NATURE

SATURDAY, NOVEMBER 8, 1924.

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Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON

Science and Philosophy.

THE different branches of knowledge are often classified according to their subject matter. To each is assigned a definite region of experience or a definite group of ideas; the conclusions of those who study these with special application are supposed to be embodied in a series of propositions which convey all that is known on the subject to any one whose interest may be aroused in it. Distinctions drawn on this basis between the various experimental sciences, or between science and mathematics or history, are accepted without question. The physicist gives his material to the chemist to be analysed, asks the mathematician to solve his equations, and inquires of the historian whether his result was known to the ancients; he recognises that these matters lie within their province, not his, and yet he has perfect confidence in their answers. The exact boundaries may sometimes be difficult to draw, and where they occur, disputes may arise between those who approach them from opposite sides; but there are large areas within which all are content to accept the jurisdiction of the recognised occupants.

But with philosophy the position is different. No student of science ever hands over any of his problems to a philosopher, or accepts gratefully from him any help that may be offered spontaneously; and yet the reason for his aloofness does not seem to be merely a diversity of subject matter so complete that the two studies can never enter into contact. For philosophers, who surely know what they are studying, undoubtedly believe that their studies have some bearing upon science; while the bewilderment which philosophic writings produce in most scientific minds is akin to exasperation rather than to indifference. If science and philosophy are distinguished by their subject matter, then either there are problems involving both provinces or there are not. If there are, why do we not work in friendly co-operation? If there are not, why do we quarrel?

In a recent lecture [1] Prof. Graham Kerr suggests that the distinction is one of method, not of matter; and if he is asked why two methods applied to the same matter do not lead to concordant results, he replies that one of them is wrong. We must reject entirely the "old philosophy" and replace it by the "new philosophy—Science." The view is not entirely novel, but it has at least the merits of frankness and directness. It is scarcely a solution of the difficulty. For it cannot be expected to appeal to philosophers; and even those whose sympathies are wholly scientific may be loath to believe that the labours of so many men not obviously

[1] "Science—The New Philosophy," Proc. Roy. Phil. Soc. Glasgow, 52, 187 (1924).

devoid of intelligence have been so entirely futile; it leaves the question why there is a conflict between science and philosophy exactly where it was. But perhaps our chief wonder will be why, if philosophy has hitherto been nothing but error, Prof. Kerr thinks that he exalts the importance of science by calling it philosophy.

The answer is probably to be found in history. Before knowledge was differentiated, and when all serious students were "philosophers," a solution of all the problems of philosophy would have answered all the questions which any of them cared to ask. We suggest that when Prof. Kerr calls science the new philosophy, he means simply that it answers all the questions that he cares to ask. If that is so, nobody will quarrel with him except on a point of mere terminology. But the question remains whether science will answer all the questions (including this one) which other people care to ask. Prof. Kerr recognises himself that there is a diversity of intellectual interest; he complains, for example, that philosophers are indifferent to improvements in observational methods, which interest him so greatly. Is it not possible that he is indifferent to things which interest them, and that in this diversity of interest, which leads to the asking of different questions, lies the true distinction between science and philosophy?

Let us consider from this point of view the problem which causes the fiercest contention, that of the reality of the material world. Science and philosophy are here concerned with the same subject matter, namely, the experience received through the senses. Are they asking the same question about it, or is there confusion arising from their common inheritance of the word "real"? The scientific question is to be answered ultimately by experiment. Now an experiment is simply a portion of experience which is regular in the sense that it can be repeated and can be experienced by all men at all times; improvements in observational methods are improvements or extensions of this regularity. It seems, therefore, that the question which science asks is whether and how far sense-experience can be reduced to or analysed into this kind of regularity. The supreme test of regularity is prediction; and it is easy, therefore, to understand why Prof. Kerr maintains that, to the man of science, the question of reality "was disposed of long ago when it was realised that occurrences in the external world could be prophesied."

Philosophers, however, are not interested in experiment; that is precisely the difference between students of philosophy and science; and therefore this cannot possibly be the question that they are asking. Many of us find it hard to discover what that question is; but it seems to arise from the contemplation of the irregularities of experience. Side by side with the regular portion of sense-experience which an observer shares with all men at all times, and inseparably entangled with it, there is an irregular portion which is peculiar to him at a particular moment and makes it *his* experience. It is almost impossible to frame any question about it in words or to understand a question framed by others; for words, being a method of communication between different persons, are necessarily based on the common and regular portion of experience. But if any one can frame such a question, either for himself or for others, and if he finds it interesting, surely it is a legitimate subject of study. It is, however, a study concerning which science cannot possibly have anything to say, and on which its conclusions and its success in prediction can have no bearing whatever.

If this view is right, when any one asserts that anything is real he means nothing more and nothing less than that he has been able to satisfy to some extent his intellectual aspirations. When we assert that atoms or electrons are real, we are not deciding between the philosophic doctrines of materialism and idealism, because we have no understanding of those doctrines or interest in them. When also a philosopher asserts that time or space is not real, he is not throwing any doubt on any scientific doctrine; for the purpose of that doctrine, namely, to describe and explain the regularities of sense-experience, does not appeal to him. While this mutual lack of interest continues—and it is something very fundamental in the constitution of human minds—there can be no reconciliation between science and philosophy. For knowledge is what somebody thinks; science is what men of science think about, philosophy what philosophers think about; and while they continue to think about different things and ask different questions, no idea that is important to one can be important to the other.

Reality was not, however, the only problem of the "old philosophy" from which modern science and philosophy descend. Science, we agree, must solve this problem for its students; but can it solve the other problems, such as the nature of justice or of beauty? Prof. Kerr apparently thinks it can. The New Philosophy, he tells us, identifies greater human perfection with greater prosperity and happiness. But there are others, not less entitled to speak for science, who cannot accept the ideal of the contented pig, and would regard wisdom and virtue as no less important ingredients of perfection. When science speaks with divided voices, who shall decide? Philosophy, of course, say the philosophers; and our difference with them in the matter of reality need not make us unwilling to grant their claim. For if, as has been suggested, the philosophic view of reality is based on the consideration of individual and irregular experiences, concerning which no two persons can agree and which are important for that very reason, surely it may throw some light on moral and æsthetic judgments, concerning which opinion is similarly diverse. If philosophy takes for her province those subjects round which, from their very nature, bitter disputes must ever range, we may be well content to leave her in possession and to share with mathematics and history the province of positive knowledge. Nor will she have reason to complain if we reject any conclusions that she may offer us ; for our rejection will merely extend her sphere and offer her new fields to conquer. N. R. C.

Primitive Fishes and Petroleum.

(1) *The Evolution and Distribution of Fishes.* By Prof. John Muirhead Macfarlane. Pp. ix + 564. 25*s*. net.
(2) *Fishes : the Source of Petroleum.* By Prof. John Muirhead Macfarlane. Pp. ix + 451. 25*s*. net.
(New York : The Macmillan Co. ; London : Macmillan and Co., Ltd., 1923.)

(1) THESE two very interesting books by the professor emeritus of botany in the University of Pennsylvania form an aftermath of his early studies of the fossils of the neighbourhood of Edinburgh. In his previous volume, "The Causes and Course of Organic Evolution," he propounded the thesis that "organisms evolved first in fresh-water areas, and only by degrees spread into marine surroundings," and the first and larger of the two volumes now under review deals with the application of this view to the fishes. The volume, the preparation of which must clearly have involved a vast amount of research into the literature of the subject, makes out a strong case for the author's view, and in spite of its multiplicity of detail, provides interesting reading for any one interested in the evolutionary history of the lower vertebrates.

It is to be regretted that the author will be regarded by most vertebrate morphologists as having to a certain extent queered his pitch by his adhesion to certain theories now generally discarded. He is a firm believer that vertebrates are descended from nemerteans. The majority of morphologists are probably now in agreement that the various types of ancestral vertebrate above the cœlenterate level of organisation have continued on their evolutionary way and are no longer to be recognised as persisting in any of the invertebrate groups of to-day, whether Nemertea, Annelida, Arthropoda, or any other.

From his various references to the air-bladder, it would appear that the author regards this organ as being in the teleostean fishes respiratory in function, and that he believes that in marine fishes it tends to degenerate in correlation with the higher degree of oxygenation of the water making the gills more competent to deal with the respiratory needs. As a matter of fact, our present-day knowledge of the morphology and physiology of the air-bladder seems to establish clearly (1) that this organ of the teleost is an evolutionary development from the lung, (2) that its function is a hydrostatic one—serving to keep the specific gravity of the fish equal to that of the water in which it swims, regardless of changes of pressure due to changes of depth, and (3) that its disappearance in particular teleosts is, as a general rule, related to their having adopted a bottom-frequenting habit.

Passing over such points of detail, which after all are not essential to the main thesis, we find that the larger part of the book is devoted to a discussion of the physical and biological environment of fishes during the various geological periods (Chapters iv.-viii.), and to a survey of the distribution of the various groups of fishes in relation to time and space (Chapters ix.-xiii.). The chapters dealing with these subjects are preceded by three introductory chapters—the first more or less philosophical, the second dealing with geological conditions in relation to the evolution of fishes, and the third dealing with the evolution of fishes from the invertebrata. The closing chapters of the book deal with the distribution of fishes in relation to geological and geographical conditions in the past (Chapter xiv.), fishes in relation to a Southern continent (Chapter xv.), the problem of Lake Tanganyika (Chapter xvi.), and the geographical and geological relations of the more primitive fishes (Chapter xvii.).

As has already been indicated, the main sections of the book are palæontological, and these gain much in interest and value from the author's breadth of view. He appreciates the disintegrative effect of bacterial and other agencies, and sees that to explain the wonderfully complete and exquisitely preserved entire fish skeletons occurring in certain deposits, it is necessary to assume abnormal conditions such as showers of volcanic ash at the time of their entombment. He also would appear to appreciate—as so many palæontologists do not—the need of taking due account of everything available from the studies of embryologists and anatomists upon allied types of existing animals when endeavouring to draw general morphological conclusions from the facts of palæontology.

In his review of the successive geological formations, the author urges that the Downtonian and other Upper Silurian deposits, containing abundant remains of primitive fish, are undoubtedly of fresh-water origin. He accepts the generally admitted fresh-water character of the Old Red with its archaic types of elasmobranchs, dipneusts, and ganoids. During the earlier part of the Carboniferous period the abundant fish population was still predominatingly fresh-water, although now for the first time seaward migration of various elasmobranchs foreshadowed the marine fish fauna of the Carboniferous Limestone. These marine fishes soon died out, and in Triassic times the predominatingly ganoid fish fauna became again restricted to fresh water. In Jurassic times, fish began again to spread into the sea—the immigrants this time including actinopterygian teleostomes as well as elasmobranchs. This invasion of the sea by elasmobranchs from fresh water became still more pronounced during the Cretaceous period, a number of genera becoming conspicuous that still persist at the present day, while they were now accompanied by typically teleostean derivatives of the Ganoidei. In the fresh waters were other teleostean types, ancestors of some of the great fresh-water groups of to-day, while with them were still abundant dipneusts and ganoids. Curiously, the Cretaceous teleosts all died out and became replaced by new Eocene types, although many of the elasmobranchs persisted unchanged.

(2) The second volume, like the first, is written to sustain a particular thesis, in this case more restricted in scope but at the same time of greater practical interest. While there is general agreement that mineral oil is of organic origin, there is no such general agreement as to the type of organisms to which the great oil deposits owe their origin, some assigning the chief rôle to vegetable organisms, others to Protozoa such as Foraminifera, others again to fish. Prof. Macfarlane is a strong supporter of the last-mentioned view, and in this volume he marshals the evidence in what will seem to many convincing fashion, in spite of his various heresies in regard to the evolution of the early vertebrates.

The author points out the frequent association in geological time of oil-containing deposits with rocks containing abundant remains of fresh-water fish. Although a botanist, he does not allow that vegetable remains have played any appreciable part in the production of oil. "The group of fishes alone in the animal kingdom conforms in every respect to the requirements for formation of crude petroleum." Their sudden destruction in immense shoals, their frequent richness in oil, their tendency to float and to accumulate in masses, and the rapid disengagement of oil from their decaying bodies, present a combination of factors favourable to the production of petroleum "not even approached distantly by any other group of animals." Kerogenite or oil-shale—the main source of crude petroleum—is invariably associated with fish remains, and in accounting for its formation the author recalls the experimental work of Stuart, showing how oil in muddy water tends to be carried down and entangled among the deposits of mud at the bottom.

Prof. Macfarlane recognises in the course of geological history a number of distinct epochs during which oil-formation was particularly active—an Old Red epoch synchronous with the abundance of fresh-water elasmobranchs, dipneusts, and other primitive fish during the Middle and Later Devonian period, a Jurassic epoch when the abundance of fresh-water ganoids reached its climax, a late Cretaceous and early Tertiary epoch marked by great abundance of marine elasmobranchs, and still later epochs marked by oil-deposits of teleostean origin—first marine and later, as the present day is approached, fresh-water.

The author takes an optimistic view as to the oil supplies of the future. In addition to large, as yet untapped, supplies of free oil in various parts of the world, he emphasises the presence of vast expanses of oil-shale, both in the old and new worlds, which merely await the development of more efficient means of extraction. Holding the views he does, he very rightly insists upon the need of highly trained geologists, with special training in fish palæontology, for the working out of possible sources of oil-supply in the future.

Properties of Colloidal Systems.

Licht und Farbe in Kolloiden: eine phänomenologische Monographie. Von Prof. Dr. Wolfgang Ostwald. Erster Teil: Optische Heterogenität, Polarisation, Drehung, allgemeine Absorption, Heterogenitätsfarben, Brechung. (Die Ergebnisse bis 1914.) (Handbuch der Kolloidwissenschaft in Einzeldarstellungen, Band 1.) Pp. xiv + 556 + 17 Tafeln. (Dresden und Leipzig: Theodor Steinkopff, 1924.) 7.60 dollars.

THE large volume before us is the first part of a work designed to deal exclusively and exhaustively with the optical properties of disperse systems. Readers familiar with the existing text-books of colloid chemistry, in which a score of pages, or less, is devoted to these properties, will be struck with the large amount of information which the author has made readily accessible. The method of presentation he has chosen is, we are told, the "phenomenological," an adjective which the author feels obliged to explain even to the German reader; he does so in the following terms: "The author sees the characteristic of this method of presentation in the attention paid to *all* phenomena, and not only to selected ones, which fit a particular theory. A second characteristic consists in the attempt to separate concepts and to arrange phenomena in orderly fashion as neatly as possible." It will be generally agreed that these are desiderata in all scientific writing, but the author develops an antithesis between phenomenological and mathematical treatment which will scarcely command such general assent. Fortunately, the important question whether quantitative relations can be discovered, or be proved to hold generally, by methods other than mathematical, need not be debated here, as the vast majority of the phenomena treated in the work under review are much too complicated for mathematical treatment at present. Even where such treatment has been carried out, with all the apparatus of modern mathematical physics, as in the case of gold sols, the results are only in moderate agreement with experimental measurements.

The six headings of the sub-title give an indication of the scope of the present volume. Optical heterogeneity and its most striking macroscopic manifestation, turbidity, are first discussed generally, and the contributory factors; reflection, refraction and scattering at the interface are analysed. The Tyndall phenomenon is then treated at great length; Rayleigh's formula for non-conducting particles and Mie's for gold particles, both small compared with wave-length, are given and calculated results are compared with experimental determinations. A chapter on the design and use of the ultra-microscope follows, which far exceeds in scope and completeness anything to be found in the existing literature. It is illustrated with a number of exceptionally beautiful plates, several of them in colour, which will give the reader unfamiliar with the instrument some idea of the appearance of ultra-microscopic images and, incidentally, of the difficulty of interpreting most of them.

The chapter on polarisation falls into two main divisions: the state of polarisation of the light reflected and scattered by small particles, and the optical activity of certain sols. Among the most interesting phenomena described is the multirotation of gelatin, the change of specific rotation with age being paralleled by a change in viscosity. The connexion between the two is obscure, and its elucidation might throw light on the constitution of emulsoid sols. The chapter on absorption deals largely with the applicability of Lambert's and Beer's formulæ to disperse systems, and the effect of the degree of dispersity on selective absorption. Colours produced by optical heterogeneity form the subject of the next section; as one of the chief factors in producing colour in systems with *non*-metallic particles is the preferential scattering of the shorter wave-lengths, there is a certain amount of overlapping with the first section. In the final chapter the problem of a "mean" refractive index of heterogeneous systems and attempts to deduce it from the constants and the volume ratios of the phases are treated.

The author confesses to a special affection for his present subject, and his enjoyment in developing it is, indeed, quite obvious. While such enjoyment on the author's part is certainly stimulating to the reader, it has led to a breadth of treatment which (as the preface admits) may sometimes seem excessive, and to a certain amount of repetition. The latter may not be a defect to the student, who will not read the book at one sitting nor probably "with his feet on the fender." The author naturally has to deal with a number of controversial subjects—the interpretation of the microscopic and ultra-microscopic images of gels is a good example —and, while he does so with plenty of spirit, he manages to write entirely *sine ira et studio*.

The book, as stated on the title page, covers the literature up to 1914. Even during the comparatively sterile period of the last ten years some investigations of fundamental importance have appeared, *e.g.*, to mention one only, that by Porter and Keene on sulphur suspensions containing particles *large compared with wave-lengths* and indigo in *transmitted* light. No theory of this phenomenon is available so far; until one is found there will be a distinct gap in the optics of disperse systems.

This and a few other omissions caused by the avowed limitation to work done before 1914 do not in any way detract from the value of the book. It provides a very large amount of information, little of which is to be found in the existing text-books, on some of the most immediately striking, and at the same time important, properties of colloidal systems. The purchaser will have to let this consideration weigh against the price, which, like that of many recent German books, is very high—although no doubt the lavish and expensive illustrations go some way towards justifying it.

E. H.

The Appeal of the Himalaya.

Wonders of the Himalaya. By Sir Francis Younghusband. Pp. vii + 210. (London: John Murray, 1924.) 10*s*. 6*d*. net.

SIR FRANCIS YOUNGHUSBAND is one of the great Asiatic explorers, for he was almost the first to cross Central Asia from Pekin to India, the first to traverse the Mustagh and other high passes in the north-western Himalaya, and was in later years head of the British expedition to Lhasa. The effect of his new book should be to inspire many of the coming generation with his passion for exploration, and especially for investigation of the unsolved problems of the Himalaya. The volume is a popular narrative of four of his early journeys, made when he was a subaltern in the King's Dragoon Guards. Life in that regiment did not satisfy him.

"I would gladly," he says, "have entered into the life of a cavalry regiment if the regiment had been really in earnest about training itself for war. But they were not. The Colonel had had me up in orderly room and told me that I was always going on as if we were preparing for active service; but we never went on active service, so it was of no use preparing for it. What we had to do was to prepare to turn out smart for parade when some general came round, and in that way we should get a good name."

Lieut. Younghusband came of a family of explorers. He was a nephew of Shaw of Yarkand, and a regiment governed by a man who would have been appropriately its head tailor gave inadequate scope for his energies. He soon made his name as a most capable explorer and was sent on various missions, his success in which gained for him, by the age of twenty-four, the Gold Medal of the Royal Geographical Society. The author expresses the hope that his book will be read by boys; but it would appeal to readers of almost any age, owing to its expression of the author's deep enjoyment of his experiences, his appreciation of the good qualities of his men, and its graphic descriptions of Himalayan geography. The expeditions described include his preparatory traverse in the southern Himalaya through Dharmsala to Simla; to Manchuria in 1886; across Central Asia from Pekin to Rawal Pindi, during which he passed through the Karakorams and over the Mustagh Pass; and a special mission in northern Kashmir to search for the supposed Saltoro Pass, to investigate the depredations by Hunza raiders in the Pamir and Hunza country, and to note the proceedings of a Russian expedition that was secretly visiting that region.

Sir Francis Younghusband is a dauntless traveller, and his courage is displayed by his defiance of those who regard beginning a sentence with a preposition as one of the worst of literary sins. He does it habitually —half-a-dozen times on a page, and with two succeeding sentences beginning with "but."

The narratives are throughout of intense interest, and may be read with pleasure by those who know the previously published accounts of the expeditions, for amid the stories of narrow escapes from avalanche or suspicious Asiatics are pæans on the Himalaya and their wonders and majesty. Sir Francis Younghusband describes their barrenness, poverty, and intertribal strife; but he makes his reader share his feeling that these ills are evanescent, and that the grandeur, purity, and light of snow-capped mountains are the source of their never-tiring joy and inspiration.

J. W. G.

Mathematics for Engineers.

(1) *The Design of Diagrams for Engineering Formulas and the Theory of Nomography.* By Dr. Laurence I. Hewes and Herbert L. Seward. Pp. xiii + 111. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 25*s*.

(2) *Elements of Graphic Statics.* By Prof. Clarence W. Hudson and Prof. Edward J. Squire. Pp. viii + 91. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 6*s*. 3*d*.

(3) *A Treatise on Engine Balance using Exponentials.* By P. Cormac. Pp. xi + 151. (London: Chapman and Hall, Ltd., 1923.) 21*s*. net.

(4) *Leçons de mécanique rationnelle, professées à l'École des Mines et de Métallurgie Faculté technique du Hainaut à Mons.* Par François Bouny. Tome 1: Calcul vectoriel, Cinématique, Statique, Potentiel. Pp. viii + 600. (Paris: Albert Blanchard; Mons: Librairie Leich, 1924.) 50 francs.

(1) MESSRS. Hewes and Seward's account of chart construction for engineering formulæ consists of two main sections. The first 34 pages are somewhat general in character, and explain the formation of functional scales and the drawing of charts in general. The remaining 70 pages are devoted to the theory and practice of nomography. Both portions are well written, with a wealth of excellent diagrammatic illustration. The book is well printed and the charts well reproduced.

The volume is obviously intended for readers who are not shy of mathematical reasoning and calculation. This is illustrated by the beginning of Chapter iii., where the nomography proper commences. The authors base themselves on the fundamental property of collinear points, namely, that their Cartesian coordinates satisfy a determinantal equation, and they show how various types of problems can be solved nomographically. If it can be assumed that engineers can follow such reasoning with ease, then there is something to be said in favour of this mode of presentation; and the authors do it fairly well. We must point out, however, that it is fatal to become a slave to one particular line of reasoning or to one particular method. To do all formulæ by the determinantal method is dull and by no means educative, while often this method is distinctly more laborious than straightforward practical processes which can be readily devised in most cases from easy first principles. Probably most engineers would prefer elegance and ease of design to logical completeness of mathematical argument.

(2) In their little book on graphic statics, Profs. Hudson and Squire give a careful study of the

theory of forces in a plane, and then apply the methods to simple structures, and to the discussion of shearing forces and bending moments. The book is pleasant to read, never irrelevant and always to the point. Fig. 9a is upside down!

(3) The first few pages of Mr. Cormac's book tend to discourage the prospective reader. One does not like such disregard of usual practice as $a \times -1 \times -1 = a$. One cannot approve of the statement that $dz/d\theta = \iota z$ gives $z = e^{\iota\theta} + C$, so that if $z = 1$ when $\theta = 0$, we get $C = 0$. It is unpleasant to see $\underline{|3}$ written $|\!\underline{\ \ }3$. It is unusual to write $(1 + 2h \cos \theta + h^2)$ with (1 on one line and the remainder in the next. But all this only means that Mr. Cormac should have submitted his manuscript or the proofs to a severer scrutiny: it does not destroy the interest and value of the attempt made by the author to develop the theory of engine balance by means of exponentials, or more correctly by the use of vectors in the Argand plane. The idea is that a mass m at distance r from an axis of rotation ω, in direction θ measured from a fixed direction, has acceleration representable by $-r\omega^2 e^{\iota\theta}$ and an "inertia resistance" representable by $mr\omega^2 e^{\iota\theta}$. In conjunction with various expansions like $(1 - r \cos \theta)/(1 - 2r \cos \theta + r^2)$ in terms of Fourier series, elaborately worked out in an appendix of 20 pages, this notation is applied to various types of engines, flywheels, and cranks. The book is an interesting application of complex numbers and de Moivre's theorem to an important topic in engineering practice, and is on the whole well written.

(4) Prof. Bouny's book is the first part of a treatise on the principles of mechanics intended for students of technology. The present volume discusses vectors, kinematics, and statics (including potential theory). Volume II. will deal with particle and rigid dynamics and with the mechanics of continua. It is stated that the book represents lectures delivered to first and second year students at the School of Mining and Metallurgy at Mons, the students being in general beginners in the study of theoretical mechanics.

As is to be expected, the book is very reminiscent of French treatises, both in matter and in method. It is in fact a treatise in the real sense of the word, the subject being discussed with the logical completeness and the logical sequence that form so admirable a feature of French school and university text-books. In Great Britain, text-books are written with the object of coaxing the student, especially if he happens to be studying technology, so that he is suspected of taking but little interest in theoretical and fundamental principles. French and Belgian writers do not coax their readers. They explain their subject carefully, logically, and with full-dress seriousness. Examples, if they exist at all, do not pander to the tastes of engineers who like to see practical applications with numerical results!

The present volume is in fact one that anybody may read who wishes to study the principles of mechanics for their own sake, and not merely if he happens to be interested in mines but is yet prepared to admit that theoretical principles also deserve attention. The standard is somewhat high. Only the best equipped mathematicians among technological students at British universities could read with profit Prof. Bouny's book. Mathematicians should certainly read it. There are nearly 300 examples with solutions.

Vectorial notation and methods are used throughout. For the mining engineer and metallurgist this must be a distinct hardship, because the kind of mechanics they need is such that the use of vectors would be sheer faddism. This is tacitly admitted by the author himself, who gives the most important results in ordinary Cartesian, polar, or intrinsic notation as the case may require for practical application, after having deduced the vectorial forms.

S. BRODETSKY.

Practical Human Physiology.

Human Physiology: a Practical Course. By C. G. Douglas and J. G. Priestley. Pp. ix + 232. (Oxford: At the Clarendon Press; London: Oxford University Press, 1924.) 12*s*. 6*d*. net.

DURING the last twenty or thirty years, with the vast increase in physiological knowledge, especially from animal experiments and from the chemical point of view, there has been unfortunately an increasing divorce between medicine and physiology to the detriment of both. The researches of Haldane and his fellow-workers on respiration have been mainly human experiments, and probably most of his results could not have been carried out in any other way. This is the point of view of the book before us, and the experiments given can all be performed on the students themselves. It is based on the practical course for the honour school of physiology at Oxford, and taken with Sir Charles Sherrington's book on "Mammalian Physiology" the ground is covered very thoroughly. Naturally, a large proportion of the book is devoted to respiration—nearly three-quarters, using respiration in its widest sense of the transport of oxygen and carbon dioxide by the blood as well as through the lungs. This section includes such important subjects as the effects of muscular work and the administration of oxygen, the determination of the basal metabolism, of the volume and reaction of the blood as well as the more usual determination of oxygen and carbon dioxide carrying capacity. The book does not, however, deal with respiration alone. Modern methods of blood examination are discussed, including the agglutination of the red cells, blood grouping, transfusion and the fragility of the red cells. The functions of the kidney are investigated, water diuresis is discussed, and methods given for the determination of the sugar and urea in the blood. The recent important work of J. B. S. Haldane on the maximum concentration of chloride and bicarbonate in the urine is very suitable for class work and is included.

Under the heart and circulatory system, blood pressure and the polygraph tracings of the pulse are investigated experimentally, and the electro-cardiograph is shortly referred to. Finally, there is an excellent section on the investigation of the stomach and intestine by X-rays and the stomach tube. Contrary to general impressions, these facts are very suitable for class experiments, and easily rouse interest and give valuable results.

A practical course serves two main purposes—to demonstrate the general truth of the science and to train the student in methods of investigation. For the man who devotes his life to physiology, all methods are almost equally important, and animal experiments here may have advantages over experiments on man, as well as some disadvantages. Most students of physiology intend to practise medicine, and here perforce the subject of experiment is generally human, whether in the great experiment designed by Nature such as disease, or in careful observation of treatment. It is in this way that the present book is particularly valuable.

In one other way the volume is admirable. Many practical books consist of a list of unconnected experiments, and the book is of little use outside the laboratory. This book is eminently readable, and the experiments are put together as a connected whole, although complete details are given for the actual experiments and for the calculation of the results—an important thing in any respiration work.

The only serious drawbacks are the large branches of physiology which are left untouched—the central nervous system and metabolism as studied by changes in the urine with work, rest, and various diets. Perhaps the authors are right in leaving this to be written by some one else, and keeping themselves to the branches in which they have such unrivalled practical experience.

The course is more suitable for small advanced classes. Perhaps in a few years, when other courses similar to this and covering the other branches of physiology have been written, it will be possible to abstract a shorter and simpler practical course of human physiology which should be followed by all students of medicine.

Our Bookshelf.

Birds in their Relations to Man: a Manual of Economic Ornithology for the United States and Canada. By Dr. Clarence M. Weed and Dr. Ned Dearborn. Third edition, revised. Pp. viii+414+18 plates. (Philadelphia and London: J. B. Lippincott Co., 1924.) 15*s.* net.

As this book deals with North American birds and conditions, its interest to readers in Great Britain is naturally general rather than particular. Nearly half the space is allotted to a detailed consideration of the food habits of the species which are of most importance economically in the United States: in addition, however, there are chapters on methods for studying the food of birds, on the development of economic ornithology in America, on birds' food in general, and on measures for the conservation and encouragement of useful species and for preventing the depredations of those which are injurious.

From among the many examples to be found in the book, the following evidence as to the economic value of birds may be cited. During a plague of canker-worms in Illinois orchards, the stomach contents of 141 birds belonging to 36 species were examined. Canker-worms were found in 60 per cent. of the individuals and 72 per cent. of the species, and formed 35 per cent. of the total food of all the birds examined. It may be noted also that, so long ago as 1885, economic ornithology was taken up by the Federal Government, and the task of investigation and public instruction entrusted to what is now the Bureau of Biological Survey of the U.S. Department of Agriculture.

A summary is given of the State and Federal (but not Canadian) laws for the protection of birds, and the underlying principles of these are of some interest. The State laws, varying in detail from one State to another, are of primary importance and are based on the assumption that all game and wild birds are the property of the State, and may only be killed as the State Government may permit: landowners have no privileged position in this respect. The Federal law before 1913 merely reinforced the local laws in incidental ways, but it was then decreed that birds which do not permanently remain within a given State are the property of the United States Government, and so certain migratory species are now protected by a Federal Act. The authors fail to carry this development a stage further and to mention the Migratory Birds Convention of 1917, which provided for reciprocal legislation in Canada and the United States. One also notes that the bibliography contains no reference of later date than 1915.

Précis de chimie physique. Par H. Vigneron. Pp. xii+408. (Paris: Masson et Cie, 1924.) 30 francs.

M. VIGNERON's book deals with general theories rather than with details of experimental methods, and he is therefore able to cover a wide range of topics in a somewhat small space. He points out that a large part of the subject can be discussed adequately from the kinetic point of view by means of molecular models; but that after a certain point has been passed, these have to be elaborated more and more, until they become of no real value in the quantitative interpretation of the phenomena. It is at this point that thermodynamical relations become important, since the mechanism of the processes can then be neglected; but with the obvious drawback that these relations throw very little light on the mechanism, and are therefore more satisfying to the physicist than to the chemist.

It is, indeed, not unusual in France for physical chemistry to be studied and taught by a physicist, instead of by chemists only, and this difference may account for a rather refreshing variation in the author's method of treatment; but this is counterbalanced by his complete lack of interest in the chemical characteristics of the materials studied. Thus all his phase-rule diagrams are anonymous, and in this way lose the interest that comes from studying facts instead of theories; and he attributed to cyanobenzene, "another organic compound," as he explains to his readers, an asymmetric quality which this simple and symmetrical substance could not possibly possess, and was actually detected in the case of amyl *p*-cyanobenzylideneamino-cinnamate. Such an error would be impossible in the case of a chemist with even a modest knowledge of organic chemistry.

This view of the author's own limitations is confirmed by the fact that the chapter on physical properties and chemical constitution contains no reference to optical activity, by his classification of the fats as "glucosides" of the fatty acids, and by his statement that oleic can be converted into stearic acid by "adding to its molecule an atom of hydrogen." The book may, however, be heartily commended to chemical students who have already mastered this side of their subject, since they can be quite sure that there will be no duplication, and that they will find the author's method of treatment both novel and stimulating.

Chemistry for Dental Students. By Prof. H. Carlton Smith and Rachel M. Smith. Fourth edition, revised and enlarged. Vol. 1: *Qualitative Analysis and Dental Metallurgy.* Pp. vii+186. 12*s.* 6*d.* net. Vol. 2: *Organic and Physiological Dental Chemistry.* Pp. v+320. 17*s.* 6*d.* net. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.)

THESE volumes, comprising the fourth edition, are intended to provide for courses in chemistry, dental metallurgy, dental materia medica and physiological chemistry for dental students, and have been written primarily to meet the requirements of American students. Nevertheless the methods adopted are sufficiently general to appeal to wider interests. The sections on microchemical analysis and physiological chemistry are to be noted specially, particularly Chap. xviii. on saliva. The subject matter for these sections has been selected with special reference to dental problems, and is quite likely, from the method adopted, to stimulate a desire on the part of the student to learn more of the subject generally. The chapter on tooth decay, being a readable summary of the present state of knowledge of the subject, may be recommended to others besides dental students.

The plates are good and give an adequate idea of the appearance of the substances as seen in the microscope. References are given to original work and to special text-books, mostly to American works. It would be an advantage to British students if references to corresponding British text-books and original work were furnished.

The authors' intention appears to be to induce students to continue their study of dental chemistry, and in this they may fairly claim to have been successful.

J. J. F.

Collective Index of the Journal of the Institute of Brewing, 1911 to 1923. Compiled by W. H. Bird. Pp. iv+330. (London: Harrison and Sons, Ltd., 1924.) n.p.

THE production of indexes is a laborious and often a thankless task, yet to their compilers the scientific world owes a deep debt of gratitude. The work before us is carried out consistently upon a recognised principle, and is presented in a clear and workmanlike manner. In adopting the principle of the "Inverted Title" as the basis for the construction of his Index of Subjects, Mr. Bird is probably following the style of an earlier index to the Journal of the Institute. Our criticism, at any rate, is directed to show the defects of indexes prepared on this principle. Such indexes are, of course, in reality "Title Indexes"; they serve as subject indexes only by the accident of the language of their titles. As the following illustration will show, such indexes are cumbersome, owing to the repetition of the titles, inconvenient for study, and costly to produce. For example, "Cold: beer towards—, and the Wallerstein process; sensitiveness of. P. Petit. 1916. 468." This entry, suitably modified, appears four times in the Index—occupying eight lines. In the modern type of index one entry would suffice, with a reference from the Wallerstein Process. Moreover, the modern index would bring together matter which in the above Index is distributed under "Chilling," "Cooling," "Refrigeration," "Temperature," etc. The "Inverted Title" index still survives in the book trade, but it has long been discarded from library practice. It is, in our opinion, wholly unsuited for the purposes of Collective Indexes to the papers of learned societies.

E. W. H.

Infection and Resistance: an Exposition of the Biological Phenomena underlying the Occurrence of Infection and the Recovery of the Animal Body from Infectious Disease; with a Consideration of the Principles underlying Specific Diagnosis and Therapeutic Measures. By Prof. Hans Zinsser. Third edition. Pp. xvi+666. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923). 24*s.* net.

PERHAPS no medical or biological subject has expanded to such an extent as that of immunity, when one remembers that its origin dates back only to the late 'eighties of last century. Its doctrines have, however, revolutionised the medical outlook on the questions of infection and resistance and are now bearing practical fruit in the prophylaxis and treatment of infective disease. It is scarcely possible for one man unaided to deal adequately with the whole subject. All that he can do is by extensive and intensive study to give a critical estimate of the general trend and scope of the subject. This, Dr.

Hans Zinsser, professor of bacteriology and immunity at Harvard, has attempted to do, and, in our judgment, with a great measure of success. We have carefully read through his book and can strongly recommend it as an authoritative work. On every page are the signs of extensive acquaintance with the literature, and from all the wealth of details and contradictions of the latter, he has succeeded in creating a readable account of what must prove a fascinating subject of study to all. W. B.

Continuous Current Circuits and Machinery. By Prof. J. H. Morecroft and Prof. F. W. Hehre. Vol. 1. Pp. viii+467. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 20*s.* net.

THIS book is designed primarily for the use of students in engineering schools. An elementary knowledge of physics and mathematics is all that is demanded of the reader, and yet a good introduction is given to practical engineering calculations and methods. The authors begin by a brief description of the electron theory, as many of the phenomena described follow readily when this theory is adopted. Some of the sentences, however, may well puzzle the beginner. "This shortage of electrons at the end of the rod constitutes the positive charge at this end." The positive charge, therefore, seems to have no real existence. Similarly we are told that a negative charge can exist in a perfect vacuum. It, also, can have little real existence. This is better, however, than talking about positive and negative fluids.

Following a prevalent practice among engineers, the authors seem to make little distinction between magnetic induction and magnetic force. A *gauss* is defined as a *maxwell* per square centimetre. It is better to define the maxwell as the unit line or tube of magnetic induction and not as a line of force. Many useful examples in electrical engineering are given, and the student who works through them all will have made good progress in becoming a qualified electrical engineer. We regard this as a book suitable for first and second year students at a technical college and can recommend it as such.

A Bibliography of Sir Thomas Browne, Kt., M.D. By Geoffrey Keynes. Pp. xii+255+5 plates. (Cambridge: At the University Press, 1924.) 42*s.* net.

THIS handsome volume, of which only five hundred copies have been issued, is dedicated to the memory of Sir William Osler, who was one of the most enthusiastic admirers of Sir Thomas Browne. The work consists of twelve sections, the first ten of which are devoted to the bibliography of Sir Thomas Browne's writings, and the last two to the bibliography of biography and criticism and the sale catalogue of Sir Thomas Browne's library, all but two of the sections being preceded by a bibliographical preface. There are four appendices containing the bibliographies of imitators of "Religio Medici" and "Vulgar Errors," and of the works of Dr. Edward Browne, Sir Thomas's eldest son, and an account of Simon Wilkin, the Norwich publisher and editor of Sir Thomas Browne's works. The text is interspersed with reproductions of the MS. and title pages of early copies of "Religio Medici," "Hydrotaphia," "Christian Morals," and other works. There are two fine portraits, the first, which serves as a frontispiece, being that of Sir Thomas and his wife, Dame Dorothy Browne, by an unknown artist, and the other that of Simon Wilkin.

Mr. Geoffrey Keynes, who is attached to the surgical unit of St. Bartholomew's Hospital, is to be congratulated on his scholarly achievement, on which, as we learn from the preface, he has been engaged for sixteen years. It will rank next to Wilkin's classical edition as the most important contribution to the literature of Sir Thomas Browne's works.

History of the Great War: Based on Official Documents. Medical Services General History. Vol. 4: *Medical Services during the Operations on the Gallipoli Peninsula; in Macedonia; in Mesopotamia and North-West Persia; in East Africa; in the Aden Protectorate, and in North Russia. Ambulance Transport during the War.* By Maj.-Gen. Sir W. G. Macpherson and Maj. T. J. Mitchell. Pp. xvi+711. (London: H.M. Stationery Office, 1924.) 25*s.* net.

THIS is the final volume of the general history of the Medical Services during the War, and is perhaps the most readable. The ground covered is adequately expressed in the title. The book shows the great and varied difficulties which had to be contended with, and while it is clear that towards the end of the campaigns the problems were mastered to a certain extent, there were deplorable breakdowns in the Dardanelles, Mesopotamia, and East Africa, some being so notorious as to lead to Parliamentary inquiries. These disasters are attributed mostly to lack of preparation before the campaigns started, but the editors, naturally perhaps, do not commit themselves to an exact statement as to the rank and position of those actually concerned. They admit, however, that "in some respects the administration of the Medical Services was a factor in the breakdowns."

Introduction to Modern Philosophy. By C. E. M. Joad. (The World's Manuals.) Pp. 112+4 plates. (London: Oxford University Press, 1924.) 2*s.* 6*d.* net.

MR. JOAD's little volume is clearly written and gives a short outline of the present tendencies in modern philosophic thought. It contains chapters on the difference between idealism and realism, Mr. Bertrand Russell, Croce and Gentile, pragmatism, and finally Bergson. At the end of each chapter is a criticism of each system. The work is rather too short to be of much use to scholars, but it ought to fulfil admirably the purpose for which it is written, namely, to present to non-professional readers the works of the professional writers.

Physikalische Chemie der Zelle und der Gewebe. Von Prof. Dr. Rudolf Höber. Fünfte, neubearbeitete Auflage. Hälfte 2. Pp. v+545-906+xi-xvi. (Leipzig: Wilhelm Engelmann, 1924.) 12 gold marks.

THE second half of this volume, of which the preceding part was noticed in these columns on July 21, 1923 (vol. 112, p. 93), has been received. It contains the remaining Chapters viii. to xii. of the new edition.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Wind and Waves.

IN a letter published in NATURE on August 19, 1920, p. 777, I said that, judging from appearances, wind-formed waves increased in length only when the waves were in a "breaking" condition, and it was suggested that the breaking crests, by imparting their momen-

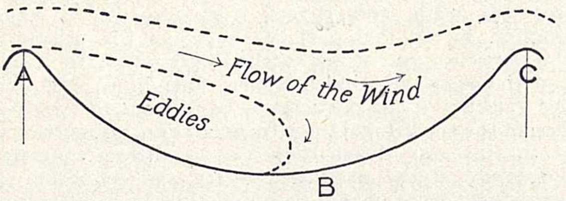

FIG. 1.—Trochoidal wave of large amplitude, with an indication of the direction of the flow of the wind.

tum to the upper strata of the water, and so establishing a gradually increasing surface current, would necessarily also cause a gradual increase in the wave-length equal to the increase of stream speed per wave-length × by the period of the wave. An example of the alteration in the lengths of a train of breaking waves may be seen at the foot of any weir where the flow is sufficient to form a stationary "bore." The wave where the stream over the apron is first arrested carries a large breaking crest, and down-stream follow several waves also breaking, but not so heavily. Following these again are waves which do not break, and counting from the first wave, observation will show that the distance from crest to crest diminishes notably so long as the waves are breaking.

The cause indicated in my earlier letter must certainly have some effect, but it seems inadequate to account for the long waves met with in the ocean. Another way in which the action of the wind may increase the wave-length is that when the wave slopes are steep, each crest acts as a screen to the water surface immediately to leeward, and the full force of the wind operates only on the windward slopes, while the trough and lee surfaces are more or less becalmed (Fig. 1). The results of this irregular distribution of wind pressure are considered briefly in the present note.

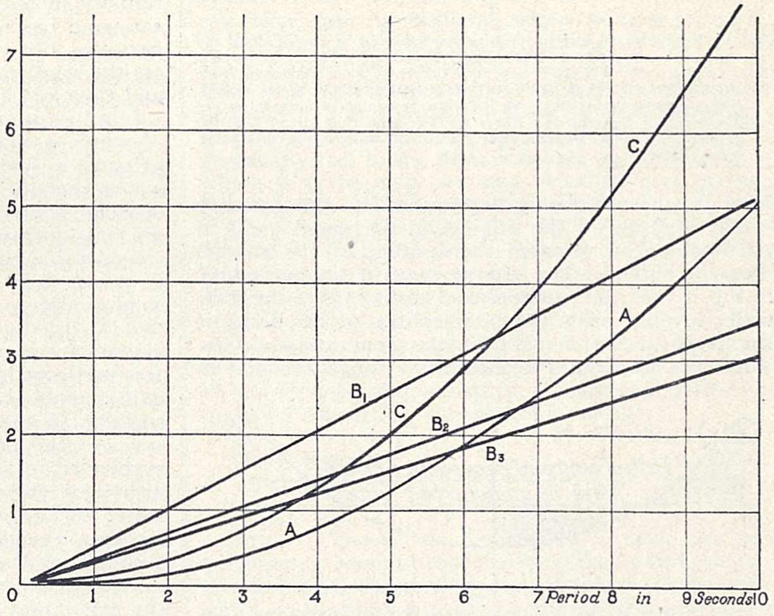

FIG. 2.—Relation between the periods, wave-length, and velocity of trochoidal waves.
Ordinates of A $\times 10^2$ = wave-length in ft.
„ $B_1 \times 10$ = velocity in ft. per sec.
„ $B_2 \times 10$ = „ miles per hour.
„ $B_3 \times 10$ = „ knots.
„ $C \times 10$ = amplitude of corresponding cycloid, in feet.

There have been no accurate observations of the shapes of wind-formed waves—not sufficiently accurate, that is, to distinguish them either from the trochoidal waves of Rankin and Froude or irrotational gravity waves, which have been only partially investigated. So long as the amplitude is small all these forms should be nearly identical, but the limiting form for the trochoidal wave is a cycloid, the crest of which is a knife edge with an angle of 0°, while for the irrotational wave the limiting crest angle (according to Stokes) is 120°.

The other chief difference between these forms is that while in the trochoidal wave each particle moves in a circular orbit, and returns to exactly the same position after each wave period, in the irrotational wave there is a continuous forward motion of the fluid, greatest at the surface and rapidly decreasing with the depth, but always small compared with the wave speed. Thus, in the irrotational wave, the orbits of the particles are not closed curves but form a succession of loops.

It will be sufficient for the present purpose to consider only trochoidal waves, and in Figs. 2 and 3 the principal properties of such waves are shown diagrammatically.

Fig. 2 gives the wave-length and wave velocity in terms of the wave period. These quantities can be easily determined from the limiting cycloidal form, for at the crest in this case the weight of the particle is just balanced by the centrifugal force in the orbit, and the particle in the crest moves with the same velocity and in the same direction as the wave, so that $4\pi^2a/T^2=g$, $v=2\pi a/T$, and $\lambda=gT^2 2\pi$, where a is the radius of the generating circle of the cycloid, v the wave velocity, and λ the length of a wave the period of which is T.

It is easy and convenient to remember that a wave the period of which is 1 second is nearly 5 ft. long, and that a 6-second wave is nearly 180 ft. long and has a speed of 18 knots.

Below the surface the amplitude of the wave motion decreases exponentially with the depth, and if r is the amplitude at depth D, $r=ae^{-\kappa D}$. The constant κ can be determined by the consideration that if in still water a certain portion is bounded by two level surfaces, that portion must retain the same volume when the level surfaces are transformed into equipotential trochoidal surfaces by the wave motion. From this it is found that $\kappa=1/a$, so that for every trochoidal wave the amplitude is reduced to $1/e$ of the surface value at a depth equal to the radius of the generating circle of the corresponding cycloid.

The reduction of amplitude is shown to scale in Fig. 3. It is worth notice that the still-water level of the sea does not coincide with that of the centre of the generating circle of the trochoidal surface, the level in question being determined by the equality of the volumes of the raised and depressed parts of the fluid. This requires the equality of the shaded areas in Fig. 4. The intersections of the curve QQ′ in Fig. 3 with the equipotential surfaces give the still-water level of each, the intersections of PP being at the level of the centres of the generating circles. What the maximum height from trough to crest in ocean waves may be has never been accurately measured. This could be readily determined by photography in the following way: Let two cameras be fixed back to back with the axes of their lenses in the same line, and let a pair of such double cameras be used at different levels on board ship, simultaneous exposures being made with the cameras pointing in approximately the same direction. The four pictures thus obtained from each exposure would then give the data necessary for determining the height and length of the waves. Breaking waves more than 600 ft. from crest to crest have been encountered, and had their form approached a cycloid, the height would have been of the order of 200 ft. The most trustworthy guesses, however, do not, I believe, exceed a quarter of this amount or less, and this is evidence, so far as it goes, that long waves of large amplitude depart from the trochoidal type, at any rate near the crests, although in other parts the difference is probably small.

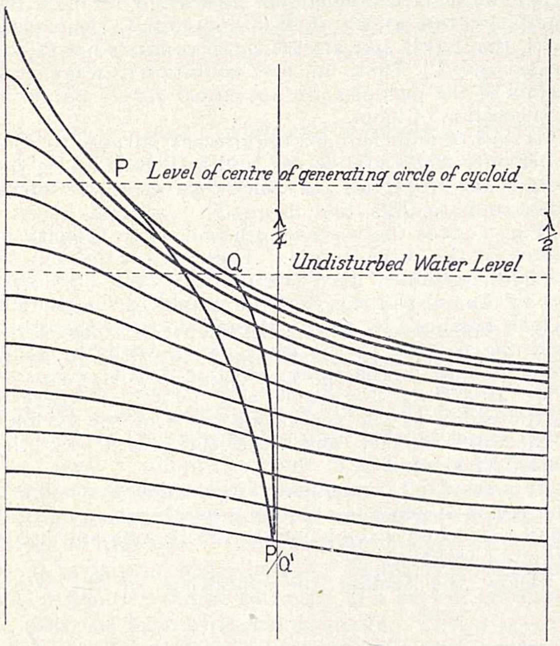

FIG. 3.—Equipotential surfaces showing the reduction of amplitude of the wave motion at different depths below the surface. The upper curve is a cycloid. For each succeeding curve the centre of the generating circle is lowered by ⅛ of the radius of the generating circle of the cycloid. The intersections of the curve PP with the equipotential surfaces are the levels of the centres of the respective generating circles, and the intersections of QQ′ with the same are the still-water levels corresponding to each.

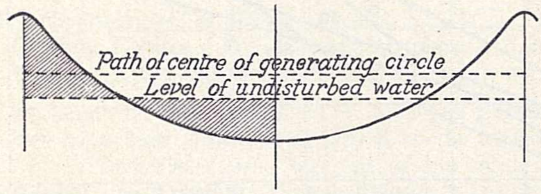

FIG. 4.—To show the relation of the still-water level to the wave form. The water raised and depressed above and below this level must have the same volume, which implies the equality of the shaded areas in the diagram.

Experience shows that these slopes are often steep enough to produce something like a calm in the lee of the crests, and to get an idea of the effect of the wind on the wave in these conditions, it may be assumed that, except near the crest, the motion is trochoidal, and that from A to B in Fig. 1 the atmospheric pressure on the surface is the same as if the water was still, while from B to C it is increased by some fraction θ. In this part of the wave the orbits of the particles are convex to the direction of the wind, and the excess of wind pressure, though not affecting the velocity of the particles, is equivalent to a reduction of the centrifugal force by an amount proportional to that excess. From these two conditions, namely, constancy of the particle velocity and reduction of centrifugal force, it will be found that for a reduction in the latter by some fraction θ, the radius of the orbit and the period are both increased by the same fraction, so that the original radius r and period T become, between B and C, $r(1+\theta)$ and $T(1+\theta)$, and in every complete period this growth would be repeated. Thus each wave formed by the wind may be considered as having different periods in different parts of its length, but the average length will continually increase. As stated above, the pressure of the wind has no effect on the orbital velocity of the particles, but the surface drag, acting only or chiefly on the windward slopes, will increase that velocity, and therefore also the amplitude.

Until experiments have been made on the action of wind on water, it seems scarcely worth while to attempt a quantitative estimate of the rate at which waves increase either in length or amplitude. It is obvious, however, that the rate is slow, for long waves are only formed on large water surfaces and after a considerable time. Experiments on the distribution of pressure on wave forms might be easily tried on solid models in any wind channel, but for the experimental production of wind-waves a rather more elaborate equipment would be required. The cost of this need not be large if any of the copies of Froude's experimental tank could be made available. Let a rectangular chamber, consisting of roof and sides only, say 3 × 6 ft. in section and some hundred feet long, be suspended in the tank, so that 3 ft. of the sides are immersed and a 3 ft. square channel left over the water surface; air currents of known velocity could be sent through this and the waves formed examined through suitable glass panels in the sides.

If the channel were 300 ft. in length, waves near the exit might probably reach a length of 2 feet, but a reference to Fig. 3 will show that the amplitude of the motion 3 ft. below the surface would be very small, so that the wave motion in the channel would have but little effect on the rest of the water in the tank. An efficient wave absorber (not merely a shelving beach) would be required to deal with the emergent waves. Experiments on the lines indicated above would, I believe, give valuable results not only as regards the generation of waves, but also as to the effect of wind in promoting ocean currents.

A. MALLOCK.

9 Baring Crescent, Exeter,
September 25.

The *St. George* Expedition to the Pacific.

WITH reference to recent newspaper notices of the work being done by the scientific staff of the *St. George* Expedition to the Pacific, the members of the Scientific Expeditionary Research Association will be greatly obliged if you will give the courtesy of your columns to the following brief résumé of the results obtained to date.

The expedition reached the Isthmus of Panama on June 9, 1924. After a short stay in the Canal Zone, devoted by the staff to assiduous collecting, the *St. George* carried out a lengthy cruise to the various tropical islands of the Eastern Pacific, including the Pearl Islands in the Gulf of Panama, Gorgona, off Colombia, and the Galapagos; Cocos, Coiba, and Taboga islands were also visited. Very large zoological collections were made at these islands, and it is likely that a considerable number of new species and varieties have been obtained. Small mammals have been captured by Mr. P. H. Johnson at all the islands; these should prove of notable interest, as few specimens have been obtained there previous to our visit. They include numerous rats exhibiting a wide range of variation, particularly in the Galapagos.

Much attention has been given to the birds by Lieut.-Col. Kelsall; up to the present more than 300 specimens have been obtained, a number smaller than expected, due to the difficult but unavoidable conditions that often prevailed.

The entomologists have had conspicuous success, their collections being most extensive. Miss Cheesman's attention has been devoted in the main to those groups not usually collected, and which in consequence are required to fill gaps in the British Museum collections. It is probable that some of the species will prove to be new, but it is impossible to ascertain this until they have been worked through by specialists. Lepidoptera and Coleoptera, collected by Mr. C. L. Collenette with the assistance of Miss Longfield, are very well represented; special attention was devoted to the less conspicuous forms as being likely to be of greater interest than the large and showy ones. Early stages have been described and preserved wherever possible; many ecological facts have been recorded and should prove of great interest.

Dr. C. Crossland has made large collections of Polychæta, Nudibranchs, and Polyzoa, and Mr. J. Hornell, extensive series of Mollusca, marine and terrestrial. It is expected that these will afford most useful data for the settlement of synonymy and consequently for better knowledge of geographical distribution. At least five Atlantic species of polychætes have been found in the Panama region, indicating that an appreciable number will be found common to the Atlantic and the Pacific when the collections are systematically examined.

Large numbers of flowering plants were gathered in the principal islands visited; those from Gorgona have been received at home already. We understand from a cable received a few days ago that the authorities at Kew place considerable value upon them; indeed, in consequence of their representations it has been decided to pay a second visit to this interesting island, in order to make the botanical material as complete as possible.

Geology has had adequate attention from Mr. L. J. Chubb, who has amassed an extensive series of notes and rock specimens from the various islands.

The outstanding result of the expedition, so far as can be judged at present, has been the discovery by the undersigned of several series of figures graven upon large boulders lying between tide-marks on the eastern shore of Gorgona. The most numerous were two series of archaic figures among which are distinguished what seem to be rude representations of sun-gods and a stepped pyramid, together with figures of monkeys, birds, and other animals. Besides these are two comparatively modern sculptured portraits, one perhaps of Incan age, the other referable to the buccaneering days of the eighteenth century.

A number of stone weapons and implements were also found, associated with potsherds of considerable interest. Advantage is to be taken of our pending return visit to search the island thoroughly for further archæological remains.

JAMES HORNELL,
Scientific Director, *St. George* Expedition.
Panama, September 24.

Optical Records and Relativity.

PROF. LLOYD MORGAN, in his interesting and most original and suggestive article, "Optical Records and Relativity" (NATURE, October 18, p. 577), sums up his argument in sixteen questions. These raise a variety of problems, but are all directed to the conclusion that we may accept the physics of relativity and yet find that the scientific creed of classical mechanics stands in no need of revision. The crux of his whole position appears to me to lie in the answer to his question 6, which he expects to be affirmative, but which must in my view be emphatically negative. The question is: "May we, on the basal principle of relativity, give primacy in 'reality' to either set of events [optical records and their distant source-events], . . . since each is acknowledged as physically 'real' in the same sense?" Surely the answer is that the source-events are, in the theory of relativity, four-dimensional, while the optical records in any aspect of them are only two-dimensional, and the latter cannot therefore have primacy. To say that it is indifferent which we regard as primary, because both are real in the same physical meaning, is like saying that because the map of a country is physically real in the same meaning as the country of which it is the map, we may therefore give primacy either to the country or to the map?

Can I have misunderstood my friend Prof. Lloyd Morgan? I should have thought he would have agreed that his question had been finally answered in Berkeley's "Theory of Vision."

In directing attention to this one point I have observed the condition laid down in the first paragraph of the article, and have dealt only with the relation of two orders of physical reality. I have not raised any question concerning theory of knowledge.

H. WILDON CARR.

The Athenæum,
Pall Mall, S.W.1.

SINCE "Theory of Knowledge" opens up very wide issues, I sought to focus one salient point, namely, psychological reference. No doubt we here come down in the long run to the nature of mind and its relation to physiological events in the body. But my aim was to deal with the retinal record as what Prof. Whitehead calls a percipient event or a sensorium, that is, a state of the body. The question I raised is this: What is "the mind" in some way up against in vision? Is it the percipient event as record? Or is it the distant event with which this percipient event is co-related?

Believing that physical relativity is concerned with *this* co-relation, I led up to sundry questions. Prof. Wildon Carr in his courteous letter regards as crucial the answer to one of them (No. 6). The external "source-events" are, he says, four-dimensional; but "the optical records in any aspect of them are only two-dimensional, and the latter cannot therefore have primacy."

I find it difficult to understand in what aspect the record on the retina *as a curved surface* is two-dimensional only. I submit that for fruitful correlation any percipient event is four-dimensional. When, owing to retinal curvature, that which on other grounds we call a straight line is for appearance in some measure deformed, the question arises: Which are we to acknowledge as "really" deformed, the something out there or the percipient event in the record? On the basal principle of physical relativity, may we give primacy to either?

C. LLOYD MORGAN.

Organisation in Chemical Societies.

IN spite of Prof. Philip's able defence (NATURE, October 25, p. 609), it must be confessed that Dr. Travers' objections have much point. It is surely the main business of the Chemical Society in the first place to publish the discoveries of its members, and in the second place to maintain a reference lending library for the benefit of its members. It is doubtful if it should undertake the publication of Abstracts or of Annual Reports unless these pay their way. This is educational work simply, and might reasonably, especially in view of the great industrial importance of chemistry, be financed out of public funds. A Government Department, such as that of Scientific and Industrial Research, might quite well be expected to undertake the publication of chemical abstracts, of chemical patents similar to the publication of Friedländer, and of chemical books of reference, organic and inorganic, frequently revised, on the lines of Beilstein and Stelzner.

J. E. MARSH.

University Chemical Laboratory,
Oxford, October 28.

PROF. PHILIP would have been well advised if he had struck out the last paragraph of his letter in NATURE of October 25. He may have found it satisfying, but it does not accord with the usages of professional controversy, nor does it strengthen his reply to my criticism.

I must point out that I did not attempt to deal with the finances of individual societies. That the Chemical Society has temporarily waived its entrance fee has nothing to do with the fact that 15*l.* is an undue tax on chemists who wish to belong to British chemical societies. Prof. Philip practically admits that American Chemical Abstracts are superior to the British equivalent. They cover "a wider area," a fact which, for some reason he does not give, he does not consider to be an advantage. They are published as a whole in *octavo* size, instead of half in *octavo* and half in *quarto*. One does not have to walk from one set of shelves to another to look up references in any one year. If Dr. Philip will accept a constructive suggestion, it is that his Committee should follow the lead of the United States in these respects.

My experience of the Chemical Society's library has been unfortunate. I have frequently been told that I could not have direct access to series of journals, because members were not admitted to the room where the journals were kept, because indexers were working in the room, etc. As to the meeting-room, on this point Prof. Philip is silent; most members of the Society are inclined to eloquence on the subject.

This state of affairs will continue so long as the various chemical societies continue to cherish their individuality to the extent of preserving absolutely distinct offices, staffs, etc. At the moment they may be co-operating on paper; actually they are in active competition for members, using all the arts of advertisement, including the unique offer of some of the cheapest chemical qualifications in the world.

M. W. TRAVERS.

147 Queen Victoria Street,
London, E.C.4,
October 29.

The Physical Nature of Verse.

IF Prof. E. W. Scripture (NATURE, October 11, p. 534) had said that *normal English* verse was *mainly* a matter of rhythm—instead of saying that verse is purely a matter of rhythm—he would have been in line with ordinary opinion to-day. I have myself taught this, at Cambridge and elsewhere, for a quarter of a century. Prof. Scripture contributes nothing new except his method of research and the unnecessary word "centroid." His conclusion is too sweeping, and at the same time defective. The works of Homer, Pindar, Virgil, Horace, and Ovid are verse; and in them we are obliged to take account of quantitative feet. Shakespeare's blank verse line is rhythmic; Milton's is rhythmic and quantitative as well; both observe the principle of number. One of the great æsthetic principles, that uniformity shall admit of variety, so that we receive a continual satisfaction of expectation, mingled with recurrent surprise, would be thwarted if verse were written solely on Prof. Scripture's principle.

Old English verse was of this type:

Áthelstan sóvran of eárls the lórd,
Bárons' beígh-gìver, and his bróther álso,
Édmund Átheling of éndless fáme
Sléw in báttle with their swórds' édges
Thére at Brúnanbùrgh.

Each half-verse had two stresses, and would admit a third, a half-stress; and the two were linked by alliteration.

Geoffrey Chaucer dropped the alliteration, introduced rime, number, *and the suggestion of musical rhythm*. He wrote, for instance:

Whán that Aprìllë with his shoúrës soótë
The dróghte of Márche hath pérced to the roótë,
And báthëd èvery veíne in swích licoúr,
Of which vertú engéndrëd is the floúr . . .

He managed the suggestion of musical stress by keeping two rules: (1) a stress must fall either on the fourth or the sixth syllable, unless stresses fall on the second, eighth, and tenth; (2) a stress must always fall on the tenth syllable, and it must be a full stress unless a full stress has fallen on the eighth syllable. In this way he combined the free rhetorical rhythm of the pure English verse with the (substantially indicated) musical rhythm of certain foreign verse.

Nearly all our good verse, everything that can be called classical, combines these two principles.

As for the ancient classical feet, when we mention them nowadays in describing English verse we use a certain licence. By "anapæst" we do not mean two short syllables followed by a long syllable, but two unemphatic syllables (interstresses) followed by an emphatic syllable (a stress). In that sense, for example, Swinburne's chorus in *Atalanta*, "When the hounds of Spring are on Winter's traces . . ." may be described as anapæstic.

Curiously enough, Prof. Scripture (in my view) marks a mistaken emphasis in one of the two examples in which he exhibits his "centroids." Hamlet's line should run :

To bé or nót to bè : thát is the quéstion.

Prof. Scripture is right in exalting rhythm as a main principle in English verse. He is clearly wrong in saying "it has no metre." E. W. LUMMIS.

S. Margarets-at-Cliffe,
Kent.

The Spectrohelioscope.

IN the issue of NATURE for October 25, p. 628, is published an article by Prof. G. E. Hale on the spectrohelioscope. It may be of interest to readers of NATURE to know that, so early as 1912, I made experiments with such an instrument, using a rotating disc in which was cut a number of radial slits. Preliminary experiments were made and a rough model was constructed by the kind help and suggestions of Mr. F. Twyman, who also described the method to Prof. R. W. Wood. Unfortunately, owing to the pressure of more important work, these experiments were abandoned and the model dismantled, but not before certain conclusions were arrived at.

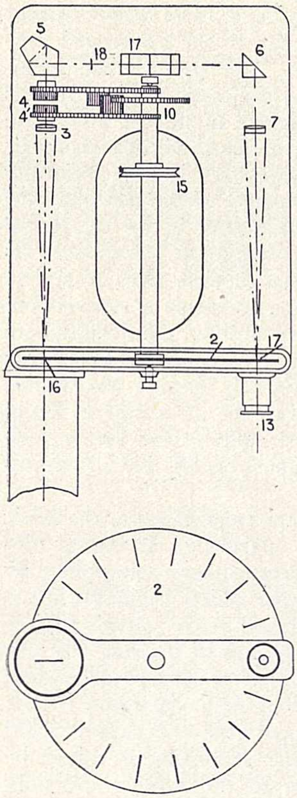

FIG. 1.

In January of 1923 the matter was taken up again and a series of measurements made and experiments carried out, to see if an instrument could be designed and constructed. There are certain difficulties to be met with, and one of these is to maintain an exactly similar movement of the image of the collimator slit on the corresponding slit passing in front of the eyepiece, but this can be overcome. I do not see any reason why a spectrohelioscope built on rotating sector principle should not give excellent results, and there are further uses to which such an instrument could be applied.

A drawing of one of the models suggested was forwarded to several British astronomers in June 1923, including Prof. Fowler, of the Imperial College, who also commented favourably upon it. Fig. 1 is from a drawing of one of the instruments proposed. In place of the compound prism shown, a replica diffraction grating can be used with advantage.

The instrument consists of a rotating disc (2) in which are cut a number of radial slits. The light which forms an image of the sun or other object comes to a focus on the rotating disc at (16). The light passes through the slit and is collimated by the object glass (3), and passes through the deflecting system (4) and (4′) and the pentagonal prism (5). The dispersing element (17) is a high dispersion compound prism which forms an image by means of the object glass (7) on the disc at position (17). This slit image will be in monochromatic light and will pass out through the slit at (17) into the observing eyepiece (13).

When the instrument is in use, the disc (2) is rotated, by means of the pulley (15) and an electric motor, at a speed which will eliminate flicker, and the object is then seen in monochromatic light corresponding to that for which the compound prism is set. When light of a different wave-length is required, a suitable deflecting prism is interposed at (18). The degree of purity will, of course, depend on the width of slits employed. The deflecting prisms (4) and (4′) are used to correct small errors of deviation due to the dispersing prism (17) and are driven by suitable gearing to make one complete revolution as the entrance slit passes the object.

F. STANLEY.

Bellingham and Stanley, Ltd.,
71 Hornsey Rise, London, N.19.

Abney Sectors in Photometry.

IN the issue of NATURE for September 27, p. 466, there appears a letter from Mr. G. F. Wood describing, with illustration, a type of photometric sectored disc, the transmission of which is a function of the distance from the centre of the disc.

It may be of interest to Mr. Wood and to readers of NATURE to know that a disc of exactly this type was invented by Dr. E. P. Hyde in 1912, and described in an article in the *Astrophysical Journal*, vol. xxxv., No. 4, May 1912, page 237.

It should be noted that this type of disc can, in general, be used only where the light beam is of small dimensions compared with the dimensions of the disc ; otherwise, there will be a non-uniform field of view. The disc invented by Dr. Hyde was intended for use with a spectrophotometer where the light beam is limited by the width of the slit.

In this connexion, I understand that the firm of Franz, Schmidt and Haensch, makers of photometric apparatus, list Dr. Hyde's disc in their catalogue as an auxiliary to their spectrophotometer.

FRANCIS E. CADY.

Nela Research Laboratory,
Nela Park, Cleveland, October 16.

Popular Science Exhibitions.

YOUR commendation of the Royal Society's Exhibition of Pure Science at the British Empire Exhibition, Wembley, will, I feel sure, be welcomed by all readers of NATURE. I hope you will allow me to suggest that it might be supplemented by a word of praise for the scientific chemistry exhibits, which, owing to the admirable enterprise and liberality of the chemical manufacturers, were detached from the science exhibits of the Royal Society and placed as a sort of intellectual heart in the centre of the fine display of manufacturing chemistry in the Palace of Industry. Incidentally also, this gave rise to the striking book on "Chemistry in the Twentieth Century" and to the publication of a series of popular pamphlets which have had a large sale in the Exhibition.

It is right to add a word of acknowledgment of the debt due to Mr. W. J. U. Woolcock, the manager of the Association of British Chemical Manufacturers, for the great part he has played in putting so clearly in evidence the creditable state of British chemistry, both pure and applied. A. S.

If the Earth went Dry.[1]

By Sir NAPIER SHAW, F.R.S.

THE various countries of the globe differ from one another in respect of dryness, though none are literally dry, year in and year out. Still some are very nearly dry; others are moist, and some, comparatively speaking, wet. Herein consists one of the main causes of the complication which students of the physics of the atmosphere have to face.

For a meteorologist, water in the form of vapour is the most important constituent of the atmosphere; it provides not only the material for clouds, rain, snow, and hail, but also the means of supplying the energy which makes those things possible. Recent investigations have made it clear that the important functions attributed somewhat loosely in meteorological literature to warm air really belong to the water vapour which the warm air carries. We may well therefore ask the question, "What on earth should we do without water?" What would meteorology be like if its warm air were never saturated and never could be saturated? The answer to the question is, "Very little would be left; but still something." It is that "something" to which I wish to direct attention. "What would be left of meteorology if the earth went dry?"

As a subject it is, of course, hypothetical. Water is an important constituent, not only of the atmosphere but also of all living material, so absolute prohibition in the sense in which I am using the term would put an end not only to that part of meteorology which I may call the joy of its life, but also to life itself in any form. So far as I know, it would be futile to put the question to a biologist. It is not so for the meteorologist. Although the most familiar conception of the meteorologist, the spontaneous ascent of warm air through its environment by what is called convection, would disappear, there would still remain quite unimpaired and even enhanced the spontaneous descent of air by cooling on a mountain slope and also a peculiar form of the ascent of warmed air by the building up of a layer of air in convective equilibrium—a new conception of considerable interest which gives a true representation of the convection of warm air as distinguished from saturated air.

A GENERAL VIEW OF ATMOSPHERIC STRUCTURE.

I start from a certain idea of atmospheric structure, which, though not novel, may require setting out. I will ask you to regard the meteorological atmosphere as being an envelope of some twenty kilometres' thickness, with a structure of the same type as the stratosphere which has been identified in our own upper atmosphere. By a stratosphere I mean a thermal structure expressed by approximately vertical isothermal surfaces which surround the polar axis like a series of collars projecting vertically outward from successive parallels of latitude. Such a structure would require a certain circulation of air, in order to balance the distribution of pressure which is inevitable when there are vertical columns of different temperature; but that being provided, the structure would be an extremely stable atmosphere, impenetrable by any convection. That is as it should be; because the structure is only possible if vertical convection is ruled out. Vertical convection of any sort would mix up the layers and transform the isothermal structure into some sort of approximation to the labile state of convective equilibrium. Any convection would be a step in that direction.

Taking the structure of the stratosphere as the original idea, we may say that the lower layers of our own atmosphere have been modified by convection, with the aid of water vapour, and have been converted into a state which approximates much more nearly to that of convective equilibrium than to the isothermal conditions of the stratosphere. The part of the atmosphere thus modified we call the troposphere. In this region temperature is arranged in layers which are nearly horizontal instead of in nearly vertical sheets or columns. Our present troposphere is not uniformly thick; it extends from the surface of the earth upward through about seventeen kilometres in the equatorial region, and about half that height at the poles. Its upper boundary, called the tropopause, may be said to mark the present limit of the operation of convection. If convection became more active, the troposphere would be enlarged at the expense of the stratosphere; if on the other hand convection became less active, the boundary would be lower, the stratosphere would come down nearer to the earth; and if there were no convection at all, the atmosphere would be all stratosphere.

We may therefore regard the troposphere as the result of persistent excavation by quarrying, carving, or nibbling of the under side of a stratospheric atmosphere by convection of one sort or other which originates in the warmth and moisture developed at the earth's surface or the loss of heat in the absence of the sun. In our present atmosphere convection is largely dependent upon water vapour, hence our first conclusion is that if there were no water vapour, the excavation would be greatly reduced and the stratosphere would be brought down much nearer to the surface and only interfered with by such convection as belongs to dry air.

It is possible that in the course of years this reduction of convection might affect the temperature of the stratosphere but its immediate results would be limited to the troposphere, and its effects upon the body of air comprised within the troposphere are dynamical as well as thermal. The troposphere may be said to form the flywheel of the atmospheric engine. It is in a state of perpetual motion, which we call the general circulation of the atmosphere, as the dynamical effect of heat received from the sun by radiation, communicated chiefly at the ground level and afterwards radiated into space from the earth's surface and the atmosphere. The working of the atmospheric engine would be much simplified if there were no water vapour, because then, without serious error, the atmosphere might be regarded as perfectly transparent both

[1] Paper read before Section A (Mathematics and Physics) of the British Association at Toronto on August 8.

for the solar radiation by which the heat is gained and for the terrestrial radiation by which the heat is lost.[2] Loss or gain would take place only at the surface and the balance of loss or gain of heat would be the result of a comparatively simple account.

THE BALANCE OF GAIN AND LOSS OF HEAT.

As a prelude to the question of downward convection, which is applicable equally to dry air and moist air, let us examine the question of the balance of gain of heat from the sun and the loss of radiation from the ground.

Taking a station such as Davos, the diurnal and seasonal isopleths of the intensity of solar radiation, which is referred to a surface normal to the sun's rays, shows that the diminution of the intensity with the increasing obliquity of the sun's rays is due to absorption by the atmosphere, principally by water vapour. If there were no water in the atmosphere, the intensity of solar radiation would reach and remain at the amount indicated by the solar constant throughout the period of sunlight, changing instantaneously to zero with the disappearance of the sun at sunset and recovering its full activity at sunrise. That activity is about 1·93 gram calories per square centimetre per minute, equivalent to 135 kilowatts per square dekametre or 1·35 kilowatt (2 horse-power) per square metre.

I digress for a moment to direct attention to the vastness of the power of the sun. Some days ago, looking at the Montmorency Falls, a distinguished engineer suggested that the energy represented by the Falls might be 20,000 horse-power. The power of sunlight upon an area of 200 yards by 100 yards, about four acres, would exceed that amount—if the whole of the energy of sunlight could be converted into work, as practically the energy of a waterfall can be.

We have supposed the area to be at right angles to the sun's rays. To get the amount on a square dekametre of horizontal surface, we must multiply the figure for normal incidence by the sine of the angle between the sun's rays and the horizontal surface, the sine of the sun's altitude. As the sun recedes from its noon altitude the intensity of its radiation decreases gradually from its noon value to zero when at sunset the sun is at grazing incidence.

To set against this gain of energy by solar radiation we have the loss of heat by radiation into space, which, if the atmosphere be perfectly transparent (as we will assume dry air to be), depends upon the fourth power of the temperature, and nothing else, except the radiating power of the surface. Taking that radiating power as that of a perfectly black body, as we may fairly do if there is no ice or snow, the loss of heat by radiation according to Stefan's law is σt^4 where t is the absolute temperature and σ is a constant, namely, $5{\cdot}72 \times 10^{-12}$ watts per square centimetre.

Thus we get the following table for the sun's altitude when there is a balance of solar and terrestrial radiation for a horizontal surface:

Temperature.		Sun's Altitude for Balance.	Temperature.		Sun's Altitude for Balance.
Tercentesimal.[3]	Centigrade.		Tercentesimal.	Centigrade.	
200	− 73	3½°	310	+ 37	20¾°
210	− 63	4¼°	320	+ 47	23¾°
220	− 53	5°	330	+ 57	27°
230	− 43	6°	340	+ 67	31°
240	− 33	7¼°	350	+ 77	35¼°
250	− 23	8½°	360	+ 87	40°
260	− 13	10°	370	+ 97	46°
270	− 3	11¾°	380	+107	53¼°
280	+ 7	13¾°	390	+117	62¼°
290	+17	15¾°	400	+127	79¼°
300	+27	18°	402	+129	90°

THE UPWARD CONVECTION OF DRY AIR.

Since the air is dry it must necessarily cool on rising to the maximum extent of 1t per 100 metres. It can only penetrate the air above it if the lapse rate of the environment is of the same magnitude. That is the condition for what is called convective equilibrium (Bjerknes's barotropic condition). Consequently, upward convection by warmed air can only occur by building up a layer in convective equilibrium; and then, an infinitesimal increase of temperature at the surface would cause the passage of the warmed air to the top of the existing convective layer and its subsequent extension with only an infinitesimal difference of temperature beyond the existing top. When the penetrative convection caused by water vapour is non-existent, we are limited to this gradual piling up of a layer which differs only infinitesimally from convective equilibrium and increases in thickness with the continuance of the solarisation of the ground. Certain amplifications of this statement are necessary when the solarised surface is not horizontal, and locally when the angle of elevation varies from place to place; but, subject to that reservation, we may understand that if the earth were dry, upward convection would mean the compilation of a layer of air in convective equilibrium.

We may ask how far the layer would extend under given conditions of solarisation and the answer depends upon the condition of the atmosphere when the solarisation begins. From our knowledge of the maximum and minimum temperatures in a dry atmosphere, such as that of Egypt, we may conclude that the convective layer which is formed during the day is abolished during the night by the turbulence due to winds operating upon the surface layer cooled by terrestrial radiation from the ground.

For the present, let us suppose that the diurnal range at the ground is 20t (the normal range at Helwan), and that this range falls off uniformly with height until the undisturbed level is reached. Let h be the height of that level and let d be the mean density of the column. Then by equating the amount required to warm the atmosphere with the heat gained during a day under a sun which is vertical at noon, and

[2] This statement may be admitted for the purpose of computation in this paper, although, according to observations of Anders Ångström, "the perfectly dry atmosphere has a radiating power as great as 50% of the radiation of a black body at the temperature of the place of observation" (Smithsonian Misc. Coll., vol. 65, No. 3, p. 88, 1915).

[3] Tercentesimal temperature is the temperature measured in centigrade degrees from a zero 273 degrees below the normal freezing point of water. It is approximately equal to the absolute or "Kelvin" temperature, but there is a technical difference between the two which cannot always be ignored. In this as in other papers a unit step on the tercentesimal scale is denoted by t.

allowing for a loss by outward radiation to the extent of that corresponding with the mean temperature for Helwan, we get an equation for *h*. This equation can be solved with the aid of the pressure equation and gives approximately 2 kilometres for the height of the daily convective layer at Helwan.

Similar equations can be got for other latitudes, and

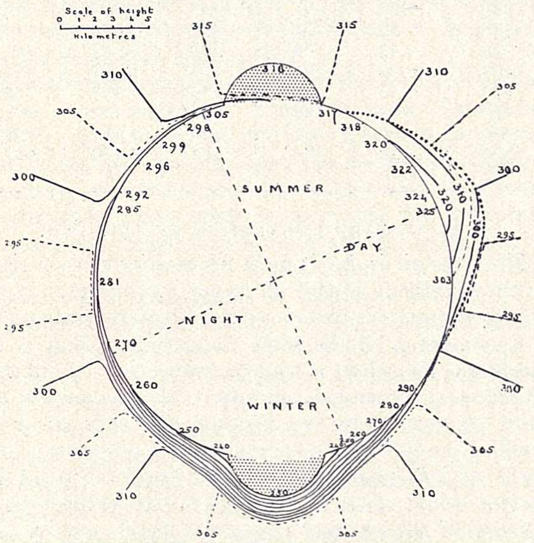

FIG. 1.—Distribution of temperature in a dry atmosphere at the northern solstice on a globe with hemispherical polar caps.

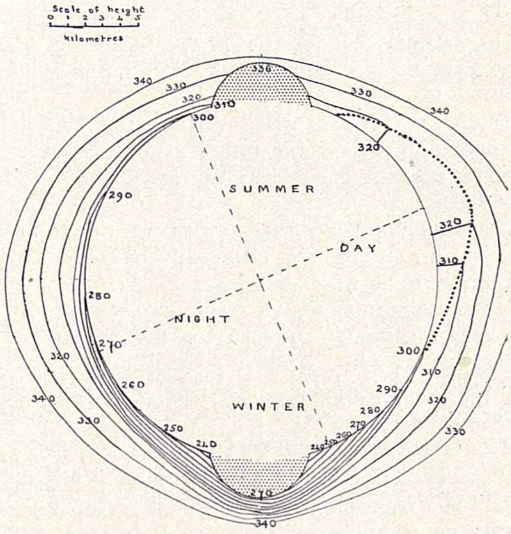

FIG. 3.—Distribution of potential temperature corresponding with Figure 1.

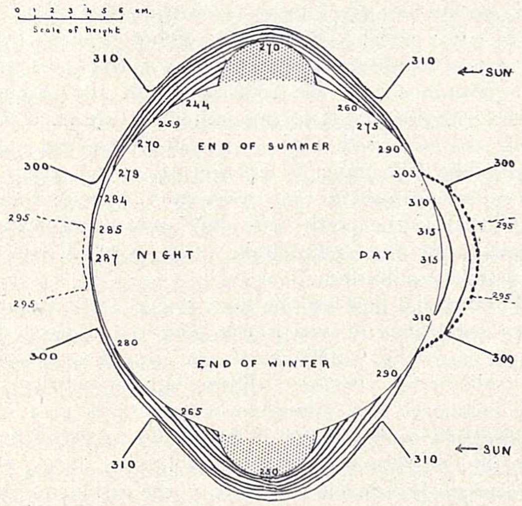

FIG. 2.—Distribution of temperature in a dry atmosphere on a globe with hemispherical polar caps at the autumnal equinox of the northern hemisphere.

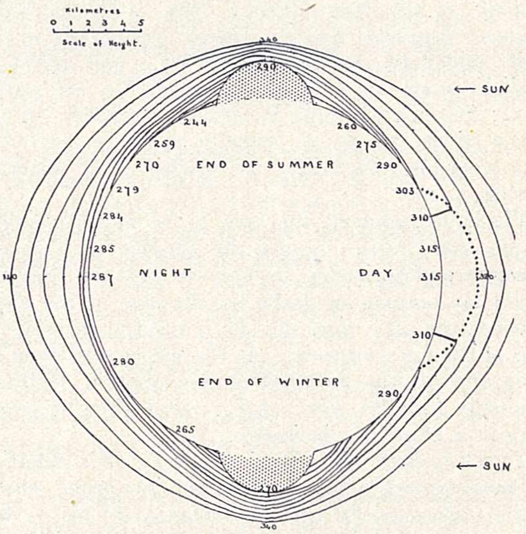

FIG. 4.—Distribution of potential temperature corresponding with Figure 2.

The boundary of the convective atmosphere is indicated in each diagram by a line of dots.

the average height of the convective layer works out for the year as follows:

Latitude	0	10	20	30	40	50	60	70	80	90
Solar radiation per day (gm. cal. per cm.²)	916	904	869	807	725	629	521	435	393	380
Height of the convective atmosphere (km.)	2	2	1·9	1·8	1·6	1·4	1·1	1·0	0·8	0·8

Mean values for the year have no real practical application for the polar regions, but let that pass.

THE DOWNWARD CONVECTION OF DRY AIR: KATABATIC WINDS.

Downward convection along a surface which is losing heat by radiation will proceed with undiminished or even increased intensity when the earth is dry, and we may form a rough estimate of the result of the process by considering the case of a conical surface in the polar regions with its vertex 2 kilometres above sea level and a base of 500 kilometres radius.

We proceed from the knowledge that a slope is required in order to cause a downward flow at all, and that in the polar regions a pool of cold air is formed during the seasonal night with the coldest air at the bottom, in spite of the fact that descending air is automatically warmed to the extent of 1t for every 100 metres of descent. We assume further that during the winter the air at the base does not get persistently and continually colder from the first incidence of shadow to the end of night, but reaches a steady state in which the further cooling of the air at the foot of the slope is prevented by air coming down under the influence of the loss of heat from the slope. The descending air has its temperature raised by the increase of pressure; but it loses heat to the cooling ground over which it marches. Eddy convection will bring a certain thickness of the descending current into contact with the ground. The increased temperature of the descending air is used to wash away, so to speak, the loss of heat by radiation from the whole slope. When a steady state has thus been reached, if we suppose the temperature of the base to be maintained at 10t below that of the summit and the turbulence to be sufficient to mix up the surface air to a thickness of 50 metres, we find that it will be necessary to have a radial outflow of 300 km. per hour over the periphery of the circle of 500 km. radius in order to wash away the result of radiation and keep the thermal balance.

That is a tremendous wind and perhaps we have cause to be thankful that the polar regions are not entirely dry. There is, of course, ample opportunity for mistakes in the assumptions and even in the arithmetic; but no changes either in assumptions or in arithmetic can, so far as I can see, enable us to escape from the conclusion that katabatic winds on polar slopes are a very real and very potent phenomenon of the atmosphere, which would certainly not be diminished by its becoming dry.

DIAGRAMS OF TEMPERATURE AND POTENTIAL TEMPERATURE.

With the physical principles thus enunciated I have endeavoured to construct diagrams representing the distribution of temperature and potential temperature over the earth at the solstice and equinox, making use of the information about diurnal range and seasonal variation given by extant observations in regions that are approximately dry. I use both temperature and potential temperature in consequence of the interesting reciprocity between them. We have only three types of condition: stratosphere, convective equilibrium, and downward convection. In the stratosphere, isotherms are vertical, lines of equal potential temperature horizontal; in the convective equilibrium, exactly the reverse is the case. Where downward convection is maintained there is horizontal stratification with inversion of temperature.

As illustrations of the material upon which the figures of the diagrams are based, I quote the following:

1. Seasonal variation of thermal structure of the polar atmosphere at Maudhavn, North Siberia, Lat. 77½° N. from H. U. Sverdrup, Maud-Ekspeditionens Videnskabelige Arbeide, 1918–19.

TEMPERATURES AT VARIOUS DATES.
(Tercentesimal Scale.)

Height in Metres.	Feb. 26.	Mar. 22.	April 11.	June 17.	July 11.
0	229	241	253	274	280
200	239	240	251·5	272·5	279
1000	246	247	259	271·5	274

There is transition from continuous and very rapid *increase* of temperature with height, 17t for 1000 metres, in February (before sunrise) to the common *lapse-rate* of the world, 6t for 1000 metres, in July.

2. Data for diurnal range of temperature in July in dry tropical regions.

DIURNAL RANGES.
(Tercentesimal Scale.)

	Mean.	Mean Max.	Mean Min.	Abs. Max.	Abs. Min.	Period.
Wadi Halfa .	304·4	313·8	296·2	322	290	1902–20
Helwan . .	300·3	308·4	294	315·9	289	1904–20
Salt Lake City	..	309	284	312	279	..

On the principles mentioned and with data of this kind culled from various sources, I have made out diagrams of the distribution of temperature in a dry atmosphere at the solstice (Fig. 1) and at the equinox (Fig. 2); also the distribution of potential temperature at the same epochs (Figs. 3 and 4).

THE GENERAL CIRCULATION OF A DRY ATMOSPHERE.

Finally, we have to consider what the circulation of the atmosphere would be in the supposed conditions of dry air. Looking at the diagram of the distribution of temperature, we see that an arrangement of the vertical columns of air round the pole would be the dominant feature, and therefore a vigorous west-to-east circulation round the pole in the upper atmosphere of the higher latitudes, compensated, as it must be, from the principle of conservation of moment of momentum, by a west-to-east circulation partly in the equatorial region.

There is also the flow of air down the polar slopes, which will certainly simulate the procedure which we attribute to the polar front. In the dynamical effects which they produce, the elevations at the poles are indeed the equivalents of very vigorous anticyclones, and the revolution of the earth will take care that the currents which they feed shall produce a circulation opposite to the westerly circulation under which they are formed.

There will be the discontinuities of temperature and of wind velocity typical of the polar front and the corresponding dynamical effects. Even if the earth went dry, the weather of the world would be of the same type as now in respect of general and local circulations; only as regards intensity would those circulations be affected.

If this conclusion be accepted, as I think it must be, we have next to think out what, after all, the effect of restoring the water would be, and then we shall have made a schematic representation of real weather. The thermodynamical aspect of the subject is treated in a paper on the energy of saturated air in a natural environment for the International Mathematical Association, in which the convective energy of a kilogram of air in virtue of its full complement of water vapour is represented by the area enclosed between the curve of environment and the adiabatic curve of saturated air drawn through the point at which saturation is assumed to exist. The amount of energy thus represented is found to vary from zero to 10,000 joules or more per kilogram.

Acoustical Problems.

By Major W. S. TUCKER, D.Sc.

OF all branches of physics, acoustics has probably been the most neglected of recent years; and although a good deal of work is being done in America, the number of investigators working in acoustics in Great Britain is surprisingly small. The War caused a temporary revival of interest in certain aspects of the subject, and a number of papers of scientific value were produced as the result of the application of acoustical methods to the location of submarines, guns, aeroplanes, and mining activities. Very few of the large personnel, however, who were engaged in these problems have continued in this work. Return to the universities of those engaged in teaching and research resulted in a resumption of their pre-War activities.

Yet there are many problems well deserving of systematic study. To give one illustration, the study of the properties of collectors of sound such as trumpets—and all those aspects of sound distribution in which the wave-length is comparable with the dimensions of the object—require further development by the mathematician, although the cases of obstacles large or small as compared with the wave-length have been adequately dealt with. In experimental acoustics many physical laboratories used for instruction are only equipped with apparatus of a very elementary character, and after a brief course in the first year, the students cease to take any further interest in that branch of physics. The shortage of text-books on the subject is another feature, and it is scarcely possible to appreciate how much work has been done in recent years, except by a laborious study of scientific journals, few of which are available in the average college library. Yet there is a growing demand for the solution of problems which are beginning to affect our everyday life, and the calling of "acoustical engineer," or "consultant in acoustics," should be among the professions worthy of a more definite place.

Our mode of locomotion largely involves the production of rapid explosions—only too often inadequately silenced—and our main roads are more noisy than the railroad tracks. In the neighbourhood of our busy aerodromes, noise is continuously distracting, and our quiet countryside has been invaded by the sounds of the low-flying continental traffic.

Our halls and council chambers, now that wood ceases to be an indispensable part of the walls and ceilings, are so resonant that much expense has been entailed in remedying their poor acoustical properties, and if further problems need be cited, the distortion of our speech and music by "loud speakers" is surely a matter requiring something more than the experimental investigations undertaken by commercial firms.

These are only a few of the problems the solution of which will almost certainly be found in the physical laboratory, but in order that they may be dealt with effectively, some attention must be paid to the perfecting of acoustical measurements. The researches of Harvey Fletcher, Knudsen, Minton, and other American physicists have shown what are the limitations of the ear, and although no instrument could be devised combining the extreme sensitivity and large musical range of that organ at the same time, there is ample evidence to show that the ear either for absolute or relative measurements should not be relied upon. Electrical methods of comparison must ultimately be used, and microphones must be devised in which some simple law must connect the intensity of the measured sound with the effect it produces. There is a great need for a source of sound which can be accurately reproduced, and can serve as an arbitrary unit, worthy to be included among the standards as a basis of physical measurement.

One of the chief problems in acoustical research is the provision of an acoustical laboratory. If a closed room is chosen, the distribution of sound in the room is so strongly affected by reflexions of the walls that nearly all experiments involving sound measurement are vitiated. If a siren be employed as a source of sound, and the pitch is gradually raised, a given point in the room may give a maximum of intensity for one note and a minimum for a note of another pitch. This effect is overcome to some extent by "lagging" the walls of the room with sound-absorbent material, but the effect can still be distinguished, and if one attempts to obtain resonance curves for any acoustical apparatus, these curves will be distorted.

The only means of working satisfactorily is to do experiments in the open air, and in spite of difficulties with wind and varying temperature, and possible extraneous noises, good results can be obtained. Measurements of absorbing powers of different materials have been made, by Wallace Sabine and his associates, by employing rooms in which elaborate precautions have been taken to insulate them from the outer air. In this case values have been deduced from the period of reverberation, the ear being employed as the means of estimating the duration of the effect. Not only have absorbing powers been measured, but also the experiments have been developed to such an extent as to measure deafness, and quite recently to estimate the amount of energy given out by various musical instruments, and by the human voice. Values of absorbing power for different materials have been obtained with sufficient accuracy to enable architects and builders to improve effectively the acoustic properties of halls and churches. Tests of reverberation are difficult to carry out if there are disturbing sounds in the neighbourhood. It is reasonable to anticipate that with a pure note source of sound and a tuned microphone for reception, more accurate methods could be devised for measuring reverberation periods—methods which will ignore the "jamming" effect of outside noises.

One of the chief problems in acoustical measurement is the design of a source of sound in which the note is pure, and the output is fairly uniform throughout a reasonable range of musical notes. Developments in wireless have introduced to us a very useful generator of sound in the thermionic valve and its appropriate electric circuits. Alternating currents closely approaching a simple harmonic character have been generated, and the alteration in pitch is accomplished by the simple adjustment of inductance or capacity. By a process of "heterodyning" familiar to the wireless expert, Cohen has been able to produce a very constant output for cycles varying from 50 to 5000 per second, and these oscillatory currents can be used to actuate "loud speakers." If only the loud speaker were devoid of resonance properties, the problem above referred to would be effectively solved.

Another useful piece of apparatus has been designed by E. A. Milne and Fowler in which the simple Seebeck siren is converted into a pure tone generator by so shaping the holes of the disc as to cause the flow of air to alter in quantity by a simple harmonic relation with time. If the pipes supplying the air can be made non-resonant this source of sound is probably the best available. An attempt is being made to devise pure tone centrifugal sirens in which pipes for conducting the air past the ports of the rotating part are dispensed with, but here we have the disadvantage of acoustical output increasing with the frequency of the note. With apparatus of this character and with suitable microphones, accurate resonance curves can be obtained for various sound receivers.

There are problems of sound transmission through the air which involve large scale experiments and the accurate knowledge of upper winds and temperatures. These might be considered under the heading of meteorological acoustics, and they are of increasing importance in long-range listening for aeroplanes. The work of Tyndall, Osborne Reynolds, Rayleigh, and, more recently, Van Everdingen and E. A. Milne, have resulted in the explanation of those phenomena of variation of range for sounds up-wind and down-wind. Milne has obtained expressions for range and corrections for refraction due to variations of upper wind and upper temperature when these follow a linear law. Explanations of zones of silence at some distance from the source have also been afforded. The Acoustical Section, working for the three Fighting Services and the Department of Scientific and Industrial Research, has been able to verify experimentally some of these laws, and the latter have been very helpful in the design of directional sound-receiving apparatus.

One of the features of recent developments in acoustics has been the production and improvement of the Service sound locators for detection and location of aeroplanes. These instruments will not in general point to the source of sound owing to (1) lag of sound, if the source is a moving one, and (2) the departure of the wave front from the spherical owing to refraction due to wind and temperature variations. The ease with which these instruments can be used depends on the structure of the atmosphere in which, apart from refraction due to the above causes, there are irregularities due to local temperature and humidity variations, and local whirls and eddies.

These variations in the medium have all been grouped under the heading of "acoustic clouds." Contrary to what might be expected, these acoustic clouds are most in evidence on a warm sunny day of good visibility, and are undoubtedly due to unequal heating from the sun's radiation. After sunset these clouds dissipate, and we get, not only good listening as regards range, but also greatly improved powers of finding direction. The blurred acoustical image becomes well defined. On the other hand, a uniform fog is acoustically clear and it is only on the fringes of the fog that sound absorption takes place. Experiments have recently been performed with aeroplanes in which some idea of the dimensions of the acoustic clouds has been deduced. These have been obtained by taking a photographic record of the sound obtained from an aeroplane in flight, and observing the periodicity of the sound fluctuations.

One of the outcomes of the study of meteorological conditions has been the fixing of an "acoustic skyline," which, under adverse wind conditions, always lies above the visual skyline. A source of sound moving through the air may be observed to rise or set over the skyline, with a definiteness almost as complete as the rising and setting of the sun, and when the sound is below the skyline a kind of acoustic twilight is produced. At this stage sense of direction is lost, the sound is diffused, and only arrives at the observer or microphone by scattering.

Other problems involving big scale experiments are connected with the production of powerful directive sources of sound, and include the breakdown of the air as a medium of sound transmission when the displacements due to the source of sound become large.

The foregoing statement merely provides a summary of those problems which are engaging the attention of research workers in acoustics, but they may serve to indicate how very fruitful is this field of investigation for the expert experimental physicist.

Obituary.

Mr. A. E. Crawley.

The death took place on October 21 of Alfred Ernest Crawley, who was well known as the author of several works on anthropological matters. He was born in 1869, the son of the Rev. Samuel Crawley, Rector of Oddington, Oxford, was educated at Sedbergh and Cambridge, and entered the scholastic profession; he abandoned this for journalism in 1908. An adept in several branches of sport, his works on tennis and ball games are of recognised authority. In anthropology, besides contributing to the journals of several scientific societies, to Nature, and to Hastings's "Dictionary of Religion and Ethics," he was the author of three books of some importance—"The Mystic Rose, a Study of Primitive Marriage," published in 1902; "The Tree of Life, a Study of Religion," published in 1905, and "The Idea of the Soul," which appeared in 1909. Of these "The Mystic Rose" was the best known—it undoubtedly exercised no inconsiderable influence on the anthropological thought of that day, especially in so far as it emphasised the importance of marriage ceremonies, a side of the subject to which Westermarck had then paid too little attention in his monumental study of human marriage.

Certain characteristic lines of thought are common to all Crawley's books, and indeed so early as 1895 he had outlined in the Journal of the Anthropological

Institute his fundamental principle that the aim of analysis of social institutions and religions should be to arrive at the mental attitude of primitive man towards his institutions and beliefs. In his view the study of marriage, for example, had been too exclusively sociological, and his book represented an attempt to bring marriage institutions and ceremonies as well as other primitive customs into the domain of psychology by defining the psychological needs which were satisfied by the magical or religious observances by which they were accompanied. Crawley's work was accurate and scholarly and was based upon wide reading and a critical appreciation of his authorities. Some at least of his work is of enduring value.

DR. E. O. HOVEY.

EDMUND OTIS HOVEY, curator of the Department of Geology and Invertebrate Palæontology in the American Museum of Natural History, had just entered his sixty-third year when he was struck with paralysis in his office and died on September 27. In his younger days Dr. Hovey filled some teaching posts; he was brought by his installation of the mineralogical exhibit of Missouri at the Chicago Exposition to the notice of the American Museum, and entered its service in 1894.

Dr. Hovey was perhaps best known to geologists for his work in connexion with the eruption of Mont Pelé, Martinique, which took place on May 8, 1902. He was immediately sent as representative of the American Museum of Natural History, arrived at Martinique on May 21, and after distributing supplies to the impoverished inhabitants, spent about three weeks in studying the Soufrière on St. Vincent and four weeks on Mont Pelé. His results were published in a preliminary report issued by the Museum in its Bulletin on Oct. 11 of the same year. In February 1903 Hovey was again sent to note what changes had taken place and to extend his studies to the other recent volcanoes of the Caribbean chain; and again in 1908 to bring the observations up-to-date. Other expeditions made by Hovey on behalf of the Museum were to South Dakota and Mexico.

As museum curator Hovey took a keen interest in his professional work, being responsible for several attractive models in the public gallery. Though in charge of the fossil invertebrata, he can scarcely be considered a palæontologist. He did, however, collaborate with R. P. Whitfield, and with him produced the very helpful catalogue of the types and figured specimens among those fossils in the American Museum (1898–1901). We have lost in E. O. Hovey a useful worker, a cheery companion, and a constant friend.

F. A. B.

WE regret to announce the following deaths:

Prof. W. A. Locey, professor and director of the Department of Zoology, Northwestern University, since 1896, who was known for his work on the embryology of the nervous system, aged sixty-seven.

Dr. Clara S. Ludlow, of George Washington University and the United States Army Medical School, Washington, who carried out work in the Philippines on the transmission of disease by mosquitoes, on September 28, aged seventy-one.

Prof. G. Pruvot, honorary professor in the Faculty of Science of the University of Paris, and formerly Director of the Laboratory of Marine Zoology at Banyuls-sur-Mer (Pyrénées-Orientales).

Prof. W. A. Macfadyen, professor of philosophy in the Transvaal University College, Pretoria.

Current Topics and Events

GREAT BRITAIN is beginning to appreciate the importance of broadening the education of the mathematician and the scientific worker. In all subjects new knowledge has been and is piling up at a great rate. The universities demand more and more for a degree, and the student is constantly becoming more overloaded. At the same time, the lines of demarcation between the subjects are breaking down, and the importance for every scientific worker of a knowledge of allied sciences is growing greater every day. Sir William Pope expounded this idea in a lecture delivered in July last before the Royal Society of Arts. He pointed out the importance for chemists of a knowledge of physics and the need of a reform by which natural philosophy (that is, physics and chemistry) would become a single whole instead of being made up of half-a-dozen disconnected subjects. He would unite them into one by emphasising the fact that they are all based upon the electronic constitution of matter and energy. The importance of a knowledge of physics to the mathematician was emphasised at the conference held recently at the University College of Southampton, and the October issue of the *Mathematical Gazette* contains a valuable article by Prof. Piaggio on the subject. The main value of this article lies in the author's discussion of the means by which it can be made possible for the mathematician to attain a knowledge of physics in addition to mathematics within a reasonable time. He goes through the various branches of applied mathematics as at present taught at universities and picks out a considerable number of items that could well be dropped in order to make room for more important matter.

A CORRESPONDENT sends us copies of the journal, *La Province de Namur*, of June 1 and October 15, containing descriptions of a large pearl, reported by M. E. de Ceuster, of Moustier-sur-Sambre, to have been found in a coconut. Where pearls come from has always been a mystery in India, and so long ago as 1240 A.D., a Kashmir physician records them as coming from bamboos, coconuts, heads of elephants, fish, etc. Pearls are definite animal concretions of carbonate of lime around a core which may be a foreign body, the egg or some part of the body of the organism, or the egg or part of the body of a contained parasite. True pearls only occur in molluscs, and they are microscopically and chemically identical with the nacre—the inner lining of the shell—

in all molluscs. Actually the structure consists of a vast number of very thin and corrugated laminæ of an organic substance known as conchiolin, holding spicules of carbonate of lime. The transparency, the overlapping of the laminæ, the corrugation, and the angles of the lime spicules give the lustre so well known in the precious pearls. Somewhat similar rounded off concretions may be found in any animal's body—as Bunyan says, "A pearl may in a toad's head dwell"—but they are not found in plants, smooth and rounded off in this way. Concretions do occur in the latter, both of calcium carbonate and of calcium oxalate, but they are generally rough, and are not formed in layers with a similar basis of conchiolin; a simple test for them would be the presence or absence of plant cellulose. In the East generally the pearls formed by the giant clams of the reefs are termed "coconut pearls," as their appearance bears a resemblance to the cut surface of the kernel of the coconut; they often attain the size of a pigeon's or small hen's egg, the clams themselves varying up to two feet across. Needless to say, as they have no lustre, they are of no beauty and of no value. Any plant concretion that may fairly be termed a pearl would certainly be "new to science."

The presidential address given on October 23 to the Institution of Electrical Engineers by Mr. W. B. Woodhouse lays stress on the rapid growth of the electrical industry during the last twenty years and looks forward hopefully to the future. Mr. Woodhouse makes the timely statement that electricity is not a panacea for industrial and social ills, and so it behoves engineers to speak out just as definitely when unjustifiable claims are made for it as when it is unfairly attacked. In connexion with education, he made the interesting suggestion that a system of interchange of employees and staff between manufacturers and supply undertakings would be of value to both sections of the industry. In his opinion, there is a direct obligation in the industry to bear the cost of post-graduate training by providing salaries which would be sufficient to encourage young men showing the necessary ability and energy to continue the widening of their experience beyond the normal period of their training. If this were adopted, the industry would benefit largely.

Mr. Woodhouse then turned to another topic. Electricity is at the present time the cheapest form of illuminant. Its use, therefore, for lighting purposes is increasing at a rate never before equalled in the history of the industry. An important problem that has only been partially solved hitherto is the reduction in the costs of distribution to the average consumer. In general the cost of distribution adds 300 per cent. to the costs of production. It is interesting to note that the somewhat analogous case of distributing milk from house to house adds only 100 per cent. to the wholesale price. It is not generally realised that if the cost of fuel were halved, the reduction in the price of electricity would be trifling. Unfair comparisons are often made between Great Britain and other countries where the methods of transport are not so developed. For example, the carriage of coal from South Wales to London in order to generate electricity is more economical than transmitting the electricity by overhead wires from the coalfield. Mr. Woodhouse pointed out that the electrical industry, like all other human organisations, is changing, but that this is necessary if progress is to be made. He asked the younger engineers to continue that spirit of adventurous research which characterised the early pioneers.

The American Institute of Sacred Literature—"an organisation for the promotion of popular study of the Bible and religion"—is inviting the co-operation of scientific workers and others in its efforts, and has produced a number of pamphlets written by leading men of science on the religious aspect of their work. We have before us an interesting little pamphlet by Prof. Edwin B. Frost, director of the Yerkes Observatory, entitled "The Heavens are Telling." Prof. Frost begins by stating and illustrating the enormous span of the material universe, the immense number of luminous objects which it contains, and the vast reaches of time required for their development, which must give to all who consider them a new and larger idea of the Cause behind them. After dealing with the exceedingly minute atoms and electrons which obey laws as definite and unvarying as the immense systems of the stars, Prof. Frost directs attention to the unity of the universe, as illustrated by the similarity of matter in the heavens and on the earth. This line of thought suggests that the combination of spirit and material body such as we possess may not be of great variety, and that we may not be vastly dissimilar from beings which may inhabit other planets circling around their appointed suns. Prof. Frost deplores the slow social development on the earth, particularly with respect to the evils of war, and considers that, from the planetary point of view, the most thorough application of the principles of Christianity seems to be the only way to bring our planet up to the moral standard to be expected of it. He contends that the scientific study of the material world tends to make spiritual conceptions less material, and divorces spirit from the material notions of mass, space, and time.

The Christmas Lectures at the Royal Institution this year are to be delivered by Mr. Frank Balfour Browne, lecturer in zoology (entomology) in the University of Cambridge, the subject being "Concerning the Habits of Insects."

The arrival of the German-built Zeppelin at Lakehurst, N.J., coinciding with the successful voyage to the Pacific coast and back of the airship *Shenandoah*, described in Nature of March 1, p. 313, seems to have given a fresh impetus to American enthusiasm for the rigid airship. According to the *Engineer*, plans are now under discussion for the building of a series of these vessels, but of dimensions considerably in excess of any design so far evolved. Immediately on passing into American possession, the German Zeppelin, officially designated ZR3, was emptied of the hydrogen with which she had been charged for the Transatlantic voyage, and had her gas cells refilled with helium. This is in accordance with the official American policy of forbidding the use of hydrogen in lighter-than-air craft under Government control. From a statement by Dr. R. B. Moore, former Chief Chemist of the United States Bureau of Mines, there is now in the United States a reserve of helium sufficient to keep filled and ready for service 200 airships of the capacity of the *Shenandoah*.

THE Fuel Research Board of the Department of Scientific and Industrial Research has for some time past been engaged in a general survey of the coal seams in all the coalfields of Great Britain with the object of classifying these according to their chemical and physical characteristics, and thus affording to the consumers valuable information as to the purposes for which each coal seam or each portion of a coal seam would be best suited. The first step in this direction was taken in the Lancashire and Cheshire Coalfield in co-operation with the local Coal Research Association, and the first result of this work has just been published in the form of a detailed report (London: H.M. Stationery Office, 2*s.* 6*d.* net) upon the Arley Seam of the Lancashire Coalfield. A good deal of useful information has been collected, the greater part of which was no doubt already in existence and available for those who knew where to find it, but it is a decided convenience to have the whole of this summarised and available in a compact and readily accessible form. There are a large number of illustrations, all of which, except the very useful map which forms the frontispiece, are photographs of coke produced under different conditions. It would be too much to say that these are useless and devoid of interest, but it is certain that the information which they convey is by no means commensurate with the expense of their production. It would have been better to have omitted these ten plates and to have published the pamphlet at a correspondingly lower price

MR. J. ELLIS BARKER, in the course of a further letter, writes as follows: "In your issue of the 1st November I protested that your reviewer, in dealing with my book, 'Cancer: How it is caused, How it can be prevented,' condemned my book on the basis of a number of serious mis-statements of his and of misrepresentations of my views which I enumerated. In a note appended to my letter your reviewer, instead of dealing with my arguments, describes my justified protest as a 'hymn of hate.' As he did not deal with my charge of mis-statement and mis-quotation, I imagine that your readers will draw their own conclusions." We agree with Mr. Barker that readers of NATURE, having read the review of Mr. Barker's book in our issue of October 4, p. 496, and also the correspondence on the subject which followed, may draw their own conclusions, and we are content to leave the matter thus.

DR. CHARLES SINGER, lecturer on the history of medicine at University College, London, is to deliver the Fitzpatrick Lectures of the Royal College of Physicians, London, on November 11 and 12. Dr. Singer will take as his subject "The History of Anatomy."

AN Economic Botanist with an academic knowledge of botany, and practical experience of plant breeding including paddy breeding, is required by the Government of Madras. Particulars may be had from the Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1. The latest date for the receipt of applications for the appointment is November 15.

A PRIZE of 300*l.* is offered by the Committee of the Christie Hospital, Manchester, for research on cancer. The object is to support research work already in progress, and the competition is open to workers of any nationality qualified in medicine or in science cognate to medicine, but all papers submitted must be in the English language. Applications must be received by the chairman of the Medical Board of the hospital on or before December 31.

A NUMBER of scientific works from the library of the late Sir William Crookes will be offered for sale by auction by Messrs. Hodgson and Co., 115 Chancery Lane, W.C.2, on Friday next, November 14, at 1 o'clock. The items include sets of the Chemical Society's Journal, *The Analyst*, the Journal of the Franklin Institute, the Journal of the Society of Chemical Industry, Phil. Trans. of the Royal Society, 1863–1918, Catalogue of Scientific Papers (Royal Society), *Comptes rendus* of the Paris Academy of Sciences, 1864–1924, Revue Générale des Sciences, 1890–1924, etc. Catalogues are obtainable from the auctioneers.

AT the statutory meeting of the Royal Society of Edinburgh held on October 27, the following Officers and Council were elected: *President*, Sir James Alfred Ewing; *Vice-Presidents*, Principal J. C. Irvine, The Rt. Hon. Lord Salvesen, Prof. J. H. Ashworth, Prof. T. H. Beare, Dr. W. B. Blaikie, Sir Robert Blyth Greig; *General Secretary*, Prof. R. A. Sampson; *Secretaries to Ordinary Meetings*, Dr. Alexander Lauder, Prof. W. Wright Smith; *Treasurer*, Dr. James Currie; *Curator of Library and Museum*, Dr. A. Crichton Mitchell; *Councillors*, Prof. T. H. Bryce, Prof. J. Y. Simpson, Prof. D'Arcy W. Thompson, Sir James Walker, Prof. E. T. Whittaker, Prof. Henry Briggs, Mr. W. L. Calderwood, Prof. T. J. Jehu, Prof. C. G. Barkla, Prof. J. Graham Kerr, Lt.-Col. A. G. M'Kendrick, Mr. James Watt.

AT a General Meeting of the University of Durham Philosophical Society held on October 30 the following officers were elected:—*President*, the Chancellor of the University; *Vice-Presidents*, Sir Charles A. Parsons, Sir Theodore Morison, Prof. T. H. Havelock, Mr. Wilfred Hall, Prof. A. S. Ferguson, Dr. B. Millard Griffiths; *Secretaries*, Mr. J. W. Bullerwell and Dr. Grace C. Leitch; *Editor*, Dr. G. W. Todd; *Librarian*, Dr. F. Bradshaw; *Chairmen of Sections*, Mr. R. G. Lunnon (Chemical and Physical), Dr. Hickling (Geological and Biological), Mr. J. L. Burchnall (Mathematical), Dr. J. Wight Duff (Archæological), Mr. F. H. Alexander (Applied Science), Dr. A. Robinson (Philosophy); *Committee*, Dr. H. V. A. Briscoe, Commander Hawkes, Mr. S. H. Collins, Dr. G. R. Goldsbrough, Dr. J. A. Smythe, Mr. E. R. Thomas.

THE Gilbert White Fellowship has recently received as a gift from the Earl of Dartmouth, four volumes of a Journal for the years 1788, 1789, 1793, and 1794, with MS. entries by the second Lord Dartmouth (1731–1801) and some contemporary newspaper cuttings inserted. The entries are in diary form and mainly meteorological and horticultural, with some records of plants, birds, and insect life. The localities from which the observations date are Albury, Weymouth, Castlehill, Whatcomb, Encombe, Carne, Henbury, Portland Place (London), Hayes (Kent), Maidenhead Bridge, Tunbridge Wells, Walton-on-Thames, Brighthelmstone (Brighton), Aylesford, and Grosvenor Square (London). About three-fourths of the entries are from Hayes, Kent. The association with Gilbert White and his "Natural History of Selborne" is that this "Naturalist's Journal" was drawn up and has a preface by White's correspondent, the Hon. Daines Barrington.

IN the present year there occurs the tercentenary of the "Arithmetica Logarithmica," the first great work of Henry Briggs, the friend and coadjutor of Napier, and the computer of the first table of common logarithms. In many senses the day of logarithmic tables to 4, 5, 6, or 7 figures is past. Where much computing has to be done, logarithms to a few figures are rarely used; what are used, and are often badly needed, are logarithms to 10, 15, or 20 figures. Recently the French have proposed to issue a 14 figure table and the Germans a 15 figure table. To celebrate worthily the tercentenary of Briggs's achievement, the Biometric Laboratory of University College, London, has arranged to issue "Logarithmetica Britannica," a standard table of logarithms of the 90000 integers of five digits, to 20 places of decimals. The necessary calculations are being undertaken by an able and enthusiastic computer, Mr. A. J. Thompson, of the General Register Office, Somerset House. It is to be published in nine parts by the Cambridge University Press, at the rate of about two parts a year, the first section (Part ix.) giving logarithms of integers from 90000 to 99999, together with their second and fourth differences, being now in the press. The success of the undertaking, which is not an enterprise of profit, can only be assured if a large section of the mathematical world shows readiness to commemorate with the producers of this work the tercentenary of the "Arithmetica Logarithmica."

Our Astronomical Column.

THE NOVEMBER METEORS.—Mr. W. F. Denning writes that this display may be expected to recur on the morning of November 15, but that it is not likely to be an abundant one. Meteors are evidently distributed along all parts of the elliptical stream, for some of them are visible every year at mid-November. Occasionally there is quite a noteworthy shower, though the parent comet (1866 I. Tempel) may be near aphelion. The radiant point of the shower being situated in the "sickle" of Leo, which does not rise until about 10.15 P.M., the meteors are invisible in the early hours of the evening. This year moonlight will somewhat interfere with observation and overpower the fainter meteors. On clear evenings between November 17 and 21, some of the Andromedids of Biela's comet may probably be seen.

A REMARKABLE PLANETARY NEBULA IN CASSIOPEIA.—Mr. J. H. Reynolds contributes an article to the *Observatory* for October on the nebula N.G.C. 7635, which was noted by Sir W. Herschel as containing an 8th magnitude star eccentrically placed. The article is illustrated by a photograph taken at Mt. Wilson by Prof. E. Hubble. It shows a slightly flattened ring 2′ 40″ by 2′ 15″, the interior of which is dark except for the southern third of its area, where it is strongly luminous. There is also some faint nebulous light outside the ring.

The star in the centre of the ring is very faint, about mag. 17; the star of mag. 8 mentioned above is about three-sevenths of the distance from centre to circumference. Its spectrum has been photographed at Mt. Wilson, being of type intermediate between O5 and the Wolf-Rayet stars. This spectrum makes the actual association of the star with the nebula more probable. Mr. Reynolds suggests that the illumination of the nebula may be due to its radiation, though its eccentric position is against its being the parent star of the nebula. He notes that if we assume the distance of the nebula as 20 parsecs (almost certainly a minimum estimate) its diameter is some 3000 astronomical units. (By an error, 9000 is given in the article.) He looks on these gas shells as marking the place of former novæ, and thinks that their duration is probably short.

MINOR PLANETS.—It seems most likely that the interesting object discovered by Dr. Baade on October 23 is a planet; its aspect is quite stellar, and its motion could be represented by an orbit not unlike that of Eros. Photographs were obtained at Greenwich on October 28 and 30, the magnitude being about 9·0. The arc of observation is still too short to deduce a trustworthy ellipse, but it appears that perihelion was passed about a month before discovery, and that the perihelion distance is somewhat less than that of Eros, which is 1·14. Prof. Kobold has computed the following parabolic orbit, presumably not with the idea that it is the real form of orbit, but in order to represent the motion for the next few weeks. On October 30 his computed place was right in declination, but 10 sec. too small in R.A.

$$T = 1924 \text{ Oct. } 2{\cdot}592 \text{ G.M.T.}$$

$$\left.\begin{array}{l}\omega = 134^\circ\ 17'\\ \Omega = 210\quad 55\\ i = 32\quad 7\end{array}\right\}1924{\cdot}0$$

$$\log q = 0{\cdot}12463.$$

EPHEMERIS FOR MIDNIGHT.

	R.A.	N. Decl.
Nov. 7	$22^h\ 17^m\ 24^s$	$5^\circ\ 59'$
11	22 35 0	3 53
15	22 52 0	2 3
19	23 8 28	0 32

The last two places have been deduced by extrapolation.

The motion is through Pegasus and Pisces. The meridian passage remains nearly stationary at about $7^h\ 15^m$, so that the object will be observable for some time.

Mr. B. M. Peek, while observing Nova Persei on October 27, detected a faint object very near it, which proved to be a minor planet. He communicated with Dr. W. H. Steavenson, who was able to observe it on the following night. If it had been new, it would have been the first visual discovery for many years, but Mr. G. Merton has established its identity with No. 709.

Research Items.

CEREMONIAL EXCHANGE IN EASTERN MELANESIA.—M. Raymond Lenoir, who has made a special study of the institution of north-west America termed, in his opinion improperly, *potlatch*, has published in *L'Anthropologie*, T. xxxiv. No. 5, an examination of the system of ceremonial exchange in the trobriands described by Dr. B. Malinowski in his "Argonauts of the Western Pacific," in the light of conclusions derived from a consideration of the evidence relating to similar customs not only from America, but also from the Asiatic Eskimo, the Chukchees, and the Melanesians of Bismarck Archipelago and the Solomons. Dr. Malinowski found that sea voyages, entailing a long and expensive communal preparation in accordance with a certain ritual, were undertaken with a view to the exchange of certain objects of wealth which were passed on by the recipients from island to island in an endless chain. This ceremonial he regarded as a phase of primitive economics. M. Lenoir, however, regards it as an institution which has grown out of a state of war, of which it is an attenuated form, and intended to preserve the relative status of different social groups. The maritime expedition is a raid in which the booty carried off by the victors or the gift received by them at the making of peace is represented by the ceremonial exchange of these objects. The conception of status applies to both forms of ceremonial exchange described by Dr. Malinowski, and the economic conception is accordingly a secondary or later development.

THE PRE-INCA AND INCA CULTURE OF PERU.—From 1899 until 1901, Dr. Max Uhle was commissioned by Mrs. Phoebe Hearst to conduct archæological excavations in Peru on behalf of the University of California, but owing to a variety of causes, no report on the excavations has been published. It has now been decided by the University to issue descriptions of the collections made by Dr. Uhle. The first of these has just been published as one of the Publications in American Archæology and Ethnology of the University. In it Messrs. A. L. Kroeber and W. D. Strong describe the collections from Chincha. The Chincha Valley was a peculiarly favourable site for archæological study as the Chincha Indians were one of the strongest and most famous tribes of Peru, and before the Incas became supreme, threatened to conquer all the interior of Southern Peru. Excavations were carried out at six main points in the Valley. The most important evidence which they produced, from the point of view of the sequence of culture and chronology, was the pottery; but the conclusions to which this points are supported by the other antiquities. These included shells and beads, textile apparatus and textiles, and objects of metal, as well as human remains. The cultural periods distinguishable are Inca, with which were associated beads of blue glass of European origin, and possibly two pre-Inca periods, Late Chincha I. and Late Chincha II., the latter being perhaps a phase of transition with which the Inca overlaps. There are also some indications of a proto-Chincha period in the form of objects of shell and ivory as well as fragments of pottery which suggest the Nasca or proto-Nasca style. The chronology suggested is for the Inca period *c.* 1425, for Late Chincha II. about a century earlier, and for Late Chincha I. from about 1000 or 1100.

THE GOAL OF COMMERCE.—Mr. G. G. Chisholm, in the Herbertson memorial lecture, published in the summer issue of the *Geographical Teacher*, says that the goal of commerce "is that stage in the evolution of commerce when the inhabitants of the earth will be able to enjoy the greatest possible variety of commodities supplied at the least cost and with the greatest attainable stability of prices." This is a definition with which few will wish to quarrel. There may be dissentients, however, when Mr. Chisholm goes on to say that the only condition of reaching that goal on which it is necessary to lay stress is the completion of all the main lines required in the network of communications. In fact, he himself proceeds to point out that there are other important factors besides lack of communications which stand in the way that leads to this goal. He instances the excessive density of population in Far Eastern regions. The low wages arising from over-population in certain lands react, he points out, on industries in other countries by bringing about excessive competition on one hand, as in the case of India and Lancashire in the cotton trade, and on the other, by restricting the purchasing power of the people and therefore the market which those lands might afford. After many references to writings on the subject of over-population, Mr. Chisholm contributes the suggestion that the best solution of the problem of how to reach the goal of commerce is "to raise the standard among the poorer classes of the coloured peoples as quickly as possible to the level of the whites, so far as that can be done." He does not develop his suggestion or touch on the problem as to how the increase of wages of the peoples, who at present have a low standard of living according to Western ideas, can be prevented from leading to a serious rise in the price of raw materials (such as cotton, jute, rubber) and of foodstuffs (such as oil-seeds, coffee, cocoa, tea, and so forth), as to lower appreciably the standard of living of the peoples of the industrial regions of the world. In an article in the *Times* of October 18 attention is directed to the enormous increase of the consumption of wheaten flour in the Far East. Vancouver, which exported only about half a million bushels of wheat in the year ending March 1921, exported forty-one and a half million bushels in the year ending March 1924! This went mainly to Japan and China. At the same time the price of wheat in Great Britain, which rarely before the War exceeded 35*s.* per quarter, has this month risen to more than 70*s.*! This article affords a very interesting comment on the problem in question.

TSETSE-FLY INVESTIGATIONS IN NIGERIA.—The *Bulletin of Entomological Research*, vol. xv., August 1924, contains a paper by Drs. L. Lloyd, W. B. Johnston, W. A. Young, and H. Morrison, on tsetse-fly investigations in the northern provinces of Nigeria. This work contains a record of the trypanosome infections, food, and breeding of *Glossina morsitans* and *G. tachinoides*, obtained by examining these flies at various foci over a period of fourteen months. It confirms the fact that the breeding of both species is practically confined to the dry season, and follows a period of increased food supply. The tsetse-fly, *Glossina morsitans*, does not feed on reptilian blood, but in times of hunger draws some of its food from birds: in the locality under consideration it resorts mainly to small antelope, big game being scarce. *G. tachinoides* is less restricted in its diet, and in the wet season one-fifth of its food was drawn from a group of animals which included man, monkey, and dog. The infection of the flies with *Trypanosoma vivax* and *T. congolense* bears a close relation to the amount of blood obtained from antelope, and consequently *G. morsitans* is in general nearly four times as heavily infected as *G. tachinoides*. Infections with

T. brucei and *T. gambiense* are scarce in this locality. Trypanosome infection rises just before the main breeding season in *G. morsitans* in all localities, and in *G. tachinoides* in places where the fly is largely a mammal feeder. The proportional infection in general falls in the season of most rapid breeding, owing to the masking of the actual rise by the number of young flies examined. It rises rapidly when breeding ceases. The total infection is reduced when fly-food is hard to obtain, in the time of long grass and flood, owing to *T. vivax* infections dying out when the flies are starved. There is just an indication that postponement of grass burning may interfere with the free breeding of *G. morsitans*, and in some cases that of *G. tachinoides*. This possibility is to be tested. The experiment of excluding game and pig from one of the dry season foci of the flies by means of fencing will be carried out.

DISTINCTION OF THE TWO DRUGS, *HELLEBORUS NIGER* AND *H. VIRIDIS*.—Mr. T. E. Wallis and Miss Alison M. Saunders have carried out a useful if somewhat negative service to pharmaceutical knowledge by their careful anatomical investigation of the rhizomes and roots of *Helleborus niger* L. and *H. viridis*, upon which they report in *The Pharmaceutical Journal and Pharmacist* for July 26, 1924. These parts of both plants are employed as drugs, and various writers have described anatomical criteria in these organs by which the two species may be distinguished. The result of thorough examination of a wide range of specimens is to negative the validity of all such suggestions, and the authors recall an earlier suggestion of Hartwich that the rhizomes should be collected with the basal leaves attached, as these are trustworthy means of determining the two species.

A MILDEW DISEASE OF THE "WILD HOP."—A brief note by Messrs. E. S. Salmon and W. M. Ware in the *Gardeners' Chronicle* for October 18 records the finding of *Peronoplasmopora humuli* on "wild" hops in the hedgerows of Kent and Middlesex. Until now this fungus, first described by Japanese workers as occurring in that country, has been little noticed in Great Britain, since it was found by the writers on cultivated hops in the Experimental Hop Garden at Wye in 1920, when it was assumed to be an introduction from America or Japan, introduced with the hop plants. This is still perhaps the explanation of its occurrence here, as if it had been long at home upon the "wild" hop of the south of England, itself usually an escape from the hop of cultivation, it should surely have more frequently been reported from the cultivated hop-field. Messrs. Salmon and Ware note its striking resemblance to the mildew on nettle, *Peronospora urticæ*, and are apparently engaged in further investigation before deciding that these two mildews are not the same species.

A LOWER CRETACEOUS FERN.—Prof. Seward describes an exceptionally well-preserved specimen of the genus Tempskya, a fern characteristic of certain Lower Cretaceous Floras, in the *Annals of Botany*, vol. 38, No. 151, July 1924. He names the specimen provisionally *T. Knowltoni* (anatomical characters of stem, root, and petiole alone scarcely providing the material for a final placing of the plant), after Dr. F. H. Knowlton of the U.S. Geological Survey, from whom he received the specimen and who reports that its probable source is the Kootanie formation of Montana. Tempskya was a fern of somewhat unusual habit, a mass of slender dichotomously branching stems, some of the branches bearing thickly clustered petioles, and all growing within a thick tangle of interlacing roots, forming together a kind of "false stem," which as a whole in some cases had a definitely dorsi-ventral habit. The stem contains a solenostelic vascular system, and Prof. Seward concludes that the examination of the present specimen supports his previous decision, based on material examined earlier, that this fossil fern has affinities with the modern Schizeaceæ.

JURASSIC AMMONITES OF INDIA.—Dr. L. F. Spath (*Palæont. Indica*, N.S., ix., No. 1, 1924) gives a revision of the ammonites from Kachh based on the collection of J. F. Blake, now in the British Museum, and introduces many new generic names. The species are mainly of Upper Jurassic age, ranging from Callovian to Kimeridgian, but a few are referred to the Aptian. The author considers that the widespread simplification of suture-lines in post-Triassic ammonites has not been fully appreciated, and suggests that the natural order of Jurassic ammonites may well be from complex to simple. The "families" considered are regarded as morphological rather than genetic units, and their relationship to the long-lived and fundamental families Phylloceratidæ and Lytoceratidæ will be considered later.

ROSE QUARTZ.—The cause of the colour in rose quartz has been very thoroughly investigated by E. F. Holden, and his conclusions are published in the *American Mineralogist*, vol. 9, April and May, 1924. Rose quartz is always massive. Occasionally pink crystals occur, but their colour is due to the presence of hæmatite inclusions. The effect of radium radiations on white or rose quartz is invariably to produce a dark smoky colour, and it is interesting to notice that smoky quartz is a constant associate of radioactive minerals in Madagascar and Ontario, whereas rose quartz is not. Careful analyses show that the rose colour cannot be due to titanium or iron, which are in all cases accounted for by the presence of rutile inclusions and limonitic stains respectively. Manganese, however, varies regularly with the depth of the tint; the absorption spectrum agrees with that of trivalent manganese glasses and solutions; and the pleochroism is exactly like that of other minerals which owe their colour to the presence of trivalent manganese compounds. The colour can, moreover, be closely imitated by dissolving less than 0·01 per cent. of manganese in a silica gel, and in this case, as in actual rose quartz, the colour disappears on heating to the transition temperature of 575° C. The convergence of evidence is therefore completely in favour of the conclusion that rose quartz owes its tint to the presence of trivalent manganese. In a former paper (*Am. Min.*, vol. 8, July 1923) the same author showed that the colour of citrine, like that of colloidal solutions of ferric hydrate, is due to sub-microscopic particles of hydrous ferric oxide.

THE VAPOUR PRESSURE OF CARBON AT HIGH TEMPERATURES.—In an investigation of the carbon arc light, Messrs. H. Kohn and M. Guckel have measured photometrically the brightness of the crater surface, using different kinds of nearly pure carbons and graphite, with different currents, and pressures varying from 5 to 0·06 atmospheres, the gases employed being air, argon, nitrogen, and carbon dioxide (*Zeitschrift für Physik*, September 17). Above a certain input the surface brightness, and therefore the temperature of the positive crater, reaches a maximum value, which does not increase with increase of current; this constancy has been observed at atmospheric pressure, from 0·3 to 2·1 amp. per sq. mm.

The maximum temperature was the same at the same pressure for the different carbons, and the different gases in which they were used. The ionisation in the arc, on the other hand, depended on the gas; the difference between the anode fall in air and argon was about 50 per cent. The equilibrium temperature of the crater is thus independent of the chemical and electrical processes in the arc, and probably depends, as Lummer has already indicated, on a thermodynamical equilibrium, the evaporation equilibrium of carbon. The pressure equilibrium-temperature curves are identical over the whole range for all four gases; from 5 to 0·8 atmospheres they can be represented by the Clâusius Clapeyron equation, and so can be regarded as the vapour pressure curves of carbon, confirming the preliminary results of Fajans and of Kohn. The probable value of the heat of vaporisation of graphite, at room temperature, is deduced as $\lambda = 139 \cdot 2$ k. cal.; this value may be 7 per cent. too high or too low. The value deduced from the theoretical chemical constants, assuming the vapour to be monatomic, is 141·4.

THE EFFECT OF OXIDISERS ON SENSITIVENESS AND ON THE DEVELOPABLE IMAGE.—In the October number of the Journal of the Franklin Institute is a communication on this subject by Messrs. S. E. Sheppard, E. P. Wightman, and A. P. H. Trivelli, of the Eastman Kodak Company. After a concise summary of the results of recent work, the authors say that it appears from these and other facts that the development centres are latent image spots "which apparently consist of colloidal silver, and that these in turn proceed from pre-exposure sensitive spots in the grain, which may also consist of silver specks, possibly only a few atoms in magnitude." Previous work has shown that the treatment of an ordinary plate with copper sulphate solution merely lowered the sensitiveness of the plate, shifting the H. and D. curve to the right. But the authors find that if the emulsion is diluted so that there is only one layer of silver-salt grains, the copper sulphate treatment causes a marked increase of the steepness of the H. and D. curve, the maximum density being little if at all affected. This matter is being further investigated. When plates are treated with chromic acid the sensitiveness is rapidly reduced and gradually approaches a constant value. The authors have tried the effect of chromic acid on the developable image, and find that it is very considerably destroyed, the slope of the H. and D. curve is much reduced, but that after even many hours' treatment, the last traces of the developable image are not removed. Permanganate appears to be more active in its destruction of sensitiveness than chromic acid, and the authors are investigating its action on sensitiveness and on the developable image.

RESEARCH ON INDIAN TIMBERS.—An account of the research work being carried out on Indian timbers at the Forest Research Institute, Dehra Dun, India, appears in the *Chemical Age* for October 11, 1924. The most important section of the work deals with timber seasoning, experimental kilns with complete mechanical equipment having recently been erected. Wood preservation is also receiving attention; several of the Indian railway companies are installing plants for treating sleepers. Sleepers treated with the oil Avenarius Carbolineum have been found to show no signs of decay after being in the ground for two years. During the past year, 11,000 timber tests have been carried out. An experimental paper-pulp plant is now working, and an exhaustive inquiry into the tanstuffs of the mangrove forests (Lower Burma) has just been completed.

THERMAL ACTIVATION BY COLLISION.—In the Journal of the Chemical Society for September, Hinshelwood and Hughes describe experiments on the thermal decomposition of chlorine monoxide. The reaction appears to be complicated by intermediate products, but an average value of the velocity constant was found. From this the number of molecules reacting per second is calculated. The ratio of this to the number entering into collision per second (in both cases per c.c.) gives the fraction of effective collisions. Pfaundler (whose name does not appear to be mentioned) about forty years ago suggested that only collisions between molecules having a certain excess of energy above the mean value are effective, and if Q is the excess energy, Maxwell's result shows that the ratio mentioned can be equated to $e^{-Q/RT}$. The value of Q is found to be 22,000 cal. By plotting log $(1/t)$, where t is the time for a given fractional decomposition, against $1/T$, a value of the "heat of activation" is found in the usual way to be 21,000 cal., and the conclusion is reached that the agreement seems "to render it certain that bimolecular reactions can be interpreted in terms of simple thermal activation by collision," without recourse to the radiation theory.

DESTRUCTIVE DISTILLATION OF COAL.—The Journal of the Royal Society of Arts for September 26 and October 3 and 10 contains a report of Cantor Lectures by Mr. E. V. Evans, chief chemist of the South Metropolitan Gas Company, on this subject. A given number of therms available as raw coal can be distributed among gas, tar and coke in a variety of ways, depending on the type of carbonisation process adopted and the conditions of its operation. A diagram is given showing the distributions in high temperature carbonisation and in low temperature carbonisation. The yield of therms as gas in the former is more than double that in the latter, less tar is obtained, and less volatile matter is left in the coke as compared with low temperature carbonisation. There is practically no difference between volatile therms and coke therms in the two processes if the volatile part in the coke is taken into account. The difference is merely one of distribution. The rate of carbonisation is shown by diagrams. A very large volume of gas of high calorific value is evolved in the first ten minutes after closing the door of the retort: in this period 5 per cent. of the total gaseous therms is produced. In the second lecture the very close relationship existing between gas and tar was fully considered. Laboratory experiments show that the total volatile therms (gas and tar) decrease gradually as the rate of carbonisation becomes slower, there being a very marked decrease in the case of exceedingly slow carbonisation, and the ratio of gas to tar therms decreases considerably with reduction in the rate of carbonisation. The results are interpreted by tar cracking. The belief that the rapid heating of coal is very wasteful of thermal energy is mistaken. The physical conditions obtaining in the retort were explained in the third lecture, which concluded with an account of a process for producing briquettes from a mixture of coal and coke. This is considered more promising for the manufacture of smokeless fuel than low temperature carbonisation. By mixing inert material such as coke with the original coal, a rapid rate of heat transmission is attained which results in enhanced yields of volatile therms. Such an innovation in the carbonising process opens up new possibilities in the development of the gas industry.

The International Union of Geodesy and Geophysics.

THE International Union of Geodesy and Geophysics held its second meeting at Madrid on October 1-8, at the invitation of the Spanish Government. Out of the twenty-seven countries which now belong to the Union, twenty-five were represented at Madrid, and the total number of delegates who attended amounted to one hundred and fifty.

The scientific work of the conference was carried on in the seven Sections into which the Union is divided, namely, Geodesy, Seismology, Meteorology, Terrestrial Magnetism, Oceanography, Volcanology, and Hydrology, and in each of these the time available was barely sufficient for the adequate discussion of all the reports and communications which were presented.

The Section of Geodesy commenced its meetings four days before the formal opening of the conference, and even then found the time at its disposal too short. Its meetings were very well attended, there being usually about fifty members present, and a large amount of very useful work was accomplished.

In each Section, reports were received of the work done in various countries during recent years, and especially since the last meeting of the Union in Rome in 1922; proposals sent in by the different national committees were discussed; and joint meetings were held with other Sections to investigate matters of common interest.

At the meeting in Rome the Swiss representatives had proposed that the Union should recommend the adoption by countries newly taking up geodetic work, or where new work admitted of it, of an international ellipsoid of reference. This gave rise to a very full and interesting discussion, and finally the executive committee's recommendation to employ in such cases Hayford's ellipsoid of 1909 was agreed to, although an alternative proposal to use an "arbitrary ellipsoid" differing but slightly from Hayford's obtained a considerable measure of support. The importance of carrying out geodetic work in the southern hemisphere, of such a standard that it could be used in the determination of the earth's figure, was strongly urged, and Australia was suggested as an area where such work could very advantageously be undertaken. A committee was appointed to take such steps as might be necessary to advance the completion of an arc of meridian from the Arctic Ocean to the Mediterranean.

In the Section of Seismology, a very instructive report on the recent Japanese earthquake was presented by the Japanese delegates, and was fully discussed. The Section decided to continue the publication of the International Seismological Summary at Oxford, and also of the seismological memoirs which are published from time to time at Strasbourg.

The Section of Meteorology re-elected Sir Napier Shaw as its president for another period. A number of interesting reports were received, and joint meetings were held with the Section of Oceanography on marine meteorology, and with the Section of Hydrology on their relative spheres of activity and on the measurement of rainfall data. The Section decided to continue investigations in the next few years into the physical conditions in the upper air, and to extend them to altitudes above those usually reached by "ballons-sonde"; also, to proceed with research in the subject of solar radiation.

The Section of Terrestrial Magnetism had a long programme which provided many useful discussions on the procedure of observatory work, the measurement and interpretation of records, and the design of instruments. The extension of magnetic surveys to areas not yet surveyed, and especially in high northern latitudes, was strongly advocated. In the next few years the Section decided to direct its attention to the international comparison of instruments, the magnetic and electrical characterisation of days, and to certain special investigations for which instruments will have to be designed.

Prof. Odon de Buén, of Madrid, was elected president of the Section of Oceanography in succession to the late Prince of Monaco. Much attention was given to echo-sounding, and also to tidal phenomena. In the latter subject, a joint meeting was held with the Section of Geodesy to discuss the subject of earth-tides. A committee was appointed to arrange for co-operation with the International Association for the Exploration of the Sea and the avoidance of duplication of effort.

The subject of the changes of level and of gradient in the vicinity of volcanoes was discussed at a joint meeting of the Sections of Volcanology and Seismology; and in the former the geothermal gradient and the thermal constants of rocks occupied the attention of the members at its meetings. The bureau of the Section is at present at the Vesuvius Observatory, but it is hoped that the University of Naples may offer it accommodation, which would be a more satisfactory arrangement.

The Section of Hydrology was formed only at the Rome meeting, so that much of its time was occupied with questions of organisation. A proposal that it should amalgamate with the Section of Meteorology was considered, but was not adopted. In the special work of the Section, a valuable report on the gauging of the Nile discharge was presented from Egypt; the statistical methods in use in Italy in such work were explained; and a very interesting report came from France, which dealt with the prevision of floods and with the estimation of hydro-electric potentialities. The extension of the Section's work to the phenomena of glaciers and the avoidance of encroaching on the work of existing organisations was considered and a satisfactory solution was reached.

At the final meeting, the invitation of the Republic of Czechoslovakia to hold the next meeting of the Union in Prague in 1927 was accepted. Col. H. G. Lyons was elected general secretary of the Union for a further period.

The Spanish Government extended the most ample hospitality to the delegates. The Chamber of Deputies, not being in use at the time, was available for the meetings. H.M. the King of Spain presided at the opening meeting, and later a reception was held at the palace by their Majesties the King and Queen, to which all the delegates were invited. The arrangements for the meeting and for the various visits to museums, scientific institutions, etc., which were made by the National Committee and were in the hands of Señor D. Cubillo and Señor D. Galbis, were extremely well planned and worked without the least hitch throughout. After the close of the meeting, many of the delegates availed themselves of the excursions which the committee had arranged to Andalusia and to the eastern provinces, where they were shown the scientific institutions and the objects of special interest at the various places.

The technical communications received by the Sections will be published by them in due course in their reports of the meeting.

Ecology of Moorland Plants.

OTTO STOCKER, of Bremerhaven, has a very interesting review of the recent work by Montfort and himself upon this problem in *Die Naturwissenschaften* for August 8. The problem is an old one. Plants of the heath and of moorland, such as Calluna and Erica, have a form and structure that suggested to some of the earlier workers, and notably to Schimper, that they must be adapted to reduce water-loss arising from transpiration. Schimper advocated this view in his classical book upon "Plant Geography," and, faced with the problem that moors are by no means dry places, influenced probably also by his earlier studies of the mangrove swamps bordering salt water lagoons, he escaped from the difficulty by the assumption that these moorland soils must be "physiologically dry." This view of the xerophytic character of moor vegetation has been handed on from text-book to text-book, although it is based almost entirely upon the appearance of the vegetation and is unsupported by experimental evidence, apart from certain American experiments which showed that extracts of bog soils were toxic to certain non-ericoid mesophytes under certain experimental conditions.

Now Montfort has shown by direct experiment that the water of moorland soils is not toxic to moorland plants, and he also concludes by the way in which these plants still release water from cut stems, or exude it in drops from the leaves (guttation), that the moorland water in no way diminishes the absorption of water by the root system or its active pumping upwards into the shoot. Furthermore, by measurements of transpiration as well as of water absorption, Montfort showed that these processes went on freely in all plants grown in normal moorland water, though some extracts of soils in which secondary decompositions were proceeding might prove toxic to plants and reduce water absorption and transpiration as well as every other normal activity of the plant.

"Physiological dryness" seems, then, to be a myth; under the examination of Stocker there is not much left of the case for the xerophytic character of Calluna and the ericoid shoot. It is true that the single leaf of the ericoid plant may be interpreted as xeromorphic in structure, but a calculation of the total leaf surface per unit of root system puts Calluna ahead of many mesophytes in its proportion of transpiration surface, and an examination of the amount of transpiration of the plant as compared with its root absorbing system shows Calluna to be better classed as a "xeromorphic mesophyte," able to lose water like a mesophyte because in its natural habitat plenty of water is practically always available. Stocker has his own teleological explanation to replace the one he has so decisively disposed of. He suggests that the special ericoid type of leaf has its advantage on the wind-swept moor as a type that prevents the marginal withering effect produced by drying winds.

It may be pointed out, however, that exactly the same criticism can be brought against this view of Stocker's that he levels against the view of Schimper, namely, that it lacks experimental basis. His next suggestion, that this type of vegetation dominates the moors because its high rate of transpiration enables it to accumulate large quantities of salts from the relatively dilute salt solution of the moor, certainly seems to rest upon a fundamental fallacy, which again has often crept into the text-books. The salts in the soil are not drawn in with a current of water rushing into open pipes and then concentrated by the evaporation of this solution at the leaf surface. The water itself enters, diffusing across a protoplasmic membrane in accordance with the osmotic gradient, and this condition determines the entry of water alone and not of the salts with it. If the salts enter, they in their turn will diffuse inwards according to their relative concentration within and without the plant, and therefore their rate of entry will only be indirectly affected by the rate of transpiration, and this process is not likely to influence greatly the amount of salt collected in the plant.

This conclusion, the only one possible from a physico-chemical point of view, has now an experimental basis in the work of Muenscher (*American Journal of Botany*, vol. 9, pp. 311-329, 1922). Whilst, then, Stocker disposes effectually of the present teleological explanation of the characteristic ericoid type of leaf, he is not very happy in the similar type of explanation that he puts forward himself. But it may be asked —is it necessary to put forward any theory of this type to account for the characteristic heath and moorland vegetation? The writer has recently approached the subject from another point of view in two brief papers with Miss Hinchliff, published in the *Naturalist* (1922, pp. 263-268, and 1924, pp. 201-209).

Dr. F. E. Clements, Associate in Ecology of the Carnegie Institution, has recently shown in his monograph upon "Aeration and Air Content," published by the Carnegie Institution, that one of the governing factors in the peaty soil of the moorland and the heath is the lack of proper aeration in this soil, which renders it unsuitable for the growth of the root system of a normal plant. The present writer has pointed out that the metabolism of the root system of different plants may be expected to differ, and that some plants may require less oxygen for their growth; that the plants on peat are perhaps such plants, and that associated with this peculiarity they have another, namely, that they form unusually large quantities of fat in the roots as they grow. These fatty substances are then sent up into the shoot and accumulate first at the surface of the shoot as an early and abnormally thick cuticle, and then within the shoot again in early deposits of secondary endodermis and then of cork layers within that endodermis. It is pointed out that these fatty deposits are responsible for certain structural changes, and a later paper (Beatrice Lee and J. H. Priestley, "The Structure, Occurrence and Distribution of the Cuticle," *Annals of Botany*, July 1924) has strengthened the conviction that a thick cuticle deposited at an early stage will profoundly modify the structure of the young shoot and of the leaves upon which it is deposited.

This developmental factor may in the end prove to have a great deal of influence upon the characteristic form and structure of the plants growing on the peat. In this case their characteristic habit is not traced to an adaptation to control water loss, but is found to be a natural developmental consequence of the characteristic metabolism of a root system growing in a soil that lacks sufficient aeration. Wherever the peat plants grow, whether in peat or in other soils, they will retain this characteristic metabolism, accumulate fats, and show the same characteristic structure. But in peat soils they reign supreme because other plants which do not have this metabolism fail to grow there. One further interesting point about this view is the light it throws upon the unsuitability of many of these peat plants to soils that are rich in calcium, calcium salts producing very insoluble soaps with fatty acids, so that in a soil rich in calcium the fatty acids, instead of passing upwards to the shoot, accumulate in the root system and plug it up until its normal functions are carried out with difficulty.

J. H. PRIESTLEY.

High-Speed Tool Steel.

NEARLY a quarter of a century has elapsed since a revolution in metal-machining practice was caused by the invention of the so-called high-speed cutting tools by Messrs. Taylor and White, of the Bethlehem Steel Company, U.S.A. This discovery was not an isolated one but was simply the last of a series of connected discoveries leading to this particular result. To a large extent it was empirical and in advance of the metallurgical theories of the time. It gave rise to various researches designed to explain the remarkable properties of these steels. Most of these have thrown some light on the properties in question, but none of them can be said to have provided a complete explanation of all the phenomena observed. The paper, therefore, by Messrs. Marcus A. Grossmann and Edgar C. Bain "On the Nature of High Speed Steel," presented at the autumn meeting of the Iron and Steel Institute, is to be welcomed in that it constitutes a further attempt to place on a scientific foundation a comprehensive theory of the mode of action of these steels.

The paper gives an account of the physical phenomena occurring from the time of casting the homogeneous melt to the production of the hardened tools. The authors emphasise the point that high-speed steel, far from being an alloy having wholly unique properties, merely possesses to an unusually marked degree certain of the tendencies which may already be discerned in other steels and alloys. They have availed themselves of the results of many of the methods of investigation applicable to metals, and the more recently developed conceptions of crystal structure and hardness constitute the foundation upon which the views offered have been built. They consider high-speed tool steel essentially as a binary alloy, of which one constituent is a solid solution of chromium in iron and the other the complex carbide containing tungsten, chromium, vanadium, and carbon. In the unhardened condition the finished bar is regarded as containing on an average 30 per cent. of carbide, but this is not evenly distributed. Rather more than half of it is in the form of fine particles which have been precipitated from solid solution, and, owing to "coring" in the original dendrites, it is never completely removed. There is a concentration gradient from the centres to the edges of the crystals. The remainder of the carbide is in comparatively coarse particles, which represent the plates of carbide in the original eutectic. These are still present in fairly pronounced streaks throughout the piece.

When this aggregate is heated to the hardening temperature (about 1300° C), the solubility of the carbide in the γ iron increases rapidly as the temperature rises, so that at the highest temperature nearly half the total carbide can be dissolved in the matrix. Owing, however, to the sluggishness of diffusion of the alloying elements, especially the tungsten, the amount dissolved never reaches the theoretical figure, and the austenite formed is far from homogeneous. In addition, small regional concentration gradients are set up round the larger carbide particles, the solution of which is never complete. Incidentally, the particles of excess carbide exercise a very useful function in preventing grain growth at this high temperature, which would otherwise be so rapid as to render the steel useless on account of brittleness.

After being suitably heated, the steel is now quenched, and in this process a portion of the austenite is transformed into martensite, so that freshly quenched high-speed steel shows under a microscope grains consisting of a mixture of austenite and martensite, and distributed through them the excess carbide particles. A light etching reveals the austenite grains and the excess carbide particles, but suitable further etching shows the martensite quite clearly. The relative proportions of martensite and preserved austenite undoubtedly vary from place to place. The regions lower in carbide contain more martensite, while those richer in carbide contain more austenite.

A piece of freshly quenched steel is thus to be conceived as containing regions of austenite-martensite mixtures of widely varying stability. On heating at comparatively low temperatures, softening is considered to take place in the martensitic areas, and this low-alloy martensite resembles carbon steel martensite. The decomposition of this can be traced both in changes of hardness and of shrinkage. On heating to 600° C. the phenomenon of secondary hardness is observed, due to the conversion of the austenite regions to martensite or troostite. This reaction takes place throughout the tool. The total effective hardening may be considered, therefore, as representing the algebraical sum of hardening effect of the transformation of the various austenites and the softening of the various martensites.

The authors do well to emphasise the point that "secondary hardness" is by no means restricted to high-speed steel and that it is not the same as "red hardness." The retention of austenite on quenching is characteristic of many alloy steels on heating to sufficiently high temperatures. When this is reheated at low temperatures, secondary hardening sets in owing to the formation of minute crystals of α iron and the precipitation of fine carbide particles. Indeed, it is likely that if the tungsten of high-speed steel were omitted altogether, the remaining elements alone would be sufficient to cause the retention of the austenite and the appearance of secondary hardening. The special usefulness of high-speed steel, however, is due to the extent to which it exhibits the property of red hardness, and it is here that tungsten plays its rôle. The large, heavy, immobile atoms of this metal act by supporting the structure at these slightly elevated temperatures and prevent the diffusion and agglomeration of the carbide particles, which would otherwise take place with consequent softening.

H. C. H. C.

Isotopes and Spectra.

THE question of the spectroscopic evidence of the existence of isotopes, which has already been brought forward in our correspondence columns (see NATURE, March 29, May 31, August 16) is dealt with at length in two papers published in the *Japanese Journal of Physics*, vol. ii., Nos. 6-10,—the first by Nagaoka, Sugiura, and Mishima, on "The Fine Structure of Mercury Lines and the Isotopes," and the second by Nagaoka and Sugiura, on "Spectroscopic Evidence of Isotopy."

The assumption is made that the mercury atom consists of a central mass with a proton quasi-elastically connected with it. Vibrations of this system are conceived to give rise to spectrum lines. Thus, several mercury lines are known to have large numbers of closely adjacent satellites. It is thought that these are due to coupled vibrations of the nucleus owing to the stimulus given by the principal line which seems to be excited by the change of electron configuration according to Bohr's scheme. A number of facts are adduced in support of the hypothesis. It is possible to calculate the intervals between the lines which would be produced by the vibrations of such a nucleus. Knowing the masses of the main core and the proton, and taking these from the observed values of Aston for the isotopes of mercury, the calculated intervals are shown to be in good agreement with the intervals between the satellites of mercury lines. The latter were carefully measured by the use of crossed Lummer-Gehrcke plates, and a discussion is introduced on the forms of the interference points so produced. It is concluded that the fine structure of mercury lines is due to the existence of several isotopes.

In the second paper the more general hypothesis is advanced that non-series lines in spectra are produced in an essentially different manner from the series lines. The latter are adequately accounted for by the movements of satellite electrons, according to Bohr's model, but the non-series lines are assumed to arise from the vibrations of pairs of atoms coupled in the manner described above for the mercury nucleus and its associated proton. When an element has two or more isotopes, two kinds of coupling are possible—symmetric and asymmetric—corresponding to pairs of atoms having the same and different masses respectively. A formula is given for calculating the wave-length intervals between lines arising from the coupled atoms, and these are shown to be in good agreement with intervals found in the spectra of elements the isotopes of which are known.

The lines having these intervals are accordingly looked upon as products of atomic vibrations and not of passages of an electron from orbit to orbit. Most of the lines so explained are spark lines. They are remarkably numerous in the spectra of the monatomic gases; thus, more than 90 per cent. of the 856 neon lines given by Paschen are assigned to atomic vibrations, and in argon a still greater proportion. An explanation of this is given. It is concluded that atomic vibrations give rise to spectra having constant frequency differences, and the suggestion is made that unknown isotopes may be detected from spectroscopic data.

Problems of Unemployment Insurance.

AT the recent Toronto meeting of the British Association, a paper by Prof. John R. Commons, of the University of Wisconsin, on "The Limits of Unemployment Insurance," was read to the Section of Economic Science and Statistics. In view of recent discussion in Great Britain of the relative merits and demerits of insurance by industry, insurance by firms, and the present State system, a short account of this paper may be of interest.

Prof. Commons is a well-known advocate of unemployment insurance in the United States. Conditions in the States are, of course, very different from those prevailing in Britain, and in particular there is a strong prejudice against a State insurance scheme. Prof. Commons in his paper emphasised the point that the principle of overhead charges (*i.e.* those manufacturing costs that go on whatever the number of units produced) applies to labour just as much as to capital, though this fact is not generally realised by industrial firms.

The modern manufacturer is faced with problems of business cycles, overhead costs, and organised labour that were unknown to his predecessors of the time when Adam Smith wrote, or perhaps more correctly it would be truer to say that nowadays these problems are greatly intensified. Business cycles are "a normal abnormality of the nineteenth and twentieth centuries."

The business cycle results in a lag both in time and amplitude in the daily wages received by labour, compared with the prices obtained for the product by the employers. Organised labour, however, tends to reduce this lag by boosting wages during the rise and holding them up during the slump. Consequently, such labour obtains a higher *daily* wage, while employed, on account of the business cycle than would otherwise be the case.

Two solutions of the problem are apparent, either (1) the curve of employment or (2) that of daily wages must be smoothed out. If attention be concentrated on the first solution rather than on the second, the community of interest rather than the antagonism of interest between capital and labour becomes clearer.

Statistics, however, point to a curious paradox, for large firms show greater fluctuations in their labour demands than the smaller. This is not what might have been expected, since the large firm has presumably a much larger item of overhead relative to the number of employees, which would at first sight seem to intensify the inducement to make greater efforts to stabilise production, thus reducing the overhead costs per unit of product. Apparently in practice the large firms take care of their capital overhead by means of high profits at the peak and large reserves for the trough of the business cycle, compelling their employees to take care of the labour overhead on a slumping market. If the employment cycle is to be smoothed out, the principle indicated from this analysis is that industry should take care of both kinds of overhead. The only way, however, to induce industry to take care of this labour overhead charge is "through the pocket book."

Prof. Commons arrives ultimately at three propositions:

(1) The larger establishments should each carry, so far as possible, its own risk by way of setting aside its own reserve, not merged with the reserves of other establishments in a common fund.

(2) Establishments having a small number of employees should be treated differently from those with a larger number. They might, for example, be organised in the form of a mutual insurance scheme.

(3) Employees should not ordinarily be required to contribute to the fund out of their wages.

"It will be seen," concludes Prof. Commons, "that only from the largest establishments and not from the smaller establishments, nor from the employees nor from the State, can any material progress be made towards prevention of unemployment."

University and Educational Intelligence.

BELFAST.—Applications are invited for two posts in the Queen's University, namely, the professorship in bio-chemistry and the lectureship in bacteriology. Terms of the appointments are obtainable from the secretary of the college.

BRISTOL.—Prof. Andrew Robertson, professor of mining and mechanical engineering in the Merchant Venturers Technical College, has been appointed principal of the College in succession to the late Dr. Wertheimer.

CAMBRIDGE.—T. R. B. Sanders, Trinity College, has been elected to a fellowship at Corpus Christi College. A. M. Binnie, Queens' College, has been awarded the John Winbolt Prize in engineering. The number of freshmen who have matriculated this term is 1498. The corresponding figure in 1913 was 1110.

LEEDS.—The council of the University has appointed Dr. F. S. Fowweather to the lectureship in chemical pathology recently instituted. Dr. Fowweather graduated with First-Class Honours in Chemistry (1st Division) at the University of Liverpool in 1914. Later he took up the study of medicine and graduated M.B., Ch.B., at Liverpool in 1922, afterwards obtaining the Diploma in Public Health (D.P.H.).

OXFORD.—Applications are invited by the Imperial Forestry Institute for a lectureship in tropical forest botany. Candidates must possess a thorough knowledge of tropical systematic and economic botany and ecology with special reference to forest vegetation. The latest date for the receipt of applications, which should be sent to the secretary of the institute, is February 15.

THE University of Manitoba is requiring a lecturer in zoology, to enter upon his duties at the beginning of next year. Applications for the post, together with particulars of candidates' published work, should be received not later than December 6 by the Secretary to the Board of Governors, University of Manitoba, Winnipeg, Canada.

APPLICATIONS are invited by the Denbighshire Education Authority for the principalship of the Acton Hall Technical Institute. Applicants must hold an honours degree in science, and a knowledge of mining is desirable. Applications, ten in number from each candidate, must be received by November 24 at the latest by the Secretary and Director of Education, Education Offices, Ruthin.

AT the annual convocation of the University of Bombay on August 19 the Chancellor, Sir Leslie Wilson, Governor of Bombay, delivered an address on "Democracy," in the course of which, enlarging on the dignity of labour, he observed that there is no reason why a graduate should not drive a plough or a motor-car. India's crying need to-day, he said, is not for Colleges of Arts but for scientific work and vocational training.

AT the time of writing, the following have been elected Parliamentary representatives of the universities of Great Britain and Northern Ireland:—CAMBRIDGE—Mr. J. F. P. Rawlinson (U.), Sir Geoffrey Butler (U.). COMBINED ENGLISH (Birmingham, Bristol, Durham, Leeds, Liverpool, Manchester, and Sheffield)—Sir Martin Conway (U.), Mr. H. A. L. Fisher (L.). LONDON—Dr. E. G. G. Little (Ind.). WALES—Mr. E. Evans (L.). QUEEN'S, BELFAST—Col. T. Sinclair (U.).

WE have mentioned in these columns the guide books and other pamphlets issued this year by the London County Council's Education Committee with the object of popularising the evening classes and other provision for adult education for Londoners. In this connexion it is interesting to note the causes to which the Buffalo Department of Education attributes the popularity of its adult education classes, which were in 1923 attended by one out of every fifteen persons in Buffalo over 16 years of age. These are as follows: Advertisement in newspapers, coloured posters, leaflets taken home by school-children, announcements in motion picture theatres; personal invitations addressed to previous year's students; advisory committees elected by students to keep in constant touch with teachers in regard to subject-matter of courses, units of study and location and hour of classes; and special training for this work of teachers selected on account of their personality and their close acquaintance with the practical side of their subjects.

THE twenty-fifth annual general meeting of the Science Masters' Association is to be held under the presidency of Sir Berkeley Moynihan at the University of Leeds on January 5-7 and will consist largely of lectures and demonstrations by members of the University staff. According to the provisional programme which has been issued, there will be a reception by the Pro- and Vice-Chancellors of the University and Sir Berkeley Moynihan on the evening of January 5, after which the latter will deliver his presidential address. The second day of the meeting will be devoted to lectures and demonstrations, while on the last day there will be a joint discussion with the representatives of the University on the connexion between science teaching in schools and universities, followed by visits to works in the neighbourhood. An exhibition of books and apparatus will be open throughout the meeting. The railway companies are issuing return tickets for the meeting at the rate of a single fare and a third. The honorary secretaries of the Association are Mr. C. E. Sladden, Eton College, and Mr. W. J. Gale, Sloane School, Chelsea.

THE Universities Bureau of the British Empire, which among its many activities has already placed all interested in university education deeply in its debt by the annual production of the Yearbook of the Universities of the Empire, has increased the debt by a pamphlet giving the professional schools and post-graduation courses available in the universities and university colleges of Great Britain and Ireland. The universities are taken in order and under each are given particulars of correlated courses of study such as are generally referred to as "schools" and of specialist studies available at that institution. This is followed by a list of the various "schools"; under each entry is given the centres at which that particular subject can be studied. Finally, there is a list of subjects with the names of centres with which each is particularly associated, so that it is possible from the list to see at a glance where a subject receives special attention. The pamphlet is valuable for reference purposes and should also be extremely useful to colonial and foreign students desirous of pursuing their studies in Great Britain or Ireland. It can be obtained from the Bureau at 50 Russell Square, London, W.C.1.

FROM the Hokkaido Imperial University we have received a pamphlet consisting of replies to a *questionnaire* distributed last year by the League of Nations Committee on Intellectual Co-operation. It covers almost every phase of the university's history, its present condition and plans for the future. The schools of agriculture, forestry, fishery, and civil engineering have since 1918 been frequented increasingly by Chinese students, and some Americans have been attracted by the Fishery School and the entomological collections. In all these schools English has a conspicuous place in the curricula, but all lectures excepting those delivered by foreign teachers of foreign languages (English and German) are now delivered in Japanese. The university farms cover 1500 acres and the university forests more than 300,000. A considerable amount of university extension work is carried on in the form of lectures in scientific subjects for teachers and popular science lectures. The chief publication of the university is the Journal of the College of Agriculture, of which 160 exchange copies are distributed to universities and other institutions in foreign countries, including 65 in the United States, 14 in Great Britain and Ireland, 11 in Germany, and 10 in Australia.

Early Science at the Royal Society.

November 9, 1664. Sir Anthony Morgan promised to draw up a report concerning his majesty's power to give a grant of Chelsea College [Referring thereto, Oldenburg wrote: "Our council is now pressing to have an end of Chelsea College, which we doubt not will prove good; in which case Mr. Howard will be the society's gardiner, without admitting of any competitor, and Dr. Wilkins the weeder"].

1681. The Society was acquainted that Mr. Hodges was in a short time going to the East-Indies to reside at Haukly, upon the river Ganges; and that he was very ready to serve the Society in what he was able in that place.

November 11, 1663. Sir Robert Moray presented from prince Rupert to the Society an instrument of his highness's invention for casting any platform into perspective. It was ordered that the president, Dr. Wilkins [and others] wait upon the prince on the Friday following, and return him the humble thanks of the Society; and to shew him an instrument of Dr. Wren's invention for casting any natural object into perspective. Mr. Hooke suggesting that additions might be made to the invention, so that it might incline and recline, and be fitted to draw likewise solid bodies in perspective, and to describe all kinds of dials, was desired to bring in these additions. In the meantime it was ordered, that the prince's instrument should remain simple, as it was then, without any alteration thereon.—Sir Robert Moray mentioned a new use to be made of thermometers, viz., to know by their help the degrees of heat in a man's body in fevers, etc., by putting it into a man's hand, or mouth, or urine, etc. The physicians present conceived that there would be little certainty in it.

November 12, 1662. Dr. Charlton promised to provide a pike against the meeting for dinner, in order to show every sound tooth moveable.

1668. Mr. Oldenburg read a letter from Monsr. Huygens, in answer to what he had lately written to him by order of the Society, desiring him that if he did not think fit to print what he had discovered on the subject of motion, he would impart to them his theory of it, together with such experiments, as he grounded his theory upon. Monsr. Huygens' answer was, that he was ready to communicate to the society those rules and theorems, which he had found out in all the species of motion.

November 13, 1672. Mr. Locke being called upon for his sulphur-ball, which he promised at the last meeting to produce at this, excused himself, that he had forgot it, promising to bring it at the next.

November 14, 1666. Sir Robert Moray produced a loadstone digged up in England in Devonshire, brought from thence by the sons of Sir William Stroud for the king; which was committed to Mr. Hooke for the repository.

1678. Dr. King upon occasion of discoursing of pearls and bezoar-stones related, that he had often found pearls in the stomach of an oister; and conceived them to be generated as the bezoar-stones in the stomach of a goat.

November 15, 1682. There was a discourse with regard to great age. Mr. Hooke took notice of what Sir Christopher Wren had formerly acquainted the Society, that the people at Hudson's Bay commonly live to 120 or 130 years of age; and till that age are very lusty, and commonly go to hunting, which, when they are no longer able to do, they usually invite all their kindred, and lie down and resign themselves to be strangled by the eldest of those, who survive, and who takes the care of government in his father's stead.

Societies and Academies.

LONDON.

Royal Microscopical Society, October 15.—R. S. **Clay** and T. H. **Court**: The development of the Hooke microscope. After referring to the description of Hooke's original instrument in his justly famous "Micrographia" (1665) and to the account given by Sturm in his "Collegium Curiosum" (1776) of his experiments with an English Hooke microscope which had been lent to him, attention was directed to the important improvement of the instrument due to Helvelius and described by him in his "Machina Coelestis" (1673), namely, the screw fine-adjustment. All previous writers ascribed this addition to Marshal, whose celebrated instrument is first described in Harris' "Lexicon Technicum" (1704) (though it had almost certainly been constructed and used so early as 1693). The failure of earlier writers to mention the important share which Helvelius had in the development of the microscope is most probably due to the extreme rarity of the "Machina Coelestis."

PARIS.

Academy of Sciences, October 16.—M. Guillaume Bigourdan in the chair.—A. **Lacroix**: Short account of the second general meeting of the International Geodesic and Geophysical Union, held at Madrid on October 1-8.—Charles **Rabut**: Scientific rules for the reinforcement of constructions in masonry.—Paul **Montel**: Complex families.—Maurice **Gevrey**: Certain linear integro-differential equations of the second order.—André **Bloch**: A theorem of M. Borel and a generalisation of the Picard-Landau theory.—E. M. **Antoniadi**: Some changes recently observed on Mars with a telescope of 83 cm. aperture, at Meudon Observatory. These changes are shown on reproductions of eight drawings taken at different dates.— — **Lyot**: The polarisation of the planet Jupiter.—R. **Dugas**: A system of points of variable mass.—Louis de **Broglie**: A theorem of M. Bohr.—W. P. **Allis**: The damping of the oscillations of a Hertzian resonator. The decrement of the free oscillations of a resonator is the sum of two terms, one of which corresponds to the Joule effect, the other, δ_H, to the radiation. It is shown experimentally that δ_H is inversely proportional to the square of the wave-length.—C. **Marie** and G. **Lejeune**: The influence of colloids on the cathode overvoltage of hydrogen and metals.—René **Audubert**: Photovoltaic phenomena. Details of experiments on the effect of light on the electromotive force of cells the electrodes of which consist of metals carrying a skin of another substance, such as copper oxide, copper bromide, silver chloride, silver sulphide.—Henri **Lafuma**: The corresponding temperatures of solid bodies. Discussion of a recent communication by M. Brodsky on the same subject.—M. **Bourguel**: A general method for the preparation of true acetylenic hydrocarbons. The acetylene hydrocarbon ($R.C{\equiv}CH$) taken as a starting-point is converted into its sodium derivative (by sodium amide), methylated with methyl sulphate. The resulting hydrocarbon, $R.C{\equiv}C.CH_3$, by heating with sodium amide, is converted into the sodium derivative of the isomer $R.CH_2.C{\equiv}CNa$; this gives readily the hydrocarbon $R.CH_2.C{\equiv}CH$, the next higher homologue of the original $R.C{\equiv}CH$. The yields are high, and details of the application of the method to cyclohexylpropine are given.—E. **Caille** and E. **Viel**: Transformation of the iodostibinates of nitrogenous organic bases into crystallised iodomercurates.—de la

Condamine: The estimation of carbon monoxide in industrial gases. Comparative analyses with ammoniacal cuprous chloride, acid cuprous chloride, and the Damiens cuprous sulphate reagent.—Alfred **Schoep**: Dumontite, a new radioactive mineral. This new mineral is found as an enclosure in cavities in tobernite from the Belgian Congo. It is a hydrated lead uranyl phosphate.—G. **Rempp** and J. **Lacoste**: New study on the daily variation of the direction of the wind at Strasbourg.—Maurice **Lenoir**: The nucleus of the mother cell of the embryonic sac in *Fritillaria imperialis* observed during its prosynoptic evolution.—Mme. L. **Randoin** and H. **Simonnet**: The food equilibrium. Maintenance of the pigeon by means of a food regime entirely lacking the water soluble factor. — Charles **Henry**: The radiation of homeotherms and the calculation of nervous sensibilities.—Marcel **Duval**: The amount of sodium chloride in the blood of some marine invertebrates. Contrary to current views, the blood of certain marine invertebrates, particularly crustaceans, contains sodium chloride in slightly lower concentration than the external medium. As the blood and the surrounding sea-water are isotonic, it is probable that the deficiency in the osmotic pressure of the former is made up by the presence of organic substances.—Paul **Fleury**: The laws of action of laccase: influence of the reaction of the medium.—R. **Anthony** and Mlle. F. **Coupin**: A rhinencephalic convolution peculiar to certain carnivora: the *gyrus transversus areæ piriformis*. — E. **Hubault**: The presence of *Liponeura cinerascens* and of *L. brevirostris* in the upper valley of the Meurthe.

WASHINGTON.

National Academy of Sciences (Proc. Vol. 10, No. 8, August).—P. S. **Epstein**: On the simultaneous jumping of two electrons in Bohr's model. A new series in the arc spectrum of calcium ($1p - mp_1$), attributed to the simultaneous jumping of two electrons, has been discovered by H. N. Russell and F. S. Saunders. This condition can be accounted for on the principle of correspondence provided that there is coupling of electrons within the atom.—J. A. **Becker**: The Compton and Duane effects. The two effects may be distinct and their appearance or non-appearance may depend on the intensity of radiation. Using an aluminium crystal as the secondary radiator, the Compton effect (quantum shift) was obtained, and on decreasing the intensity and increasing the time of exposure of the photographic plate, the Duane shift (tertiary radiation) appeared faintly. An additional note states that measurement of the total intensity of scattered radiation in circumstances including both effects has shown that, contrary to expectation, it is proportional to the primary radiation.—E. B. **Wilson**: Coulomb's law and the hydrogen spectrum. Working from the simple equations for force, quantum condition, frequency condition, spectral law and energy, for the electron moving in a circular orbit, it is shown that either Coulomb's law holds, or the law of inverse cubes, involving a quantised force and potential energy, but with no restriction as to the size of the orbit.—Carl **Barus**: Density and diffusion measurement by displacement interferometry in extreme cases. Very high values were obtained for hydrogen; it appears that there is a static error, referred temporarily to the surface tension of the mercury in the gauge.—L. B. **Loeb** and M. F. **Ashley**: Ionic mobilities in gaseous mixtures. The behaviour of ions in gases has been ascribed to two causes: the clustering of neutral molecules about a charged molecule (cluster ion theory); and the attractive forces of a single charged molecule on surrounding neutral molecules (small ion theory). Experiments on carefully prepared ammonia give results which, when related to the concentration of ammonia, are intermediate between what might be expected from the "cluster" and from the "small" ion theories. They are in accord with the hypothesis that mobility varies inversely as the square root of the molecular weight of the gas multiplied by the dielectric constant minus one. This modification of Kaufmann's law can be derived from Sir J. J. Thomson's equations for the mobility of ions.—R. L. **Moore**: Concerning upper semi-continuous collections of continua which do not separate a given continuum.—George E. **Hale**: The spectroheliscope (see NATURE, Oct. 25, p. 628).—M. T. **Bogert** and J. J. **Ritter**: The constitution of the so-called "Pechmann dyes," and the mechanism of their formation from *beta*-benzoylacrylic acid. These highly coloured dyes, discovered by von Pechmann more than forty years ago, have the same percentage composition as naphthaquinones, but their constitution is different. *Beta*-benzoylacrylic acid seems to be transformed to the enolic form, which then loses water and condenses to a dilactone containing the indigo chromatophore.

Official Publications Received.

Western Australia: Geological Survey. Bulletin No. 89 (revised and amended edition of Bulletin No. 50): The Geology and Mineral Industry of Western Australia. By A. Gibb Maitland and A. Montgomery. Pp. 119. (Perth: Fred. Wm. Simpson.)

U.S. Department of Agriculture: Bureau of Biological Survey. North American Fauna, No. 47: Revision of the American Pikas (Genus Ochotona). By Arthur H. Howell. Pp. iv+57+6 plates. (Washington: Government Printing Office.) 15 cents.

The Rockefeller Foundation. Annual Report, 1923. Pp. xiii+389. (New York: 61 Broadway.)

Sultanic Agricultural Society: Technical Section. Bulletin No. 13: Experiments on the Spacing of Crops. By James Arthur Prescott. Pp. 64. Bulletin No. 14: The Effect of Water on the Cotton Plant; an Account of Experiments conducted at Bahtim on the Irrigation of Cotton. By James Arthur Prescott. Pp. 63. (Cairo.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 491: Theory of Determination of Ultra-Radio Frequencies by Standing Waves on Wires. By August Hund. Pp. 487-540. (Washington: Government Printing Office.) 15 cents.

University of California Publications in American Archæology and Ethnology. Vol. 21, Nos. 1 and 2: The Uhle Collections from Chincha, by A. L. Kroeber and William Duncan Strong; Explorations at Chincha, by Max Uhle. Pp. 94+24 plates. (Berkeley, Cal.: University of California Press.) 1.60 dollars.

Bulletin of the National Research Council. Vol. 9, Part 1, No. 48: Critical Potentials. By K. T. Compton and F. L. Mohler. Pp. 125. (Washington, D.C.: National Academy of Sciences.) 1.60 dollars.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 30 (Botanical Section): A Banana Disease caused by a Species of Heterodera. By Tewfik Fahmy. Pp. ii+11+9 plates. 5 P.T. Bulletin No. 38: A Multiple Temperature Incubator. By C. B. Williams and T. W. Kirkpatrick. Pp. iv+9. 3 P.T. (Cairo: Government Publications Office.)

Ceylon Journal of Science. Section B: Zoology and Geology. Spolia Zeylanica. Vol. 13, Part 1, September 16th. Pp. 141. (Colombo: Colombo Museum; London: Dulau and Co., Ltd.) 3 rupees.

University of California Publications in American Archæology and Ethnology. Vol. 17, No. 5: Nabaloi Tales. By C. R. Moss. Pp. 227-353. 1.75 dollars. Vol. 17, No. 6: The Stege Mounds at Richmond, California. By Llewellyn L. Loud. Pp. 355-372+2 plates. 35 cents. (Berkeley, Cal.: University of California Press.)

Report of the Aeronautical Research Institute, Tôkyô Imperial University. Vol. 1, No. 8: Kinematographic Study on Aeronautics. By Kwan-ichi Terazawa, Kichisuke Yamazaki, and Yûzô Akishino. Pp. 213-224+plates 16-18. (Tôkyô: Maruzen Kabushiki-Kaisha.) 1 Yen.

Auxiliary Tables of the Survey of India. Fifth edition. Revised and extended by Dr. J. de Graaff Hunter. Part 1: Graticules of Maps. Pp. 25. 1 rupee; 2s. Part 2: Mathematical Tables. Pp. xiii+89 2 rupees; 4s. Part 3: Topographical Survey Tables. Pp. xxi+52 1.8 rupees; 3s. (Dehra Dun: Trigonometrical Survey.)

Bernice P. Bishop Museum. Bulletin 10: Report of the Director for 1923. By Herbert E. Gregory. Pp. 38. Bulletin 11: Vocabulary of the Mangaian Language. By F. W. Christian. Pp. 31. Bulletin 12: The Island of Lanai; a Survey of Native Culture. By Kenneth P. Emory. Pp. 129+11 plates. Bulletin 13: Bibliography of Polynesian Botany. By E. D. Merrill. Pp. 68. Bulletin 14: The Characters and Probable History of the Hawaiian Rat, by Gerrit S. Millar, Jr.; Ectoparasites of some Polynesian and Malaysian Rats of the Genus Rattus, by H. E. Ewing. Pp. 11. (Honolulu, Hawaii.)

Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 1923-24. Vol. 68. Pp. 148+xxxvi+vii. (Manchester: 36 George Street.) 12s.

Diary of Societies.

SATURDAY, NOVEMBER 8.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10 A.M.—Dr. J. Kerr Love: Some Neglected Corners of the Otological Field (Presidential Address).

MONDAY, NOVEMBER 10.

ROYAL IRISH ACADEMY (Dublin), at 4.15.
BIOCHEMICAL SOCIETY (in Physiological Department, St. Bartholomew's Hospital), at 5.—G. Thomas: Micro-estimation of Urea in 0·2 c.cm. of Blood.—E. Holmes: Excretion of Salicyluric Acid after Ingestion of Sodium Salicylate by the Human Subject.—R. E. Chapman: Carbohydrate Enzymes of Starch-free Monocotyledons.—E. M. Hume and H. Henderson Smith: Effect of Ultra-violet Irradiation of Environment on Growth and Calcification of Rats fed on Vitamin A-deficient Diet.—G. A. Harrison: Effect of Insulin on Cholesterolæmia.—R. L. Mackenzie Wallis: Observations on Glucose and Lævulose Tolerance Tests.
ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Major R. W. G. Hingston: Physiological Difficulties in the Ascent of Mount Everest.
INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—P. Dunsheath and others: Discussion on Research in the Cable Industry.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-on-Tyne), at 7.15.—S. C. Bartholomew: Power Circuit Interference with Telegraphs and Telephones.
INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—C. E. Henshaw: An Outline of the Process of Casting in Bronze by the "Cire Perdue" Method.
ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.), at 8.—Judge Dowdall: What is a Society?
SURVEYORS' INSTITUTION, at 8.
MEDICAL SOCIETY OF LONDON, at 8.30.—Dr. E. F. Buzzard and others: Discussion on Encephalitis Lethargica.
CAMBRIDGE PHILOSOPHICAL SOCIETY (in Anatomy School, Cambridge), at 8.45.—Sir Ernest Rutherford: The Natural and Artificial Disintegration of Elements.

TUESDAY, NOVEMBER 11.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. Singer: The History of Anatomy (Fitzpatrick Lectures) (1).
INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.—D. E. Batty: The Electric Road Vehicle—its Characteristics and its Economic Field of Usefulness.
INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—T. B. Johnson: Chairman's Address.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.
INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at 207 Bath Street, Glasgow), at 7.30.—A. Lindsay: Chairman's Address.
QUEKETT MICROSCOPICAL CLUB, at 7.30.—G. C. Robson: Brackish Water Fauna.
INSTITUTE OF CHEMISTRY (Students' Association, London), at 8.—Debate.

WEDNESDAY, NOVEMBER 12.

PREHISTORIC SOCIETY OF EAST ANGLIA (at Geological Society), at 2.15.—Dr. C. Fox: A Settlement of the Early Iron Age at Abington Pigotts, Cambs.—H. Dewey and J. P. T. Burchell: The Gravels at Reculver, Kent.—R. A. Smith and W. H. Cook: Report on the Discovery of a St. Acheul-Moustier Floor near Rochester, Kent.—A. L. Armstrong: Recent Excavations at Grimes' Graves.—J. Witham: An Account of Researches and Discoveries in the Burnley District of S.E. Lancashire.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Sir Richard Owen as Conservator (Thomas Vicary Lecture).
NEWCOMEN SOCIETY (Annual General Meeting) (at Caxton Hall, Westminster), at 5.30.—T. Rowatt: Some Original Models of Smeaton's Eddystone Lighthouse.
INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—Discussion on the New I.E.E. Wiring Regulations (Buildings).
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduates Section) (at Bolbec Hall, Newcastle-on-Tyne), at 7.—G. L. Hutchinson: The Corrugated Ship.
INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Graduates Section) (at Chamber of Commerce, Birmingham).

THURSDAY, NOVEMBER 13.

ROYAL SOCIETY, at 4.30.—N. K. Adam and J. W. W. Dyer: The Molecular Structure of Thin Films. Part VI.—T. Alty: The Cataphoresis of Gas Bubbles in Water.—*To be read in title only*:—D. R. Hartree: Some Relations between the Optical Spectra of Different Atoms of the same Electron Structure. I. Lithium-like and Sodium-like Atoms.—P. A. M. Dirac: The Conditions for Statistical Equilibrium between Atoms, Electrons, and Radiation.—Ida Doubleday: Boundary Lubrication. Further Consideration of the Influence of the Composition of the Solid Face.—Christina C. Miller: The Stokes-Einstein Law for Diffusion in Solution.—Helen S. French and Prof. T. M. Lowry: Studies of Co-ordination. Part I. Absorption Spectra and Co-ordination of some Cupric Compounds.—L. F. Bates: The Range of α-Particles in Rare Gases.—D. H. Black: The β-Ray Spectrum of Mesothorium 2.—J. Keith Roberts: The Thermal Expansion of Crystals of Metallic Bismuth.—R. Stoneley: Elastic Waves at the Surface of Separation of Two Solids.
SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Engineers' Club, 39 Coventry Street, W.), at 5.—F. M. Potter, H. C. Marris, and others: Discussion on Chemical Works Costs.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. Singer: The History of Anatomy (Fitzpatrick Lectures) (2).
LONDON MATHEMATICAL SOCIETY (Annual General Meeting) (at Royal Astronomical Society), at 5.—Prof. W. H. Young: The Progress of Mathematical Analysis in the Twentieth Century (Presidential Address).—H. Causdale: General Equation of the n-th Degree.—T. W. Chaundy: Poncelet's Poristic Polygons (Second Paper).—Prof. H. Hilton: Successive Evolutes of a Plane Curve.—E. L. Ince: The Real Zeros of Solutions of a Linear Differential Equation with Periodic Coefficients.—A. E. Ingham: Some Tauberian Theorems of Hardy and Littlewood.—J. E. Littlewood: The Riemann Zeta Function.—W. P. Milne: Contravariant Envelopes of the Plane Quartic Curve.—E. C. Titchmarsh: (1) The Convergence of Certain Integrals; (2) An Inversion Formula involving Bessel Functions.—Dr. D. M. Wrinch: A Class of Problems in Electrostatics and Hydrodynamics.
ROYAL AERONAUTICAL SOCIETY (at 7 Abermarle Street, W.), at 5.30.—Prof. L. Bairstow: Skin Friction.
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Commandant Mary Allen: Women Police Work among Children.
OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—T. Smith: (*a*) The Back Vertex Power of a Combination of Lenses; (*b*) The Theory of Neutralisation.—R. Kingslake: A New Type of Nephelometer.
INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Section) (at University College, Dundee), at 7.30.—G. Rogers: Automatic and Semi-Automatic Mercury-Vapour Rectifier Substations.
INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre) (at Trinity College, Dublin), at 7.45.—Discussion on the New I.E.E. Wiring Regulations (Buildings).
INSTITUTE OF METALS (London Local Section) (at Royal School of Mines), at 8.—Prof. T. Turner: Oxidation, with special reference to Thin Films.
INSTITUTION OF MECHANICAL ENGINEERS (Cardiff Section).
SOCIETY OF DYERS AND COLOURISTS (Bradford Junior Branch) (at Bradford).—L. S. Priestley: The Conditioning of Cotton and Artificial Silk.

FRIDAY, NOVEMBER 14.

DIESEL ENGINE USERS' ASSOCIATION (at Engineers' Club, Coventry Street, W.), at 3.30.—Further Report of Committee on Heavy Oil Engine Working Costs.
ROYAL ASTRONOMICAL SOCIETY, at 5.—T. C. Hudson: Perturbation of Directivity.—Prof. I. Yamamoto: Some Relations between the Solar Constant and Solar Activity.—Prof. W. G. Duffield: The Problem of Measuring Gravity at Sea.—M. C. Johnson: Scattering and Absorption in the Atmospheres of Emission Line Stars.—A. Buxton: Note on Expressions for the Measurement of the Effect of Diffraction and the Presence of Optical Aberrations in the Images of Point, Line, and Plane Luminous Sources.—N. Goryatchew: Occultations of Stars by the Moon observed at the University Observatory, Tomsk, Siberia, 1923, 1924.—Dr. J. Lunt: The Spectrum of Germanium.—S. D. Tscherny: Occultation of Venus by the Moon, 1924, Sept. 24, observed at the Astronomical Observatory, Kiew.—W. S. Franks: Observed Colours of 205 Red Stars.—N. Liapin: The Transit of Mercury across the Sun's Disc, 1924, May 7, as observed at the University Observatory, Simferopol, Crimea.
PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—D. W. Dye and L. Hartshorn: The Dielectric Properties of Mica.—Dr. L. Simons: The X-ray Emission of Electrons from Metal Films, with Special Reference to the Region of the Absorption Limit.—Dr. W. H. Eccles: Demonstration of an Electrical Method of Synthesising Vowel Sounds.
SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at Ardrossan), at 7.—J. G. Roberts: Chemical Pottery.
JUNIOR INSTITUTION OF ENGINEERS (Annual General Meeting), at 7.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—G. Avenell: Round about Swanage (Lantern Lecture).
INSTITUTE OF METALS (Swansea Local Section) (at University College, Swansea), at 7.15.—Dr. W. Rosenhain: The Inner Structure of Alloys.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Newcastle-upon-Tyne), at 7.30.—J. F. King: Girders in Ships.
INSTITUTION OF MECHANICAL ENGINEERS (Leeds Section).—Vice-Admiral Sir George G. Goodwin: The Trend of Development of Marine Propelling Machinery (Thomas Hawksley Lecture).
SOCIETY OF DYERS AND COLOURISTS (Manchester Junior Branch) (at Manchester).—Dr. R. S. Willows: Studies in Liquid Films.

SATURDAY, NOVEMBER 15.

PHYSIOLOGICAL SOCIETY (at London Hospital).

PUBLIC LECTURES.

SATURDAY, NOVEMBER 8.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—E. Lovett: The Amulets of Ancient Egypt and Modern London.

WEDNESDAY, NOVEMBER 12.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Sir Leonard Rogers: Leprosy as an Imperial Problem.
UNIVERSITY COLLEGE, at 5.30.—J. C. Gröndahl: Nature Feeling in Norwegian Literature. (Succeeding Lectures on November 19, 26.)—G. F. Barwick: The British Museum Library—I. The Reading Room.

THURSDAY, NOVEMBER 13.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Prof. W. Wilson: Atomic Structure and Quanta.
UNIVERSITY COLLEGE, at 5.30.—Dr. C. Pellizzi: La dottrina sociale e storica di G. B. Vico (in Italian).

FRIDAY, NOVEMBER 14.

KING'S COLLEGE, at 5.30.—Prof. L. T. Hobhouse: Scientific Method.

SATURDAY, NOVEMBER 15.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. H. S. Harrison: Evolution and Darwinism.