the host. On the other hand, a passive exosmosis of substances took place from the host into the infection drop, this leading in some cases to stimulation, in others to inhibition, of fungal germination. The question of the existence of tropic stimuli as a factor in infection was discussed, and attention was directed to the necessity of investigating the nutritional requirements of particular fungi, in connection with which numerous problems had arisen in recent work.

Zoological Society, October 18.—Sir S. F. Harmer, vice-president, in the chair.—Prof. G. Elliot **Smith**: The habits of Tarsius.—S. **Hirst**: Some new parasitic mites.—Prof. J. P. **McMurrich**: Note on the systematic position and distribution of the Actinian, *Sagartia luciae.*

MANCHESTER.

Literary and Philosophical Society, October 14.—Mr. T. A. Coward, president, in the chair.—Dr. I. **Langmuir**: Molecular structure. The modern conception of the atom is that of a nucleus surrounded by electrons, and all the chemical and physical properties of the atom are due, in a large measure, to the number of these electrons and their arrangement around the nucleus. The author indicated three postulates, and explained in certain cases how these postulates accorded with the simple and well-known properties of the atoms considered. He was able to show wherein lay the fundamental difference between organic chemical compounds and inorganic compounds; and he explained how the electrical conductivity of certain substances in the molten state or in solution could be accounted for and why some elements are gaseous and others solid under ordinary conditions.

October 18.—Mr. T. A. Coward, president, in the chair.—Prof. T. H. **Pear**: The visualisation of numbers in space: some comments upon Galton's theory of number-forms. The ability to picture numbers mentally during calculation is not infrequently combined with a tendency to see them arranged in a definite pattern, each number occupying a fixed position relative to the subject's line of sight. Such number-forms are by no means rare; 7 per cent. of a large number of university students were found to possess them. The spatial relations of the numbers are so definite and fixed that tri-dimensional wire models representing them exactly can be made. Two such models, made by members of the society, were exhibited. Most possessors of number-forms do not regard their gift as unusual, and are sometimes surprised to discover that calculation is possible without them. The lecturer discussed a number of aspects of the subject, of which Sir Francis Galton's original description in the "Inquiries into Human Faculty" can now be supplemented or corrected. While Galton believed that number-forms were hereditary, the lecturer held that Galton's evidence was inadequate, and he produced evidence to show that environmental factors could produce resemblances between number-forms amongst unrelated persons as great as, or greater than, those found by Galton to occur in the same family. Moreover, the common appearance in number-forms of the clock-face, the statistical frequency with which the turns occur at 10 and 12, and the occasional representation of the negative values support the view that they are acquired.

PARIS.

Academy of Sciences, October 17.—M. Georges Lemoine in the chair.—A. **Blondel**: A vectorial equation, in complex notation, of the alternator with two reactions. Its applications.—C. **Camichel**: Hydraulic states of flow. An experimental study of the conditions of steady and turbulent flow of water in tubes.—C. **Le Morvan**: Photographic and systematic map of the moon. Remarks on the second part of the map of the moon, comprising the surface visible at the phases between opposition and new moon.—M. **Baudouin**: The material representation on stone of the constellation of the Great Bear, belonging to the polished stone period. A detailed account of five undoubted cases representative of the constellation Ursa Major on bones of the neolithic period.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the second quarter of 1921. Observations were possible on 88 days during the quarter: the results are given in tables showing the number of sunspots, their distribution in latitude, and the distribution of the faculæ in latitude.—M. **Brillouin**: Bohr's atom. The Lagrange circum-nuclear function.—K. **Ogura**: The curvature of light rays in the field of gravitation.—C. E. **Brazier**: The resistance of the air to the movement of spheres, and the rate of ascent of pilot balloons. From the experimental data of Cave and Dines, Rouch, and La Porte, the values of K, the coefficient of resistance, are calculated corresponding to increasing values of N (Reynolds's number).—A. **Dauvillier**: Contribution to the study of the electronic structure of the heavy atoms and their spectral lines.—M. **Dejean**: The demagnetising field of cylindrical bars of mild steel. Curves are given showing the relations between the intensity of magnetisation and strength of field for a series of bars of the same steel, varying in length from 5 mm. to 1200 mm. The demagnetising influence of the poles is illustrated by a second series of curves derived from the first set.—G. **Claude**: The manufacture of hydrogen by the partial liquefaction of water gas. Experiments in the preparation of hydrogen suitable for ammonia synthesis from water gas, commenced in 1908, were abandoned on account of the difficulties encountered. The work has been taken up again and the difficulties surmounted. The gas is allowed to do external work on expansion, and the lubrication troubles caused by the low temperatures were prevented by the addition of 5 per cent. of nitrogen to the hydrogen. A diagram of the apparatus is given. A plant is now working at Montereau treating 500 cb.m. of water gas per hour, and giving 230 cb.m. of hydrogen containing 1·5 per cent. of carbon monoxide. The energy required can be cheaply furnished by the utilisation of one quarter of the liquefied carbon monoxide in a gas engine.—H. **Copaux**: A rapid method for the estimation of phosphoric acid. —A. **Mailhe**: Petrol prepared from rape oil. Rape oil was treated at 550–650° C. with a copper-aluminium catalyst, and the lighter liquid fractions hydrogenated over nickel. The petrol contained large proportions of aromatic and naphthenic hydrocarbons.—P. **Bugnon**: The theory of syncotylia and the case of *Streptopus amplexifolius*. The notion of the phyllode applied to the interpretation of the cotyledon of the Monocotyledons.—L. **Léger** and S. **Stankovitch**: Artificial impregnation and development of *Aspro asper*.—L. **Blaringhem**: The production of the "marbled varieties" of the bean, *Vicia Faba*. An account of the results of experiments in crossing *Vicia Faba*, variety *pliniana*, with the variety *equina*.—R. **Courrier**: The determinism of the secondary sexual characters in the Arthropods. In agreement with previous observations on vertebrates, the seminal elements do not determine the secondary sexual characters in Arthropods. These are probably determined by a hormone produced by an organ physiologically independent of the seminal gland.—Mlle. M. **Gauthier**: Coccidia of *Cottus gobio*.—L. **Fournier** and L. **Guénot**: The treatment of syphilis by bismuth. An account of the treatment of 110 cases of syphilis by tartro-bismuthate of potassium and sodium: the favourable results fully confirm those of R. Sazerac and Levaditi, and prove the powerful therapeutic effects of bismuth against syphilis in various forms.

BRUSSELS.

Royal Academy of Belgium, July 2.—M. Cesàro in the chair.—G. **Cesàro**: An elementary demonstration of the form of the caustic by reflection, and of the formula giving the refractive index of a prism as a function of the minimum angle of deviation.—G. **Cesàro**: The form of the crystals deposited by a thin layer of crystal-forming liquid on a plain sheet of glass.—C. **Servais**: Orthological reciprocal tetrahedra. —J. **Neuberg**: The orthogonal projection of a tetrahedron on a plane and on a surface of the fourth order. —F. **Swarts**: Some fatty fluorides.—A. **de Hemptinne**: Reduction of metallic oxides by the silent electric discharge (fourth communication).—E. **van Aubel**: A relation between the absolute melting points, boiling points, and critical temperatures of bodies.—E. **Henriot** and R. **Crombes**: Variation of the refractive index with temperature. Numerical comparison of the different formulæ proposed.

August 6.—G. Cesàro in the chair.—C. **Servais**: The quadrics of revolution.—A. **Demoulin**: Encircled surfaces.—V. **Willem**: Synchronism of the respiratory movements and the cardiac pulsations of fishes.—H. **Rouche**: Parafluorometanitrobenzoic acid.

October 8.—G. Cesàro in the chair.—P. **Stroobant**: Observations of Saturn made in 1921 at the time of disappearance of the ring.—J. **Verschaffelt**: The graphical construction of capillary menisci.—J. **Verschaffelt**: The determination, by graphical construction, of the capillary rise of a liquid between two coaxial cylinders.—J. **Neuberg**: A problem on articulated quadrilaterals.—A. **de Hemptinne**: The reduction of metallic oxides by the silent electric discharge.—L. **Godeaux**: A linear congruence of skew cubics.—M. **Keelhoff**: Airy's formula.

WASHINGTON, D.C.

National Academy of Sciences, Proceedings, vol. 6, No. 10. October, 1920.—A survey of research problems in geophysics prepared by chairmen of sections of the American Geophysical Union. This detailed research survey has the following major subdivisions: W. **Bowie**: Present status of geodesy and some of the problems of this branch of geophysics; H. F. **Reid**: The problems of seismology; C. F. **Marvin**: The status and problems of meteorology; L. A. **Bauer**: Some of the chief problems in terrestrial magnetism and electricity; G. W. **Littlehales**: The problems and functions of the Section of Physical Oceanography of the American Geophysical Union; H. S. **Washington**: The problems of volcanology; R. B. **Sosman**: An outline of geophysical-chemical problems.—W. D. **Harkins**: The ionisation of strong electrolytes. Discussion of the various meanings attached to the word "ionise."—A. G. **Webster**: A condition for Helmholtz's equation similar to Lamé's. —W. **Duane**, H. **Fricke**, and W. **Stenström**: The absorption of X-rays by chemical elements of high atomic numbers. The critical absorption wave-lengths of the K series of most of the available chemical elements from tungsten to uranium were measured. The values of the wave-lengths are uniformly larger than those obtained by photographic methods, by an amount between 1 and 2 per cent.—E. H. **Hall**: The Thomson effect and thermal conduction in metals. A continuation of previous papers on thermal conduction. Data are given for eighteen metals, and compared with the theory.—J. **Lipka**: Motion on a surface for any positional field of force. The complete geometric characteristic properties of the system of trajectories are determined.

Books Received.

Geography for Senior Classes. By E. Marsden and T. Alford Smith. Pp. x+521+14 coloured maps. (London: Macmillan and Co., Ltd.) 7*s*. 6*d*.

Islands Far Away: Fijian Pictures with Pen and Brush. By Agnes G. King. Second edition. Pp. xxxii+256. (London: Sifton, Praed and Co., Ltd.) 18*s*. net.

Catalogue of Scientific Papers. Compiled by the Royal Society of London. Fourth series (1884–1900). Vol. 17, Marc–P. Pp. v+1053. (Cambridge: At the University Press.) 9*l*. net.

Relativity and Gravitation. Edited by J. Malcolm Bird. Pp. xiv+345. (London: Methuen and Co., Ltd.) 8*s*. 6*d*. net.

Atomic Theories. By F. H. Loring. Pp. ix+218. (London: Methuen and Co., Ltd.) 12*s*. 6*d*. net.

Guide Pratique de Sylviculture. By Dr. F. Fankhauser. Troisième édition française, by M. Petitmermet. Pp. 348. (Lausanne, Genève, and Paris: Payot et Cie.)

Bartholomew's General Map of Europe, showing Boundaries of States according to Treaties. 35 in. by 23 in. (Edinburgh: J. Bartholomew and Son, Ltd.) 1*s*. net.

Le Parasitisme et la Symbiose. By Prof. M. Caullery. (Encyclopédie scientifique: Bibliothèque de Biologie générale.) Pp. xiii+400+xii. (Paris: G. Doin.) 14 francs net.

Plane Geometry for Schools. By T. A. Beckett and F. E. Robinson. Part 1. Pp. viii+239+v. (London: Rivingtons.) 5*s*.

Hellenism and Christianity. By E. Bevan. Pp. 275. (London: G. Allen and Unwin, Ltd.) 12*s*. 6*d*. net.

Department of Scientific and Industrial Research. The Geological Survey of Great Britain and the Museum of Practical Geology: Report of the Geological Survey Board with the Report of the Director for the Year 1920. Pp. 25. (London: H.M. Stationery Office.) 1*s*. net.

The Psychology of Society. By Morris Ginsberg. Pp. xvi+174. (London: Methuen and Co., Ltd.) 5s. net.

Ministère de l'Agriculture. Direction Générale des Eaux et Forêts. (2e Partie): Service des Grandes Forces Hydrauliques (Région du Sud-Ouest). Résultats Obtenus pour le Bassin de l'Adour pendant les Années 1917 et 1918: Tome 7, Fascicule A. Pp. 39+Charts 2–51. 2e Partie: Eaux et Génie Rural. Service des Grandes Forces Hydrauliques (Région du Sud-Est). Annexe 1 du Tome 9: Nivellements. Planches 162–191. Annexe 2 du Tome 9: Cartes. Charts 21–28. 2e Partie: Eaux et Améliorations Agricoles. Service des Grandes Forces Hydrauliques (Région du Sud-Est): Compte rendu et Résultats des Etudes et Travaux au 31 Décembre, 1917. Tome 9. Pp. 491. (Paris: Ministère de l'Agriculture.)

Exceptional Children and Public School Policy: Including a Mental Survey of the New Haven Elementary Schools. By Prof. A. Gesell. Pp. 66. (New Haven: Yale University Press; London: Oxford University Press.) 4s. 6d. net.

Laboratory Manual in General Microbiology. Prepared by the Laboratory of Bacteriology and Hygiene, Michigan Agricultural College. Second edition. Pp. xxii+472. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 21s. net.

General Physics and its Application to Industry and Everyday Life. By Prof. E. S. Ferry. Pp. xvi+732. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 24s. net.

Handbook of Meteorology: A Manual for Cooperative Observers and Students. By J. W. Redway. Pp. v+294. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 24s. net.

Organic Dependence and Disease: Their Origin and Significance. By Dr. J. M. Clarke. Pp. 113. (New Haven: Yale University Press; London: Oxford University Press.) 12s. 6d. net.

A Treatise on the Transformation of the Intestinal Flora, with special reference to the Implantation of Bacillus Acidophilus. From the Sheffield Laboratory of Bacteriology, Yale University. By Prof. L. F. Rettger and H. A. Cheplin. Pp. vii+135+8 plates. (New Haven: Yale University Press; London: Oxford University Press.) 12s. 6d. net.

Les Combustibles liquides et leurs Applications. Par le Syndicat d'Applications Industrielles des Combustibles liquides. Pp. iii+621. (Paris: Gauthier-Villars et Cie.)

Examples in Optics. Compiled by Dr. T. J. I'a Bromwich. Pp. 16. (Cambridge: Bowes and Bowes.) 2s. net.

University of Calcutta: Anthropological Papers, No. 6. The First Outlines of a Systematic Anthropology of Asia, with Tables of Stature, Cephalic Index, and Nasal Index of Living Subjects. By Prof. V. Giuffrida-Ruggeri. Translated from the Italian by Haranchandra Chakladar. Revised by the author with additions. (Reprinted from the Journal of the Department of Letters, vol. 5). Pp. 110. (Calcutta: University Press.)

Sir Jagadish Chander Bose: His Life, Discoveries, and Writings. Pp. vii+40+248. (Madras: G. A. Natesan and Co.) 3 rupees.

The Induction Motor and other Alternating Current Motors: Their Theory and Principles of Design. By B. A. Behrend. Second edition, revised and enlarged. Pp. xxiii+272. (New York and London: McGraw-Hill Book Co., Inc.) 24s. net.

Alchemy: Its Science and Romance. By the Rt. Rev. J. E. Mercer. Pp. x+245. (London: S.P.C.K.) 9s. net.

Handbuch der Holzkonservierung. Edited by Ernst Troschel. Pp. xi+540. (Berlin: J. Springer.) In Germany, 18 marks; in England, 54 marks.

The Physical Society of London and the Optical Society. A Discussion on "The Making of Reflecting Surfaces," held on November 26, 1920, at the Imperial College of Science and Technology, South Kensington, S.W.7. Pp. iii+44. (London: The Optical Society.) 5s.

Found Wanting: A Labour Verdict on Prohibition. By C. H. Sitch and J. E. Davison. Pp. 15. (London: Harrison, Jehring and Co., Ltd.) 6d.

Botanical Memoirs, No. 10: The Somatic Organization of the Phæophyceæ. By A. H. Church. Pp. 110. (New York and London: Oxford University Press.) 5s. net.

Absolute Measurements in Electricity and Magnetism. By Prof. A. Gray. Second edition, rewritten and extended. Pp. xix+837. (London: Macmillan and Co., Ltd.) 42s. net.

Radioactivity and Radioactive Substances. By Dr. J. Chadwick. (Pitman's Technical Primer Series.) Pp. xii+111. (London: Sir Isaac Pitman and Sons, Ltd.) 2s. 6d. net.

Illustrations of the Flowering Plants and Ferns of the Falkland Islands. By Mrs. E. F. Vallentin. With Descriptions by Mrs. E. M. Cotton. Pp. xii+64 plates and text+2. (London: Lovell Reeve and Co., Ltd.) 84s. net.

Technique of the Teat and Capillary Glass Tube: Being a Handbook for the Medical Research Laboratory and the Research Ward. By Sir Almroth E. Wright, with the collaboration of L. Colebrook. Second edition. Pp. xxvi+384+3 plates. (London: Constable and Co., Ltd.) 42s. net.

Diary of Societies.

THURSDAY, NOVEMBER 3.

ROYAL SOCIETY, at 4.30.—Prof. T. R. Merton: The Spectra of Lead Isotopes.—G. I. Taylor: Experiments with Rotating Fluids.—Prof. L. Bairstow, Miss B. M. Cave, and Miss E. D. Lang: The Two-dimensional Slow Motion of Viscous Fluids.—Prof. H. C. H. Carpenter and Constance Elam: The Production of Single Crystals of Aluminium and their Tensile Properties.—Prof. C. V. Raman and B. Ray: The Transmission Colours of Sulphur Suspensions.—Prof. E. F. Burton and Miss E. Bishop: The Law of Distribution of Particles in Colloidal Solution.

LINNEAN SOCIETY, at 5.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Sqdn.-Ldr. R. M. Hill: Manœuvres of Getting Off and Landing.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. H. Joseph: A Retrospect of a Quarter of a Century of Seaside Practice.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—J. S. Highfield: Inaugural Address.

CHEMICAL SOCIETY, at 8.—Informal Meeting.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Dr. G. Cranstoun: Cystic Adenoma of the Uterus.—Dr. R. L. MacKenzie Wallis: Glycosuria in Pregnancy.

FRIDAY, NOVEMBER 4.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.45.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—Col. H. G. Lyons, Prof. C. V. Boys, Col. E. H. Grove-Hills, and Col. Sir G. P. Lenox-Conyngham: The Eötvös Gravity Balance.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. H. S. Hele-Shaw: Power Transmission by Oil (Thomas Hawksley Lecture).

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—H. E. G. Boyle: Report on his visit as Official Representative of the Section to the first meeting of the Canadian Society of Anæsthetists at Niagara, and to the meeting of the American Society of Anæsthetists at Boston in June last.

MONDAY, NOVEMBER 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS, INC. (at Geological Society), at 5.30.—C. H. Naylor: Extraction Turbines.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—J. S. Highfield and others: Discussion: How Best to Speed Up Electrical Progress.

ARISTOTELIAN SOCIETY (at 21 Gower Street), at 8.—Prof. J. H. Leuba: Intuition in Experience and in Philosophy.

SOCIETY OF CHEMICAL INDUSTRY (at Chemical Society), at 8.—N. E. Rambush: Comparison between Laboratory Fuel Tests and Practical Working Results of the Producer Gas Process.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—M. W. Hilton-Simpson: The Aureo Massif, Algeria.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—P. Waterhouse: Inaugural Address.

TUESDAY, NOVEMBER 8.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. Moon: First FitzPatrick Lecture.
ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—E. P. Chance: The Laying-habits of the Cuckoo (*Cuculus canorus*) and the Life of the Young Cuckoo.—Dr. W. Rae Sherriffs: Evolution within the Genus. Part I., *Dendronephthya* (*Spongodes*), with Descriptions of a Number of Species. Part II., Description of Species (Alcyonaria) taken by the "Siboga" Expedition.—Dr. C. F. Sonntag: The Comparative Anatomy of the Tongues of the Mammalia. V., Lemuroidea and Tarsioidea. VI., Summary and Classification of the Tongues of the Primates.—R. I. Pocock: The External Characters and Classification of the Mustelidæ.
ROYAL PHOTOGRAPHIC SOCIETY, at 7.—S. O. Rawling: Sepia Toning with Colloidal Sulphur.—W. L. Wilkinson: Scott Archer's and Hardwick's Wet Collodion Formula Revised.—Miss F. M. Hamer: The Optical and Photographic Properties of Some Isomeric Isocyanines.
QUEKETT MICROSCOPICAL CLUB, at 7.30.—F. Addey: *Pinus sylvestris*.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Capt. G. Crowden and Prof. G. Elliot Smith: The Mound Builders of Dunstable.

WEDNESDAY, NOVEMBER 9.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. L. D. Stamp and S. W. Wooldridge: The Igneous and Associated Rocks of Llanwrtyd (Brecon).—Dr. L. D. Stamp: The Base of the Devonian, with Special Reference to the Welsh Borderland.
ROYAL SOCIETY OF MEDICINE (Surgery: Subsection of Proctology), at 5.30.
INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Sectional Meeting), at 6.—Dr. G. W. O. Howe: Address.
INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—Dr. L. Aitchison: Chromium Steels and Irons.
ROYAL SOCIETY OF ARTS, at 8.—D. R. Wilson: The Work of the Industrial Fatigue Research Board, and its applications to Industry.

THURSDAY, NOVEMBER 10.

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—A. J. Wilmott: Experimental Researches on Vegetable Assimilation and Respiration. XIV., Assimilation by Submerged Water Plants in Dilute Solutions of Bicarbonates and of Acids, and Improved Bubble Counting Technique.—E. G. Young: The Coagulation of Protein by Sunlight.—E. G. Young: The Optical Rotatory Power of Crystalline Ovalbumin and Serum Albumin.—A. R. Ling and D. R. Nanji: The Longevity of Certain Species of Yeast.—F. Kidd, C. West, and G. E. Briggs: A Quantitative Analysis of the Growth of *Helianthus annuus*. Part I., The Respiration of the Plant and of its Parts throughout the Life Cycle.—G. S. Currey: The Colouring Matter of Red Roses.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. Moon: Second FitzPatrick Lecture.
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—F. S. Marvin: The Teaching of History.
OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Dr. A. Gleichen: The Path of Rays in Periscopes having an Inverting System comprising Two Separated Lenses. —Dr. J. W. French: The Interocular Distance.—T. Chaundy: Note on the Thin Astigmatic Lens.
INSTITUTE OF METALS (London Section) (at Royal School of Mines), at 8.—Prof. C. H. Desch: Plastic Flow in Metals.
INSTITUTION OF AUTOMOBILE ENGINEERS (at Olympia).—T. Thornycroft; N. Macmillan: Marine Motors.
ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Sir William Thorburn and Dr. W. Harris: Discussion: The Treatment of Persistent Pain due to Lesions of the Central and Peripheral Nervous System.

FRIDAY, NOVEMBER 11.

OIL AND COLOUR CHEMISTS' ASSOCIATION.
PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—Sir William Bragg: The Structure of Crystals of Organic Substances (Presidential Address).
ROYAL ASTRONOMICAL SOCIETY, at 5.
ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.
ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Dr. W. S. Inman: The Relationship of Squint, Left-handedness, and Stammering.—Dr. C. F. Harford: The New Psychology and its Relation to Problems of Vision.

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

THURSDAY, NOVEMBER 3.

UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Feudalism: The Background of the European System (1).
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (1).
CHADWICK PUBLIC LECTURE (at Royal Institute of British Architects), at 8.—Prof. P. Groom: Dry Rot of Wood and Sanitation.

FRIDAY, NOVEMBER 4.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (4). At 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (1).

MONDAY, NOVEMBER 7.

KING'S COLLEGE, at 5.30.—Dr. W. R. Ormandy: Liquid Fuel Engines (2).
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (1).

TUESDAY, NOVEMBER 8.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Modern Scientific Revolution and its Meaning for Philosophy (5); The Principle of Relativity.—Dr. W. Brown: Psychology and Psychotherapy (4).—L. J. Hunt: Cascade Synchronous Motors and Generators (4).

WEDNESDAY, NOVEMBER 9.

KING'S COLLEGE, at 4.30.—Dr. C. Da Fano: Histology of the Nervous System (5). At 5.15.—Prof. R. R. Gates: Flora of the British Empire.
SCHOOL OF ORIENTAL STUDIES, at 5.—Rev. W. Sutton Page: Chaitanya and the Vaishnava Revival in the 16th Century.
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (2).

THURSDAY, NOVEMBER 10.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 3.—W. Bateson: Recent Advances in Genetics (2).
UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: European Feudalism: Its Variation and Decay (2).
BIRKBECK COLLEGE, at 5.30.—Prof. F. Soddy: The Bearing of Physical Science on Economics (1).
KING'S COLLEGE, at 5.30.—H. W. Fitz-Simons: Bridge Construction (3).

FRIDAY, NOVEMBER 11.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (5). At 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (2).
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (3).

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