THURSDAY, MAY 4, 1916.

THERMODYNAMIC AND KINETIC THEORIES.

(1) *Statistical Theory of Energy and Matter.* By Dr. T. Wereide. Pp. xvi+170. (Kristiania: Gyldendalske Boghandel Nordisk Forlag, 1915.) No price.

(2) *Eight Lectures on Theoretical Physics delivered at Columbia University in* 1909. By Dr. Max Planck; translated by Prof. A. P. Wills. Pp. xi+130. (New York: Columbia University Press, 1915.) Price 1 dollar.

IN the development of modern theoretical physics two lines of inquiry have played an important part. One has been the attempt to deduce reversible physical phenomena from the inequalities of irreversible thermodynamics; the other the endeavour to reconcile irreversible phenomena with the equations of reversible dynamics. Between the two we have arrived at a more or less satisfactory representation of many phenomena of an essentially statical character. Progress has, however, been somewhat retarded since the death of Boltzmann, nor can we forget Lord Kelvin's healthy criticisms and the steadying influence in times gone by of representatives of the old rigorous school of Cambridge philosophy, such as Watson and Burbury.

(1) Dr. Thornstein Wereide's introduction to the statistical theory of energy and matter is calculated to revive interest in these oft-debated problems. The author will scarcely be surprised at our statement that the book does not appear to throw light on any new facts or contain any original work of a fundamental character, but the method of treatment and of exposition is novel in many respects, and the account of Soret's phenomena describes experimental researches the results of which appear to be inconsistent with preconceived hypotheses.

The book is divided into two sections. The first is occupied exclusively with the deduction of the fundamental formulæ of statistical mechanics, and occupies practically the first sixty-four pages, since "Maxwell's distribution of velocities," though placed at the beginning of section ii., really belongs to the first section. The second section describes the applications of the theory to various physical phenomena, including specific heat, equilibrium, phenomena associated with change of state, diffusion, the phase rule, magnetism, radiation, and finally the quantum hypothesis of Planck.

A study of the first section might with advantage be supplemented by reading some of the older classical treatises and papers on the kinetic theory, in which the application of Lagrange's and Hamilton's equations of motion is developed in greater detail. For example, the proof of Lagrange's equations is unsatisfactory, and the discussion in § 9 cannot be regarded as constituting a rigorous *proof* of the stated property that the density of probability of a system in statistical equilibrium is a function of the energy alone. To understand this property thoroughly it is necessary to read the older proofs based on the formulation of the Jacobian determinant of the co-ordinates and momenta of the system.

Irreversibility is postulated in the following argument:—

"Let us suppose that the system at a given moment passes through a number of elements, W, that are not all possible. It is then very improbable that the system will cease frequenting the elements hitherto frequented, and never visit them any more. On the other hand, it is very probable that the system, as time passes, will take up more and more elements into its circuit provided that an entrance into these elements is possible."

This assumed, the author deduces that—

"A system that is left to itself will change in such a manner that the density of probability for a given state will either remain constant or decrease. The density of probability can never increase."

And he goes on further to restate the hypothesis as follows:—

"A system that is left to itself will move in such a manner that the number of configurations either is constant or it increases. The number of configurations can never decrease."

Unfortunately this assumption is the exact opposite of the second law of thermodynamics, which states that in an isolated system the number of configurations which it is possible for a system to assume is always decreasing. In this case the decrease takes place by the gradual wiping out, one by one, of the possible configurations for which the sum of the potential and kinetic energies of visible motions is a maximum.

The quantum hypothesis is, of course, an innovation since the days of the classical treatises on the kinetic theory. What the author of this book says in commenting on this theory is sensible enough, namely, that by means of this hypothesis Planck has explained phenomena that others have failed to explain, and it cannot, therefore, be rejected merely because it fails to account for everything.

Dr. Wereide thinks that the best way of throwing light on this question is by a renewed study of the trustworthiness or otherwise of statistical methods.

Now it so happens that the writer of this review, before abandoning gases in favour of aeroplanes, endeavoured to direct attention to a method of investigation in statistical mechanics under the title of "Energy Accelerations." The essential feature of this method was to study the *second* differential coefficients with respect to the time of the squares and products of the velocities of a statistical dynamical system, these determining accelerations of energy which would not be altered in sign by reversing the motions, just as the second differential coefficients of the co-ordinates determine the accelerations of the masses. Unfortunately this suggestion does not appear to

have been taken up. Yet it *does* lead to conclusions which impose serious limitations on the conditions under which statistical energy equilibrium is possible. It shows that a given distribution of density of the co-ordinates of a system in statistical equilibrium can only possess a definite amount of kinetic energy; that such a state of equilibrium may be stable or unstable; that certain distributions are incompatible with statistical energy equilibrium because they would give a negative value for the squares of the velocity compounds, and in particular that statistical energy equilibrium, such as occurs in the molecules of a gas, is impossible in a system of bodies attracting each other according to the Newtonian law of gravitation. It is quite likely that such an investigation if continued would lead to the deduction of a system the energy of which might have one or more of a series of discrete values, and might not be capable of continuous variation, or again of a system possessing a large number of discontinuities in the amount of energy which it could contain. It is scarcely probable that the amounts of energy would be proportional to the numbers 1, 2, 3, . . ., but we imagine Planck's assumption is partly justified on the grounds of its simplicity.

Where, as in this case, a method of investigation does necessarily lead to definite conclusions it is important that these conclusions should be worked out, as they must have a disturbing effect on preconceived theories.

(2) In 1909 Prof. Max Planck was invited to give a course of eight lectures at the Columbia College, New York, on the present system of theoretical physics. Under the terms of the Ernest Kempton Adams bequest to Columbia University an English translation of these lectures has now been published, drawn up by Prof. A. P. Wills. It will be seen that the date of these lectures is anterior to Planck's enunciation of his quantum hypothesis, which thus forms no part of their contents.

It is no easy task to give a simple and comprehensive account of such a vast subject in eight lectures, but Prof. Planck's exposition is remarkable for its conciseness, lucidity, and comprehensiveness. As a general survey of the subject the ground covered is best indicated by the titles of the lectures, namely, "Reversibility and Irreversibility," "Thermodynamic States of Equilibrium," "The Atomic Theory of Matter," "Equation of State for a Monatomic Gas," "Heat Radiation, Electrodynamic Theory," "Heat Radiation, Statistical Theory," "General Dynamics, Principle of Least Action," and "Principle of Relativity." We may take the last lecture as a good example of the general character of the book.

Starting with the ordinary notions regarding relative motion of Galileo and Newton, the author first refers to Hertz's theory, and then follows a description of the difficulties introduced by Fizeau's and Michelson and Morley's experiments, both of which lead to the belief that the relative velocity of light is independent of the relative velocity of the ether. The author then shows how these difficulties can be reconciled by the introduction of a new system of space and time co-ordinates for moving bodies which will bring the phenomena attributed to the ether into accordance with the conventional dynamics of material bodies.

The book is one which might with advantage be placed in the hands of a candidate for Honours in physics in one of our universities. To read it cannot fail to be of assistance to a student who has to cover a large amount of work in a limited time. G. H. B.

A CRETACEOUS FLORA.

Catalogue of the Mesozoic Plants in the British Museum (Natural History). The Cretaceous Flora. Part ii., Lower Greensand (Aptian) Plants of Britain. By Dr. Marie C. Stopes. Pp. xxxvi + 360 + xxxii plates. (London: British Museum (Natural History); Longmans, Green and Co., and others, 1915.) Price 21*s*.

THE Cretaceous Flora, part ii., is devoted to the Lower Greensand (Aptian) flora of Britain. Several species have previously been recorded, but hitherto no general account of the flora as a whole has been written. The most important part of the book is that which deals with new species of Gymnosperms. Twenty-seven Conifers are described, for the most part represented by cones or petrified wood, nine Cycadophyta, five Angiosperms, and two Ferns. The introduction includes some interesting observations on climate, a summary of previous work, and remarks on the geological position of the plant-bearing beds. The descriptions are carefully compiled, and the work of other authors receives frank criticism. A helpful summary is given of current views on the diagnostic value of different anatomical features in the identification of Coniferous wood. The wisdom of employing the generic name Podocarpoxylon for specimens which cannot as a rule be assigned with certainty to the Podocarpineæ is questionable; but Dr. Stopes has, on the whole, adopted a judicial attitude with regard to the taxonomic value of anatomical characters.

One of the most remarkable types is that for which the new generic name Colymbetes is proposed; the type-specimen consists of a piece of well-preserved wood enclosing a large pith surrounded by a broad perimedullary zone; next to this is a ring of bundles of vertical tracheids, succeeded by a series of concentric cylinders of secondary wood, composed alternately of vertical and horizontal elements. It is believed that the alternate cylinders are the products of a single cambium, which, "for some reason unknown, turned at right-angles periodically."

Some new facts are given with regard to *Bennettites Gibsonianus* and other Cycadean plants, and a few new types are described. It is suggested that the formation of more than one cylinder of secondary wood may be accepted as a distinguishing feature of certain Cycadean stems referred to Cycadeoidea, the wood of Bennettites being the product of a single cambium. The con-

clusion that Buckland's stems from Portland, on which the genus Cycadeoidea was founded, bore no lateral fertile shoots like those characteristic of Bennettites, as defined by Dr. Stopes, is not in accordance with a statement made by Buckland in a memoir which appears to have been overlooked. In 1912 Dr. Stopes published an account of some Angiospermous stems from British Aptian strata, and in the present volume some additional types are described. Impressions which are almost certainly those of Dicotyledonous leaves have been recorded from rocks slightly older than the Lower Greensand, but the specimens described by Dr. Stopes are the oldest known examples of petrified Angiospermous wood. The anatomical characters are carefully analysed and no pains have been spared to compare the fossils with recent forms. As the author points out, the Angiospermous wood so far discovered exhibits no features which can be regarded as primitive, and it is clear that the evolution of the present dominant class had already reached an advanced stage.

Dr. Marie Stopes has successfully accomplished a laborious and difficult piece of work: the well-illustrated volume is a contribution of permanent value to British Palæobotany.

A. C. SEWARD.

A NEW TEXT-BOOK OF OPTICS.

A Treatise on Light. By Dr. R. A. Houstoun. Pp. xi+478. (London: Longmans, Green and Co., 1915.) Price 7*s.* 6*d.* net.

RECENT years have witnessed the production of several good treatises on optics in the English language, chief amongst them being Preston's "Theory of Light," Schuster's "Theory of Optics," R. B. Wood's "Physical Optics," Edser's "Light for Students," and J. P. Southall's "Principles and Methods of Geometrical Optics," to say nothing of more special works, such as Trotter's "Illumination." But Dr. R. A. Houstoun's "Treatise on Light," now before us, occupies a place of its own. It will be welcomed as a manual for classes of a more advanced character than those in which optics is taken merely as a part of a general physics course. The study of optics for its own sake, so neglected in most of the universities, would assuredly receive better attention if optics were handled in the spirit of this book, and with as full an insight into recent developments and investigations. It is, indeed, alive with modern information and research; and, as numerous passages reveal, it is written by one to whom optical laboratory work is familiar, and who directs it to bring out useful and important results.

The book is divided into four parts:—(i) geometrical optics; (ii) physical optics; (iii) spectrometry and photometry; and (iv) the mathematical theory of light. Incidentally, the topic of physiological optics is interpolated in part iii. The section on geometrical optics presents an advance in many features over the exposition of that subject in most text-books, its treatment of thick lenses, of lens combinations, and of aberrations being, on the whole, extremely satisfactory. In few points only does the author give the reviewer occasion to grumble. One of these is his awkward convention as to the signs *plus* and *minus*, which do not here signify measurement to the right and left, respectively, from any fixed zero or origin. Another is the inconvenient practice of treating all rays as travelling from the right to the left, instead of the more usual left to right. Nowhere does the author give the definition of the metric unit of power of lenses, the *dioptrie*, though it was adopted internationally in 1875. The only mention of it—and he spells it *diopter*—is in the brief passage on defects of vision. He builds up the theory of thick lenses quite logically from Helmholtz's tangent law. His brief directions as to the measurement of focal lengths on pp. 75 and 76 are very good. Most unfortunately, he uses the Greek letter λ on p. 300, not to denote wave-length, but to signify a coefficient of absorption; and, in defiance of modern practice, he employs the symbol ν, not to denote the anti-dispersion coefficient, but to signify its reciprocal.

On p. 65 all that the author has to say on the residual chromatic aberration known as "secondary spectrum" is that "it can be diminished considerably by using some of the new glasses made in Jena. They appear, however, to offer difficulties in manufacture and to be not very durable." This is scarcely fair to the achievements of Abbe and Schott; for, though their phosphate crown glasses have not proved permanent, their success in producing pairs of crowns and flints that will eliminate secondary dispersion, and in introducing the really valuable novelty of baryta crowns, should be frankly acknowledged. The advantage of using for a lens a glass with a higher index of refraction, as stated on p. 59, diminishes the spherical aberration considerably; and the baryta crowns give precisely this advantage over the other kinds, while requiring relatively less compensation by means of correcting lenses of flint. The author's remarks on the resolving powers of microscopes, telescopes, spectroscopes, and diffraction gratings are distinctly good. It is a curious point that the ordinary method of describing the working aperture of a lens, so familiar to photographers, as a fraction of the focal length, is only mentioned in this work in connection with the Féry spectrograph and the Rowland grating. Another curiosity in arrangement is the inclusion of the subject of persistence of vision in the section headed "Optical Lantern."

Amongst the outstanding excellences of the work we may praise the chapters that deal with interferometers and spectrographs. The two chapters on spectroscopy—the earlier and later spectroscopic work being separated—are very good. The author seems to labour under the erroneous impression, however, that Newton used only a circular aperture and not a slit. There is a cryptic sentence on p. 238, that the dispersion, as specified by $d\theta/d\lambda$, "is easily found experimentally to

be a minimum at minimum deviation, for if we turn through minimum deviation the spectrum is shortest there." But on the ordinary definition of the dispersion this is far from true. Perhaps the author's definition of dispersion is to be preferred. The author alleges, on p. 252, that it is difficult to show in the laboratory the reversal of the sodium lines. If he will adopt the following plan he will, on the contrary, find it very easy, even as a lecture demonstration. Use a hand-feed arc lamp. Let the lower carbon be hollowed out so as to form a sort of small crucible; but let a slight V-notch be cut in its rim on the side towards the projecting lens-system of the lantern. Let the upper carbon be thin and pointed and set to strike the arc by contact with the rim on the opposite side. Put a pellet of sodium in the "crucible," and then move the top carbon down and up several times so as to strike the arc repeatedly. A continuous spectrum is evoked, accompanied usually by bright lines, including the D-line; but the D-line at once changes to a black line, since the light has to pass through the mass of sodium vapour which is slowly pouring over the V-notch.

In the chapter on the later spectroscopy Rowland's photographic charts, Balmer's series, the work of Kayser and Runge, and that of Stark, Zeeman, and Michelson, are admirably described and summarised. The chapter on infra-red and X-rays is also admirable, but the early work of Crookes, which led up to the radiometer, is ignored. Chapter xx., on lamps and illumination, is less satisfying. Surely the estimate of 200,000 candles per square inch for the intrinsic brilliancy of the crater of an arc lamp is too high.

The fourth part, the mathematical theory of light, is a very able and very welcome feature of the work, though it is not all easy reading. It deals with the propagation of single pulses and groups of waves; the modern notion of the true function of prisms, not as sorters-out of hypothetically pre-existing trains of periodic waves, but as the manufacturers of these trains out of miscellaneous and utterly irregular impulses; the electromagnetic theory of light; the experiments of Hertz; the problems of reflexion and refraction; the theory of dispersion; the theory of radiation; and the pressure of light. A pregnant chapter on the relative motion of matter and ether, in which the celebrated paradoxical experiment of Michelson and Morley forms the pivot of the argument, brings the book to the close with the remark that the Michelson-Morley experiment is a somewhat narrow basis on which to rear such a structure as the "relativity" doctrine of Einstein. It is indeed.

To many of the chapters Dr. Houstoun has appended series of questions and problems. These are excellent, being real problems of optics, and not, as in the majority of college text-books, mere mathematical puzzles. There is a reality and freshness about them that is wholly commendable.

The tables included at the end of the book are all too short. But they are satisfactory compared with the index. One looks in vain for many things. The index contains no reference to aperture, Ångstrom's unit, crossed prisms, diffuse reflexion, index of refraction, luminosity, luminescence, persistence of vision, power of a lens, refraction, or selective radiation; and the inquirer who wants to know the significance of μ or of $\mu\mu$ will vainly hunt for the footnote on p. 243 or that on p. 298, where these mysteries are revealed. In an important text-book such as this an index ought not to be left to a compiler who does not grasp what are the good things that must not be left unindexed. One misses even any reference to some of the best and most instructive things in the book, the original researches of the author himself, which are to be found on pp. 299, 324, and 350. The publishers ought at once to scrap the index without waiting for the second edition, which is certain to be called for at no distant time. S. P. T.

OUR BOOKSHELF.

The Moon: Considered as a Planet, a World, and a Satellite. By J. Nasmyth and J. Carpenter. Cheap edition. Pp. xix+315. (London: J. Murray, 1916.) Price 2*s.* 6*d.* net.

IT is a pleasure to direct attention to the issue, at an extraordinarily low price, of a complete edition of Nasmyth and Carpenter's classical work on lunar physiography. Accustomed as we are of late years to cheap editions, this reprint appears to us to present really exceptional value. The work first appeared forty-two years ago, and was reviewed in NATURE of March 12, 1874. That the appreciative tenor of that review was entirely deserved is sufficiently evidenced by the fact that four editions have been issued. Nevertheless, it may not be out of place to quote a fairly recent French endorsement:—

"Au point de vue pittoresque, aucune représentation précédente ne pouvait donner une meilleure idée de ce que l'on voit au télescope que les reliefs de Nasmyth. Les photographies actuelles sont plus exactes, mais elles sont loin d'atteindre le charme des planches de cet ouvrage qu'on ne se lasse point d'examiner."

It so happens that the review copy of the first edition has somewhat often been in the hands of the present writer, and as the illustrations are such an important feature, it is satisfactory to be able to state that the reproductions in this latest edition compare favourably with the originals. The text, written when distinction of literary style could be found even in books of science, can still be read with profit and with pleasure.

H. E. G.

Graphics and Structural Design. By Prof. H. D. Hess. Second Edition. Pp. viii+435. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 12*s.* 6*d.* net.

THE first edition of this book appeared in 1913. The author was formerly designer and computer for the Pencoyd Iron Works and the American

Bridge Company, and is now a professor in Sibley College, Cornell University, His experience, therefore, leads us to expect that his volume will contain much matter of service to structural draughtsmen, and that the treatment will be suitable for students. The early demand for a second edition is evidence that the author has been successful in his treatment, and this is confirmed by inspection of the text. The book does not pretend to deal with the mechanics of materials —the student is referred to other books for this —and the reader who has studied materials will find his knowledge drawn upon throughout the book in application to a large number of structures. Sufficient is given at every step to enable the student to understand which particular theory is being applied. There are practical examples, fully worked out, of every class of structure discussed, and the formulæ used in practice are explained clearly. A large number of exercises to be worked by students is included.

Although the methods of design are American, the British student and designer of structures will profit considerably by going through this volume. We have read chapters xvii. and xviii. with particular interest; these deal respectively with retaining walls and with bins for holding grain and coal; the latter chapter is exceptionally complete, and, as is usual throughout the book, contains typical examples worked out.

Rambles in the Vaudese Alps. By F. S. Salisbury. Pp. x+154. (London: J. M. Dent and Sons, Ltd., 1916.) Price 2*s.* 6*d.* net.

MR. SALISBURY'S book gives a pleasant account of a summer holiday in 1908, spent at Gryon in unambitious excursions among the limestone Alps of the western Oberland. The fine views of such mountains as the Diablerets and the Grand Muveran, in the immediate neighbourhood, and the magnificent gable-end of the Dent du Midi on the other side of the Rhone, as they rise above slopes of green pasture and dark pine-wood, make this an unusually attractive district.

The author writes, not for geologists or botanists, but for lovers of mountain scenery and mountain flowers. As, however, he did not reach Gryon until the beginning of August, he was too late for the blossoms which, some five or six weeks earlier, make the meadows, from three to five thousand feet above sea-level, a carpet of many colours. These, in that month, have given place to less graceful kinds, such as the yellow and purple gentian, the white hellebore (*Veratrum album*), and the monkshood. But his visits to the summits and passes, some three thousand feet above the level of Gryon, were rewarded by such lovers of the mountain air as the *Dryas octopetala* and the alpine aster, the little blue gentians, and even the edelweiss. Some photographs of the flowers, by Mr. Somerville Hastings, add to the interest of the book, and it is one which the tourist who loves to linger rather than to hurry, and desires to learn a little about the plant world of the Alps, will find a useful and attractive companion.

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.*]

Zeppelin Notes.

As one who happened to be in a region which came in for attention from Zeppelin bombs, I have jotted down some of the points of more immediate interest which stand out from an experience in which everything was rather blurred:—

The bombs could be heard approaching as they rushed through the air. The whistling noise—a little like the tearing of calico or the noise made by a gigantic rocket—became a crescendo shriek of terrific intensity just before the bomb struck the ground and the explosion occurred. In the present instance I estimated the height of the Zeppelin as about 4000 ft., and, neglecting air resistance, this would give the bombs a final velocity of about 500 ft. per second. The actual speed was probably less than this, and is considerably less than the velocity of sound (1100 ft. per sec.), which accounts for the fact that the bombs can be heard before their arrival.

Standing as I was at about 200 yards from where one of the bombs fell, the noise of the actual explosion did not appear to be very loud. The reason is probably to be sought in the almost complete numbing of one's senses. All one could do was to stand stock-still and wait for the next bomb. The feeling was much the same as if one had been given a hard blow between the eyes with a bolster or some relatively soft object. I heard a piece of bomb "zip" past me, and afterwards found it embedded in a balk of timber about two yards from where I was standing. A huge cloud of black smoke arose into the air, reminding one of the photographs of Jack Johnson shells bursting.

The results of an explosive bomb show curious freakishness, especially in enclosed spaces. Evidently "pockets" of high pressure result in various directions, and the destruction is confined to the direction of these pockets. Considerable damage may be caused apparently by the air rushing in to restore the pressure after a high-pressure wave has passed forward. For example, one bomb fell near a small outhouse. The doors were blown bodily inwards—mostly owing to the hinges and frames breaking loose—yet the surrounding wall of the house was "started" outwards. One pane of glass in a window-frame disappeared, while an adjacent pane similarly situated was undamaged. The lid of a kettle was deftly blown off by the air wave going down the spout, the kettle being undamaged.

The bombs fell in soft marshy ground, and the effects of the explosion were very local. Apart from flying missiles, the danger zone did not appear to exceed 25 yards or so. Windows, about 15 yards away, on the side of an outhouse remote from the explosion were quite intact.

Pieces of one of the explosive bombs perforated some steel plates standing vertically about 10 yards away. The edges of the holes were rounded, and showed undoubted signs of fusion, due no doubt to the speed of the shearing. In one instance a piece of the phosphor-bronze casing of the bomb penetrated a steel plate more than 1 in. thick.

The holes caused in the soft clayey ground by the explosive bombs were approximately conical, some 10 ft. across, and about 4 ft. deep.

The incendiary bombs could be heard coming with

a whizzing noise, rather like the explosive bombs. They blazed furiously, and lit up the whole neighbourhood. We had, however, no great difficulty in extinguishing one with a hand fire-extinguisher. They contain, I imagine, tar, petrol, and much besides.

The rapid succession of the bombs and the spacing apart of the holes showed that the Zeppelin was travelling at high speed at the time, due no doubt to the activity of the anti-aircraft guns. She could not have hoped to hit any specific object, and, indeed, ludicrously failed to hit anything but clay.

The control of the airship was considerable. She was very nimble in endeavouring to evade the searchlights, which, however, had no difficulty whatever in keeping her in the beam.

OBSERVER.

THE KIMMERIDGE OIL-SHALES.

THE rapid extension of the use of oil fuel in the Navy, coupled with the desirability, for obvious reasons, of securing adequate supplies from home sources, has led to renewed attention being given to the large and easily accessible deposits of oil-bearing shales which have long been known to occur in the vicinity of Kimmeridge, in Dorsetshire, and there is reason to believe that the question of their immediate utilisation has already been urgently pressed upon the notice of the Admiralty.

Assuming that oil of a satisfactory character can be obtained from these shales, there are several considerations which would seem to point to Kimmeridge itself, or some place in its near vicinity, as a suitable spot at which to establish workings, not the least important of which is its proximity to Portland, one of our leading naval stations. Kimmeridge is close to the coast, and although somewhat exposed to gales from the south-west, might be made sufficiently secure as a harbour to enable shipments of the shale to be made to Castletown, or other convenient locality, if it were found impracticable to distil the shale near the place where it is raised. And in any case, should difficulties be found in making the Kimmeridge haven sufficiently safe for vessels to lie at anchor or alongside the jetty that would have to be constructed, Portland Harbour of Refuge is only a few miles distant, and can be entered at any time of tide, and in any weather.

Many attempts have been made to work the Kimmeridge shales for oil, but hitherto without much success, owing largely to the character of the product and the difficulty of rectifying it into a marketable product as naphtha and illuminating oil. But the nature of oil fuel is wholly dissimilar from that of ordinary burning oil, and its chemical and physical characters are quite different. Nor is the same standard of quality as regards colour, freedom from sulphur, etc., needed in a fuel oil as in an oil intended for illuminating purposes. Hence it is possible that there may be an outlet for the Kimmeridge oil that has hitherto been denied it.

The Kimmeridge shales have long received the attention of geologists, and their extent and distribution have been carefully traced. The outcrop along the Dorsetshire coast begins a mile or two to the west of St. Alban's Head, and, as seen from the sea, forms a very striking natural feature as Kimmeridge is approached. The deposits extend to very considerable distances, and are of unknown depth. To the west they are found at Portland, which, indeed, is known to rest upon them, and they were formerly worked for fuel in the island. They come out here and there along the West Bay, or in its vicinity, as far as Abbotsbury. They have been known in times past to ignite spontaneously, probably owing to the heat developed by the rapid oxidation of marcasite, or some other form of iron pyrites. They extend to the north of Dorsetshire, and have been traced by borings and by outcrops in a north-easterly direction to Norfolk, and through Lincolnshire to the Humber.

In the neighbourhood of Kimmeridge the shale was long used as fuel, and is still so used to a limited extent in the country cottages. In the sixteenth and seventeenth centuries it was worked for alum as at Whitby, and by the same methods, the large quantity of pyrites it contains affording the sulphuric acid, whilst other portions served as fuel for evaporation, etc.

The shale seems to have been first worked for oil about 1848, when small shipments were sent to Weymouth, where the retorting was done—a fact which was held, although unsuccessfully, to invalidate Young's patent for the manufacture of paraffin oil by destructive distillation at a low temperature. At the famous trial Vice-Chancellor Stuart ruled that "the manufacture of offensively-smelling and unmarketable oils from Kimmeridge shales could not be held to be an anticipation of Young's patent." It is, however, interesting to note that Weymouth was the first place in the United Kingdom at which the distillation of shale for the production of hydrocarbon oils was attempted on a manufacturing scale.

In addition to oils of various grades the shales yield notable quantities of ammonia on distillation, a fact which has an important bearing upon their commercial value.

In a highly interesting and suggestive paper recently read to the Institution of Petroleum Technologists, Mr. W. Hardy Manfield has given a very full account of the Kimmeridge oil-shales, their distribution and geological features, and of the various attempts which have been made to turn them to account. The communication also gives a description of the methods of winning oil-shale, of distilling it, and of treating the products, based upon practical experience. The paper is particularly valuable on account of the author's local knowledge of the Kimmeridge deposits.

The great objection to the use of Kimmeridge oil is due to the large quantity of sulphur it contains, which it has hitherto been practically impossible to remove to a sufficient extent to make the oil marketable. All attempts at purification by the methods of treatment ordinarily used—mainly acid and alkali—are of little value. The

fact is nothing is really known concerning the nature of the combination in which the sulphur is present. It is evidently very firmly held, for the compound or compounds will stand the most drastic treatment without being broken down. There is here a fine field of investigation for any chemist who will grapple with the problem. What seems to be wanted in the first place is that these sulphur compounds should be satisfactorily isolated, and their properties studied. When we know more about them it may be possible to learn how to deal with them. We would invite attention to what is really a very promising subject for inquiry. There can be little doubt that it would yield to systematic attack by modern experimental methods familiar to organic chemists, and there are the possibilities of great material benefits to him who will satisfactorily solve the problem.

THE WASTAGE OF COAL.

THE Committee for the Investigation of Atmospheric Pollution has just issued its first report, from which it is evident that it has carried out its self-appointed task in a thoroughly scientific and (if the terms are not incompatible) business-like manner. Nineteen towns have undertaken a periodical analysis of the impurities carried down by rain falling on different stations, and also of the constituents of the dust deposited on a specially designed dust gauge of standard dimensions. These results have been tabulated in metric tons per sq. kilo. per month under the headings of insoluble matter (including tar, non-tarry carbonaceous matter, ash), soluble matter (including volatile, combustible, and non-volatile solids), and sulphuric acid (as sulphate), chlorine (as chloride), and ammonia.

The summary at the end of the report gives a comparative survey of the data from the different localities. These data naturally vary with the nature of the environment, whether industrial, residential, or rural. With the exception of some rather interesting and curious local variations, the general results are such as might be anticipated. In industrial centres, such as Oldham, Bolton, and the Ancoats district of Manchester, the impurities reach a maximum, and yield 25 tons or more of total solids per month, and proportionate quantities of sulphuric acid (3–5 tons), chlorine (0·9–1·5 tons), and ammonia (0·15–0·25 ton), whilst Malvern, situated in an agricultural area, shows a minimum record of less than 5 tons of total solids per month, the monthly mean being 2·13, with 0·50, 0·24, and 0·02 ton of sulphate, chlorine, and ammonia respectively.

This large amount and wide distribution of atmospheric pollution from burning coal (for the impurities are practically all derived from coal) raises two issues: the one a question of injury to animal and plant life, the other one of economy.

Leaving on one side the health question, and confining our attention to the economic problem, which is a pressing one in these days, we look to our coal supply, not only for fuel, but for the raw material for explosives, dyes, synthetic drugs, ferrocyanides, ammonium salts, and, to some extent, sulphuric acid, in every one of which there is a more or less serious shortage. Yet of the two hundred million tons of coal consumed annually, less than forty million tons are burnt economically, that is to say, gasified in gas retorts and by-product coke ovens, whilst the remainder, or 80 per cent., is used, not only as raw fuel in which all the valuable by-products are lost, but through incomplete, and therefore wasteful, combustion contaminate the atmosphere and the soil over an area which may be reckoned in hundreds of square miles.

Is there no way of compassing this absurdly wasteful system of utilising coal? Prof. H. E. Armstrong, in a recent address to the Society of Chemical Industry, suggested that the society should advocate an enactment forbidding the use of raw coal for domestic purposes. We are confident that such an enactment, even if it were made more comprehensive in its scope, would instantly solve the problem of the by-product wastage, and simultaneously clear the atmosphere of smoke without injury or discomfort to home or commercial life.

Faced as we are with the shortage of by-products as well as with the immediate and pressing necessity of restricting expenditure, the subject of fuel economy is one which, along with the wastage on drink, demands more than any other form of economy, on account of the prodigious sums involved, an instant and drastic change in our traditional method of *laissez faire*.

In the circumstances it is somewhat unfortunate that the Local Government Board, which instituted an inquiry into smoke abatement in the spring of 1914, should have suspended its sittings just at a time when the result of its deliberations might have borne some fruit; and it is to be hoped that a similar committee having wider powers may shortly be appointed to deal with, in addition to smoke abatement, the larger question of the wastage of coal. J. B. C.

NOTES.

THE tercentenary of Shakespeare's death is being commemorated this week, and tributes to his genius are being paid in many other parts of the civilised world. The event may not be regarded as of particular scientific significance, yet to let it pass unnoticed in these columns would be to show a want of pride for the memory of the greatest master of our literature. In the Elizabethan age, the cockatrice, the mermaid, the phœnix, the unicorn, and like legendary creatures were realities to the general public, and as such were referred to in the works of the great dramatist and other contemporary writers. We have, for example, in "The Winter's Tale," the line, "Make me not sighted like the basilisk," and in "The Tempest," "Now I will believe that there are unicorns." Not only was more or less credulity given to the existence of these and other fabulous creatures, but a web of mystic lore encircled the most common and best known of beasts, birds, and fishes. But though Shakespeare gave credence to many of the legends he quoted, especially in regard to the animals and plants of distant lands, he had a greater knowledge of natural

history than many of his contemporaries. An article in the *Times* of May 2 shows that he was familiar with the characteristics and habits of many birds, and the accuracy of his references to them would do credit to a modern field naturalist. The greatness of Shakespeare, however, lies not so much in the fact that he reflected in his works the best knowledge of his time, which is more than can be said of most writers to-day, but that he enriched and defined with thought what most people feel, and perceived in Nature resemblances and meanings which are hidden to the ordinary mind. In these respects, poetry is independent of knowledge, which does not, however, destroy the magic and the mystery upon which the imaginative mind can play, but transfers them to higher planes. For Shakespeare's knowledge and his power to set in vibration every chord of the human spirit, we join this week in reverent admiration with lovers of good literature throughout the Empire.

THE special correspondent of the *Times* at Amsterdam reports that the change of the legal time-standard in conformity with the daylight saving scheme came into force in Holland on May 1 without any appreciable disturbance of the daily life of the community. All clocks were put forward one hour at midnight on Sunday; therefore, instead of 1 o'clock, 2 o'clock was struck one hour after midnight. This "summer time" will be used until October 1. It is stated that there has been little opposition to the change except among Frisian farmers and dairymen, who, for practical reasons connected with haymaking and milking, desire exemption from observance of the new time. The *Times* correspondent adds that calendars giving the times of the rising and setting of the sun necessarily require readjustment to the altered time. He does not indicate, however, how this change is to be effected; that is to say, whether the calendars are to show astronomical occurrences, such as times of sunrise, sunset, moonrise, tides, and so on, according to one time-standard in summer and another in winter. In legalising the daylight saving system, Holland has followed Germany and Austria, which introduced it by administrative decree on May 1. A Bill with the same object has been passed by the French Chamber of Deputies with the support of the Government, and is now before the Senate; and Sir Henry Norman has handed in the following notice of motion at the House of Commons:—"That, in view especially of the economy in fuel and its transport that would be effected by shortening the hours of artificial lighting, this House would welcome a measure for the advancement of clock time by one hour during the summer months of this year."

A LETTER of Sir Lauder Brunton to the *Lancet* of April 3, 1915, anticipates to some extent the recommendations contained in the memorandum on "Industrial Fatigue and its Causes," issued by the Health of Munition Workers' Committee, and described in our issue of April 20 last (p. 162). Sir Lauder Brunton refers to an experiment made many years ago by the late Mr. Lindsay Russell, Surveyor-General of Canada, and Prof. Pearce when surveying the boundary-line between the United States and Canada. From the force of circumstances it was sometimes necessary to work the men for seven days a week, and several weeks at a time. On other occasions, when there was no necessity for such extreme exertion, the men were only worked six days a week, and allowed to rest completely on the seventh day. It was possible to calculate exactly the amount of every man's daily work in foot-pounds. On reckoning it up it was found that the number of foot-pounds done by the men working six days a week was almost the same as when they worked seven days a week. Sir Lauder Brunton expresses the opinion that in all probability if munition workers work at their full capacity for six days it will be better both for them and the work they turn out that they should rest on the seventh.

WE are glad to note that the Reale Accademia dei Lincei of Rome is taking up the question of the maintenance of the zoological stations at Naples and Messina, and that the Italian Government is being asked to provide the means for continuing the work of these institutions.

AT the ordinary scientific meeting of the Chemical Society, to be held at Burlington House on Thursday, May 18, at 8 p.m., the last of the three lectures arranged for this session will be delivered by Prof. F. Gowland Hopkins, F.R.S., who has chosen as his subject, "Newer Standpoints in the Chemical Study of Nutrition."

MR. CLIFFORD C. PATERSON, a principal assistant in the physics department of the National Physical Laboratory, is to join the Osram-Robertson Lamp Works, Ltd., as director of laboratories for research and technical manufacturing purposes. The arrangement will commence at the conclusion of the war or before that date if possible.

A SHORT account of the career of the late Mr. Erasmus Darwin Leavitt, who died on March 11, appears in *Engineering* for April 28. Mr. Leavitt was a well-known American engineer, and was one of the pioneers who developed the use of high steam pressures in stationary engines in the United States. He was one of the founders of the American Society of Mechanical Engineers, and was elected president in 1883.

THE death of Mr. John Tweedy is announced in *Engineering* for April 28. As vice-chairman of Messrs. Swan and Hunter, the well-known Tyne shipbuilders, he was one of the leaders in the design of high-speed merchant craft. One of the notable services which he rendered was connected with the balancing of the engines, and his name will be remembered in connection with the Yarrow-Schlick-Tweedy system of balancing. He was elected president of the North-East Coast Institution of Engineers and Shipbuilders in 1902, and for some time served on Lloyd's technical committee.

THE report for the year ending June 30, 1915, of the secretary of the Smithsonian Institution contains some interesting facts as to the amount of money the institution has at its disposal for the assistance of scientific research and exploration and for general administration. Its total permanent fund amounts to 205,920*l.* The income of the institution during the year dealt with was 22,408*l.* With the balance of 6112*l.* on July 1, 1914, the total resources for the year amounted to 28,520*l.* The disbursements for the year amounted to 20,086*l.* The institution was charged by Congress also with the disbursement of grants for scientific work amounting to 121,200*l.*

THE late Dr. P. Wharton-Hood, who died at the advanced age of eighty-two, on April 27, rendered an important service to surgery early in his career. His father, Dr. Peter Hood, a well-known physician in London, had attended Mr. Hutton, the famous "bone-setter," through a long and severe illness. In acknowledgment of the father's services, Mr. Hutton imparted to the son all that pertained to the practice of "bone-setting," and what was found to be good in that practice was given by the son to the medical profession in a series of articles contributed to the *Lancet* in 1871. The late Dr. Wharton-Hood and his father, Dr. Peter Hood, were pioneers in the introduction of massage

as a legitimate and effective means of treating sprains and other injuries. The son's best-known work is "The Treatment of Injuries by Friction and Movement," which was published in 1902.

IN a circular issued to the fellows of the Chemical Society, the treasurer states that the council has decided to publish portraits of the three past presidents, Sir Henry Roscoe, Dr. Hugo Müller, and Prof. Raphael Meldola, who have died during the past year. The portraits will be suitable for framing or for binding with the Journal, and will be sold at a cost not exceeding 1s. 6d. each to those fellows who apply to the assistant secretary before August 1, 1916. If there is expressed a sufficiently general wish to possess portraits of other past presidents, arrangements will be made to carry this into effect. A complete list of the thirty-four past presidents of the society is given, and fellows are requested, when sending in their applications, to denote on the form provided which portraits they desire to possess.

ASTRONOMICAL science has lost an energetic worker by the death of Dr. W. F. King, C.M.G., the chief astronomer of the Department of the Interior of Canada, who had done so much to systematise and extend the work of the Dominion Observatory at Ottawa. Born in England, in 1854, he early went to Canada, and was educated at Toronto University, passing out as one of the most brilliant of its alumni. His active scientific career began with the work of the International Boundary Commission, and from his last issued report we find that he was still actively engaged upon geodetic problems. These included the determination of the boundary line through Passamaquoddy Bay, the re-survey of the 49th parallel and that of the 141st meridian. In a new country such delimitations are pressing and important, and Dr. King worked on them with vigour and success. To him also fell the duty of organising the Ottawa Observatory and the settlement of its programme of work. His official position required him to encourage and support many new scientific schemes and institutions that mark the rise and progress of the Dominion. In no department is Dr. King's work better seen and acknowledged than in that of spectroscopy, as carried out in the Dominion Observatory. The observations are of the highest character and interest, and in the large outcome he took an active part. The bold scheme of supplementing the optical equipment of the observatory by the addition of a 60-in. reflector was his conception, and the progress made in its construction is due not a little to his energy and enthusiasm. The excellent seismographic work, embracing a wide network of stations, though under the immediate superintendence of Dr. Klotz, is another evidence of his administrative ability, and the magnetic survey carried out with vigour over a large area similarly displays the extent of his resources and the power of his organisation.

AN interesting experiment in the practical application of anthropology is to be made shortly in the United States. One of the great difficulties of the Administration has been the question of the alienation of land of Indian holders. These lands are frequently of value on account of their timber, and their purchase by speculators at absurdly inadequate prices, and the consequent impoverishment of the Indians, have been a scandal, to which Dr. W. K. Moorehead in particular has directed attention on more than one occasion. In Minnesota power to sell their land is vested only in owners of mixed Chippewa descent; the land of the pure-blooded Chippewa is inalienable. Speculators have, however, been successful in getting hold of it, and the Government has had to intervene. As a result, to prove title it has been necessary to show the mixed descent of the vendor. This is a matter of some difficulty, and a prominent anthropologist has been invited to visit the Chippewa with the view of deciding the question of mixed descent in the cases in dispute. The lawyers of both sides have agreed to abide by his verdict. This solution will recall certain recent proceedings in our own courts, but it is to be hoped may lead to a more decisive result.

A VALUABLE article in the current Journal of the Royal Anthropological Institute (vol. xlv.) is that by Mr. R. Grant Brown, on the Taungbyon festival in Burma, illustrating the animistic basis of the Buddhism of the province. It represents the cult of Two Brothers, who are said to have been Mohammedan martyrs. The chief part of the rite is the ceremonial cutting down of two *teinbin*, or coffeewort, trees (*Nauclea cordifolia*) by officiants representing the Two Brothers. These trees are, except in connection with their cult, not otherwise regarded as sacred. The custom raises some interesting questions the origin and meaning of which continue to be obscure. Do the trees, as Sir James Frazer would say, represent the Spirit of Vegetation, slain at the ceremony, and at a later time reborn in the fields? Or, as Mr. Brown seems to prefer, did one of these trees, according to Prof. Ridgeway's speculations, once grow on the grave of the martyrs, and thus came to be held sacred, and its branches were distributed to the people because they were supposed to be impregnated with the spirits of these holy men? Mr. Brown justly remarks that it is not necessary to assume a single origin for any custom, and a custom may be continued for reasons altogether different from those which originated it. It seems to be possible that the Two Brothers were deified on account of the strong feeling of local patriotism because they opposed the tyrannical native dynasty. In any case, it is interesting to note that these Mohammedan brothers were deified among a strictly Buddhist population.

A LARGE portion of the *American Naturalist* for March is accorded to Profs. Stockard and Papanicolaou, to enable them to complete their analysis of the hereditary transmission of degeneracy and deformities by the descendants of alcoholised guinea-pigs, already alluded to in these columns. The authors find that the offspring of alcoholised females have a higher viability than in the case of alcoholised males, from which they conclude that the male germ cell is more affected by alcohol than the ovum. The male offspring of alcoholised females are inferior to their female offspring. The female offspring of alcoholised males show a higher mortality and more deformity than the male offspring, from which they conclude that the female-producing sperms are more modified by treatment than male-producing sperms.

THE spring number of *Bird Notes and News*, the organ of the Royal Society for the Protection of Birds, reports that a fresh raid by plume-hunters has been made on the albatrosses of Laysan Island, one of the largest of the U.S.A. bird reserves. The breast feathers only seem to have been taken, and to obtain these between 150,000 and 200,000 birds were slain, their bodies being found lying in heaps all over the island. The majority of the victims were furnished by the white- and the black-footed albatross, and after these the greatest sufferers were frigate birds and the blue-faced booby. This iniquitous traffic in plumes could now be effectually killed if the import of plumage into this country were prohibited. Having regard to the restriction in imports now in force, this item might well be added to the list. The ghastly toll of bird-life demanded by the milliners has long

been a standing disgrace to civilised communities. At the present juncture the Government might well prohibit entirely the importation of all plumage—ostrich feathers and eiderdown only excepted—as a useless and undesirable import, and a wholly indefensible form of extravagance.

IN a recent number of the Journal of the College of Agriculture, Tohoku Imperial University, Japan, Mr. Schin Yoschida gives an account of a series of interesting researches. He has investigated the manner in which "milk" is formed in the crops of brooding pigeons. The so-called "milk" is not produced in glands, but by a proliferation and fatty degeneration of the epithelial cells lining the crop. The growth and shedding of the epithelial cells occur only during the brooding season, and affect both male and female birds. Mr. Yoschida has also made further inquiries into the nature of the horny masses (callosities and ergots) found on the legs of horses. He maintains that an examination of their microscopical structure supports the contention that these horny masses represent the hoofs of two of the missing or vestigial digits of the horse. He infers "that the callosity is the nail of the second toe, and the ergot (the horny spur hid by the hair of the fetlock), of the fourth toe."

THE first part of the ninth volume of the Journal of the Marine Biological Association contains an account of some biometric investigations carried out in connection with the question of the localisation of the different races of herrings inhabiting North European seas. The first investigation of this kind was made by Matthews, for the Scottish Fishery Board, about the end of last century, and somewhat later Heincke made a similar study of herrings obtained mainly from the Baltic. Criticism of Heincke's work showed defects of treatment, and his conclusions, as well as those of Matthews, were seen to be of little value since they were deduced from insufficiently large samples. As the question of the distribution of local races of herrings has considerable importance in fishery regulation, the Board of Agriculture and Fisheries organised, in 1913, a comprehensive scheme of investigation applying to all parts of the British seas, and a number of fisheries laboratories arranged to take part in the work. One result of the war has been, of course, the suspension of most of this investigation, but fortunately all the organisation had been completed prior to August, 1914, and some progress was made during 1915. Dr. Orton, in the paper now noticed, gives an account of the practical methods employed at Plymouth by himself and his colleagues. Some eighteen variable characters were measured in each of well above 1000 herrings. As there is no immediate likelihood of a general discussion and analysis of all the results obtained by the Board, the details of this investigation of the Channel herrings are now tabulated and published.

IN Kew Bulletin, No. 2, 1916, several new species of plants are described from India, China, and Africa. Among the African species is *Gardenia fragrantissima*, Hutchinson, of which an illustration is given; *Utricularia papillosa*, Stapf, from Nigeria; and an interesting Asclepiad, *Caralluma carnosa*, N. E. Brown, from the Transvaal, which is illustrated by a plate from a photograph taken in the garden of the Botanical Laboratory, Pretoria, by Mr. Pole Evans, the discoverer of the species. Two interesting and little-known South African Euphorbias are also illustrated by a plate in this number, *E. pubiglans*, a native of Port Elizabeth, and *E. enopla*, with fierce spines which are modified peduncles, from the Witte Poort Mountains and the Karoo.

A SUMPTUOUSLY illustrated paper by Mr. S. Okamura on the mosses of Japan has recently been issued as article 7 of vol. xxxvi. of the Journal of the College of Science, Tokyo. These contributions include citations of new localities and descriptions of new species from the island of Sachalin and from the Corean peninsula. Among the new species may be mentioned a minute and interesting Archidium, *A. japonicum*, with a stem 2–5 mm. high, from the Prov. Musashi, Hondo. *Schistostega osmundacea*, the luminous moss, is now recorded from several localities in Japan for the first time, having previously only been known in Europe and North America. A new aquatic moss, *Bryhnia Nakanoi*, is also described and figured.

ONE of the railway problems of the near future must be the linking of the Balkan lands to western Europe by a route independent of the Central Powers. To find an alternative to the railway route *viâ* Vienna and Budapest to Constantinople will strengthen the relations of Italy and France with the Balkan people at the expense of Austria and Germany. In a paper on the Adriatic Slavs (*Geographical Journal*, xlvii., April, 1916), Sir Arthur Evans advocates the reopening of the old Roman route by the Save valley from Lombardy to Belgrade. A few miles between existing railways would make the line complete from west to east, and, subject to the formation of a South Slavonic State in the Illyrian region, would constitute a route to Belgrade more direct from France and England than that *viâ* Vienna. By Milan, Padova, Gradisca, and Laibach, it would be possible to reach Belgrade from London in thirty-nine hours, compared with 44½, the time taken by the Orient express before the war. The saving in time would be proportionately much greater from many parts of France. In connection with this article attention may be directed to another, in the same number of the *Geographical Journal*, by Mr. H. C. Woods, on communications in the Balkans, which is illustrated with maps.

PROF. A. RICCÒ has contributed to the Italian Seismological Society an interesting paper on the distribution of the epicentres of the greater Italian earthquakes (Bollettino, vol. xix., 1915, pp. 35–47). He shows that these epicentres are arranged chiefly about the crest of the Apennines and its continuations. The distance between successive epicentres varies from 25 to 110 km., the average distance being 50 km. The area of total or partial ruin is usually bounded by a curve, which is elongated in the direction of the mountain-chain, and the longer axis of this curve varies in length from 30 to 300 km., the average length being more than 120 km. Thus the greater part of the Apennine axis is marked out by the ruins caused by earthquakes. Prof. Riccò notices that the same centre is often revisited by great earthquakes; for example, eight earthquakes have originated in the Norcia centre from 1328 to 1860, and ten in the Cassino centre from 1004 to 1891.

THE Canadian Department of Mines has issued a very full description of the Canadian oil-fields under the title of "Petroleum and Natural Gas Resources of Canada," in two bulky volumes. The first volume deals with the occurrence and distribution of oil-fields in various parts of the world, with the chemical and physical properties of petroleum and natural gas, and the methods employed in drilling wells, in pumping, storing, and transporting oil and gas, and with the utilisation and conservation of these substances; the second volume contains a detailed description of the various Canadian oil-fields. The work is one of the

greatest value to all interested in any aspect of this very important industry. In this connection attention may be directed to the very full account of the natural gas industry to be found in a paper by Dr. J. A. L. Henderson, read on March 21 before the Institution of Petroleum Technologists.

IN the *Rassegna Nazionale*, xxxviii., (2), 1, a fortnightly review dealing mainly with politics and literature, science is represented by a popular article on "Infinity" by Pietro Pagnini, in which the peculiarities of infinite space, time, and number are discussed.

ABOUT the first fortnight of March, 1915, the peach blossoms in the gardens at Rome were damaged by the larvæ of a micro-moth identified as *Recurvaria nanella*. An account of the biology of this insect is given by Armando Mignone in the *Atti dei Lincei*, xxv., (1), 3, 5. It belongs to the family Gelechiidæ, and the description of the European form appears to be identical with Scott and Paine's observations in the United States. The imago spends most of the day resting with wings closed on the peach and certain other fruit trees. The larvæ, which are hatched in the autumn, are leaf-miners, making long tunnels in the leaves. In the winter they come out and hibernate in places where they are almost invisible, investing themselves with a silk covering, and the following spring they emerge and attack the young buds.

SPECIAL PUBLICATION No. 33 of the Department of Commerce of the United States Coast and Geodetic Survey deals with the results up to the present time of the magnetic survey of the country and of the adjoining seas. These results are given in the form of tables, and are embodied in a chart to a scale of about 110 miles to the inch. The *isogonic lines*, or lines of equal deviation of the compass from true north, are drawn for each degree of deviation from 24° east in the north-western States to 24° west in the north-eastern States. The date for which they hold is January 1, 1915. In the north-western States the isogonic lines run nearly east and west, in the central States nearly north and south, and in the eastern States north-west to south-east. In the west and south they are fairly regular in shape, but in the east and in the regions south of the great lakes they are much folded. Along a line from Florida to a point 100 miles west of Lake Superior there is no secular change in the deviation of the compass; at points east of this the north end of the compass needle is moving to the west at a rate which exceeds six minutes of arc per annum in the north-eastern States, and at points west of the line the north end is moving to the east at a rate which is nearly four minutes per annum in the south-western States.

THE *Royal Engineers' Journal* for April contains an article on explosives compiled from one which appeared originally in the *Revue Militaire Suisse*. All the more generally used explosives are described, with some account of their manufacture. No mention is made, however, of modern methods of making nitrocellulose; only the old pot method is described. Similarly, recent improvements in the manufacture of nitroglycerine are not referred to. Reference is made to the interesting explosive residue left when a rhodium–zinc alloy is dissolved in hydrochloric acid, this residue exploding when heated to 400° C. in a vacuum. In conclusion, it is pointed out that it is by no means possible to state definitely which is the best of the "high explosives"; probably the most powerful one in use is tetranitroaniline. It would be extremely difficult to produce a substance having greater explosive force than those already discovered and in use at the present day. Whether any advantage would be gained by the discovery of explosives which are more powerful than those already in use is another matter. With "high explosives," once it is possible to plant them on the exact spot at which it is desired to effect destruction, such destruction can be effected with as great completeness by the employment of one of the present-day "high explosives" as with any new one which may be discovered. On the other hand, any increase in the "safety" properties of "high explosives," and improvements in other directions tending towards facilitating their transport, would be a gain from a military point of view.

R. L. DATTA and N. R. Chatterjee have recently described (Journal of the American Chemical Society, 37, No. 3) the action of aqua regia on acetone, ether, methyl, ethyl, and allyl alcohols, and formic and acetic acids, with the production of chloropicrin. The yield of the latter substance is almost quantitative in the case of acetone and allyl alcohol when the reaction mixture is warmed. It is stated that the following method of preparing chloropicrin is far preferable to Hofmann's method in which bleaching powder is allowed to act on picric acid. To a mixture of two parts of nitric acid with three parts of hydrochloric acid, a quantity of acetone equal to one-tenth part of the acid mixture used is gradually added, the reaction mixture being warmed slightly. After heating on a water-bath to complete the reaction, the liquid is steam-distilled, the compound separated, dried over calcium chloride, and finally redistilled at a slightly reduced pressure.

MESSRS. GEORGE ALLEN AND UNWIN, LTD., are publishing at an early date, for the Polish Information Committee, pamphlets entitled "The Landmarks of Polish History," "The Polish Question as an International Problem," "An Outline of the History of Polish Literature," "National Music of Poland," and "Poland as an Independent Economic Unit." Further pamphlets, entitled "A Sketch of Polish Art," "The Population of the Polish Commonwealth," "Poland as a Geographical Individuality," and "Intellectual Poland," are in active preparation.

OUR ASTRONOMICAL COLUMN.

VARIABLE STARS OF SHORT PERIOD.—Prof. E. C. Pickering directs attention to some similarities and peculiarities in the formulæ representing the light variations of the typical short-period variable stars (Circular 190, Harvard College Observatory), not only affording criteria for purposes of classification, but also indicating structural features. It is found that β Lyræ should be regarded as intermediate between the Algol eclipse variables and the δ Cephei stars—exactly the order, it may be added, demanded by Sir Norman Lockyer's meteoritic hypothesis.

PHOTO-ELECTRIC PHOTOMETRY.—Prof. J. Stebbins gives some details regarding the employment in stellar photometry of a specially sensitive rubidium cell (Lick Observatory Bulletin, No. 277). This particular cell is an outcome of some two years of conjoint research with Prof. J. Kunz. The observational work was carried out at Mount Hamilton, June 21–July 30 last year, and several sets of measures are included for nearly every day during the interval embracing three cycles of the star's period. Important real irregularities are revealed, but the mean light curve has nevertheless been determined. The two maxima are found to be practically equal. A marked asymmetry of the light curve on each side primary minimum (the decrease of light being more rapid than the increase) is explained by an assumed non-uniform surface intensity

of the apparent discs of the component stars. In addition to this important work, some measures of the light of the spectroscopic binaries, and thus "suspect" eclipse variable stars θ Aquilæ and σ Scorpii are given. In spite of the very short period of the latter star, 0·2468 day according to Father M. Selga, the evidence points to a slight variation.

THE MOTION OF THE SIDEREAL UNIVERSE.—The view that the galactic system is but a model of many has been supported by additional evidence since the "white" nebulæ were identified with remote galaxies. Such evidence is found in the very high line-of-sight motions, and the dark-line spectra of the spiral nebulæ, the probable finite dimensions, spiral structure, and integrated spectrum of the Milky Way itself. Quite lately this idea has inspired some researches necessarily of a tentative character. Messrs. R. K. Young and W. E. Harper have, in fact, made a determination from the data at present available concerning the radial velocities of some sixteen nebulæ, of the direction and magnitude of the translational motion of the solar subuniverse (Journal of the Royal Astronomical Society of Canada, No. 3). The deduced velocity is 598 km./sec. ($2\frac{1}{2}\times$p.e.) towards R.A. 20h. 24m., and declination $-12°$. Very nearly the same results have been obtained independently. According to the *Observatory* (March) Mr. Truman finds that our nebula is moving towards R.A. 20h., declination $-20°$, with a speed of 670 kilometres per second.

THE WAVE-LENGTHS OF THE CHIEF NEBULAR LINES.—An extensive series of measures of the two chief nebular lines has been made at the Lick Observatory (Bulletin 279). Nineteen spectrograms of the three nebulæ, N.G.C. 6572, 7027, and Orion, were measured by each of three observers, the resulting wave-lengths being 5006·847 and 4958·902 I.A. The method of reduction is not fully described, but the use of a reduction curve connecting micrometer measures and wave-lengths showed that Runge and Paschen's wave-length 5015·73 Å. for this helium line is 0·12 Å. too small. Corrections for radial velocity were calculated from the displacements of $H\beta$. Combined with Keeler's, Hartmann's, and Wright's (recalculated) the rounded, weighted means are:—

5007·02	4959·09 A. (Rowland).
5006·84	4958·91 I.A.

ENGINEERING AND SCIENTIFIC RESEARCH.

IN a paper before the Society of Engineers on May 1 Prof. J. A. Fleming emphasised the necessity of bringing scientific discovery and research to bear upon our national industries. It is estimated, he said, that not less than 1,000,000,000*l.* is invested in material and plant used in the mechanical and electrical engineering industries in this country.

Progress is hampered by want of co-ordination between the various learned and technical societies and by the conservative element in our universities and public schools. We have to consider (1) improvements in training men who will become engineers; (2) the best means by which science can be brought to bear on engineering problems; and (3) scientific methods in relation to the business side of engineering.

In our present educational system, Prof. Fleming added, too much attention is devoted to the cultivation of memory and words, and too little study is devoted to the facts of nature and the power to draw correct inferences from observation. One barrier in the way of industrial progress has been the imperfect scientific training of foremen, managers, and young heads of departments in engineering works. A much-needed educational reform is the compulsory attendance of lads after leaving the elementary school at a technical continuation school. Certificates issued by such schools should have an important determining influence on a boy's future, and should be valued accordingly.

Students at technical colleges should avoid undue specialisation and should be encouraged to acquire a broad knowledge of the principles of chemistry, mechanics, physics, mathematics, and metallurgy.

Research work may be divided into three departments:—(1) Those which aim at determining physical constants; (2) those providing new methods of examination and tests of material and structures; and (3) those leading to the discovery of some new process, material, or machine. In the first two departments there is great scope for further work. As instances of recent valuable work of this character, Prof. Fleming mentioned metallography, the development of high-temperature thermometry, and the recent application by Prof. E. G. Coker of polarised light in studying the stresses in celluloid models of beams, struts, riveted plates, etc.

A good instance of the third branch of research work was the simultaneous discovery in France and the United States of the electrical treatment of fused cryolite to produce aluminium in bulk. This third section of research work calls for special gifts, and it is important to study the conditions which give rise to this originative power. While natural ability plays a great part, effort should be made to utilise the power of inspiration possessed by some great investigators like Lord Kelvin and Clerk Maxwell. The existing centres of research, such as the Cavendish Laboratory at Cambridge, the Royal Institution, and the National Physical Laboratory, should be more fully supported. An important step has been the establishment of the Advisory Council on the Development of Scientific and Industrial Research, and it is satisfactory to find that its aid is being given largely through the intermediation of established professional and technical institutions and societies. In dealing with new problems it is highly desirable to utilise, so far as possible, existing channels of information and inquiry.

Abroad much technical research work is carried out on behalf of private associations of manufacturers in particular industries, and it is to be hoped that British firms will develop this co-operative method of stimulating and utilising research. The same applies to the collection and dissemination of information of industrial value, and to the general scientific organisation of the business side of engineering. The subsidisation of private or national research work by Government funds is but a small part of the whole problem.

In the ensuing discussion Col. R. E. Crompton contended that the British mind possesses the originative powers in a high degree. He recalled that much of the pioneering work in electrical matters was done in this country, and the later advance in Germany was due to better organisation, more general appreciation of the benefits of applied science, and the support of the industrial banks. Scientific and technical education on a far greater scale is needed. Other speakers agreed in advocating more systematic education in scientific matters, and fuller co-operation between the manufacturers and those engaged in scientific work, and a number of instances of valuable research work, initiated since the outbreak of war, were mentioned.

The view was expressed that the co-operation of scientific and technical societies and journals should be more fully utilised with a view of bringing the benefits of scientific method and research to the notice of manufacturers in this country.

crystallisation. A cellular network is formed by fused sodium nitrate, showing close analogy with the similar network described by Cartaud as present in certain rapidly solidified metals.—E. **Fleury**: The ancient glaciations of the Serra da Estrella (Portugal).—C. **Sauvageau**: The gametophytes in *L. flexicaulis* and *L. saccharina*.—R. **Anthony**: A brain of a fœtus of a chimpanzee. A detailed description and comparison with the adult brain and with the brain of a human fœtus of seven to eight months.—E. **Bataillon**: The *rôle* of sodium and potassium salts in polyspermia in Batrachians.—Em. **Bourquelot** and A. **Aubry**: The biochemical synthesis of a galactoside of saligenin, β-salicylgalactoside.—J. **Bergonié**: Illusory protection against the X-rays in doctors already affected. Physical or indirect anaphylaxy. A medical man who, as a consequence of grave radiodermatitis, had given up all X-ray work, was recently under the necessity of again working with X-rays. His skin proved to be abnormally sensitive, a dose 1/160oth of that required to give a reaction with a normal skin sufficing to produce grave symptoms. The nature of these absolutely excluded the possibility of suggestion, and the case might be described as one of physical anaphylaxy.—C. **Richet**: Remarks on the preceding communication. It is pointed out that although the anaphylaxy in this case is the consequence of a physical action, the cause is really chemical, since the X-rays have determined an alteration in the tissues, which is translated by a chemical modification of these tissues or their secretions.

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National Academy of Sciences (Proceedings No. 3, vol. ii., March 1916).—S. **Paige**: The mechanics of intrusion of the Black Hills (S.D.) pre-Cambrian granite.—C. A. **Davis**: The fossil Algæ of the petroleum-yielding shales of the Green River formation of Colorado and Utah. Scientific, as well as economic, interest has been aroused in these shales because they have recently been discovered to yield petroleum when subjected to destructive distillation in closed retorts. The author finds that these shales may be examined microscopically by the methods of sectioning already in use for peats and coals.—A. V. **Kidder**: Archæological explorations at Pecos, New Mexico. The most important results are stratographical, various styles of pottery being found in superposition.—W. **Hough**: Man and metals. An account is given of the author's study of the uses of fire by man in so far as the development of metallurgy is concerned.—W. W. **Campbell** and J. H. **Moore**: The observed rotations of a planetary nebula. The nebula No. 7009 of Dreyer's New General Catalogue is rotating about an axis through the central nucleus nearly at right angles to the plane passing through the observer and the major axis of the image. The mass of the nebula is apparently several times larger than that of the sun. It is suggested that the ring nebulæ are not true rings, but ellipsoidal shells.—H. **Shapley**: A short-period Cepheid with variable spectrum. The star RR Lyræ is a periodic variable in at least three ways: first, in the light of intensity; secondly, in the radial velocity; and thirdly, in the spectrum which changes from F to A. A similar spectral change is found in RS Boötis.—W. S. **Adams** and H. **Shapley**: The spectrum of δ Cephei. At maximum the high-temperature lines are very strong, and the low-temperature lines very weak, while at minimum the reverse is the case. This indicates that at maximum the temperature of the gases constituting the star's absorbing envelope is higher than at minimum.—W. S. **Adams**: Investigations in stellar spectroscopy. I.—A quantitative method of classifying stellar spectra. Method replaces to a considerable extent direct estimations of spectral type by numerical estimates of relative line-intensity, which may be made with much higher accuracy.—W. S. **Adams**: II.—A spectroscopic method of determining stellar parallaxes. III.—Application of a spectroscopic method of determining stellar distances to stars of measured parallax. The method of computing absolute magnitudes and parallaxes from the variation of the intensities of lines in the stellar spectrum is capable of yielding results of a very considerable degree of accuracy.—W. S. **Adams**: IV.—Spectroscopic evidence for the existence of two classes of M type stars. Two groups of M stars are indicated clearly by examination of the intensities of the hydrogen lines.—A. E. **Jenks**: The failure and revival of the process of pigmentation in the human skin. It is found that, on the one hand, there is an extension of the albinistic areas, and on the other a revival of the process of pigment metabolism within an at-one-time albinistic area.—R. W. **Sayles**: Banded glacial slates of Permo-Carboniferous age, showing possible seasonal variations in deposition. A study of the slate and tillite formations of Squantum (near Boston) affords evidence of seasonal changes in the locality, indicating that it was in a temperate zone during Permian times as now.—F. **Morley**: An extension of Feuerbach's theorem. All circular line-cubics on the joins of four orthocentric points touch the Feuerbach circle.—L. P. **Eisenhart**: Deformations of transformations of Ribaucour.—W. W. **Atwood** and K. F. **Mather**: Geographic history of the San Juan Mountains since the close of the Mesozoic era. The study of the geography of this region is closely related to the geologic studies of the range, but may lead also to a study of anthropogeography.—W. B. **Clark**, E. W. **Berry**, and J. A. **Gardner**: The age of the Middle Atlantic coast Upper Cretaceous deposits. The several Upper Cretaceous formations of the Middle Atlantic coast represent all the major divisions of the European series.—Edward W. **Berry**: Upper Cretaceous floras of the world. The stratigraphic position of the more important of the Upper Cretaceous floras is indicated by a diagram.—S. O. **Mast** and F. M. **Root**: Observations on Amœba feeding on Infusoria, and their bearing on the surface tension theory. Surface tension is probably only a small factor in the process of feeding in Amœba.—R. C. **Tolman** and T. D. **Stewart**: The electromotive force produced by the acceleration of metals. Successful attempts have been made to change the relative position of positive and negative electricity in a piece of metal by subjecting it to a large retardation.

BOOKS RECEIVED.

Department of Commerce. Geodesy. Serial No. 7: Latitude Observations with Photographic Zenith Tube at Gaithersburg, M.D. By Dr. F. E. Ross. Special Publication, No. 27. Pp. 127 and plates A to Q. Serial No. 14: Triangulation in West Virginia, Ohio, Kentucky, Indiana, Illinois, and Missouri. By A. L. Baldwin. Special Publication, No. 30. Pp. 67. Serial No. 15: Triangulation along the Columbia River and the Coasts of Oregon and Northern California. By C. A. Mourhess. Special Publication, No. 31. Pp. 149. (Washington: Government Printing Office.)

The Nemesis of Docility: a Study of German Character. By E. Holmes. Pp. vii+264. (London: Constable and Co., Ltd.) 4*s.* 6*d.* net.

The Marketing of Farm Products. By Prof. L. D. H. Weld. Pp. xiv+483. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) 6*s.* 6*d.* net.

The Standard Cyclopedia of Horticulture. By L. H. Bailey. Vol. iii. Pp. v+1201 to 1760. Vol. iv. Pp. v+1761 to 2421. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) Each 25*s.* net.

Wye Salmon: Results of Scale-Reading, 1908–1915. By J. A. Hutton. Pp. 24. (Manchester: Sherratt and Hughes.)

British Museum (Natural History). British Antarctic (*Terra Nova*) Expedition, 1910. Natural History Report. Zoology. Vol. i., No. 4: Larval and Post-Larval Fishes. By C. Tate Regan. Pp. 125–155. Zoology. Vol. ii. No. 6: Myzostomida. By Dr. C. L. Boulenger. Pp. 135–140+1 plate. (London: British Museum (Natural History); Longmans and Co.) 9*s.* and 1*s.* respectively.

A Class-Book of Chemistry. By G. C. Donington. Part iv. Metals. Pp. vii+401–534. (London: Macmillan and Co., Ltd.) 2*s.*

Diseases of Poultry: their Etiology, Diagnosis, Treatment, and Prevention. By R. Pearl, F. M. Surface, and M. R. Curtis. Pp. xi+342. (London: Macmillan and Co., Ltd.) 8*s.* 6*d.* net.

Publications of the U.S. Naval Observatory. Second series. Vol. ix. (in four parts, with appendix). Part ii. Pp. iii+B. vii+B. 759. (Washington: Government Printing Office.)

Memoirs of the Indian Meteorological Department. Vol. xxi., part xiii.: On the Calcutta Standard Barometer. By E. P. Harrison. (Calcutta: Government Printing.)

The Pathology of Tumours. By Dr. E. H. Kettle. Pp. viii+224. (London: H. K. Lewis and Co., Ltd.) 10*s.* 6*d.* net.

Madras Government Museum. The Foote Collection of Indian Prehistoric and Protohistoric Antiquities: Notes on their Ages and Distribution. By R. B. Foote. Pp. xv+246+plates 64. (Madras: Superintendent Government Press.) 14*s.* 8*d.*

DIARY OF SOCIETIES.

THURSDAY, MAY 4.

ROYAL INSTITUTION, at 3.—Flints and Flint Implements: Sir Ray Lankester.

IRON AND STEEL INSTITUTE, at 10.30.—Presidential Address. *Papers:* Notes on the Theory of the Corrosion of Steel: L. Aitchison.—Notes on the Relations between the Cutting Efficiencies of Tool Steels and their Brinell or Scleroscope Hardnesses: Prof. J. O. Arnold.—A New Thermo-Electric Method of Studying Allotropic Changes in Iron or other Metals: Dr. C. Benedicks.—Initial Temperature and Critical Cooling Velocities of a Chromium Steel: Dr. C. A. Edwards.—The Influence of Carbon and Manganese upon the Corrosion of Iron and Steel: Sir Robert Hadfield and Dr. J. N. Friend.—Early Experiments on the Recalescence of Iron and Steel: A. Mallock.—A Few Experiments on the Hardness Testing of Mild Steel: W. N. Thomas.—Surface Tension Effects in the Intercrystalline Cement in Metals and the Elastic Limit: F. C. Thompson.

LINNEAN SOCIETY, at 5.—The Origin of the Garden Red Currant: E. A. Bunyard.—The Dispersal of Organisms, as Illustrated by the Floras of Ceylon and New Zealand: Dr. J. C. Willis.—A Study of the Rectal Breathing Apparatus in the Larvæ of the Anisopterid Dragonflies: R. J. Tillyard.—Description of a New Species of Idotea (Isopoda) from the Sea of Marmora: W. E. Collinge.

INSTITUTE OF METALS, at 8.30.—Sixth May Lecture: X-Rays and Crystal Structure, with Special Reference to Certain Metals: Prof. W. H. Bragg.

FRIDAY, MAY 5.

ROYAL INSTITUTION, at 5.30.—Electrical Methods in Surgical Advance: Sir J. Mackenzie Davidson.

IRON AND STEEL INSTITUTE, at 10.—(See above.)

GEOLOGISTS' ASSOCIATION, at 7.30.—Field Notes on the Faunal Succession in the Lower Carboniferous Rocks of Westmorland and North Lancashire: Prof. E. J. Garwood.

SATURDAY, MAY 6.

ROYAL INSTITUTION, at 3.—X-Rays and Crystals: Prof. W. H. Bragg.

MONDAY, MAY 8.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Travels in Ecuador: Jordan H. Stabler.

ROYAL SOCIETY OF ARTS, at 4.30.—Vibrations, Waves, and Resonance: Dr. J. Erskine-Murray.

TUESDAY, MAY 9.

ROYAL INSTITUTION, at 3.—Chinese Painting: L. Binyon.

ZOOLOGICAL SOCIETY, at 5.30.—A Small Collection of Vertebrate Remains from the Har Dalam Cavern, Malta, with Note on a New Species of the Genus Cygnus: Miss Dorothea M. A. Bate.—An Experimental Determination of the Factors which cause Patterns to appear Conspicuous in Nature: Dr. J. C. Mottram.

ILLUMINATING ENGINEERING SOCIETY, at 5.—Annual Meeting, followed by a Discussion on a Report to be presented by the Research Committee.

FARADAY SOCIETY, at 8.—An Analysis of the Theory of Gels as Systems of Two Liquid Phases: E. Hatschek.—(1) The Properties of Solid Solutions of Metals and of Intermetallic Compounds; (2) The Annealing of Metals: F. C. Thompson.—The Changes in the Physical Properties of Aluminium with Mechanical Work. II. Specific Heats of Hard and Soft Aluminium: F. J. Brislee.—A Note on the Annealing of Aluminium: R. Seligman and P. Williams.—Grain Size Measurements and Importance of such Information: Z. Jeffries.—A Contribution to the Theory of Solution: E. J. Hartung.

WEDNESDAY, MAY 10.

GEOLOGICAL SOCIETY, at 5.30.—Carboniferous Fossils from Siam: Dr. F. R. Cowper Reed.—The Lurgecombe Mill Lamprophyre and its Intrusions: H. G. Smith.

OPTICAL SOCIETY, at 8.—Apparatus used for the Teaching of Optics at the Cavendish Laboratory, Cambridge: Dr. G. F. C. Searle.

THURSDAY, MAY 11.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Seventh Memoir on the Partition of Numbers. A Detailed Study of the Enumeration of the Partitions of Multipartite Numbers: Major P. A. MacMahon.—The Occurrence of Gelatinous Spicules and their Mode of Origin in a New Genus of Siliceous Sponges: Prof. A. Dendy.—The Classification of the Reptilia: E. S. Goodrich.—The Experimental Production of Congenital Goitre: Dr. R. McCarrison.

ROYAL INSTITUTION, at 3.—Flint and Flint Implements: Sir Ray Lankester.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Annual General Meeting.

INSTITUTION OF MINING AND METALLURGY, at 5.30.—*Discussion:* The Influence of the War on the Mining and Metallurgical Industries.

FRIDAY, MAY 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY, at 5.—The Latent Heats of Fusion of Metals and the Quantum Theory: Dr. H. S. Allen.—(1) Lenses for Light Distribution; (2) The Choice of Glass for Cemented Objectives: T. Smith.

MALACOLOGICAL SOCIETY, at 7.—Descriptions of New Mollusca: G. B. Sowerby.—Solander as a Conchologist: T. Iredale.—Misnamed Tasmanian Chitons: T. Iredale and W. L. May.

SATURDAY, MAY 13.

ROYAL INSTITUTION, at 3.—X-Rays and Crystals: Prof. W. H. Bragg.

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