THURSDAY, MARCH 16, 1916.

LONDON HYDROLOGY.

Old London's Spas, Baths, and Wells. By Dr. S. Sunderland. Pp. xii + 169. (London: John Bale, Sons, and Danielsson, Ltd., 1915.) Price 7*s.* 6*d.* net.

A LARGE number of springs in London have been closed (in recent years) in order to protect the public from the risks of water-borne maladies. Some, like the famous Broad Street Pump, at the time of the cholera epidemic in 1854, have been proved to be the active distributors of disease. But it may be questioned whether in the wholesale closing of the London wells the innocent have not suffered with the guilty. It is sometimes forgotten that the change in water-supply generally signifies the substitution of *mixed* waters for the water of a single source. It is at least open to question whether, from the point of view of health, fresh drinking water from a single source is not to be preferred to mixed waters of whatever purity.

In this attractive book Dr. Sunderland states that in 1866 people in the City of London had access to thirty-five public pumps, all now closed. Many other districts of the great London basin, such as Clerkenwell, were rich in springs. All these particular sources have been abolished with drastic thoroughness in order to avoid the danger of possible contamination. In return, under a "Water Board," London enjoys the blessing so aptly described by an astonished visitor from a waterless country in the East as a "spring in every house." But now the Londoner drinks not water, but waters.

The present volume originated in the author's presidential address before the section of the Royal Society of Medicine which is concerned with the medical aspects of waters and climates. It gives the best account yet published of the springs of old London, especially of those—surprisingly numerous—which have been at various times medically employed. No fewer than thirty medicinal springs "of slight importance" in and near London are described, all of which were doubtless esteemed for curative properties by the people in their localities, whether for drinking or bathing. The chalybeate springs form everywhere the largest class of mineralised waters, and many of this kind in London were applied locally for their astringent properties, like the "Eye Waters" of Highgate and of the St. Anne's Well in Hyde Park. This popular recourse and attachment to waters for common ailments belongs, as we know, to all times and to all places, but in London it has been in our own day finally extinguished by the zeal of the sanitarian.

A wider importance attached to the old London spas—medicinal springs which from merit or accident acquired a considerable reputation in the town, and became in consequence, in varying degrees, fashionable health and pleasure resorts. The author traces the history and character of these spas, some of which were "spurious" and others "genuine" and medically valuable. He gives particulars of twenty situated north of the Thames, and eight of these were within a mile of King's Cross. It is interesting to note that one of these, the Islington Spa, was under Royal favour much frequented, as many as sixteen hundred persons drinking the water in one morning. Another notable northern spa was that of Hampstead. It took origin in the seventeenth century, and was a true health resort—offering a tonic water in a tonic air. Perhaps the chief among the spas of London, possessed of real medical value, Hampstead fell a victim to the great malady of health resorts—the unbridled appetite for pleasure. "It is reasonable to believe," says Dr. Sunderland, speaking of another London resort, "that the beneficial effect of the tonic water was counterbalanced by the feastings, just as in the present day some of the good effects of the British and foreign spas frequented by the richer classes are annulled by the high living at the magnificent hotels where some of the visitors stay."

South of the Thames there were thirteen spas, including Richmond, Epsom, and Shooter's Hill, which were really country health resorts. We are told that Streatham is the "only one of the old London spas where the waters can be drunk at the present day with beneficial effect." This mild medicinal water was formerly much frequented and esteemed by competent authority.

It is appropriate that this forgotten chapter in British hydrology should be recalled now. The brief but golden age of the London spas ceased with the rise of others further from the capital. Leamington, Cheltenham, Bath, Tunbridge Wells came into favour, and some of these in their turn have paled before the glories of more remote attractions. It is the old story of the lure of the unknown, of the "distant and the far." But conditions now are different. It must be remembered that an exact knowledge of the actions and uses of waters has only been made available in the present generation. Thanks to an accurate study

of hydrological medicine, these natural remedial agents can now be prescribed with authority and precision, and presently it will be as foolish to go to the wrong spa as to choose an inappropriate drug or an improper operation in surgery.

For the necessary growth of this knowledge research and instruction must go hand in hand. At the present time, as Dr. Sunderland points out, the value of waters and baths scientifically applied is being abundantly proved in the case of sick and wounded soldiers. The results obtained at the British spas show how great and unexpected are the resources of our own country in this respect.

That which is wanting in British hydrology is system—both in scientific teaching and in co-ordinating the unrivalled assets belonging to the health resorts of the Empire. It remains for London to meet this need by providing the means of special instruction and research. Here as elsewhere in medicine the tradition and empiricism of the past must in due course give place to ordered knowledge and instructed art.

Dr. Sunderland's book is profusely illustrated and withal entertaining, and may be recommended to all who are interested in the social as well as the medical history of London.

ORGANIC CHEMISTRY.

Organic Chemistry, or Chemistry of the Carbon Compounds. By Victor von Richter. Volume i. *Chemistry of the Aliphatic Series.* Newly translated and revised from the German edition by Dr. P. E. Spielmann. Pp. xvi+719. (London: Kegan Paul and Co., Ltd., 1915.) Price 21*s.* net.

NO more striking illustration of the development of organic chemistry could be found than that presented by the growth of this popular German treatise. Appearing about 1880, as companion volume to a modest octavo text-book on inorganic chemistry, it rapidly acquired popularity and passed through numerous editions. As the contents swelled with each succeeding edition, it became necessary first to divide the book into two parts and finally to modify the format. Like many German scientific books it soon found an American translator and publisher, and has reached its third American edition. The present volume, it should be noted, is the first *English* edition, a term which we presume refers to the nationality of the publisher rather than to the greater purity of the vernacular of the last translator. Be that as it may, Richter's organic chemistry has passed out of the region of text-books.

The theoretical part is condensed into a comparatively few pages at the beginning of the volume, and is of so sketchy and superficial a character as to possess little value for the student. Yet the subject, especially on the physical side in connection with structural problems, is one of growing interest and importance. This is a cardinal defect. On the other hand, the book is so crowded with facts as to form a kind of abridged "Beilstein." It is divided into chapters containing the names of a large number of related compounds, an outline of the mode of their preparation, and an account of their more important physical and chemical properties. Occasionally there is a proper name attached to a compound or process, and sometimes a reference. It is rarely that one finds an English name, or, indeed, that of any other nationality than German. There is no reference to the modern method for preparing silicon alkyl compounds or to its author; no reference to the discoverer of oxalyl chloride, ketene, and the numerous azoimides, or to the mechanism of the formation of formic acid from glycerol and oxalic acid, though the process is given, or to the abnormal addition of bromine to maleic acid, which is wrongly described.

English names, it appears from the preface, are purposely omitted for the remarkable reason that "references to German literature have been retained with the object of preserving to the student the advantages of the origin of the book; the English references will be otherwise readily obtainable by him." If the references are not given, nor even the names of authors of these fundamental discoveries, it is difficult to see how they will be "readily obtainable." No doubt there are advantages in having the origin of the book steadily thrust upon one as a stimulus to the British chemist; but it is to be hoped that there may be forthcoming a text-book—a real students' text-book—of organic chemistry which shall give him a clear, critical, and suggestive review of the big problems of organic chemistry with which the names of many distinguished English chemists are linked. That the English organic chemist has pursued the experimental part of the subject with the object of elucidating theoretical rather than practical problems is readily explained by the fact that his activities on the industrial side have been necessarily restricted, and he has had little incentive up to the present to busy himself with the discovery of new classes of commercially useful products.

J. B. C.

THE ELEMENTARY PRINCIPLES OF CROP PRODUCTION.

(1) *A Student's Book on Soils and Manures.* By Dr. E. J. Russell. Pp. ix+206. (Cambridge: At the University Press, 1915.) Price 3*s.* 6*d.* net.

(2) *Soils and Plant Life as Related to Agriculture.* By Prof. J. C. Cunningham and W. H. Lancelot. Pp. xx+348. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 5*s.* net.

(1) IN the past the "Farm Institute" has been very inadequately represented in our system of agricultural education, but of late much has been done to remedy this defect, and, but for the outbreak of war, more would by now have been accomplished. This type of institution is designed to serve primarily the needs of the country youth whose general education is inadequate for the more advanced courses of the universities and agricultural colleges. The common type of "farm institute" student will thus be the youth whose previous education has been restricted to the curriculum of the rural elementary school with, in most cases, an intervening period of practical work on the farm.

It is for such students that the series of text-books, of which Dr. Russell's volume is the latest issue, is primarily intended, and by the standard of their capabilities it must be judged. It is not clear just in what way Dr. Russell intends his book to be used. In scope and general mode of presentation it may well serve as a pattern for the teacher, but in the hands of the average "farm institute" student we fear that, without considerable assistance from the teacher, much of it will be rather difficult reading. The fault lies probably not so much with Dr. Russell, who has sacrificed nothing in clearness and attractiveness of presentation, as with the limitations of space imposed upon him, which have necessitated a measure of condensation which is undesirable in all elementary text-books, and in none more so than in those provided for the agricultural student.

For its refreshingly unorthodox and suggestive treatment of a well-worn subject, the book is highly to be commended. An excellent feature is the freedom with which the results of experiments made in this country have been drawn upon for the purposes of exposition. The Rothamsted experiments naturally have been chiefly drawn upon, but the useful work done elsewhere is more adequately represented than in any other text-book. The book is printed in attractive type, is freely illustrated with photographs and diagrams, and, apart from one or two obvious slips, leaves nothing to be desired in precision.

(2) In so far as they cover the same ground, the treatment of the subject by Messrs. Cunningham and Lancelot differs widely from that of Dr. Russell. In their "first study in agriculture for rural, grade, and high schools, based upon sound educational principles," they adopt throughout the didactic method which postulates at each stage the approach to knowledge through individual experimental inquiry. The student is led by easy and connected stages through the study of the origin, nature, and functions of the soil, to the study of the outstanding phenomena of plant life, and the application of the knowledge thus gained to the practical problems of crop production.

The numerous exercises in the first half of the book are well designed and practical in their bearing, and are described with a care which must ensure success in the hands of the most inexpert student. It is left to the student to draw his own conclusions, although by leading questions his attention is directed to the essential information which it is desired that he shall acquire.

The method of treatment is quite conventional, but is so well and carefully worked out that the intelligent student cannot fail to acquire a very useful knowledge of the subject. A word of commendation must be given to the photographic illustrations, which are numerous and uniformly good.

The work is intended for the American student, and the exercises and illustrations are largely such as appeal most directly to him, but students and teachers in this country will find much that is useful and suggestive in it.

OUR BOOKSHELF.

Third Appendix to the Sixth Edition of Dana's System of Mineralogy. By Prof. W. E. Ford. Completing the work to 1915. Pp. xiii+87. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 6*s.* 6*d.* net.

THE study of mineralogy has received a new stimulus in recent years from discoveries in radio-activity and in the use of X-rays for the exploration of crystal-structure. Just as the determination of optical principles from large and specially selected specimens laid the foundations of microscopic petrography, so these later physical experiments are bound to provide new methods of mineral analysis. While enlarging in the widest sense the bounds of human knowledge, they will reveal the alliances and differences among minerals that bring a philosophic touch into the dry matter of classification. The third appendix to Dana's "System of Mineralogy," drawn up by

Prof. Ford, shows the fresh material available for research, and the progress that has been made through new observations on established species in the last six years. A special list is given of literature on X-rays and crystal structure.

Numerous studies on the thermal behaviour of quartz and on its relations to cristobalite and tridymite come within the period covered by this appendix, and the attention of geologists may well be directed to the references given on p. 66. A cross-reference to these would have been useful under the heads of the other forms of crystalline silica. Among the new species we may note barbierite, which indicates that a monoclinic structure may be formed under certain conditions by the well known felspathic molecule, $NaAlSi_3O_8$. Bazzite, a blue scandium silicate from Baveno, and several vanadium minerals seem attractive novelties. Sefströmite, among the latter, passes away as a mixture. Metallic tantalum, first described in 1909, forms an important record, and specimens have already found their way from the Urals into most collections. It is late to quarrel with the makers of new names, but didymolite, with no didymium, platynolite, suggesting platinum when pronounced, and Prof. Ford's own pyroxmangite for "manganopyroxene," strike us as unfortunate. The author of this appendix, however, will at once be gratefully absolved.

G. A. J. C.

The Structure of the Fowl. By Dr. O. C. Bradley. Pp. xi+153. (London: A. and C. Black, Ltd., 1915.) Price 3*s.* 6*d.* net.

THE author of this little volume has successfully accomplished a somewhat difficult task in his effort to produce a concise and not too elaborate account of the structure of the fowl. The first chapter deals with the zoological position of birds, and includes a very interesting account of the probable ancestry of the domestic fowl. This is followed by chapters on the skeleton and muscular system, both of which are of necessity dealt with in a very elementary fashion. More detail is entered into when the author deals in successive chapters with the digestive system, the respiratory organs, the urinary organs, the reproductive organs, and the circulatory system. The descriptions of the macroscopic characters of these apparatuses are so clear and lucid that they can be well and easily followed by readers who have received little or no previous anatomical training, while the microscopic structure is dealt with in such a masterly way as to render the book of the greatest assistance to the student of comparative histology and pathology. The illustrations in these sections are excellent, and have very considerably simplified the author's task. The nervous system, the eye and its appendages, and the ear are briefly considered, and a chapter is also devoted to the skin and its appendages.

Probably the best chapter is that on the development of the chick, which is dealt with in rather more detail, the various stages being well illustrated.

While this little book would appear to contain little or nothing that is new, it is the only work with which we are acquainted that contains such an excellent general description of the structure of the fowl. The illustrations must be regarded as a special feature. There are seventy-three of them, and many are full-page plates.

There is a very complete index. G. H. W.

LETTERS TO THE EDITOR.

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

The Structure of the Line of Wave-Length 4686 Å.U.

PREVIOUS experiments by one of us (NATURE, vol. xcii., p. 5; *Phil. Mag.*, vol. xxix., pp. 284–297, 1915) have shown that the 4686 line could be obtained by passing a condenser discharge through pure helium, and it was concluded that the results supported a theory put forward by Dr. Bohr (*Phil Mag.*, vol. xxvi., p. 1, 1913). This theory, which was deduced by applying the quantum hypothesis to Sir Ernest Rutherford's atom-model, ascribed the line to helium. On the other hand, Rydberg, assuming the Pickering lines to constitute the sharp series of hydrogen from analogy with the spectra of the alkali metals, obtained by calculation the value 4687·88 for the wave-length of the first line of the principal series of hydrogen.

The present experiments on the structure of the line were commenced with the purpose of testing still further its chemical origin, and of obtaining results which would throw further light on the mechanism of emission of spectrum lines. The importance of accurate knowledge of the structure of hydrogen and helium lines from the latter point of view has already been shown by Bohr (*Phil. Mag.*, vol. xxix., p. 332, 1915). It is well known that the hydrogen lines of the Balmer series are not single lines, but close doublets, and it is therefore to be expected from both Rydberg's and Bohr's theories, that the 4686 line should also have a complex structure. According to Rydberg's theory, the line should be a doublet having the same frequency difference as the members of the Balmer series. The recent measurements of Buisson and Fabry gave 0·132 Å U. as the separation of the two components of Hα, and it follows by calculation that the two components of the 4686 line should be separated by 0·0674 Å.U. From Bohr's theory, the details of the structure of the line could not be anticipated, but from the supposed analogy between the mechanism of emission of the 4686 line and the lines of the Balmer series, it was hoped that a knowledge of the structure of the line would serve as a guide in testing different hypotheses for explaining the doubling of the hydrogen lines.

The origin of the "4686" line has recently been studied by Merton (NATURE, vol. xcv., p. 64; Proc. Roy. Soc., vol. xci., p. 382, 1915), who used a method based on Lord Rayleigh's theory of the width of spectrum lines. He concluded that either the breadth of the line is controlled by circumstances at present unknown, or that the line originates from systems of sub-atomic mass. Later experiments by the same author (Proc. Roy. Soc., vol. xci., p. 421, 1915, February, 1916) show that the widths of some spectrum lines are not wholly due to the motion of the molecules.

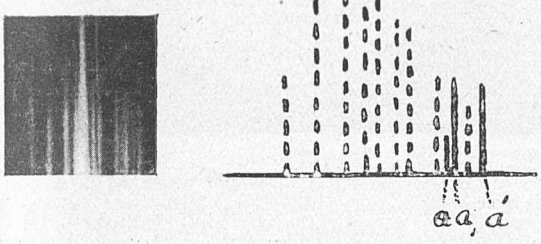
In our first set of experiments the line was excited by passing a condenser discharge through a helium

tube with an adjustable spark gap in series with it. The structure of the line was studied by means of an echelon spectroscope, consisting of thirty-three glass plates, each plate being 9·48 mm. thick. The resolving power of the instrument at 4686 was 441,421, and the distance between successive orders of the line was 0·350 A.U. The line when excited by a condenser discharge was found to be very broad and diffuse, and two successive orders were only just separated on the best photographs. In some experiments the spectrum tube was immersed in liquid air, but no measurable improvement in the sharpness of the line was obtained. This result may also be expected on Bohr's theory, as the atom is charged when emitting the lines. It was therefore decided to excite the line by means of a direct current, keeping the drop of potential between the anode and kathode as low as possible. The direct-current machine, which was connected through a liquid resistance to the electrodes, could give a voltage of 2000 and an output of one kilowatt. As fairly large currents were passed through the gas the cylindrical spectrum tube was made large, and was also provided with two heavy aluminium electrodes, one of which was concave and the other a hollow cylinder. The tube was used in the end-on position.

It was found that when the cylindrical electrode was made the kathode the light was almost completely confined to the space inside the cylinder, and that it was very intense. Experiments were usually conducted at a pressure of 1 mm., and the voltage between the anode and kathode varied in different experiments between 280 and 400. Under these conditions, although the ordinary helium lines were strong, the 4686 line was comparatively faint, and exposures of about two hours were necessary for obtaining a satisfactory photograph.

The line was found to be surprisingly sharp; in fact, it was comparable in sharpness with the lines of the ordinary helium spectrum, and much sharper than the Hβ line of hydrogen, which was photographed at the same time. In addition, all the photographs showed that the line was a close doublet, the components having almost equal intensity. The best photographs were measured up, and the distance apart of the two components was found to be 0·094 Å.U. It is interesting to note that the separation to be expected on Rydberg's theory is 0·067 Å.U.

The structure of the line is shown in the accompanying photograph, which is explained by the diagram. The dotted lines represent the different orders of the 4713 helium line and its faint component, and the full lines the 4686 line. The doublet is represented by aa_1, and a^1 is a higher order of a.



These experiments were still in progress when there appeared a very interesting theoretical paper by Sommerfeld (*Bay. Akad. d. Wiss.*, Munich, 1916) on the structure of spectrum lines, which was based on a remarkable generalisation of Bohr's theory. In this paper he quotes certain unpublished results of Paschen on the structure of several lines of the series

$$n = k'\left\{\frac{1}{(1\tfrac{1}{2})^2} - \frac{1}{\left(\frac{n}{2}\right)^2}\right\}$$

the first member of which is the 4686 line, and also of several lines of the series

$$n = k'\left\{\frac{1}{(2)^2} - \frac{1}{\left(\frac{n}{2}\right)^2}\right\}$$

which includes the Pickering lines, and also another series of lines near the hydrogen lines, one member of which, at 6560·4, was first observed by one of us in a helium tube.

In complete agreement with Sommerfeld's theory Paschen found that the 4686 line consisted of three components, each of which was accompanied by fainter satellites, and the two stronger components were separated by a distance one-fourth of that between the outer components. The values of the separations in Ångstrom units as obtained by Paschen are not given in Sommerfeld's paper, but it is stated that the ratios of the separations of the components of the 4686 line to the separations of the components of Hα agree with the values predicted by the theory. Our result for the distance between the components of the doublet also agrees approximately with the value predicted by Sommerfeld for the separation of the two strongest components. Since the appearance of the paper we have re-examined all our photographs to see if they show the presence of a third faint component which we had missed. On our best photograph we found near one of the higher orders of the doublet, but not completely separated from it, a faint line. If this line is a lower order of the third component its separation measured from the doublet is about 0·40 Å.U., and it is situated on the higher wave-length side, as is to be expected according to Sommerfeld's theory.

E. J. EVANS.
C. CROXSON.

Manchester University, March 4.

Ground Rainbows.

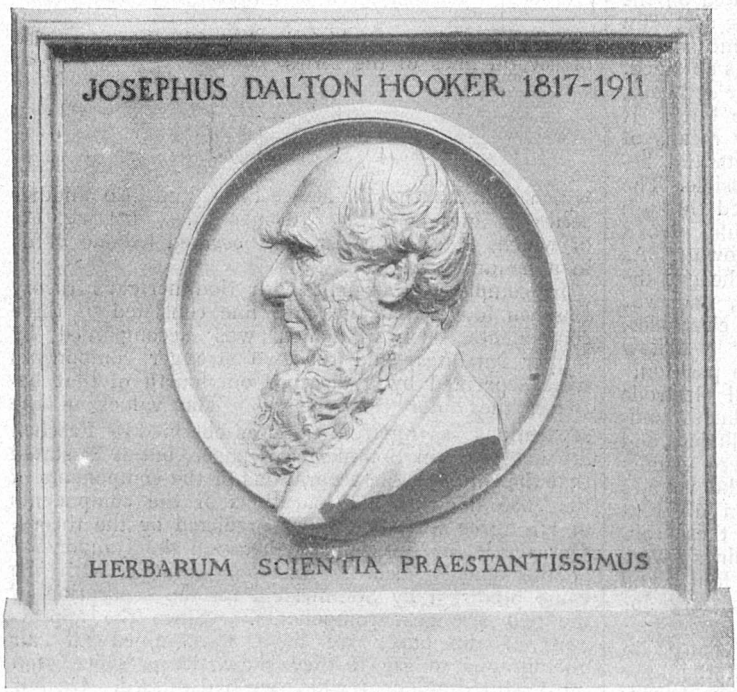
MR. A. E. HEATH asks (NATURE, March 2, p. 5) how gossamer which "seems to be a kind of spider web, comes to be spread over so large an area." Mr. Heath need have gone no further than Selborne to find the correct explanation, given by Gilbert White 140 years ago:—"Nobody in these days doubts that they (the cobweb-like appearances) are the real production of small spiders which swarm in the fields in fine weather in autumn, and have a power of shooting out webs from their tails so as to render themselves buoyant." Possibly the first part of the sentence was not true when Gilbert White wrote it, seeing that it is not always the case to-day. The thick clouds of gossamer noticed by Mr. N. T. Porter when out shooting in the early morning were noticed also by Gilbert White in September, 1741, when "intent on field diversions I rose before daybreak." If a more recent account of gossamer is preferred it may be found in Fabre's "Life of a Spider."

CHARLES J. P. CAVE.

Meteorological Office, South Farnborough,
March 7.

MEMORIALS OF MEN OF SCIENCE IN WESTMINSTER ABBEY.

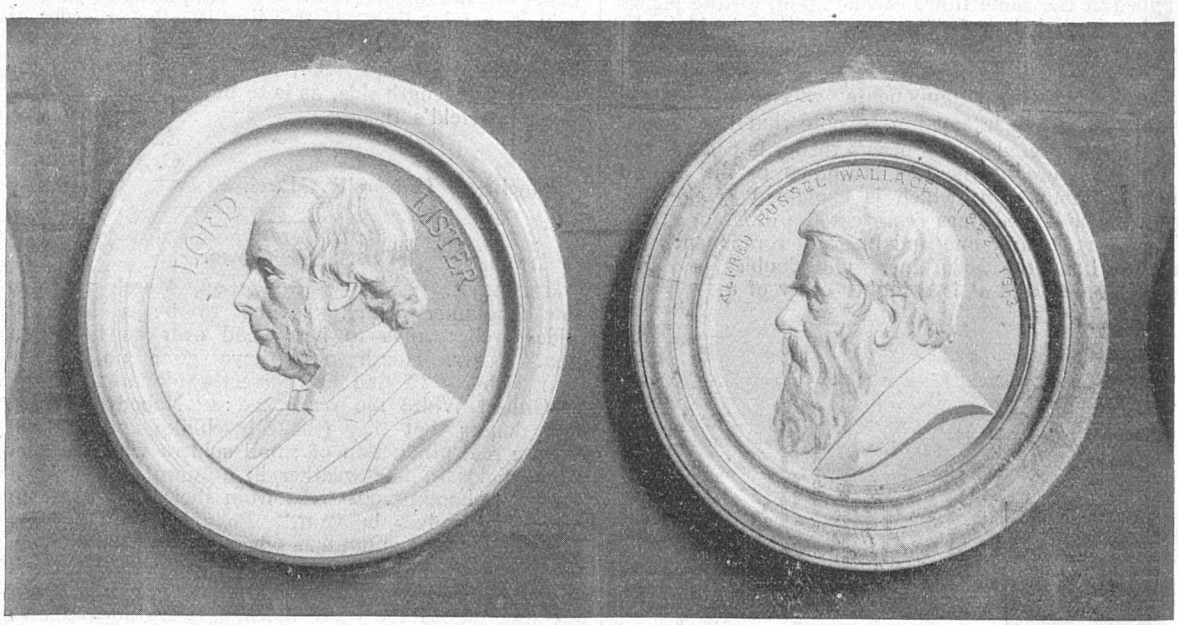
IN November last memorial tablets to Sir Joseph Hooker, Lord Lister, and Dr. Alfred Russel Wallace were unveiled in the north aisle of Westminster Abbey. By the courtesy of the Right Rev. the Dean of Westminster, Dr. H. E. Ryle, photographs of these memorials have been taken by the Dean's verger, Mr. D. Weller, and are here reproduced. The limited size of the tablets has prevented the employment of inscriptions other than those upon the accompanying illustrations.



Photo] FIG. 1.—Sir Joseph Hooker tablet in Westminster Abbey. [*D. Weller.*

The memorials were unveiled without any public ceremony, but at the afternoon service of the same day the Dean of Westminster referred to them. He said that Hooker, Lister, and Wallace would always rank among the most eminent men of science of the nineteenth century; and they were all men of a singularly modest character, who worked without regard to recognition.

It may be of interest here to mention some other memorials of men of science in Westminster Abbey. Sir John Herschel and Charles Darwin lie side by side in the nave (north aisle), where also rest the remains of John Hunter, John Woodward, and Sir Charles Lyell, of whom there is a bust. Near Darwin's memorial three other scientific workers are commemorated, J. P. Joule by a tablet, J. C. Adams by a medallion, and Sir George Stokes by a portrait-head. The grave of Newton is before the choir screen, one of the most conspicuous spots in the Abbey, and near it Lord Kelvin was buried. Close by is a memorial window erected to Kelvin. The great statue of James Watt is in the Chapel of St. Paul; and in St. Andrew's Chapel are memorials of Sir Humphry Davy, Thomas Young, and Sir James Simpson. The body of William Spottiswoode lies under the floor of the south transept of the Abbey.



Photo] FIG. 2.—Lord Lister and Dr. A. R. Wallace medallions in Westminster Abbey. [*D. Weller.*

THE REFORM OF THE MAN OF SCIENCE.

SOME correspondence has recently appeared in the *Morning Post* under the title that stands at the head of this article. Lt.-Col. J. W. Barret, of the Australian Army, a Melbourne doctor, well known for his active participation in the educational world there, writing respectfully of British men of science, laments their exclusiveness. They are, he implies, too much dominated by the idea of studentship; they regard the sphere of science too much as that of the laboratory and the academy; they do not acknowledge brotherhood with men in the greater world, who, in the spirit of enterprise and with the kind of method that prevail in conventional science, are solving great problems of industry, commerce, and national development. Another writer goes further, and would hail as a brother in science the man who elucidates the authorship of Shakespeare's plays or the technique of an old master.

It is not proposed here to enter upon a discussion of the legitimate use of the term science. We may be all for brotherhood, but the circumstances of life compel us largely to separate into groups for purposes of action, and there can be no real complaint if the word science is used in a restricted sense for what is perhaps better called natural science. This should not prevent men of science from recognising their kinship with all faithful workers for the elucidation of truth, in whatever sphere of action.

Let us avoid a controversy about mere words. Lt.-Col. Barret's complaint is a more substantial one—not one of terminology. It is essentially this, that when operations relating to the forces of nature transcend a certain scale they are no longer recognised as science, and that men of science in the limited sense thus lose a great companionship and an invaluable link with the greater world. He gives as an illustration the work of a railroad president whose operations "involve the placing of towns and even cities in new positions, the reorganisation of the agricultural education of districts, the estimation of future markets, and other complicated actions involving scientific imagination of the first order."

It is probable that most men of science would readily admit that some solid advantages would be gained by having in their camp these great operators, with all their intellectual energy, their enterprise, and their influence, and perhaps many would admit their claim to inclusion. There is undoubtedly a tendency for an increased scale of operations to remove a man from the scientific class if he was once in it, or to prevent his accession if he did not originally enter through the usual portal. The case may be well illustrated from engineering. A scientifically trained engineer who betakes himself to great problems of engineering, constructing some almost impossible railway or irrigating a whole parched province of India, seems to be moving away from science. An engineer who has acquired such powers without having received the hall-mark of formal scientific training, will find it hard to get his place acknowledged in the ranks of science.

We may ask, What is really at the bottom of this? Is it merely narrow-mindedness, or is there something more excusable? It is pleasant to think that there may be. Scientific men in their most august society are banded together "for the improvement of natural knowledge." They are by implication a body of students working in the temple of Nature for truth's sake alone, heedless of the world and its rewards. What they garner is their gift to the world: they fill another page in the Revelation that brings men nearer to the angels. Let a man wander into the world with his science as wares to sell for money profit, and he has passed from the true brotherhood. Surely this idea, perhaps here rather fancifully stated, is at the bottom of much of our exclusiveness. It is certainly expressed very often in the privacy of small deliberative councils and in personal intercourse, and it is strongly, though silently, operative in the outer world.

If this were the chief reason for the detachment of men of science we should have to ask whether it be really good and sufficient. That it has elements of good in it, no one would deny. There should be much strength in the union of disinterested people, and the flame of disinterested—that is, unworldly—study is the most sacred light of knowledge. But there is this great fact of history and actuality against an austere brotherhood: natural science has had its roots in the practical avocations of mankind, and from them it has received its chief stimulus. The application of science to the practical arts has not more benefited them than it has benefited science. In this place it is unnecessary to illustrate or amplify the argument. It is therefore not only not unbecoming, but it is vitally necessary that the improvement of natural knowledge should be bound up with solving the problems of the busy world, and the man of science who looks with any kind of disdain on those who are engaged in solving these problems, be they labelled brewer, baker, or candle-stick maker, and be they incidentally making fortunes, is despising his best friends and declaring himself a pedant.

As a matter of fact this disdain does linger. It is the inevitable product of the seminary; it is the fatuity of the cloister, arising, no doubt, from the theological beginnings of our educational system—this notion of keeping science unspotted from the world. It has much to answer for. The neglect of applied science—what is it not meaning now in the fortunes of our nation! It is comfortable for us to blame anyone but ourselves. Have we not long proclaimed the vital importance of science for the service of industry and the State? Industry and the State are doubtless much to blame, but surely no fair-minded person would say that the scientific world is exempt. Rather let us acknowledge that Lt.-Col. Barret is in essence right; the scientific world has been too exclusive; it has not bound itself as much as it might have done to great workers in the world, whose tasks, if not the same, are much akin to those of the

laboratory, men whose sympathies, already scientific, would be strengthened by association and make broad channels for the flow of science into practice.

Scientific men, we must admit, have often no conception of the real environment and problems of the industrialist; of the accumulated store of empirical knowledge from which he must select what is needed; of the skill and design with which he must apply it under the limitations imposed by men, material, and markets. They too often underrate the extent and importance of what may be called technological science and the new horizons that it opens. The technologist is often ignorantly set in the outer courts of learning; he is not quite of the elect, and antipathies arise. How much have we not sacrificed of the acceptance and efficacy of science in industry by offering young men trained in pure science and knowing nothing of manufacture, to employers trained in manufacture and knowing nothing of science, relying wholly on the manufacturer for a most difficult and precarious adjustment?

The management of our applied science has become one of the great problems of the day, and it brings with it great difficulties. Spurious technology is a hateful make-believe that has already wrought much mischief; a man, however scientific, wholly on the make—to use a concise vulgar term for a vulgar condition—is an unedifying spectacle. But it does not follow that because a man is preoccupied with industrial problems he shall lose his scientific virtue or that his achievements, however remunerative, should rank on a lower plane. It is not so difficult to distinguish the genuine from the base among scientific workers wherever they may be engaged.

We must strengthen the bonds between science and industry by something more than an appeal to the pocket. A real sympathy and interest must be created on both sides; we must open our arms wider. Even if we find difficulty in discovering, in this country, the type of railway president described by Lt.-Col. Barret, there are yet many men in our world of industry and in the service of the State who, without any list of scientific memoirs to their name, have yet been potent in the service of science, and would be more potent still if they were brought more into companionship with the scientific world. The Royal Society has the power of admitting to its ranks at the rate of one each year "persons, who in their opinion have either rendered conspicuous service to the cause of science or are such that their election would be of signal benefit to the Society." Here at least is a limited opportunity of doing something towards introducing into the circle of science the sort of men whose influence might help towards bringing about the reform to which we are bidden by a candid friend. In any of the new associations that are contemplated for giving science its right place in our national life we shall surely do well to cast our net widely and to extend our outlook beyond the conventional circumference of what have usually been deemed scientific circles.

SULPHURIC ACID IN AMERICA.[1]

IN what is known as a "professional paper," Mr. W. H. Waggaman, of the U.S. Department of Agriculture, has recently given an account of the modes of manufacture of sulphuric acid, both by the "chamber" and the "contact" process, with special reference to its production in the United States for the manufacture of fertiliser materials. As the paper contains some features of interest with respect to American practice, a short account of its contents may not be out of place at the present juncture.

The production of sulphuric acid of various strengths in the United States, according to the latest (1913) figures available is stated to be as follows:—

Grades	Quantity tons	Value dollars	Price per ton dollars
50° Baumé	1,643,318 ...	9,212,917 ...	5.61
60° Baumé	509,929 ...	3,202,528 ...	6.28
66° Baumé	797,104 ...	9,282,422 ...	11.65
Other grades	63,158 ...	986,659 ...	15.62
Total and Average...	3,013,509 ...	22,684,526 ...	7.53
Total reduced to 50° B.	3,538,980* ...	22,366,482 ...	6.32

* Exclusive of 22,947 short tons of fuming acid, not convertible, valued at 318,044 dollars.

On comparing these figures with those for the two preceding years it appears that there has been a considerable increase in production of each grade with the exception of those classed under "other grades," the decrease in which is probably accounted for by the item "fuming acid," which appears for the first time in the statistics. Presumably, therefore, the manufacture of this form of oil of vitriol has only been introduced into America within the last three or four years. If account is taken of the fuming acid it is obvious that the production of sulphuric acid has very largely increased in the United States within recent years. There can be little doubt that the disturbance in Continental production in consequence of the war, with its effect on the export trade of Germany and Austria in dyes, drugs, and fine chemicals, as well as on a variety of other finished products in which sulphuric acid plays a part, direct or indirect, has given a still greater impetus to American manufacture, and has tended to consolidate certain industries and to initiate others in the States, to the eventual loss of the belligerent nations. German manufacturers are now beginning to realise that the supremacy they have hitherto enjoyed in certain branches of chemical industry is threatened, and nowhere more seriously than in America.

American chemists have not talked to anything like the same extent as we have done about "capturing German trade." Nevertheless, as recent discussions in the American Section of the Society of Chemical Industry unmistakably indicate, aided by their elastic fiscal policy, they have quietly and deliberately set themselves to do it. And, curiously enough, the "hyphenated" Ameri-

[1] "The Production of Sulphuric Acid and a Proposed New Method of Manufacture." By W. H. Waggaman. U.S. Department of Agriculture. Bulletin No. 283. (Washington, 1915.)

can has not been the slowest to move. It may be that our people are too busy making the things required for munitions to be able to give the matter adequate attention, but we could wish to see the same signs of intelligent and organised effort on the part of the general body of chemical manufacturers in this country as we are now witnessing on the other side of the Atlantic. There can be no doubt whatever that with the fierce industrial struggle that will certainly follow the cessation of hostilities, a very serious time, fraught with the greatest peril, is in store for us, and in particular for our chemical industries. With powerful rivals on either side of us, nothing but the application of the same means, the same enlightened skill and intelligence that in the past have brought pre-eminence to Germany, and are now rapidly bringing it to America, can possibly save these industries from ultimate extinction.

It is not our purpose to follow Mr. Waggaman in his account of the methods of manufacture of sulphuric acid except in so far as they throw light on their comparative advantages in special circumstances, or deal with questions peculiar to America. As regards the contact process, his remarks as to its excellences and its commercial limitations are judicious and to the point. It is admittedly a process which demands skilled and intelligent supervision, and in which there is no room for the rule of thumb type of procedure which characterises much of the foreman management in this country. Doubtless the last word has not yet been said on "catalysers" and "poisons," and there is still room for the ingenuity of chemical engineers in the improvement of plant. But, as matters stand at present, for certain grades of oil of vitriol, and especially for those used generally in the manufacture of fertilisers—one of the most important of the outlets of production—chamber acid will probably hold its own for many years to come, especially in view of the important improvements and simplifications in plant and procedure which have been introduced within recent years.

Of the various methods which have been proposed from time to time for accelerating the chamber reactions, those which seem to have found most favour in the States are Pratt's, Meyer's, and Falding's.

In Pratt's process (U.S. patents Nos. 546, 596, 652, 687), which appears to be much used in the southern States, the gases are drawn through the first chamber by a fan, then through a tower packed with quartz, down which flows dilute sulphuric acid, when they are again introduced, by the same fan, into the first chamber. In a number of plants in which this circulatory system is employed less than nine cubic feet of chamber space are required per pound of sulphur burned in twenty-four hours.

In Meyer's arrangement, of which three installations are in use in the States, "tangential" chambers, designed so as simultaneously to mix and cool the reacting gases, are employed. These chambers are cylindrical in form; round the first run lead pipes conveying cold water. The gases are admitted at a tangent near the upper part of the chamber walls, and are discharged from outlets in the centre of the base, thereby acquiring a spiral motion which tends to mix them thoroughly.

In the Falding system the chambers are approximately one and a half times higher than their horizontal dimensions. The gases after passing through the Glover tower are introduced into the chamber near the top, where, being hot, partly from the fact that they have only recently issued from the burners, and partly because their temperature has been raised by the reactions between certain of their constituents, they collect in the upper part of the chamber and form an active layer, which gradually cools and settles down to the bottom of the chamber, where the spent gases are drawn off. It is claimed that this system requires much less chamber space in which to complete the reactions than the ordinary type. Each Falding chamber is a unit in itself, and is connected directly with the Glover tower, instead of in series as in ordinary chamber systems. Whatever doubts may exist as to the proper explanation of the mechanism of the process, it seems to be commercially successful, to judge from the number of plants in which it is in operation.

The new modification of the chamber process to which Mr. Waggaman refers consists of a method of more quickly effecting an admixture of the reacting gases by causing them to traverse a spiral tube of lead, kept at a determinate temperature. The arrangement has only been tried on a laboratory scale, but from the published results it promises well. Whether it will diminish the chamber space to the extent of 0·139 cubic foot for every pound of sulphur burned in twenty-four hours, as is claimed, seems too good to be true. Comparative experiments using glass and lead spirals appeared to indicate that the metal exerted a specific (catalytic) action. The construction of a sulphuric acid plant along the lines indicated by the author, if successful in working, would certainly greatly diminish the amount of ground space needed, and would presumably decrease the initial cost of construction. The practical man is apt to deride laboratory experiments, forgetting that all factory experience has its beginning in small scale trials. Perhaps he may think it significant that "if patent is allowed, it will be donated to the people of the United States."

NOTES.

EARLY in 1914 a committee representative of British geologists and friends of Sir Archibald Geikie was formed with the object of presenting to the Museum of Practical Geology a suitable memorial of his long association with that institution as director-general of the Geological Survey and Museum, and as a record of their appreciation of his brilliant labours in the cause of geology. It was decided that the memorial should take the form of a marble bust. On Tuesday, March 14, a number of Sir Archibald Geikie's friends

assembled in the museum to witness the presentation. Dr. A. Strahan, director of the Geological Survey and Museum, briefly recapitulated the history of the movement. The Right Hon. Sir William Mather, who was to have unveiled the bust, was unfortunately prevented from attending by a chill, but his place was kindly taken, at the last moment, by Sir William Garforth, who had played a very active part on the committee. After unveiling the bust, Sir William referred in cordial terms to Sir Archibald's contributions to science and literature, and then, on behalf of the subscribers, presented the bust to the museum. The Right Hon. J. Herbert Lewis accepted the gift on behalf of the Board of Education; he remarked that it was a source of gratification to the Board that the artist commissioned to execute the bust happened to be another of its distinguished servants, Prof. E. Lanteri, who had done so much to uphold the standards of the Royal College of Art. The Right Hon. Lord Rayleigh then, on behalf of the subscribers, presented to Sir A. Geikie a marble replica of the bust. In warmly acknowledging his appreciation of the gift, Sir Archibald spoke of the powerful effect the Museum of Practical Geology had had upon him in his early student days, and of the great educational value of its collections. The bust is a remarkably good likeness and a beautiful example of Lanteri's work. Among those present at the ceremony were Sir T. Lauder Brunton, Sir Lazarus Fletcher, Sir Thomas H. Holland, Sir F. G. Kenyon, the Right Hon. Lord Lyell, Major F. G. Ogilvie, Prof. W. W. Watts, Dr. A. Smith Woodward, and Messrs. Bedford McNeill and C. McDermid, representing the Institution of Mining and Metallurgy.

MEMBERS of the British Association who attended the Dundee meeting in 1912 will remember the striking announcement made on the first night, that Sir James Caird (then Dr. Caird), one of the leading business men of the city, had given the sum of 10,000*l.* towards the funds of the association. We regret now to announce that this eminent citizen of Dundee, and great public benefactor, died on March 9, at seventy-nine years of age. During his lifetime his donations for public purposes amounted to a quarter of a million pounds, among them being, in addition to the gift to the British Association, 5000*l.* to the Royal Society, 24,000*l.* for Shackleton's Antarctic Expedition, 1000*l.* to the Zoological Society of London, and gifts of valuable collections to the Dundee Museum. In 1903 the University of St. Andrews, "in consideration of his great and practical interest in the philanthropic and educational work of the city," conferred on him the degree of Doctor of Laws, and he received the distinction of a baronetcy in 1913.

THE death of Lady Baker, widow of Sir Samuel Baker, closes one of the most romantic careers in the history of the Upper Nile and Uganda. She was Hungarian by birth, being a daughter of Finian von Sass. She nursed Samuel Baker through a serious illness, and her devotion then led to a marriage of exceptional harmony and usefulness. It was doubtless largely owing to her influence that Baker developed from a sportsman into a geographer and ultimately into a statesman. He went to the Upper Nile to shoot big game; he gradually devoted more and more of his attention to geographical exploration, and finally, as he and his wife realised the deplorable condition of the natives, Baker entered on the crusade for the suppression of the slave trade, which led to the Egyptian conquest of the Sudan and the African work of Gordon. In the widening of Baker's sympathies and his adoption of a philanthropic, political mission, he was obviously inspired by his wife. She accompanied him on his expedition in 1860–62 into Abyssinia, and on the important expedition of 1862–65 which discovered the Albert Nyanza, and she returned with him to the Upper Nile in 1870, and on the expedition which established Egyptian supremacy there, and began the long campaign against the Sudan slave trade, which was pursued with varying fortune until the collapse of Mahdism and the Anglo-British reconquest. Lady Baker proved throughout of heroic courage, gifted with remarkable insight into the native mind, and exceptionally fertile in resource. On more than one occasion her quick realisation of danger and prompt action saved the expedition from disaster. In 1874 Sir Samuel Baker purchased an estate near Newton Abbot, South Devon, where he died in 1893, and where Lady Baker lived until her death on Saturday last, March 11.

SIR JOHN WOLFE BARRY has been elected an honorary member of the Institution of Civil Engineers.

DR. TH. HESSELBERG informs us that since the beginning of this year he has taken up his functions as director of l'Institut météorologique de Norvège, Kristiania.

THE Institute of Industry, Ltd., has arranged a conference of representative trade interests to be held at the Savoy Hotel on Thursday, March 30, to discuss "The Creation of a National Organisation adequately representing British Industrial Interests."

AT the meeting of the Royal Society of Edinburgh, held on March 6, the following candidates were elected Fellows of the Society:—Dr. R. J. T. Bell, Dr. F. E. Bradley, Mr. H. Briggs, Mr. C. T. Clough, Dr. E. J. Crombie, Mr. E. H. Cunningham Craig, Dr. A. W. Gibb, the Hon. Lord Guthrie, Prof. P. T. Herring, Sir Duncan A. Johnston, Mr. H. Levy, Dr. J. E. Mackenzie, Dr. W. F. P. M'Lintock, Prof. R. Muir, Dr. J. Ritchie, Mr. D. Ronald, the Hon. Lord E. T. Salvesen, Mr. D. R. Steuart, Mr. J. Martin White.

MANY in England will receive with great regret the news which has reached us that Prof. Oswald Külpe died in Munich on December 30, 1915, at the age of fifty-three. He was well known to students in this country for his original work in psychology and philosophy. He was associated with Prof. Wundt in the foundation of the experimental laboratories at Wurzburg, Bonn, and Munich. One of his recent works, "Die Philosophie der Gegenwart," has been translated into English and published under the title, "Present Philosophy in Germany." He visited this country in May, 1914, on the invitation of the University of London, and delivered a course of lectures on æsthetics at Bedford College.

THE retirement of Dr. Theodore Thomson, C.M.G., from the post of assistant medical officer of the Local Government Board about three years ago, and his recent death at the age of fifty-nine, deprived that Board of an extremely able public servant. Prior to his appointment as a medical inspector of the Board, Dr. Thomson had held the post in succession of medical officer of health of Sheffield and Aberdeen, and in these positions had shown the high quality of work which characterised his later work in a Government Department. His name will always be associated with important reports on two of the largest epidemics of enteric fever, due to water-borne infection, which have occurred in this country, at Maidstone and Worthing respectively. These reports are a model of precise statements of results, as well as of methods of investigation. In the important international work of the Local Government Board, Dr. Thomson for many years took a chief part, and he was the British delegate in 1903 to the International Sanitary Conference of Paris, and signed the International Sanitary Convention as the Plenipotentiary of the British Government. For this work and his special mission of inquiry into the sanitary defence of the Persian Gulf he was nominated a C.M.G. in 1905.

IN a lecture recently delivered before the Hyderabad (Deccan) Archæological Society, Sir John Marshall, Director-General of Archæology in India, directed attention to the importance of the Deccan as a field for inquiry. The points on which investigations in this region may be expected to throw light are: the date of the interments usually supposed to be prehistoric, but probably of a later age; whether the copper culture of northern India extended south of the Vindhyan range, and whence the use of iron was introduced. Recently a rock inscription of Asoka has been discovered at Maski, unique inasmuch as it refers to the Emperor under his own name, these edicts of Asoka being the earliest records we possess in India, except one bearing an Aramaic inscription recently found at Taxila. He went on to refer to the number of cave temples and monasteries, the paintings in the Ajanta and Ellora caves, and the splendid series of Saracenic buildings scattered over the region. The new society has a great work before it, and under the skilful supervision of Sir John Marshall important results bearing on the ethnography and history of southern India may be confidently expected.

IN an article in the *Daily Telegraph* of February 29 Sir Robert Hadfield points out that most of the discoveries which have proved of industrial importance have not emanated from Germany. It must be remembered, however, that the country in which the discovery is made does not of necessity reap the benefit which accrues from its commercial exploitation. When, as in Sir Robert Hadfield's own case, the discoverer can foresee the industrial possibilities, and is able to put his ideas into practice, success is bound to follow. He quotes Mr. C. R. Darling as showing that none of the prominent advances in connection with pyrometry have originated in Germany; but here again the important industry which has arisen in this country in the manufacture of pyrometers is due to the skilled scientific men who have seen how to apply new principles to the production of useful instruments. All the evidence shows that our future commercial success depends upon a closer alliance between science and industry. No scheme to achieve this end can be complete which does not foster the prosecution of laboratory research, and thus provide the seeds from which industries grow. Encouragement and financial aid should be given to all who devote themselves to research; and to this end funds should be forthcoming, either from private sources or the Government, or from both. In this way the laboratory can be connected with the workshop, to the great advantage of both.

THE *Pioneer Mail* of February 5 contains an interesting account of the presidential address delivered by Dr. H. H. Hayden to the Mining and Geological Institute of India, which dealt particularly with problems raised by the war. As director of the Geological Survey of India, Dr. Hayden spoke with the authority of an expert, and his description of the German metal ring and its vast ramifications was peculiarly instructive. He explained that for years past Germany had been gradually acquiring control, not only of metals, but also of the raw materials for their production. Her activities embraced Europe, America, Australia, and India. In Australia, for example, the Zinc Corporation had contracted to sell to her all their concentrates until the year 1919; Germany took the entire wolfram output of Burma, and the monazite sands of Travancore were being worked by German firms, the production of thorium nitrate being so regulated that the gas-mantle industry was completely controlled. Dr. Hayden then turned to India's opportunities of developing her own resources. The wolfram output of Burma is being expanded; the tungsten industry has been taken out of German hands, and a new British industry has been established. Dr. Hayden suggests that it would pay to make ferro-tungsten on the spot if the electrical method could be economically introduced into Tavoz. Dr. Fermor has shown that the manufacture of ferro-manganese may be regarded as a sound commercial proposition. If, then, India can arrange for the partially finished product to be exported instead of the ores, the tungsten and manganese industries should be assured of that permanence which is so desirable. Dr. Hayden also touched on the question of the manufacture of coal-tar dyes and the glass industry, especially in the matter of the supply of glass bangles, which latter he regards very hopefully.

WE are pleased to note from an inaugural address published in our American contemporary, *Science*, that there has been formed recently in the city of Rochester, N.Y., an "Association for the Advancement of Applied Optics." The event is one which marks the growing estimation by scientific men, and we hope also by the community at large, on the other side of the Atlantic of the importance of the subject of applied optics. During the past few months we have several times directed attention in these columns to the governmental, scientific, and popular neglect of this very important subject, and to some of the consequences of its neglect in our own country in

connection with the war. It has been shown how we, the successors of Newton, Young, Herschel, and other leaders in the early development of the science of optics and its applications, have allowed our German rivals to occupy the ground during the last twenty or thirty years. Not that we have been idle during that time, but that our efforts have not been commensurate with the ever-growing importance of the subject. For instance, we have anticipated our American cousins in this very matter, for we have had since 1902 a scientific society, "The Optical Society," the work of which completely covers the ground planned out for the new association in America. Its new president, Mr. W. J. Cheshire, a well-known worker in optics, has just succeeded the retiring president, Dr. W. Ettles, a well-known ophthalmologist, and its list of past presidents includes the familiar names of Dr. Silvanus P. Thompson and Dr. R. T. Glazebrook. What is wanted here is a keener appreciation by the scientific and general public of the importance of the work to be done. We venture to hope that the action of our American colleagues will stimulate interest here, and we wish the new association a successful career, especially as from the inaugural address in our contemporary we find that its founders are fully alive to the far-reaching ramifications of applied optics.

WITH the death in France of Mr. Frank Southgate a unique personality in the world of bird-men has passed away. As a landscape painter of the coast of Norfolk and the broads (the delicate atmospheric effects of which he could catch in a magic way), he is of course most widely known. Here we are only concerned with his life studies of birds, although his ability to paint the scenes in which these birds live adds greatly to the beauty of his pictures. A sportsman and a naturalist, no one knew better than he did the appearance, the movements, and the attitudes of those marsh-, shore-, and sea-birds which he delighted to study. But no one else has ever been able to reproduce them in pictures so successfully. Perfectly able, as he was, to draw and paint a detailed portrait of a bird, he aimed rather at showing us exactly what the birds looked like at a little distance in their natural haunts. Who among those who are familiar with the east-country books which he illustrated has not delighted in "The Fringe of the Shore," the "Stricken Mallard," and "A Corner in Broadland," for instance, to be found in "Notes of an East-coast Naturalist." But it was perhaps in depicting birds in flight that his gift of painting live birds was most remarkable. "Smack putting up Common and Velvet Scoters," in the last-named book, is a good instance of his powers. No subject of this kind was too daring for him to attempt, or too difficult to surmount. But we think that when he painted the heron dropping down to alight "In the old fen" ("Wild Life in East Anglia"), he probably reached the climax in this kind of illustration. As we look at the picture once more we marvel again at any artist daring to make the attempt—and at his success.

THE Paris Academy of Sciences awards each year a certain number of prizes to authors of important contributions to science. At the recent annual meeting of the academy, the president, M. Gaston Darboux, gave an account of the careers of men, for the most part young, to whom these prizes had been awarded, but who have fallen in the service of their country. M. Marty (Francœur prize), killed September 10, 1914, at the battle of the Meuse, was distinguished by his contributions to mathematics. M. R. Marcelin (Hughes prize), killed near Verdun, in September, 1914. His work on kinetic physical chemistry was remarkable, both in theoretical treatment and on the experimental side. M. Marcel Moulin (Gaston Planté prize), killed at the battle of the Marne, September 6, 1914, founded the Institute of Chronometry at Besançon. M. Viguier (Cahours prize), killed at Beauséjour, March 5, 1915, made his mark in the field of organic chemistry. M. Albert de Romeu (Delesse prize), killed January 12, 1915, at Bucy-le-Long, near the Aisne, was the author of noteworthy petrographic work. M. René Tronquoy (Joseph Labbé prize), wounded and missing, February 20, 1915, was proposed for the Cross of the Légion d'honneur, and was well known for his mineralogical work. M. Blondel (Saintour prize), wounded and missing, September 8, 1914, at Fère-Champenoise, was distinguished for his work on the theory of tides. M. Georges Lery (Gustave Roux prize), killed at the battle of the Marne, September 10, 1914, was a geometer of great promise. Lieut.-Col. Arnaud (Henri Becquerel prize), aged sixty years, died of illness contracted on active service. M. Jean Merlin (Becquerel prize), on the staff of Lyons Observatory, killed at Arrozel, August 29, 1914. He was known by his researches dealing with the theory of numbers. M. Rabioulle (Becquerel prize), on the staff of the Algiers Observatory, killed in the battle of the Aisne, September 21, 1914. M. Jean Chatinay (Fanny Emden prize), killed at Vermelles, October 15, 1914. Commandant Henri Batailler (Wilde prize), killed June 9, 1915, well known for his researches in ballistics.

IT is announced in the *Morning Post* that Mr. Knud Rasmussen, the Danish Arctic explorer, is planning a new expedition to northern Greenland. Mr. Rasmussen's previous work in Greenland is well known. In 1902 he took part in the Danish Literary Expedition with Mylius Ericksen, and in 1908–9 he explored from Cape York to Ellesmere Land. His work has been mainly ethnographical, a task for which Mr. Rasmussen is well suited, as he spent all his boyhood in Greenland, and speaks the Eskimo tongue with fluency. In his "People of the Polar North" he made an exhaustive study of the polar Eskimo from Cape York to Cape Alexander, and probably in this new expedition he means to continue his ethnographical studies. It is proposed that the expedition should start this spring to explore the unknown region between Peary Land and Greenland, or, if ice prevents this, the expedition will first work around Melville Bay. In 1892 Peary, reaching the east coast across the inland ice of Greenland, discovered Independence

Strait, as he thought, cutting off the northern part from the rest of Greenland. That northern part, previously, in 1882, visited by Lockwood, of Greely's expedition, was termed Peary Land, but the late Mylius Ericksen, on that expedition when he lost his life, discovered that the Independence Strait of Peary is really a bay, and that Peary Land is joined to Greenland. The exploration of that region in relation to former migration of Eskimo to the east of Greenland promises important results.

A SUMMARY of the weather for the winter season is issued by the Meteorological Office with its *Weekly Weather Report*, based on the results for the thirteen weeks from November 28, 1915, to February 26, 1916. The winter was wet in all parts of the United Kingdom, the greatest excess of rain occurring in the south-east of England, where the fall was 187 per cent. of the average. In the east of England the rainfall was 169 per cent. of the average, and in the Channel Isles it was 160 per cent. The smallest difference from the normal was 118 per cent. of the average in the west of Scotland, and 119 per cent. in the south of Ireland. The rainfall for the winter was greater in the north and east of Scotland than in the winter of 1914–15, elsewhere the rains were less, and in the south-east of England the rainfall was 4·32 in. less. The frequency of rain was everywhere greater than the average, the greatest excess in the number of rain-days being 18 in the south of Ireland and 16 in the south-east and south-west of England. Temperature for the period was in excess of the average over the entire kingdom, the greatest excess occurring in the east and south-east of England and in the midland counties, the difference from the mean ranging from 3° to 4° F. in these districts. The duration of bright sunshine was nowhere very different from the normal, districts with an excess and defect being about equally balanced.

IN the March number of *Man* Mr. Miller Christy describes a strange stone object found in an interment of the Bronze age in the parish of Newport, Essex. It is fashioned from a block of rather coarse, reddish sandstone, erratic boulders of which abound in the neighbourhood. It is roughly cylindrical in shape, with flat ends, but it was not intended to be stood on end. The most remarkable feature is that its sides are traversed longitudinally by five shallow, narrow, round-bottomed, equidistant grooves, which divide in transverse section into five approximately equal rounded lobes. At present the object of this curious specimen is a puzzle. It was not a pounder or muller. One authority suggests that it was the head of a club lashed to a handle; another, that it was used as a roller for "braying" flax. Mr. Reginald Smith was struck by its resemblance to an Egyptian pillar, derived from the bud of the lotus. If it is really a product of the Bronze age, it is difficult to account for its transfer from Egypt to Essex. The specimen is now in the museum at Saffron Walden, and it may be hoped that Mr. Christy's article will lead to a further examination of this remarkable specimen, which may disclose the object for which it was carved.

FROM the report of Mr. T. Southwell in the Journal of Agriculture of Bihar and Orissa for 1915, which has just reached us, it is plain that the newly-formed Fishery Department of Bengal, Bihar, and Orissa has a strenuous future before it, if a reign of plenty is to replace the present shortage of fish. This state of affairs is due to the lack of intelligent control, and is all the more serious since rice and fish are the principal food-stuffs of the population of these areas. But the Government is taking up the task of reformation with its hands tied, for the fishery rights belong to zamindars, who take no interest in the matter, but lease their fisheries for a nominal sum, the lessee releases at a large profit, and this process goes on through yet further stages. Apart from this, in the Bengal area immense numbers of eggs and young fish are washed by the floods into the paddy-fields and destroyed, while a further extensive mortality is caused by the ascent of brackish water. But Mr. Southwell seems to hold out little hope of material improvement until the staff of the newly-established Board is increased. At present there are but three officers to control an area "one and a half times larger than that of the whole of the British Isles."

THE hereditary transmission of degeneracy and deformities by the descendants of alcoholised guinea-pigs has formed the subject of a long series of experiments by Profs. C. Stockard and G. Papinicolaou. They contribute a very welcome analysis of their results so far obtained to the *American Naturalist* for February. Their experiments show that alcoholic fumes, drawn directly into the lungs and absorbed by the blood, are infinitely more harmful to the offspring than is alcohol taken into the system in the form of drink. Alcoholic fumes made the animals drowsy, or quarrelsome, according to their individual temperament, but they produced no other evil effects during the lifetime of the animal, nor could any injury to the tissues be traced after death. This is notoriously otherwise where men who have been "hard drinkers" are concerned. Guinea-pigs kept in an almost continuous state of intoxication during the reproductive period invariably produce defective offspring, of which very few arrive at maturity. In spite of the fact that alcohol is withheld from them, the offspring of such defectives are still more defective. All are weak and neurotic, some are grossly deformed, many are anophthalmic monsters. Physical wrecks of this sort continued to appear for three generations, when sterility seems to have extinguished further examples. Attempts to administer alcohol in the form of drink, by means of a tube, or mixed with the food, had to be abandoned owing to digestive and other troubles which vitiated the experiments. But before the authors can claim to have demonstrated the destructive effects of alcohol fumes on the germ-plasm, experiments with non-alcoholic fumes must be tried.

A SELECTED bibliography of frost in the United States, especially in relation to agriculture, has been published as a pamphlet by the United States Department of Agriculture. It originally appeared in the pages of the *Monthly Weather Review* (vol. xliii., pp. 512–517). The authors, Messrs. W. G. Reed and

C. L. Feldkamp, have selected their entries from all the material on frost and frost prevention under American conditions that have come to their attention, but disclaim any exhaustiveness for their list. A brief indication of the scope follows each entry. The arrangement is chronological and there is an index arranged according to States. The paper should prove useful to agriculturists.

THE *Geographical Review* is the new title under which the Bulletin of the American Geographical Society appears this year. An introductory note outlines the scheme of the remodelled publication. It is hoped to broaden the range of the articles and to give the notes and reviews a more critical and scholarly quality. A special feature is to be made of the bibliographical section, which, in addition to the record of books and maps, will contain an analysis of all the principal geographical publications and those bearing on geography. The classification adopted is a regional one, and is illustrated in a sketch map in the January issue. If the high standard aimed at is maintained the *Geographical Review* should rank among the most useful geographical publications and be of great assistance in the study of the subject. The January number (vol. i., No. 1), in addition to several shorter articles, notes, and bibliography, contains a lengthy paper by Mr. C. A. Cotton on fault coasts, with special reference to New Zealand.

AN investigation of the world's coal resources was undertaken by the twelfth International Geological Congress, held in Canada in the summer of 1912, with the view of estimating the tonnage available in known fields. In October last the American Geographical Society published in its Bulletin (vol. xlvii., No. 10) a summary of the results, which have been embodied *in extenso* in a monograph of three volumes published by Morang and Co., Toronto, 1913. The author of this summary, Mr. Leon Dominian, finds that on the basis of the present annual consumption of 1300 million tons, the world's coal supply is provided for centuries.

BULLETIN 254 of the Scientific Papers of the Bureau of Standards (Washington: Government Printing Office, 1915) contains a study of the qualities of platinum goods, by Messrs. George K. Burgess and P. D. Sale. The object of the investigations was in the first place to devise a simple thermoelectric test of the purity of platinum, for which purpose the temperature-coefficient of resistance and the thermoelectric force were found useful; in the second place, to investigate the loss of weight due to disintegration when platinum vessels containing various proportions of other metallic constituents are heated.

IN a series of articles in the February numbers of the *Electrician*, Mr. W. R. Cooper has given an account of the properties of selenium which will prove of great value to all those who have in view the technical applications of the sensitiveness to light which the material exhibits. Up to the appearance of these articles it has been necessary to collect information on the subject from the pages of scientific journals published in all parts of the world. Mr. Cooper's articles now provide the information in a convenient and readable form. After an account of the various forms of selenium and the modes of preparation, their sensitiveness to light in general and to variations of the wave-length of the light are discussed. Although a satisfactory general theory has not yet been evolved from the experimental facts now available, there is sufficient information about the behaviour of the material to make it likely that its properties will before long find for it some more extensive application than at present, when it is mainly restricted to the automatic lighting of isolated buoys at sea.

WE congratulate the *Athenaeum* on the promptitude with which it has been able to publish its subject-index to the Periodical, Scientific, and Technological Literature for 1915. The publication of this list within six weeks of the close of the year indexed is a remarkable feat. The list is by no means intended to be a complete index to all branches of scientific literature, but has special reference to the war in its technological aspects. Indeed, a complete list of the scientific papers published throughout the world in 1915 would probably contain 40,000 names of authors, whereas in the *Athenaeum* list we have rather fewer than 2000 names quoted. The subject-index is arranged alphabetically. The following examples of the headings for some of the longer sections will give an idea of the character of the subjects selected for indexing:—"Aeronautics," "Agriculture," "Artillery," "Automobiles," "Birds," "Coal," "Electric Apparatus," "Explosives," "Forestry," "Gas and Oil Engines," "Geology," "Mines," "Railways," "Roads," "Submarines," "Telegraphs," "Telephones," "Warships," and "X-Rays." The articles indexed are taken from 215 periodicals, which are mainly British, although thirty American and seven French periodicals are included, as well as about ten other foreign journals.

Engineering for March 10 contains the last of a series of articles on the whirling speeds of loaded shafts; these articles describe an investigation which has been made at the Royal Technical College, Glasgow, by Mr. W. Kerr. Tests on a 250-kw. turbine, and on a 3-h.p. de Laval turbine, showed some disagreement with the usual theory, and led the author to investigate the matter mathematically. It appears that there is both experimental and theoretical evidence of the existence of a critical speed for loaded horizontal shafts which is considerably below that given by the usual theory. This new critical speed is due in the first instance to the direct effect of gravity, which has been hitherto neglected in the theory. The lower critical speed seems to be less important than the higher, when it is merely a question of running through in the process of speeding up. Also, it is of little importance if the loads on the shaft are very light. In those cases in which it is shown clearly, it is probably due to inaccurate balancing. In general, there will be an undesirable instability at all speeds between the two critical values, and it would be best to keep the normal running speed outside this range.

MESSRS. JOHN WHELDON AND CO., 38 Great Queen Street, Kingsway, W.C., have just issued a catalogue of important books and papers on cryptogamic botany they are offering for sale. The works are arranged conveniently under three main divisions—economic, geographical, and general—each of which is subdivided to facilitate search for works on any particular subjects embraced by the catalogue.

OUR ASTRONOMICAL COLUMN.

COMET 1916*a* (NEUJMIN).—Copenhagen Postcards Nos. 13 and 14 give orbits and ephemerides for this comet calculated by M. J. Fischer-Petersen and Mlle. J. M. Vinter-Hansen. The earlier orbit is based on observations made at Yerkes (February 29), Greenwich (March 1), and at Bamberg on March 3. The second, given below, depends on the Yerkes and Bamberg positions, and observations made at Bergedorf on March 5 :—

Perihelion Passage (T), 1916, *March*, 9·417 *G.M.T.*

$\omega = 191^\circ\ 9'\ 87''$
$\Omega = 325^\circ\ 24'\ 10''$ } 1916·0
$i = 16^\circ\ 1'\ 48''$
$\log q = 0{\cdot}19036$

	R.A. h. m. s.	Dec. ° ′		R.A. h. m. s.	Dec. ° ′
March 15	9 5 41	+5 58·2	March 21	9 10 56	+3 11·1
17	7 17	5 1·2	23	12 57	2 18·1
19	9 2	4 5·4	25	15 6	1 26·7

The orbit is apparently periodic in short period. The comet is fainter than 11·0 mag.

COMET 1915*e* (TAYLOR).—A new orbit and ephemeris for this comet has been calculated by M. J. Braae from observations made at Rome, December 5, 1915, at Arcetri and Copenhagen, January 11, 1916, and at Bamberg and Copenhagen on February 20. The new orbit only differs slightly from the earlier elliptical orbit (NATURE, January 20) :—

Perihelion Passage (*T*) = 1916, January 30·9122 *G.M.T.*

Epoch 1916 Jan. 0·5 G.M.T.		Equinox 1916·0	
M_0	$= 355^\circ\ 17'\ 34{\cdot}6''$	ω	$= 354^\circ\ 47'\ 54{\cdot}9''$
μ	$= 557''{\cdot}191$	Ω	$= 113\ 53\ 57{\cdot}6$
Log a	$= 0{\cdot}536002$	i	$= 15\ 31\ 51{\cdot}0$
U	$= 2325{\cdot}95$ days (6·37 years).	ϕ	$= 33\ 7\ 33{\cdot}9$

The comet is very weak, having been about 12 mag. on February 20.

From Bergedorf, Prof. Schorr has reported (Circular No. 503, *Astronomische Nachrichten*) that the nucleus of this comet has divided into two portions. The nuclei were of unequal brightness, about magnitudes 11 and 13. Their positions were :—Distance, 14″; position angle, 169° and 17″ and 25°, on February 19 and 29 respectively. On the latter date the following nucleus was the weaker.

According to a note in the current number of the *Observatory*, Prof. E. E. Barnard observed the double nucleus on February 9, the separation being 10″.

VARIABLE STARS IN THE VICINITY OF R CORONÆ AUSTRALIS.—This region is under careful scrutiny, not only at Helwân, but also at the Union Observatory, Johannesburg. In Circular No. 31 both R Coronæ and the nebula are stated to be variable over a wide range. The observations of these objects are to be discussed later. Thirty-three new variable stars have been detected in the region.

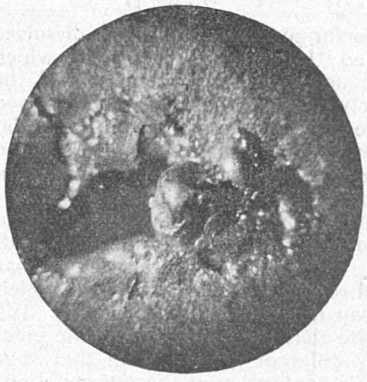
A POSSIBLE DEFLECTION OF LIGHT BY A MOVING MEDIUM.—Prof. P. Zeeman has published (*K. Akademie van Wetenschapen*, vol. xviii., pp. 711–5) an investigation of the propagation of light-waves along a velocity gradient in a moving medium specially in relation to solar phenomena. From a consideration of the Lorentz dispersion term in the Fresnel coefficient, it is demonstrated that the simultaneous existence of velocity gradients and anomalous dispersion in gases that are extremely rare (*e.g.* the absorbing vapours giving rise to the finest lines in the solar spectrum), and without density gradients, may give rise to a deflection of light.

A TUNGSTEN TARGET FOR X-RAY TUBES.[1]

GREAT advances have recently been made in the production of X-rays, chiefly by the employment of very heavy currents. The exposures necessary for producing radiographs of the thorax have been reduced from minutes to fractions of a second.

To make this possible, much attention has been devoted to the target or anti-kathode, which is the critical part of the tube, for here it is that the focus of the kathode stream strikes, and the energy of the bombarding electrons is transformed into X-radiation.

The early English tubes were furnished with substantial targets of platinum, but in the later foreign tubes with which the market was flooded the platinum was often reduced to a sheet of very thin foil laid upon a plate of nickel. For weak currents, and with an imperfectly focused kathode stream, this plan answered moderately well, but if heavy currents were used the heat generated at the focus was often so great that the platinum skin alloyed with the nickel backing, when fusion and destruction of the whole apparatus followed immediately.



Platinised nickel target damaged by the kathode focus.

This is well illustrated by the accompanying photograph of such a fused target which appeared some time ago in the Journal of the Röntgen Society.

Recently attention has been directed to the exceptional properties of pure metallic tungsten, now produced in quantity for the manufacture of metal filament lamps, and its suitability for the purpose was at once recognised, the metal having a fusing point of about 3000° C., as against 1750° C. for platinum. Tungsten is also very tough, and does not readily disintegrate by the kathodic discharge (kathode sputtering); its atomic weight, 180, is not much below that of platinum.

The British Thomson-Houston Company, Ltd., has introduced a special target of this metal that is being largely used by manufacturers of X-ray tubes. The tungsten is in the form of a thick button brazed into a solid block of copper, in some cases weighing as much as half a pound; this forms a lasting and efficient target, even when heavy currents are used

[1] "Quantitative Measurements of the Conversion of Kathode Rays into Röntgen Rays by Anti-kathodes of different Metals." By J. H. Gardiner. Journal of the Röntgen Society, No. 24, vol. vi.

for considerable periods of time, as is often necessary when using X-rays for therapeutic purposes.

The adaptation of tungsten for this purpose is an example of the great value that lies hidden in the rare and little-known elements, and doubtless other instances of a similar nature will develop as the metals become available.

OSMOTIC PRESSURE OR OSMOTIC SUCTION?

IT has often been assumed that van't Hoff's discovery, that the simple gas-law, PV=RT, may be applied to the osmotic pressures of dilute solutions, justifies the view that osmotic pressure is caused by the bombardment of a semi-permeable membrane by the molecules of the solute, just as gas-pressure is caused by the bombardment of the containing vessel by rapidly moving gas-molecules. A recent exposition of this view by Prof. Ehrenfest, in the Proceedings of the Amsterdam Academy (vol. xvii., pp. 1241–1245), has elicited a reply from Prof. J. J. van Laar (*ibid.*, vol. xviii., pp. 184–190), which will be read with very great interest by all those who have seen in the mechanism of osmosis an even more difficult problem than that of expressing the magnitude of the osmotic pressure by means of a mathematical formula. Prof. van Laar's reply is of exceptional value in that it demonstrates the inadequacy of the gas-analogy from the thermodynamic point of view, and so challenges the simple kinetic theory of osmosis on what has generally been supposed to be its strongest ground.

The osmotic pressure may be expressed, according to Van Laar, by the equation,

$$P=RT/v_0\{-\log(1-x)+\alpha x^2\},$$

where x is the molecular concentration of the dissolved substance, and α is an "influencing" coefficient, which expresses the consequences of the interaction of the molecules of the solvent with those of the dissolved substance. The logarithmic term is an essential feature of the thermodynamic equation, and it is urged that all kinetic theories which lead to expressions without a logarithmic member must be rejected.

The thermodynamic equation, it is true, leads to an expression for dilute solutions which is identical with that of van't Hoff. But in practice it is found that in more concentrated solutions deviations appear which are much smaller than those for non-ideal gases. We may therefore surmise that the so-called osmotic pressure has an entirely different ground from that suggested by van't Hoff's application of the gas-equation, and that there is here no close relation but merely an analogy.

If the osmotic pressure were actually caused by the pressure of the dissolved substance, as Ehrenfest, reviving the old theory, suggests, the pressure of the sugar molecules against the semi-permeable membrane would, in van Laar's opinion, cause the reverse effect to that which is actually observed. No water would pass from the pure solvent through the membrane into the solution, giving rise to a hydrostatic pressure in the osmometer; but, on the contrary, the inward flow of water would be checked, since the pressure in the solution would from the outset be greater than in pure water. In reality, osmotic pressure is caused by the water which penetrates through the semi-permeable membrane, giving rise to a hydrostatic pressure which prevents the further intrusion of the water. This excess of pressure is the so-called "osmotic pressure" of the solution.

Generally speaking, every theory which seeks to interpret osmotic pressure kinetically must be based on the *diffusion* of the water molecules on the two sides of the membrane. If this is done, the logarithmic member arises of its own accord, and finds a place in the equation, whether there is interaction between solvent or solute or not, *i.e.* the α-term appears quite independently of the logarithmic term. In van Laar's opinion, the kinetic interpretation of osmotic pressure, which is always reappearing again in new forms, is moving, and has moved, in a wrong direction, and should again be founded on the simple diffusion phenomenon. T. M. L.

POST-GRADUATE SCHOLARSHIPS AND FELLOWSHIPS.

THE new list of scholarships and fellowships offered by the Leeds University has just been issued. It includes some twelve entrance scholarships in arts, science, medicine, and technology, awarded on the results of the matriculation examination of the Joint Matriculation Board, in addition to a certain number (not specified) given by the local education authority. There are also twelve Clothworkers' free studentships in the textile department, and a "William Cooke" scholarship in mining, determined by special examination or selection. In addition to the above are a number of senior scholarships, awarded to students of special merit in the University, by the University, the Leeds City Council, and by various donors who have wished to perpetuate with their names their interest in the University. Such are the Leighton exhibitions established by the trustees of Mrs. Isabel Leighton, of Leeds, the Salt scholarship given by Sir Titus Salt, the John Rutson scholarship, and the Gilchrist studentship in modern languages. The list of post-graduate scholarships and fellowships is a very meagre one. There is one 1851 exhibition scholarship of 150*l.* tenable for two years, and a number of 1851 exhibition industrial bursaries of 100*l.*, both awarded by the 1851 Exhibition Commissioners, the first in science and the second in some branch of technology. There is, further, a research scholarship in colour chemistry founded by the Clothworkers, and a scholarship in gas engineering endowed by Sir Corbet Woodall. There are also two scholarships in the faculty of medicine. A limited number of research fellowships are also awarded by the University to distinguished graduates; there is one in connection with the fuel department in gas research founded by the Institute of Gas Engineers, and one in colour and textile chemistry.

It is generally recognised by university teachers that the year or years immediately following graduation are in a sense the critical years of a student's career. In science more especially he has laid up a fund of knowledge which he is about to turn to practical account. He has collected a store of potential energy; he has played the *rôle* of an "accumulator" during his university course, and his energy is now to be turned to useful work. In the northern universities at least the graduate has to earn his living, and whilst he is on the look-out for congenial, as well as remunerative, occupation he may often have to wait for many months. It is at this critical time that a post-graduate scholarship, sufficient for the student to keep himself and release his parents from the burden of further maintenance, is invaluable. It is invaluable not merely because it gives him time to look round and relieves him from the necessity of accepting the first vacancy that offers; but because he is learning in that excellent school of research how to use his knowledge and more especially how to depend upon himself.

In the "Scheme for the Organisation and Development of Scientific and Industrial Research" issued by the Board of Education we have the promise of a large extension of post-graduate research studentships and

fellowships. Although there may be cause for criticism of the method of administration of the fund placed in the hands of the committee of the Privy Council, there is no doubt that, if wisely administered, it will have very far-reaching results, not only in developing our scientific industries, but in stimulating research in our universities and levelling up the standard of scientific attainment among the whole body of our science students.

INSTITUTION OF MECHANICAL ENGINEERS.

THE annual report of the council of the Institution of Mechanical Engineers for the year 1915 shows that the fund raised in conjunction with other institutions to establish a memorial to the late Sir W. H. White, K.C.B., amounted to more than 3000*l*. After providing for a medallion portrait, to be placed in the Institution of Civil Engineers, and a donation to the Westminster Hospital, the bulk of the fund, together with any further contributions, is being devoted to the establishment of a research scholarship in naval architecture, to be administered by the Institution of Naval Architects. The report also states that the Thomas Hawksley medal for 1916 has been awarded to Prof. H. L. Callendar, for his paper "On the Steady Flow of Steam through a Nozzle or Throttle," and premiums of 5*l*. each have been awarded to Prof. A. H. Gibson and Mr. W. J. Walker, for their paper on "The Distribution of Heat in the Cylinder of a Gas Engine." A grant of 15*l*. has been made from the Bryan Donkin Fund, for original research in mechanical engineering, to Mr. A. H. Barker, in aid of his research at University College, London, "to investigate a new method of determining the radiant temperature and air temperature in a room." The balance of the third triennial award has been devoted to aiding the steam-nozzles and hardness tests researches of the institution.

The report contains particulars of the work done during the year by the various research committees of the institution. The work of the Alloys Research Committee, on the alloys of aluminium with zinc and copper, has been continued at the National Physical Laboratory. The importance of light alloys in connection with aeronautics has led to a Government grant for the erection and working of an experimental rolling-mill capable of dealing with ingots and billets. Further progress has been made with other branches of the work, including the study of the constitution of the alloys and the "disintegration" research. The series of researches relating to the double carbides of iron, under the direction of Profs. J. O. Arnold and A. A. Read, has been completed. The results of the studies on the carbides of cobalt and of molybdenum have been embodied in papers on "The Chemical and Mechanical Relations of Iron, Cobalt, and Carbon" and "The Chemical and Mechanical Relations of Iron, Molybdenum, and Carbon," both printed in the Proceedings of the Institution. A report was also submitted by Sir Robert Hadfield describing the effects of molybdenum upon iron, up to 18 per cent. of Mo. The Steam-Nozzles Research Committee has held three meetings and is engaged on the design of apparatus for conducting experiments relating to the action of steam passing through nozzles and steam-turbines. The British Westinghouse Electric and Manufacturing Company has offered to lend two large condensers to the committee, and substantial progress has been made with the design of nozzle-testing apparatus. The Hardness Tests Research Committee has been considering the design of a machine to determine rate of wear as a measure of hardness. An existing machine at the National Physical Laboratory was adapted as a preliminary procedure, but the results obtained from this machine and modifications thereof have not yet been satisfactory. The work of the Refrigeration Research Committee has been suspended, Prof. C. Frewen Jenkin, the reporter, being on active service.

Interesting particulars of the war work undertaken by members of the institution are contained in the report. The engineer unit of the Royal Naval Division, which was principally recruited from the members of the Institutions of the Civil, the Mechanical, and the Electrical Engineers, was on active service in Gallipoli. In the early stages of the war, a list was compiled of the engineering and other qualifications of members desiring to obtain commissions in the Army, and copies were forwarded to quarters where they were likely to be of use. The names of selected members have been put forward as candidates for commissions in the 12th King's Own (Yorkshire Light Infantry), Pioneer Companies, the Mechanical Transport branch of the Army Service Corps, and other engineering branches of the Army. Particulars of the engineering training and other qualifications of 159 members who expressed a desire to undertake engineering work in connection with the war have been forwarded to the Ministry of Munitions and other Government departments from time to time throughout the year. In response to an application from the Ministry of Munitions for the nomination of engineers for employment in connection with contracts for the manufacture of munitions, the council appointed a small committee to select possible candidates. The qualifications of sixty-seven members and others were considered, and the names of twenty-seven were submitted to the Ministry. In August last a list of 543 members on active service in the Army was compiled for transmission to the War Office. During the year 661 members had been on active service. Several designs for a mechanical bomb-thrower have been received from members and submitted to the War Office. Designs have also been submitted of apparatus for destroying barbed-wire entanglements, for clearing mines from the products of the explosion of the mine, and for non-slip chains for rubber tyres of motor-wagons. At the request of the Director of Fortifications and Works, a list was compiled of the names of mechanical engineers with whom the War Office might communicate in connection with problems arising out of the war.

THE ORIGIN OF ENGLISH MEASURES OF LENGTH.[1]

ALTHOUGH there is considerable variety in the measures of length used by the different nations of the world, there can be no doubt that they are, for the most part, derived from a common origin, and that their ancestors, if the expression may be used, existed in times so remote that the date of their invention has been completely lost.

For the sake of clearness, it is convenient to divide the measures of length into four categories which are, to a certain extent, independent of one another, and may be defined as follows:—

(1) The shorter measures of length, used for building and manufacturing purposes, of which the more important in ancient times were the cubit, the palm, and the digit, or finger breadth, and the English representatives are the yard, the foot, and the inch.

[1] Abridged from a paper in the Journal of the Royal Society of Arts, December 31, 1915, by Sir Charles M. Watson, K.C.M.G., C.B.

(2) The shorter measures of distance, such as the foot, the yard, and the pace. (3) The longer measures of distance, including the stadium, the mile, the parasang, the schoenos, the league, the hour's march, and the day's march. (4) Measures of length used in connection with the calculation of land areas, of which the English representatives are the perch, the chain, and the furlong.

As regards the first of these classes of measures, it is generally accepted that they were, from the earliest times, based on the proportions of the human body, so that every man had his own scale to which he could work.

The palm is the width across the open hand at the base of the fingers; the cubit is the length of the arm from the elbow to the end of the middle finger; and the fathom the length of the outstretched arms. There is no fixed relationship between these units.

There is no record as to when an attempt was first made to combine the measures in a standard scale, but it was probably at an early period, as it must have been found inconvenient for workers on the same building, for example, to use different lengths of palms and cubits, and, when a standard was fixed, it may have been some such scale as the following :—

1 digit	= 0·7375	English inch
4 digits = 1 palm	= 2·95	„ inches
6 palms = 1 cubit	= 17·70	„ „

The cubit of this scale may be called the "cubit of a man," to distinguish it from other cubits, which will be described hereafter.

There is nothing to show when the foot was added to the units of the mechanic's scale, but when this was done it was assumed to be equal to four palms, or two-thirds of a cubit.

The third class of measures of length is the most important, and the history of these is of particular interest, as they appear to have started in a state of perfection, and to have been first used by a people who possessed a high degree of astronomical and mathematical knowledge, who were acquainted with the form of the earth, and were able to carry out geodetical measurements. There can be no doubt that they are based on the angular division of the circle, and on the application of this division to terrestrial measurements.

The unit of angular measurement is the angle of an equilateral triangle, and this angle was divided by the ancient geometricians, for purposes of calculation, into 60°, the best number possible, as $60 = 3 \times 4 \times 5$. Following the same principle, each degree was divided into 60 minutes, and each minute into 60 seconds. As the circle contains six times the angle of an equilateral triangle the circle was divided into 360°. This division of the circle, although so ancient that its origin is unknown, has never been improved upon, and is still in use by all nations. An attempt on the part of certain French mathematicians to substitute a division of the circle into 400°, on account of the supposed advantages of the decimal system, has proved a failure.

The manner in which the division of the circle into 360° was used by the ancients to determine the unit for terrestrial measures of distance was as follows. If a circle be described cutting the equator of the earth at right angles, and passing through the north and south poles, its circumference in angular measurement is equal to $360° \times 60' = 21.600'$, and the length of 1 minute, measured on the surface of the globe, was taken as the unit, which is called a geographical mile at the present time. If the earth was a perfect sphere, every geographical mile would be of the same length, but, as the polar diameter is less than the equatorial diameter in the proportion of 7900 to 7926, the length of the geographical mile, measured on the meridian, is not the same in all latitudes, but increases in length from 6046 English feet at the equator to 6108 English feet at the poles. Whether the ancient astronomers were acquainted with this irregularity in the figure of the earth it is not possible to say, but it is certain that the value at which they fixed it must have been close to the actual mean value as determined by modern astronomers, which may be taken as about 6075 English feet. The Greek stadion (the same as the Roman stadium), which was one-tenth of the geographical mile, was 600 Greek feet in length, and the Greek foot was about 12·15 of our present English inches.

The next step taken appears to have been with the view of assimilating the subdivisions of the geographical mile with the cubit, and it was not easy to do this, as the cubit of a man has no necessary connection with a geographical mile. The difficulty appears to have been solved by the invention of two new cubits, of which the smaller was very nearly equal to the cubit of a man, and was contained 4000 times in the geographical mile. This, for the sake of distinction, may be called the geographical cubit. The second cubit, afterwards known as the Babylonian Royal cubit, was longer, and was contained 3600 times in the geographical mile. According to Herodotus, this second cubit was three digits longer than the other cubit. On these two cubits there appear to have been based two different divisions of the geographical mile, one in accordance with a decimal, and the other with a sexagesimal system of calculation, but there is, so far as I know, no ancient record of these scales, and the following attempt to compose them is founded on inferences, drawn from the Babylonian, Greek, and Roman measures, all of which, there can be little doubt, came from the same origin.

The first based on the geographical cubit, which was rather longer than the average cubit of a man, is as follows :—

1 digit		= 0·729	English inch
25 digits	= 1 geographical cubit	= 18·225	„ inches
100 „	= 1 fathom	= 6·075	„ feet
100 fathoms	= 1 stadion	= 607·5	„ „
10 stadia	= 1 geographical mile	= 6075	„ „

The second, or sexagesimal scale, based on the Babylonian Royal cubit, appears to have been as follows :—

1 digit		= 0·723	English inch
28 digits	= 1 Royal cubit	= 20·25	„ inches
60 cubits	= 1 plethron	= 101·25	„ feet
60 plethra	= 1 geographical mile	= 6075	„ „

The ancient Egyptian measures of length, although evidently derived from the same origin as the Babylonian, differ from these in some respects. The most important smaller unit was a cubit usually known as the Egyptian Royal cubit, which was divided into seven palms, each palm of four digits. The approximate length of the Egyptian Royal cubit is well known, as a number of cubit scales have been found which give a mean length of 20·65 English inches, and an examination of the monuments of Egypt shows that this cubit was used for building purposes from ancient times.

It is matter of controversy from whence the Greeks derived their measures of length, whether from Egypt or Babylonia; but the latter appears more probable, as their principal measure of distance, the stadion, was equal to one-tenth of a geographical mile of 6075 English feet, and this was divided into 6 plethra, each of 100 Greek feet. The Greek scale appears to have been as follows :—

	1 Greek foot	=	12·15	English inches
1½ Greek ft.	= 1 cubit	=	18·225	,, ,,
10 ,, ,,	= 1 reed	=	10·125	,, feet
10 reeds	= 1 plethron	=	101·25	,, ,,
6 plethra	= 1 stadion	=	607·50	,, ,,
10 stadia	= 1 geographical mile	=	6075	,, ,,

There was another foot used in Greece, of which Petrie gives a number of instances, derived from old buildings, varying from 11·43 to 11·74, with a mean value of 11·60 English inches. This would appear to be a foot of 16 digits, used for building and manufactures, but not connected with measures of distance.

The Roman system of measures was based on the Greek, but while adopting the stadion—called by them stadium—as the fundamental measure of distance, they used the shorter Greek foot, and introduced another measure, the double pace. They also made the land mile to consist of 8 instead of 10 stadia, while retaining the geographical mile of 10 stadia for use at sea. As they had an affection for a duodecimal system of calculation, they also divided the foot into 12 inches, in addition to the old division into 16 digits. The Roman scale, which showed considerable ingenuity in assimilating a number of different measures which had no real relationship to one another, appears to have been as follows :—

	1 digit	=	0·729	English inch
	1 inch	=	0·972	,, ,,
4 digits or 3 inches	= 1 palm	=	2·916	,, inches
4 palms	= 1 foot	=	11·664	,, ,,
6 ,,	= 1 cubit	=	17·496	,, ,,
5 feet	= 1 pace	=	4·86	,, feet
125 paces	= 1 stadion	=	607·5	,, ,,
8 stadia	= 1 land mile	=	4860	,, ,,
10 ,,	= 1 geographical, or sea mile	=	6075	,, ,,

The above remarks deal with the measures of distance used by the principal nations of antiquity up to and including the geographical mile, upon which they seem to have been based, but in addition to these there are certain longer measures of distance which must be referred to, such as the parasang, the schoenos, and the league. The fundamental idea of these measures was that they represented the distance which could be marched in a given time, such as one hour, and as the rate of marching naturally varied with the nature of the country, it was not easy to have a fixed length, and when there was made a theoretical unit it did not always agree with the actual distance.

An important application of measures of distance from the earliest times was for the calculation of areas of land, but there is considerable doubt as to what was the original unit, and whether this was a square, or in the form of a rectangle one stadium in length and one-tenth of a stadium in width. In the latter case there would have been ten measures in a square stadium, and 1000 measures in a square geographical mile, and such a measure would seem quite in accord with the ancient system of measures of distance. Its area would have been 40 × 400 geographical cubits (36 × 360 Babylonian Royal cubits). There is a very widely distributed type of land measures based on a rectangle of this form, of which the English acre is an instance, as it measures 44 × 440 English cubits.

The Egyptian unit of land area appears to have been the "set," which was a square having a side of 100 Egyptian Royal cubits. A cubit of land was the 1/100 part of this, and was the area of a rectangle 1 × 100 cubits.

In the Greek system the unit of area was the square of a plethron or 100 Greek feet, of which there were 36 in a square stadion and 3600 in a square geographical mile.

The Roman unit of land area, called the "jugerum," was a rectangle, 120 × 240 Roman feet, which was subdivided duodecimally, the uncia of land being the twelfth part of a jugerum, or the area of a rectangle measuring 10 × 240 Roman feet.

It will be seen from the above descriptions that from the earliest times the shorter measures of length were based on the proportions of the human body, and the longer on the geographical mile, and that at some remote period an attempt was made to combine them into a continuous scale, from the digit to the geographical mile.

The modern measures of the civilised world are, with few exceptions, based on the ancient units, of which they may be regarded as the direct descendants. Of these exceptions the most important are the measures of the metric system, which were designed with the object of breaking away from the records of the past by the adoption of a new geographical mile, equal to 54/100 of the true geographical mile.

The English measures of length are a good example of the modern representatives of the old units, and are worthy of study from this point of view. How the measures originally came to England it is not easy to say, but there can be no doubt that they were in use before the Roman invasion, having possibly been introduced by Phœnician traders, and were afterwards modified by the Romans, the Saxons, the Scandinavians, and the Normans, each of whom had measures, based on the old units, but altered in course of time. It was not until the thirteenth century that they were moulded by law into one uniform system.

The English scale, as authorised by statute, may be summarised as follows :—

	1 inch
12 inches	= 1 foot
3 feet	= 1 yard
5½ yards	= 1 rod, pole, or perch
4 perches	= 1 chain
10 chains	= 1 furlong
8 furlongs	= 1 English statute mile

Of these units the inch is derived from the Roman system, being one-twelfth of the foot, but the foot, on the other hand, is equal approximately to the Greek foot, while the yard, which is simply a double cubit, comes from the Babylonian system, being approximately a double geographical cubit. The perch is the English representative of the Babylonian gar, and the furlong occupies a similar place to the stadium, while the mile is composed of eight stadia, apparently in imitation of the division of the Roman mile. For use at sea, however, the geographical mile, divided into ten stadia, or, as we call them, cable lengths, has been retained, as no other mile can be used for purposes of navigation.

In order fully to understand the connection between the English measures and the ancient measures of length, it is necessary to write the scale in a somewhat different manner, and to introduce some other units which are no longer used. The revised scale is as follows :—

	1 barleycorn
3 barleycorns	= 1 inch
3 inches	= 1 palm
4 palms	= 1 foot
6 ,,	= 1 cubit
12 ,,	= 1 double cubit or yard
11 cubits	= 1 perch
405 ,,	= 1 cable's length
4 perches	= 1 acre's breadth or chain
10 chains	= 1 acre's length or furlong
8 furlongs	= 1 English mile
10 cables	= 1 geographical, or sea mile

The English inch is equal in length to 3 barleycorns set end to end. The barleycorn, as a measure, is forgotten, but on a shoemaker's tape the sizes of boots and shoes increase by a barleycorn, or $\frac{1}{3}$ inch, for every size. For example: size No. 8 of a man's boot measures 11 inches; size No. 9, $11\frac{1}{3}$ inches; size No. 10, $11\frac{2}{3}$ inches, and so on. One would have thought that the sizes would increase by one quarter of an inch at a time, but the barleycorn has held its place to the present day.

The palm, which was originally composed of 4 digits or finger breadths, and, since the time of the Romans, of 3 inches or thumb breadths, is no longer used in England, and its place has to a certain extent been taken by a measure called the hand, composed of 4 inches and employed in measuring the height of horses.

Prior to the thirteenth century, the length of the foot in England was uncertain; but, by the ordinance known as the Statute for Measuring Land, enacted in the reign of King Henry III., the relations of the inch, the foot, and the cubit to one another were definitely fixed, and have never since been altered. The cubit of this statute is the double cubit, afterwards called the yard. A translation of the Latin words of the statute, describing the different measures, is as follows:—

"It is ordained that 3 grains of barley, dry and round, make an inch; 12 inches make a foot; 3 feet make a cubit; $5\frac{1}{2}$ cubits make a perch; 40 perches in length and 4 perches in breadth make an acre.

"And it is to be remembered that the iron cubit of our Lord the King contains 3 feet and no more; and the foot must contain 12 inches, measured by the correct measure of this kind of cubit; that is to say, one thirty-sixth part of the said cubit makes one inch, neither more nor less. And $5\frac{1}{2}$ cubits, or $16\frac{1}{2}$ feet, make one perch, in accordance with the above-described iron cubit of our Lord the King."

It is interesting that, in this statute, the double cubit, thus accurately described, should have been called the cubit of the King, just as the longer cubits of Babylon and of Egypt were called Royal cubits to distinguish them from the shorter cubits of those countries. In the Latin original of the ordinance the word used is "ulna," the usual word for cubit. The word "yard," to signify the English double cubit, occurs for the first time in the laws of England in a statute of 1483, which is written in French.

The two measures, the acre's breadth, afterwards called the chain, and the acre's length or furlong, have also been used from a very early period. The former is equal to 44 single cubits, 22 yards, or 66 English feet, while the latter is exactly ten times this, 440 cubits, 220 yards, or 660 feet. The furlong is the modern representative in our system of the ancient stadium, which had a length of 600 Greek feet, or 607·5 English feet, but the reason for its being longer than the stadium has, so far as I know, not been satisfactorily explained. But the change may have been due to the fact that other measures of distance were in use in England prior to the present statute mile, which varied in different parts of the country, and the mean of these was approximately equal to the Gallic league of 12 stadia or 7,290 English feet. One-eleventh of this, 663 English feet, is approximately equal to the English furlong, and eight of these measures, following the Roman system, were combined to form the English statute mile.

But whether this is the origin or not, there appears little doubt that the mile, furlong, and chain, or acre's breadth, were in use in England in Anglo-Saxon times, as there is a law of King Athelstane, who reigned A.D. 925–940, in which it is enacted:—

"Thus far shall be the King's grith from his burgh gate where he is dwelling, on its four sides; that is three miles, and three furlongs, and three acres' breadths, and nine feet, and nine palms, and nine barleycorns."

The length of the measure called the King's grith, or King's peace, was the distance from his house within which peace was to be maintained, and it is evident that in this law an attempt was made to express the distance in terms of ordinary measures.

The terms acre's length and rood are no longer used, and this measure is now known as the furlong, while the acre's breadth has been called the chain since the beginning of the seventeenth century, when it was divided into 100 links instead of 66 feet. The chain, which was the invention of Prof. Gunter, has proved very convenient for the measurement of land acres, and is now always used.

Since the introduction of the chain, the perch or rod has been less employed in connection with land measures, but is still used by builders for the measurement of brickwork. The common English stock brick is half a cubit in length, one-quarter of a cubit in width, and one-sixth of a cubit in thickness, or rather less than these dimensions, to allow for the thickness of the mortar joints, while a rod of brickwork, which one rod or 22 bricks in length, one rod or 66 bricks in height, and three bricks in thickness. The perch or rod of brickwork contains 4356 bricks.

The English sea mile is exactly the same as the geographical mile of the Babylonian system, and its tenth part, the cable length, is identical with the stadium. In these measures there has been no change, and the only difference is that the cable length is 405 English cubits, whereas the stadium was 400 original cubits.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The next combined examination for entrance scholarships and exhibitions, at Pembroke, Gonville and Caius, Jesus, Christ's, St. John's, and Emmanuel Colleges, will be held on Tuesday, December 5, and following days. Mathematics and natural sciences will be subjects of examination at all the above-mentioned colleges. Most of the colleges allow candidates who intend to study mechanical science to compete for scholarships and exhibitions by taking the papers set in mathematics and natural sciences. A candidate for a scholarship or exhibition must not be more than nineteen years of age on October 1, 1916. Forms of application for admission to the examination at the respective colleges may be obtained from the masters of the several colleges.

Mr. S. W. Cole, of Trinity College, has been appointed University lecturer in medical chemistry, and Mr. C. S. Gibson, of Sidney Sussex College, has been appointed assistant to the professor of chemistry; both appointments are for five years.

The Smith's prizes are awarded to H. M. Garner, St. John's College, for two papers on orbital oscillations about the equilateral triangular configuration in the problem of three bodies, and to G. P. Thomson, Corpus Christi College, for four papers on aeroplane problems. A Rayleigh prize is awarded to W. M. Smart, Trinity College, for an essay on the libration of the Trojan planets.

The General Board of Studies does not propose to appoint a lecturer in animal embryology to succeed the late Dr. R. Assheton, and advises that the balance of the benefaction to the lectureship should be used for the completion and publication of the embryological work upon which Dr. Assheton was engaged.

OXFORD.—The Committee for Geography will shortly proceed to the appointment of a reader in geography at a stipend of 300*l.* a year. The reader will also hold the post of director of the School of Geography at an additional stipend of 200*l.* a year. The appointment is for five years from October, 1916, and the holder of the post will be re-eligible. Candidates are requested to send in their applications, with such evidence of their qualifications as they may desire to submit, to the assistant registrar, University Registry, Oxford, so as to reach him not later than Wednesday, May 31. Six copies of the application, and of testimonials, should be sent, and at least one copy of any published work to which it is desired to direct the attention of the Board of Electors.

THE Board of trustees of the Ohio State University has ratified the proposal made by President W. O. Thompson for the establishment and maintenance of research professorships. According to *Science* the plan provides that men of recognised ability may be relieved from teaching to devote their entire time to scientific research.

THE Education Department of the County Council of the West Riding of Yorkshire has arranged to hold a vacation course for teachers at Bingley Training College from August 2–16 next. The aim of the course is to stimulate teachers and to give them opportunities of studying new methods of teaching various subjects. The following courses will be included among those offered: a course on education, by Prof. John Adams; the teaching of handwork, by Miss Suddards; animal life, by Prof. W. Garstang; and plant life, by Dr. O. V. Darbishire. The syllabus, containing time-tables and full particulars, will be issued shortly, and can be obtained upon application to the Education Department (Secondary Branch), County Hall, Wakefield.

As has already been reported in these columns, the foundation-stone of the new Hindu University at Benares was laid by Lord Hardinge, Viceroy and Governor-General of India, on February 4. The issue of the *Pioneer Mail* for February 12 contains a full account of the function. In his address to the Viceroy, the Maharaja of Durbhanga said the contributions of the people of India to the University funds now amount to close upon one crore of rupees (666,700*l.*), including the capitalised value of the annual grants, sanctioned by ruling princes, to which the Government has added an annual grant of a lakh of rupees (6667*l.*) The site selected for the University covers more than 1200 acres. Twenty-four donors gave a lakh of rupees each. Lord Hardinge, in his speech, pointed out that it is the declared policy of the Government of India to do all within its power and within its means to multiply the number of unversities throughout India, realising that the greatest boon Government can give to India is the diffusion of higher education through the creation of new universities. "Many, many more are needed," he continued, "but the new universities to be established at Dacca, Benares, and Bankipore, soon to be followed, I hope, by universities in Burma and the Central Provinces, may be regarded as steps taken in the right direction." The University is to be a teaching and residential, as contrasted with an affiliating and examining university. It was announced at the meeting that the Maharaja of Jodhpur had endowed a chair of technology to which Lord Hardinge's name is to be attached. In addition to a lump sum grant, the Maharaja has promised an annual grant of 24,000 rupees (1334*l.*) for this purpose.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 9.—Sir J. J. Thomson, president, in the chair.—Prof. J. W. **Nicholson** and T. R. **Merton**: The distribution of intensity in broadened spectrum lines. (1) Using a neutral-tinted wedge the actual distribution of intensity in broadened spectrum lines can be accurately measured. (2) With this arrangement quantitative measurements of the hydrogen line Hα have been made, and quantitative observations of other lines of hydrogen, helium, and lithium. (3) The intensity-distribution of lines, broadened by condensed discharges and at high pressures, does not follow the well-known probability law known to obtain under certain specified conditions. (4) The broadening of Hα is symmetrical. (5) The most general characteristic of all the curves obtained is that their curvature is away from the axis perpendicular to the wave-length scale. (6) The existence of more than one component accords with the view that electrical resolution of lines is the origin of their broadening. (7) On the supposition of several components symmetrically distributed about the centre, the only general law consistent with the distribution of curvature is that of a sum of linear exponential terms, one for each component. (8) It is shown that in these circumstances discontinuities in the slope of the curves must occur. Those found in the curve for Hα are in quantitative accordance with those expected from available data with respect to electrical resolution. (9) Quantitative observations of Hβ, Hγ, and the diffuse series of helium and lithium confirm the view that electrical resolution is the principal cause of the phenomena.—Prof. H. C. **Plummer**: Prof. Joly's method of avoiding collision at sea. This brief note adds nothing to the general principle on which Prof. Joly's method is founded, but aims at greater simplicity, both in idea and practical detail, by introducing the relative speed of the two ships. The speed and course of an approaching ship being communicated by wireless, the relative speed is easily obtained without calculation by a combination of scales, which is, in fact, identical with Prof. Joly's collision predictor. The one ship may then be considered stationary, and the locus of the approaching ship at successive signals becomes a series of concentric circles. In the case of impending collision the rate of approach is a maximum along a radius and equal to the relative speed. Two methods are suggested for comparing the indications of the signals as received with this critical speed, one involving the use of two direct-reading scales, the other an equivalent arithmetical operation of the simplest kind. —Prof. W. G. **Duffield**: Apparatus for the determination of gravity at sea. The development of the form of apparatus as finally adopted is described. It depends upon balancing a column of mercury against the pressure of a constant volume of air contained in a bulb. The whole apparatus is maintained at as constant a temperature as possible. The height of the column varies inversely as the value of gravity. The apparatus was tested on a voyage to Australia and modified in Adelaide in accordance with experience gained. It was further tested during part of a return voyage under very unfavourable conditions; nevertheless, the results indicate the suitability of this type of instrument for future observations of gravity at sea.

Geological Society, February 23.—Dr. Alfred Harker, president, in the chair.—H. **Dewey**: The origin of some river-gorges in Cornwall and Devon. In North Cornwall, near Tintagel, there is an area of peculiar topography characterised by the presence of an upland plain or plateau. This plateau is dissected by deep gorges, with their walls scarred by potholes through

which the rivers flow in a series of waterfalls, cascades, and rapids. This plateau is terminated inland by degraded cliffs rising abruptly from 400 ft. above sea-level, while the plain slopes gently to the recent sea-cliffs, mostly more than 300 ft. high. The plateau has been cut across rocks of different degrees of hardness, and is overlain by deposits of detritus and peat. Wherever the plain occurs, the scenery is featureless, and the land boggy and waterlogged. The widespread occurrence of this plain over Cornwall and Devon at a uniform height suggests that in its final stages it was a plain of marine erosion. There are in Cornwall and Devon two characteristic types of scenery, to which in great part these counties owe their charm. Wide featureless plains covered with heath and marshland and dominated by tors and crags, on which the drainage is sluggish and vague, alternate with deeply-incised rocky ravines where rivers flow as rapids and cascades. These two types mark successive periods of erosion. Post-Pliocene uplift gave such increased cutting-power to the rivers that they quickly incised chasms in their former valleys, employing while so doing the activity of waterfalls and rapids.

Linnean Society, March 2.—Prof. E. B. Poulton, president, in the chair.—Dr. J. D. F. **Gilchrist**: Larval and post-larval stages of *Jasus lalandii* (Milne-Edwards). Dr. Gilchrist recalls his description, in Journ. Linn. Soc., October, 1913, of the newly-hatched larva, to which he applied the term *naupliosoma*. He now recognises that this name was rather inappropriate, since it tends to obscure the reasonable presumption that the *nauplius* stage has "been passed long before in the development of the embryo." By a record of the distribution, he makes it fairly certain that the further stages of development with which he deals really belong to *Jasus lalandii*. It should, however, be mentioned that, whatever the predominance of this particular crawfish at the Cape, the Atlantic is in some parts well provided with various members of the families Scyllaridæ and Palinuridæ.—B. M. **Griffiths**: The August Heleoplankton of some North Worcestershire pools.—Dr. O. **Stapf**: The distribution of the box-tree, *Buxus sempervirens*, Linn. The author adopted Dr. Christ's views as to the character of the box as a relict of the Tertiary flora of southern Europe, and the discontinuous distribution as brought about by disintegration of an old continuous and much larger area. But he could not share his view that the isolated stations in western France are generally due to old plantations around castles and monasteries. He considered them like the English stations as relict stations.

Mathematical Society, March 9.—Sir Joseph Larmor, president, in the chair.—Major P. A. **MacMahon**: Some applications of general theorems of combinatory analysis.—Prof. H. F. **Baker**: Mr. Grace's theorem on six lines with a common transversal.—H. E. J. **Curzon**: The integrals of a certain Riccati equation connected with Halphen's transformation.—Miss Hilda P. **Hudson**: A certain plane sextic.—Dr. W. P. **Milne**: The construction of coapolar triads on a cubic curve.—J. **Proudman**: The dynamical equations of the tides.

MANCHESTER.

Literary and Philosophical Society, February 22.—Prof. G. Elliot Smith, vice-president, in the chair.—Prof. W. W. Haldane **Gee**: Bunsen and luminous flames. A small obstacle placed at the centre of a coal-gas flame (issuing from a small circular nozzle) at a critical distance above the aperture, gives rise to a musical note of high frequency. If two such flames are made to impinge, roaring or musical flames result. Burners of the Bray and Méker type possess special properties. One experiment of great interest enabled the eddy currents produced by a flame from a triple nozzle to be studied. When the flame is adjusted—so as to be central within a wide glass tube—carbonaceous particles are precipitated from the flame, and these are whirled in an infinite variety of curves round the flame mantle. The effect is more marked when benzine is introduced into the coal-gas.—Dr. J. H. **Smith**: A *résumé* of work on the bleach-out process of colour photography. Grothus, in 1819, seems to have been the first to attempt to formulate the nature of the action of lights of different colour upon bodies, and showed that coloured bodies faded most rapidly in the "opposed" (complementary) coloured light to their own. Liesegang, in 1889, first proposed to utilise this principle in the case of the bleaching-out of aniline dyes in their complementary coloured lights for the production of coloured prints upon paper from transparent coloured pictures. Vallot, in 1895, Neuhaus and Worel, in 1902, and later Szczepanik and the author worked practically upon this process, overcoming some of its difficulties, and obtaining certain results of a somewhat crude nature. In 1907 the author brought the first bleach-out paper upon the market; and in 1911 he was successful in bringing out a new paper ("Utocolor"), by means of which good prints from autochrome plates could be obtained. The more recent work of Limmer, Gebhart, and Just was reviewed.

DUBLIN.

Royal Dublin Society, February 22.—Prof. Sydney Young in the chair.—Prof. Wm. **Brown**: The subsidence of torsional oscillations of nickel wires when subjected to the influence of transverse magnetic fields up to 200 c.g.s. units. A direct transverse magnetic field of 200 c.g.s. units has no effect on the damping of torsional oscillations of a nickel wire whether the wire be hard or soft, but an alternating transverse magnetic field of the same strength increases the damping by almost 10 per cent. in a soft wire and by about 4 per cent. in a hard wire. For a transverse alternating magnetic field of 65 units, it was found that when the frequency of the field was increased eight times the damping was decreased, that is, the amplitude of the seventieth vibration was increased about $4\frac{1}{2}$ per cent.

Royal Irish Academy, February 28.—Rev. J. P. Mahaffy, president, in the chair.—J. J. **Nolan**: The mobility of the ions produced by spraying distilled water. When distilled water is passed through a sprayer the larger drops have a positive charge of uniform surface density, as shown in a previous paper. The present paper deals with the mobility of the ions carried away in the air from the sprayer. Twelve groups of ions have been found, each group possessing a distinct mobility which changes little with time. The mobilities are 0·00038, 0·0010, 0·0043, 0·013, 0·046, 0·12, 0·24, 0·53, 1·1, 1·56, 3·27, and 6·5 cm. per second in a field of 1 volt per cm. Ions of both signs occur in all the groups with the exception of the group of mobility 6·5, which has only been found with negative charges. The negative charge carried by the ions exceeds the positive, the excess being greater in the case of the more mobile ions.—J. A. **McClelland** and P. J. **Nolan**: The nature of the ions produced by bubbling air through mercury. The mobility of the ions carried away in air which has bubbled through mercury has been measured. The mobility decreases rapidly with time, and in this respect differs from the results obtained in the above paper on the spraying of water. When sufficient time has elapsed constant mobilities are reached, and groups of ions have been found corresponding to the first five groups in the above paper. When measured earlier greater mobilities are found,

but the ratios of the mobilities are practically the same as when the stable state has been reached. When the air is dried higher values are again found, and in this case also the ratios of the mobilities have the same values.

PARIS.

Academy of Sciences, February 28.—M. Camille Jordan in the chair.—The President announced the death of Richard Dedekind, and gave a short account of his contributions to mathematics.—Paul **Appell**: Certain polygons the summits of which describe algebraic curves, and of which the sides envelop algebraic curves.—C. **Guichard**: Plane networks which, in an infinity of ways, may be considered as the orthogonal projection of the lines of curvature of a surface.—MM. **Tarazona** and **Marti**: Observation of the eclipse of the sun of February 3, 1916, made at Valencia (Spain). Only the first contact could be observed.—E. **Goursat**: The class of certain differential expressions.—T. H. **Gronwall**: Deformation in conformal representation under restrictive conditions.—B. **Jekhowsky**: The Bessel functions of several variables expressed by Bessel functions of one variable.—Gaston **Julia**: The reduction of positive quadratic forms.—P. **Alexandroff**: The power of measurable ensembles B.—Lucien **Vallery**: The stability of hypochlorites in very dilute solutions. Consequences from the point of view of their use for the sterilisation of water (javelisation). A study of solutions of hypochlorite containing from one to five parts per million of active chlorine. The velocity of decomposition is affected by the medium in two ways, one purely catalytic, the other chemical, depending upon the presence of substances capable of reacting with the molecule of the hypochlorite or with its decomposition products.—G. A. **Le Roy**: The detection of free chlorine in town water supplies. A disagreeable taste becomes perceptible when the amount of active chlorine reaches 0·05 part per million, and chemical control for solutions of such dilution presents difficulties. It is suggested that the active chlorine be concentrated by partial freezing of the water. Starting with 10 litres of water, and freezing 9·8 litres, the remaining liquid readily gives the iodide of starch reaction; 0·0005 milligram of active chlorine per litre can be detected.—Louis **Gentil**: The structure of the Middle Atlas (Central Morocco).—N. **Arabu**: Studies on the Tertiary formations of the basin of the Sea of Marmora.—M. **Deprat**: The existence of a fold of Palæozoic age between Yunnan and Tonkin.

WASHINGTON, D.C.

National Academy of Sciences, (Proceedings, No. 2, vol. ii.).—J. A. **Harris**: Personal equation and steadiness of judgment in the estimation of the number of objects in moderately large samples. While there is no certain differentiation among the experimenters in personal equation, they differ distinctly in steadiness of judgment. The latter is conspicuous in contrast with the former in that it is unmistakably influenced by previous experience.—T. B. **Johnson**: Polypeptide-hydantoins. The formulas for a large number of polypeptide-hydantoins are set up. Some of these substances have already been synthesised and methods for synthesising others are being developed.—J. N. **Rose**: Recent explorations in the cactus deserts of South America. Large collections of cacti in South America have been made, including many species which have never before been collected, and some which, though collected, have been poorly described or wrongly classified.—H. N. **Russell**: The albedo of the planets and their satellites. A table is given of the values finally derived for the albedo of the various planets and satellites. The values are in agreement with the current views of the constitution of the bodies. The value for the earth is intermediate between those of cloudy and cloudless plants.—R. A. **Millikan**: Quantum relations in photo-electric phenomena. So far as experiment has thus far gone Einstein's equation seems to be an exact statement of the energies of emission of corpuscles under the influence of light waves. Thus the correctness of the quantum theory and the reality of Planck's h are corroborated.—J. H. **Ellis**: The chemical activity of the ions of hydrochloric acid determined by electromotive force measurements. In this paper are presented accurate measurements of the electromotive force at 18, 25, and 35° of voltaic cells of the type H_2, HCl, Hg_2Cl_2+Hg, with the acid-concentration varying from 0·03–4·5 normal. From the data are calculated the energy effects attending the reaction which takes place in such cells and those attending the transfer of hydrochloric acid in aqueous solution from one concentration to another. From these results are then calculated the chemical activities (or effective concentrations) of the ions of the acid. These activities are shown to decrease with increasing concentration much more rapidly than do the ion-concentrations derived in the usual way from the electrical conductance ratio.—E. G. **Conklin**: Effects of centrifugal force on the polarity of the eggs of Crepidula. It is difficult, but not absolutely impossible, to change the polarity of eggs and cleavage cells, and the persistence of polarity and the restoration of dislocated parts to normal condition is connected with a somewhat resistent framework of protoplasmic strands.—D. L. **Webster**: The emission quanta of characteristic X-rays. To excite any characteristic radiation it is necessary to use a potential above a critical value. The lines all increase in the same ratio for any given increase of potential. There is reason to believe that the characteristic rays are always a result of excitation of higher-frequency oscillators.—T. W. **Vaughan**: The results of investigations of the ecology of the Floridian and Bahaman shoal-water corals. The ability of corals to remove sediment from their surfaces, their mechanism for catching food, their carnivorous nature, their relation to light and temperature, and so on, have been studied.—C. D. **Walcott**: Cambrian trilobites. Data have been assembled to aid in clearing up some of the problems of formations of the Appalachian region by a careful comparison of portions of their contained faunas with those of other localities.—G. E. **Hale** and F. **Ellerman**: The minute structure of the solar atmosphere. The minute structure of the quiescent solar atmosphere resembles that of the photosphere. The results apparently support the hypothesis that the solar atmosphere consists of parallel columns of ascending and expanding gases, but such questions as the dimensions of the columns and the direction of motion and velocity are reserved for subsequent discussion.—R. W. **Wood**: Monochromatic photography of Jupiter and Saturn. The variation of the appearance of Saturn and Jupiter when photographed with light of different wave-lengths suggests a mist or dust in the planet's atmosphere which scatters the shorter wave-lengths.

BOOKS RECEIVED.

Elements of Highway Engineering. By Prof. A. H. Blanchard. Pp. xii+514. (New York: J. Wiley and Sons., Inc.; London: Chapman and Hall, Ltd.) 12*s.* 6*d.* net.

Aircraft in War and Peace. By W. A. Robson. Pp. xi+176. (London: Macmillan and Co., Ltd.) 2*s.* 6*d.* net.

Individuality in Organisms. By C. M. Child. Pp.

x+213. (Chicago: University of Chicago Press; Cambridge: University Press.) 5s. net.

Notes on the Fenland. By Prof. T. McKenny Hughes, with a description of the Shippea Man. By Prof. A. Macalister. Pp. 35. (Cambridge: At the University Press.) 6d. net.

The Gravels of East Anglia. By Prof. T. McKenny Hughes. Pp. 58. (Cambridge: At the University Press.) 1s. net.

Theosophy and Modern Thought. By C. Jinarājadāsa. Pp. 171. Adyar, Madras: Theosophical Publishing House.) 2s.

Department of Mines and Geology, Mysore State. Records, vol. xiv., 1915. Part 1, Annual Report for the Year 1914. Pp. 59. (Bangalore: Government Press.) 1 rupee.

Records of the Survey of India. Vol. vi. Completion of the Link connecting the Triangulations of India and Russia, 1913. Prepared under the direction of Col. Sir S. G. Burrard. Pp. 115. (Dehra Dun: Trigonometrical Survey.) 6s.

Nutritional Physiology. By P. G. Stiles. Second edition. Pp. 288. (Philadelphia and London: W. B. Saunders Co.) 6s. net.

An Introduction to Neurology. By Prof. C. J. Herrick. Pp. 355. (Philadelphia and London: W. B. Saunders Co.) 7s. 6d. net.

Examples in Alternating-Currents for Students and Engineers. By Prof. F. E. Austin. Vol. i. Second edition. Pp. 223. (Hanover, N.H.: F. E. Austin.) 2.40 dollars.

Surgery in War. By Major A. J. Hull. Pp. xv+390. (London: J. and A. Churchill.) 10s. 6d. net.

The British Freshwater Rhizopoda and Heliozoa. By J. Cash and G. H. Wailes. Vol. iii., Rhizopoda. Part iii. By G. H. Wailes. Pp. xxiv+156+plates xxxiii–lvii. (London: Ray Society; Dulau and Co., Ltd.) 12s. 6d. net.

The Principles of Plant-Teratology. By W. C. Worsdell. Vol. i., pp. xxiv+269+xxv plates. (London: Ray Society; Dulau and Co., Ltd.) 25s. net.

The Physical Properties of Colloidal Solutions. By Prof. E. F. Burton. Pp. vii+200. (London: Longmans and Co.) 6s. net.

Hydraulic Flow Reviewed. By A. A. Barnes. Pp. xi+158. (London: E. and F. N. Spon, Ltd.) 12s. 6d. net.

DIARY OF SOCIETIES.

THURSDAY, MARCH 16.

ROYAL SOCIETY, at 4.30.—Preliminary Report on the Purbeck Characeæ: C. Reid and J. Groves.—Notes on the Genus Toxoplasma, with a Description of Three New Species: Prof. H. G. Plimmer.—The Convolutional Pattern of the Brains of Identical Twins: a Study on Hereditary Resemblance in the Furrows of the Cerebral Hemispheres: F. Sano.

ROYAL INSTITUTION, at 3.—Organic Products used as Propulsive and Explosive Agents: Prof. H. E. Armstrong.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Possibilities in the Design of Continuous-current Traction Motors: N. W. Storer.—The Use of Direct Current for Terminal and Trunk Line Electrification: N. W. Storer.

LINNEAN SOCIETY, at 5.—Resemblance between African Butterflies of the Genus Charaxes: a New Form of Mimicry: Prof. E. P. Poulton.—Notes on Plants collected in Sikkim, including the Kalimpong District: C. C. Lacaita.—Exhibition of Species of Ribes and their Garden Derivation: E. Banyard.—Early Botanical Exploration of North America: B. Daydon Jackson.

CHILD STUDY SOCIETY, at 6.—The Unconscious Mental Life of the Child: Dr. E. Jones.

FRIDAY, MARCH 17.

ROYAL INSTITUTION, at 5.30.—The Search for New Coal Fields in England: Dr. A. Strahan.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—The Composition of the Exhaust from Liquid-fuel Engines: R. W. Fenning.

SATURDAY, MARCH 18.

ROYAL INSTITUTION, at 3.—Radiation from Atoms and Electrons: Sir J. J. Thomson.

MONDAY, MARCH 20.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Military Geography of the Troad: Dr. W. Leaf.

ARISTOTELIAN SOCIETY, at 8.—Symposium "Recognition and Memory": Miss Beatrice Edgell, F. E. Bartlett, Dr. G. E. Moore, and Dr. H. W. Carr.

VICTORIA INSTITUTE, at 4.30.—Inscriptions and Drawings from Roman Catacombs: Rev. H. E. Fox.

TUESDAY, MARCH 21.

ROYAL INSTITUTION, at 3.—Sea Power as a Factor in the Evolution of Modern Races: Prof. A. Keith.

ZOOLOGICAL SOCIETY, at 5.30.—Results of Mendelian Cross in Fowls: J. T. Cunningham.—Structure of the Alisphenoid Canal in some Civets and Hyænas: R. I. Pocock.—Observations on the Cytology of Flagellates and Amœbæ obtained from Old Stored Soil: Dr. T. Goodey.—Notes on the Sitatunga or Marsh-Antelope of the Sesse Islands: Major R. Meinertzhagen.

ILLUMINATING ENGINEERING SOCIETY, at 5.—*Discussion*: Some Aspects of the Design and Use of Glassware in Relation to Natural and Artificial Illumination.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—The Rangoon River-Training Works: Sir G. C. Buchanan, C.I.E.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—Valedictory Address by the President, Sir Boverton Redwood.—The Natural Gas Industry, its Progress and Importance: Dr. J. A. Leo Henderson.

MINERALOGICAL SOCIETY, at 5.30.—An Improvement in the Methods of Determining the Refractive Indices of Minerals under the Microscope: Dr. J. W. Evans.—A Butterfly-twin of Gypsum: L. J. Spencer.

ROYAL STATISTICAL SOCIETY, at 5.15.—War Finance: Sir George Paish.

WEDNESDAY, MARCH 22.

GEOLOGICAL SOCIETY, at 5.30.

THURSDAY, MARCH 23.

ROYAL INSTITUTION, at 3.—Organic Products used as Propulsive and Explosive Agents: Prof. H. E. Armstrong.

FRIDAY, MARCH 24.

ROYAL INSTITUTION, at 5.30.—The Mechanism of Chemical Change in Living Organisms: Prof. W. M. Bayliss.

SATURDAY, MARCH 25.

ROYAL INSTITUTION, at 3.—Radiations from Atoms and Electrons: Sir J. J. Thomson.

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