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Science Teaching.

It has long been felt that a great defect in our secondary school education has been that boys and girls may pass on to the universities or out into the world of business without having received any instruction in science or any skilled guidance in the pursuit of their scientific hobbies. It is owing probably to a defect of this kind in the education of many of our public men that we have so often to complain of the indifference that is shown to pressing necessities for the better encouragement and endowment of scientific research. It is true that many of our large public schools are now provided with first-rate teachers of science and with well-equipped scientific laboratories, so that the boy or girl who takes the modern side may receive a really good foundation of scientific knowledge. It is also true, however, that, owing to the tyranny of our scholarship system the classical boys in the upper forms of secondary schools have not time to devote to instruction in any branch of science, and for the same reason the education of boys in elementary science is too frequently neglected, both in the preparatory schools and in the lower forms of secondary schools.

What is wanted in education is the cultivation of the idea that no modern citizen can be considered really well educated who has not gained some knowledge of the natural phenomena of the world in which he lives, and of the body which is the temple of his soul. If we could persuade all parents of the truth of this conception, they would not be satisfied with the education of their children unless they have had, at least in the preparatory school or in the lower forms of the secondary school, some instruction in science.

There has been some difficulty, however, in coming to an agreement as to the best and most practical form in which science should be taught in the lower forms; and it is, therefore, with great pleasure that we welcome the valuable report, just published, of a sub-committee of the Science Masters' Association.[1] The fundamental principle that underlies the method of education suggested in the report is that "the work should be done by the boys themselves with as little help as possible from the master in charge"; and accordingly, a syllabus is drawn up of subjects which, experience has shown, can be studied effectively and with simple appliances in school life. Included in the report there are also an interesting and valuable syllabus of subjects arranged as a calendar of work, and three specimens of lessons that may be given in natural history.

All this is excellent and worthy of most careful study

[1] Elementary Science, Nature Study, and Practical Work in Preparatory Schools and the Lower Forms of Secondary Schools. Report of the Sub-Committee appointed by the Science Masters' Association, 1922. (Oxford: University Press. Price 1*s*.)

and consideration by teachers in schools. The point in the report to which objection may be made is the rigid declaration that "set lectures giving mere information in a didactic manner should be avoided." Most teachers of science would agree that at an early stage the teaching of science should be mainly practical and objective. If it is not, the true spirit of scientific knowledge is lost. But why should the didactic manner be avoided? In the course of study in zoology, for example, why should there not be occasional lectures on some of those wild beasts of the world which naturally excite the interest of boys and girls. Lectures on whales, on kangaroos, on the great carnivores, on tropical insects, or even on the fauna of coral reefs, would surely be stimulating and instructive. Entirely to avoid didactic instruction is to make the teaching of science too parochial in character and to leave unsatisfied the thirst for knowledge of the wonders of the world beyond our own shores.

The new method may be admirable as a substitute for the older dry-as-dust didactic teaching, but it tends to lead into the new danger of discouraging boys and girls from reading about natural phenomena beyond the reach of their personal observation and about the thoughts and discoveries of the great men of science.

Human Character.

Human Character. By Hugh Elliot. Pp. xvi+272. (London: Longmans, Green and Co., 1922.) 7*s.* 6*d.* net.

WE are accustomed to judge of a man's character by his behaviour, that is to say, by the manner in which he reacts to the countless vicissitudes of everyday existence. In our experience these reactions differ according to the individual, and we interpret this variability of response by saying that the characters of the individuals affected are correspondingly diverse. Although character is an attribute of the man himself, it can only be known by the man's actions, and is a rough description of the mental and nervous constitution on which the reactions depend. This constitution is partly inborn, partly acquired. The pattern of the cells and nerve paths which make up the central nervous system is already laid down before birth, but the resistance which any impulse meets with in its passage through the central nervous system is the resultant not only of the inherited pattern, but also of experience, every reaction which has occurred having left some trace of its passage and produced facilitation along certain paths and blocking of certain other paths.

Character is thus a product both of nature and of nurture, the former supplying potentialities of behaviour, the latter limiting and modifying the extent to which any given reaction may take place. Although character is a question of the arrangement and resistance of a complex system of neurones, the only possible way of describing it is in terms of the reactions which it is able and wont to produce. Without taking a dynamo to pieces and measuring the physical properties of its various parts, the only method by which we could describe its potentialities would be by making it work and finding out what current and what electromotive force it gave us at varying speeds of rotation, *i.e.* by its performance; and the same holds good for any attempt to describe under the term of character the complex structural arrangements which determine the reactions of a man. Character itself we cannot with any accuracy describe or classify, but we can analyse the different factors, mental or physiological, which are involved in its formation and determine behaviour. This is the manner adopted by Mr. Hugh Elliot in the book now before us.

Since character determines behaviour, it is possible to form an idea of the essential nature of human character by analysing the motives which determine human action. The older philosophers (and their teaching is reflected in current thought) were wont to draw a marked distinction between the actions of animals, which were determined by instinct, and those of man, which were guided by reason; whereas we have now recognised that the intellectual processes of reasoning have very little to do with behaviour. Although the emotions have long been described as the springs of action, the preponderating and almost exclusive rôle of emotions in determining human activities has only been fully recognised during the last twenty years. Emotions are the representation in consciousness, the subjective side, of the complex series of automatic reactions which in animals we call instincts and which in their case we only occasionally endow with emotional attributes. Thus the quest for food, flight from an enemy, pursuit of a mate, are all automatic reactions which are shared by man with the lower animals, but in the former case we say they are due to the emotions of hunger, fear, or love.

In the first chapter of this book, which Mr. Elliot entitles "General Principles," the author emphasises the all-importance of the emotional states in the determination of behaviour. Man's life thus becomes a series of instinctive reactions differing from those of the lower animals only in their greater complexity, and in the extent to which they are varied as the result of individual training or education. Reason does not dictate behaviour. Party government would be impossible if this were the case, nor would two nations like the French and English advocate diametrically opposite methods of dealing with the same problem. Reason is but the instrument for the safer and more successful carrying out of a reaction which will satisfy the prevailing emotion, and it is to the emotional conditions of the electors or of different nations that politicians and statesmen have to appeal if they wish to get support for any particular line of action. Volition itself is another word for desire. A man with a strong will is one in whom all the faculties of the mind are slaves to the satisfaction of a dominant desire, which may be easily attained or may take years for its achievement. The author points out that what a man does is the resultant of what he feels, and since feelings are themselves dependent on external conditions of the individual, character is but an abstraction, a name for the average mental manifestations and not representing anything fixed or constant.

Theoretically it might be thought possible to build up a logical account of character, starting from the primitive instincts tending to the preservation of life, to reproduction, and to the association with other individuals in communities (the herd instinct), by showing how these are modified to produce the manifold variation of impulsive behaviour observed in man. Such an attempt would, however, involve us in constant cross-reference, since every quality of the mind is bound up with other qualities, just as every part of the brain is associated in its activities with those of all other parts. The only method left is that adopted by the author, namely, taking the more complex emotional conditions, to analyse their composition, their relationship to other mental states, and their manifestations in conduct. Such a method renders it difficult to preserve logical continuity in the treatment of the problem. Each chapter becomes an essay in itself, as is evident from a consideration of the headings in the table of contents. The first seven chapters, for example, are labelled as follows: General Principles, The Major Passions, Egoism, Love, Social and Moral Feeling, Jealousy, Religion.

There are altogether twenty-two chapters, but the treatment is much more connected than would appear at first sight from the headings just detailed. Throughout the book the point of view of the author is that of the educated amateur, so that the reader feels that he is capable of following the arguments and appreciating them critically, and indeed that he is entitled to differ from the author without presumption. After all, the most readable books are those in which the reader is only half in agreement with the author, so that he is incited to think for himself, and to form his own conclusions on the subjects dealt with. It will do no one any harm to try to analyse in the same manner in which the author has accomplished it the motives for his own actions and for those of other people. It may indeed tend to make reason play rather a larger part than has hitherto been the case.

It is curious that the author at the beginning of the work abandons the analytic method when speaking of the moral feelings. He says: "The moral emotions are a deep and powerful instinct, buried in every mind, and so much part of our constitution that we are almost unaware of their very existence. We refrain from wrong-doing as the result of a deep emotion which controls our actions, very often unknown to ourselves." This is in other words the popular idea of conscience, which is regarded as implanted in man from his birth. But surely, when the author speaks of "wrong"-doing he is begging the whole question. The moral instinct is the impulse to act in accordance with the rules of the tribe of which the individual is a member, and is developed by education, in its broadest sense, from the herd instinct. On this instinct depend the appreciation of approval and the seeking of support from the other members of the community. By education, by mimicry, by the repetition of enforced actions, by the experience of the painful results of some and the pleasurable results of other actions, the herd instinct is so moulded that the easiest reaction to commonly recurring circumstances is one that is in accordance with the rule of the tribe, and any anti-social action is attended with mental discomfort or anticipation of punishment or disapproval. This is what is commonly called conscience. The moral sense will thus be quite different in men of different races, according as they have been brought up in a Hindu or Christian community or among savages. The potentialities of development of this moral sense, this *Sittlichkeit*, will vary from individual to individual, but the content of the sense and its results in action will depend on the environment of the man from his birth.

The book is copiously illustrated with quotations from Shakespeare, Dante, and Goethe. The author points out that great writers, far more than men of science, penetrate human nature, and that of all writers Shakespeare possessed the most profound insight into character. The upshot of the whole work is that a man's character depends on his feelings. Feelings are the springs of action; education is above all a development and training of feelings. It matters more what a man does than how he does it, and it is probably on this account that the English system of education, so deficient on the intellectual side, can boast of results in many ways more successful than those achieved by the Lycée or Gymnasium.

E. H. S.

The Arabs of the Sudan.

A History of the Arabs in the Sudan: and Some Account of the People who preceded them and of the Tribes inhabiting Dárfūr. By H. A. MacMichael. Vol. 1. Pp. xxii + 347. Vol. 2. Pp. viii + 488. (Cambridge: At the University Press, 1922.) 2 vols. 90*s.* net.

THE two volumes before us present the result of Mr. MacMichael's investigations in the Northern Sudan carried on for nearly twenty years, and they may be regarded as the logical continuation of his earlier work (published in 1912) on the Arabs of Kordofan. The present work deals with all those Sudanese tribes in which Arab blood preponderates, or at least warrants the popular conception of them as Arabs.

Mr. MacMichael's area of study—roughly north of 12° N. and west of 25° E.—is so entirely his own, his conclusions so largely the result of original field work, that any detailed criticism is impossible. All that the reviewer can do is to give some idea of the scope of the book, the author's general conclusions, and where possible indicate how far these agree or disagree with the results of workers in other parts of the Sudan.

The plan of the book is unusual; the second volume consists of the translations of thirty-two native manuscripts, for the most part *nisba* "pedigrees," with explanatory notes and genealogical trees. The first volume, with the exception of sections dealing with the early history of the Nile Valley, and the non-Arab races of Darfur, is devoted to a series of dissertations or essays based on the data contained in the manuscripts in volume 2, and the study that the author has made of literary sources both Arabic and European.

Wearisome as these *nisba* are to read—and the student will be inclined to echo the sixteenth-century writer of document BA, "the knowledge of the pedigrees of persons who are unrelated to yourself is of no use"—their value is increased by their rarity, for though many Sudan Arabs are prepared to produce fragments of paper which they regard as of genealogical interest, relatively few documents of real historical value have survived the ravages of white ants and the accidents of the nomad life. Moreover, of those that did exist half a century ago, very many were burnt during the Dervish rule by the orders of the Mahdi, who feared that research might tend to invalidate his pretensions to be the Expected One, and by the Khalifa, a Baggara from Darfur who was interested in genealogy to the extent only of not desiring to appear less nobly born than those over whom he ruled.

Not all the manuscripts are *nisba*: there is a "History of the Fung Kingdom" (MS. D7) of far more general interest, while somewhere between these and the "pedigrees" come the MSS. numbered D1 and D3. The third part of the former, probably dating from the eighteenth century, contains much of general ethnological interest, while the latter, a series of biographies of holy men of the Fung period, written early in the nineteenth century, has considerable social and folklore value.

The first three chapters, dealing with the pre-Muhammadan inhabitants of the Sudan, go far back in time. Mr. MacMichael seems concerned to prove that there was a considerable inflow of Arabians into Egypt and the Sudan so far back as the Old Kingdom, but there is really no sufficient evidence for this, nor from the point of view of the present volumes is it of any importance, this alleged very early Arabian influence being ignored in the remainder of the work. The next two chapters deal for the most part with the Nubians and Beja and contain much that is interesting and suggestive, but the reviewer may be allowed to point out that the author is incorrect in attributing to him the view (1, p. 35) that "the Hadendoa are representatives of the Beni Amir stock modified chiefly by miscegenation with the tall negroes of the Nile Valley, and also, in all probability, with the . . . round-headed Armenoid population. . . ." There can be little doubt that it is Armenoid blood that is responsible for certain of the physical characters of the Hadendoa; negro influence has been but slight. In any case these three chapters are introductory only; they contain none of the author's own observations, so that they stand apart, and the critical attitude which they provoke rapidly dies down on reading the rest of the book.

The remainder of part 1 forms a most valuable introduction to the ethnology of the non-Arab races of Darfur; here Mr. MacMichael has done service not only by bringing together the scattered notices from literature, but also by the account he gives of the social organisation and religious rites which he has himself observed among the Dagu, the Fur, and the dwellers on Jebel Midob. Among these tribes, as well as among some of their even less known neighbours, rain-making ceremonies are still of importance, the rain-maker being a woman and descent being in the female line; moreover, in a general way their religious ideas, so far as it is possible to judge on present information, seem akin to those of the Nuba of Southern Kordofan, as observed by the present writer. This fact has not escaped Mr. MacMichael; it might have been added that the work of Tucker and Myers (Journ. Roy. Anthrop. Inst., 1910) suggests a definite physical relationship. Combining the information he collected from the various tribes of Darfur, Mr. Mac-

Michael concludes that the two main ethnic strains in the country are the negro and the hamitic, the latter being, at least in part, a result of the pressure exerted by Arab immigrants into North Africa upon the Berber tribes. Thus originated the ruling aristocracy of the states fringing the Sahara to the west of Lake Chad, while the Tibbu are to be regarded as an early Libyo-Berber mixture that has come to form the basis of the population of Northern Darfur, the negro element predominating in the south. It must, however, be remembered that cultural influence, perhaps relatively ancient, has come in from the east, as is evidenced not only by legends of origin but also by the very striking resemblance in the vocabularies of such peoples of Darfur as the Midob and Birked to those of the Barabra of the Nile Valley, and that with this, there was probably introduced a strain of foreign blood.

Turning now to the Arabs with whom the main bulk of the work is concerned, Mr. MacMichael begins by tracing their progress through Egypt in the Middle Ages. This is no easy matter, for even in the ninth century the historian, el Baladhuri, admits that there were great differences of opinion. Here may be quoted a dictum of the author of MS. DI: "The tribes of the Arabs who are in the Sudan, other than these [the Nuba, the Abyssinians, and the Zing], are foreigners, and have merely mixed with the tribes mentioned above and multiplied with them. Some of them have retained the characteristics of the Arabs, and the element of Nuba and Zing that is interspersed among them has adopted the Arab characteristics; and on the other hand there have been some Arabs who have become fused with the Nuba and the Zing, and adopted their characteristics; but in each case they know their origin."

Here, in brief, is the history of much of the Arab Sudan, and even if it be doubted that "in each case they know their origin" a great deal of Mr. MacMichael's research does but amplify and confirm his Arab forerunner. The whole process can be followed particularly well in the case of the Guhayna (Juhaina). In the pre-Islamic period they occupied Nejd and the neighbourhood of Medina, where a section dwell to this day. Many migrated to Egypt, taking part in the conquest with other sections of the Ḳuḍa'a, while two hundred years later they formed part of a force invading the Beja country. Some of them seem to have reached Aswan by the ninth century; by the fourteenth century they had penetrated far into Nubia, and it was the Guhayna who more than any other tribe brought about the dissolution of the Christian kingdom of Dongola.

"At first the kings of the Nuba attempted to repulse them, but they failed; then they won them over by giving them their daughters in marriage. Thus was their Kingdom disintegrated, and it passed to certain of the sons of the Guhayna on account of their mothers according to the custom of the infidels as to the succession of the sister or the sister's son. So their Kingdom fell to pieces and the A'rab of Guhayna took possession of it. But their rule showed none of the marks of statesmanship because of the inherent weakness of a system which is opposed to discipline and the subordination of one to another. Consequently they are still divided up into parties and there is no vestige of authority in their land, but they remain nomads following the rainfall like the A'rab of Arabia. There is no vestige of authority in their land, since the result of the commingling and blending that has taken place has merely been to exchange the old ways for the ways of the Bedouin Arab." Thus Makrizi in a passage not included in de Slane's translation.

It was this dual policy of following the rainfall and of inter-marriage that led to the rapid spread of the stock, so that a sixteenth-century author, or more probably copyist, writes of a total of "fifty-two tribes in the land of Soba on the Blue Nile under the rule of the Fung," while there were even more in the west, including Bornu. So at the present day all the Baggara, including those of Darfur and Wadai, regard themselves as united in the common bond of Guhayna ancestry. It is in this sense that the Guhayna constitute one of the great moieties of the Sudan Arabs, yet it must be remembered that in the Sudan the tribal name Guhayna is used in a narrow as well as a broad sense. In the former it is restricted to certain nomads inhabiting the Sennar Province; it is only in the widest sense and by much manipulation of genealogies that it is stretched to include the Baggara and the vast group of camel nomads in Kordofan, all of whom if pressed will say that they are descended from Abdulla el Guhani.

The other great division of the Sudan Arabs, even larger and more loosely knit than the Guhayna, is the Ga'aliin, the members of which claim to be descended from 'Abbas, the uncle of the Prophet. In the main this group is sedentary; the Arab element *sensu stricto* that went to form it seems to have coalesced with the older settled inhabitants of Nubia and to a considerable extent to have adopted their social habits. Indeed, Mr. MacMichael applies the term Ga'aliin-Danagla to this, the other great moiety of Sudan Arabs, which includes most of the riverain tribes as well as a number of sedentary tribes in Kordofan.

It must be understood that the reviewer has been able to touch on some only of the outstanding features of this remarkable book, which, while holding so much detailed information, abounds in suggestions which will make it a source of inspiration to every worker in the field of which it treats.

A word of tribute should be paid to the Sudan Government for its enlightened policy in guaranteeing the amount necessary to permit publication.

C. G. SELIGMAN.

The Utilisation of Coal.

The University of Sheffield: Department of Fuel Technology. Coal: a Series of Lectures on Coal and its Utilisation. By H. Chamberlain, J. W. Cobb, R. Lessing, F. S. Sinnatt, and M. C. Stopes. Pp. iii + 41. (London: The *Colliery Guardian* Co., Ltd., 1922.) 5*s*.

THIS publication in book form of the series of lectures on coal and its utilisation, delivered recently under the auspices of the Department of Fuel Technology of the University of Sheffield, renders the lectures available to a larger audience than that to which they were originally addressed. Each one is the work of an authority of acknowledged eminence in the particular branch of the subject treated, and, while of course containing nothing absolutely new, presents a clear and accurate picture of the present state of our knowledge brought thoroughly up-to-date. Perhaps the chief cause for regret is that the head of the Department of Fuel Technology, Prof. Wheeler, did not himself contribute to this series of lectures.

The first lecture, by Dr. Marie Stopes, deals with the subject which she has made peculiarly her own—the constitution of coal and the identification of the four constituents which she has isolated. This classical piece of work, at first merely of scientific interest, is gradually assuming an aspect of economic importance owing to the widely different properties of the various constituents. Wheeler and Lessing have shown, for example, that the coking property of coal appears to pertain almost wholly to the clarain and vitrain, fusain being quite and durain almost completely non-coking. At the same time, other researches would indicate that methods of separating these constituents on a commercial scale are at any rate possible of attainment, a measure of success having already been achieved in this direction by means of froth flotation. It is obvious that such a process may present great industrial possibilities and that it should be capable of greatly increasing the available supplies of coal suitable for the production of good metallurgical coke. Dr. Marie Stopes has not herself discussed this aspect of the question, although it is referred to in some of the later lectures; it may, however, be admitted that it is scarcely ripe yet for anything more than the passing reference which it here receives.

It is probably not the fault of Mr. F. S. Sinnatt, who deals with the preparation of coal for the market, that his subject is so wide that it is impossible to do anything like justice to it in so short a space; hence the lecture is necessarily of a sketchy character, and gives but little indication of the more modern developments of this important branch of technology. Mr. Sinnatt devotes a paragraph to the method of froth flotation, but does not attempt any discussion of the theoretical principles upon which this process is based; indeed, throughout his lecture he omits any explanation of the scientific principles upon which the various processes depend, though undoubtedly such discussions would have added very much to the value of his contribution.

The third lecture, by Dr. R. Lessing, is on the carbonisation of coal. The four main products of the decomposition of coal—the solid, the viscous, the liquid, and the gaseous—are dealt with, and the importance of each is pointed out, and the effect upon it of the different methods of conducting carbonisation. Dr. Lessing gives a full account of his own method of carrying out laboratory coking tests and indicates their practical application; at the same time he shows clearly the difficulties of following in detail the course of the coking operation on a large scale owing to its great complexity and to the number of varied changes that are taking place simultaneously. This is a very wide subject and one of very great importance; it may be noted that almost simultaneously with the appearance of the work under review, the Society of Chemical Industry has published an important paper by Sir George Beilby on the structure of coke, its origin and development, which is wholly devoted to the minute study of a detail which Dr. Lessing is perforce compelled to dismiss in a few lines. Dr. Lessing's lecture concludes with a review of the three types of industrial carbonisation, in gas works, in coke ovens, and in low temperature plant, although it may well be held that the term "industrial" is much too flattering a term to attach to the last-named process as it exists to-day.

In the fourth lecture Mr. Horace Chamberlain deals with the purification of coal gas from the gas-maker's point of view; his contribution is in every sense an admirable one, clear, concise, and yet setting out the principles of the various processes in sufficient detail. Perhaps the only cause for regret is that he has passed over the Burkheiser process for the utilisation of the sulphur in coal gas in somewhat too summary a fashion. It is true that this has not been a success up to the present, but it is by no means impossible that the process may contain the germs of a highly successful practice in the future.

The last lecture, by Prof. Cobb, is on ammonia from coal, in which the author shows clearly, as the result of much experimental work, the conditions under which the maximum production of ammonia may be obtained by the decomposition of coal; it need scarcely be said that the subject is one of the greatest importance, having regard both to the great manurial value of the product for agricultural purposes and to the highly important part that it plays in the economics of coal carbonisation. The lecture concludes with a brief review of the present position of the synthetic processes for the production of ammonia, the chief protagonists being the Haber and the Claude processes; Prof. Cobb evidently holds the view that there is likely to be but little to choose between the costs of production of ammonia from coal and by synthetic methods, and that it is to-day impossible to say on which side the advantage will ultimately rest.

While each of the lectures is a complete little monograph in itself, the subjects have been carefully selected, so that the book as a whole covers well a large portion of the field included under the comprehensive title of the Utilisation of Coal, a subject which is of the greatest national importance at the present moment. It has often been said that British coal has been too cheap in the past, and that we accordingly got accustomed to squandering recklessly our greatest national asset; such habits of extravagance, once acquired, are not easily got rid of, but works like the one before us have at least the great merit of indicating the right road to a much-needed improvement in this respect.

H. LOUIS.

Astrology of Comets.

Tychonis Brahe Dani: Opera Omnia. Edidit I. L. E. Dreyer. Tomus iv. Pp. 377-524. (Hauniae: Libraria Gyldendaliana, 1922.)

IN these pages Dr. Dreyer has given us an interesting collection of papers on comets, not hitherto accessible to the learned world. After the concluding page of the well-known "De Mundi Ætherei recentioribus Phaenomenis" we have a treatise of sixteen pages in German, now printed for the first time, on the comet of 1577. Next come nine pages in Latin on the comet of 1585, printed at Uraniborg in the "Diarium astrologicum et metheorologicum" of Elias Olai Cimber for 1586, and seven pages in the same language now first published on the same comet. These last two treatises are mainly astrological, as is no small part of the treatise on the comet of 1577.

The largest part of the present fasciculus is, however, occupied with a controversy on comets between Tycho Brahe and the Scottish physician John Craig. Tycho had sent Craig a copy of his printed but as yet unpublished work, "De Mundi . . ." and Craig had replied in certain letters which as Dr. Dreyer informs us were published by Noltenius in 1737. These drew from Tycho an "Apologetica Responsio," filling sixty pages of the present volume. The work was printed and a few copies were sent to friends. It was Tycho's intention to include it along with the whole controversy with Craig as a supplement to his "De Mundi . . .," but his representatives wisely decided to let the main treatise go forth by itself. No printed copy of the "Apologetica Responsio" has survived, and Dr. Dreyer has edited it from a MS. at Copenhagen. Craig replied to this work in a treatise entitled "Capnuraniae restinctio," of which Dr. Dreyer has been able to give us a fragment from a Vienna MS. The task of replying to this work was ultimately undertaken by Kepler, but abandoned by him on Tycho's death, though Kepler's unfinished reply has since been published in his collected works. Dr. Dreyer's notes on the whole volume, including the "De Mundi . . .," occupy the last thirty-two pages of the present publication.

Not the least instructive of these studies are the astrological treatises. It will be observed that with the exception of the paper written for his assistant, Tycho early abandoned the intention of publishing them. In an age when nearly all science was based on an experience not supported by carefully recorded experiments and observations, it was reasonable to give to the supposed truths of astrology the same respect that was shown to scientific teaching generally. Tycho's astrology is neither fanciful nor arbitrary, but professes to regard observation as the test of truth. Thus on p. 413 he refuses to decide on the limits of the clima of Saturn, because they rest on no sufficiently attested experience. On the other hand, he regards it as a settled fact that the comet which was seen in Aries in 1533 changed the religion in Britain and caused lasting discord. Whatever value Tycho may have attached to such speculations, he could not but feel that they were work of a very different class from the great astronomical edifice founded on his own observations of precision.

The controversy with Craig is not without its analogies. Craig held with Aristotle that objects in the ether were immutable, while objects in the elements might suffer change, and that temporary phenomena like comets must, therefore, be sublunar. Tycho Brahe held that from the relative slowness of their motion and the absence of perceptible parallax they must be more distant than the moon. The question is of the ever recurrent type where observations seem to conflict with a general principle which has hitherto known no exception.

Our Bookshelf.

An Inorganic Chemistry. By Prof. H. G. Denham. Pp. viii + 684. (London: E. Arnold and Co., 1922.) 12*s*. 6*d*. net.

PROF. DENHAM has written "An Inorganic Chemistry" for intermediate students. In this field at least half-a-dozen excellent text-books are already available; but, perhaps for commercial reasons, additional volumes of similar scope continue to be produced, and the process may be expected to continue until each leading publisher is able to offer a book of this type. Prof. Denham's book is well printed and nicely illustrated, and in this respect compares favourably with other competing volumes.

The author claims as a simplifying factor the introduction of the periodic classification of the elements in the middle (instead of at the end) of the chapters on the non-metals; but it is doubtful whether this policy will be followed by other authors, because it is obviously difficult to classify the elements when only two groups of them have been described. The policy of including a brief description of all the less common elements (except those of the "rare earths") is also of doubtful value, in view of the great difficulty which intermediate students find in becoming acquainted even with the common elements when they pass from the study of the non-metals to that of the metals. More important perhaps is the fact that while atomic weights are given at a very early stage, Avogadro's hypothesis and the molecular theory are postponed to Chapter IX., with the result that for nearly 100 pages hydrogen gas is represented as H and oxygen gas as O; in the meantime, subjects such as the theory of solutions and thermo-chemistry, and even valency and structural formulæ, are discussed on this very inadequate basis.

The author's attention may be directed to the incorrect statements which result from his undue simplification of crystal forms, which he classifies by means of planes of symmetry instead of by means of crystallographic axes. It would also be well if it were clearly stated that the vapour-pressure curves of the different forms of sulphur are purely fictitious, although they are presented in the same attractive form as the solubility diagrams, which are a pleasing feature of the book; it may be suggested that the omission of the small squares might be used to distinguish those diagrams which are mere sketches from those where accurate data are given. T. M. L.

Happy India as it Might Be if Guided by Modern Science. By A. Lupton. Pp. 188. (London: G. Allen and Unwin, Ltd., 1922.) 6*s*. net.

MR. LUPTON in a single cold-weather tour through the Indian Empire has tried to solve a series of economic problems, which have long engaged the attention of administrators and men of science. He is impressed, as all thoughtful observers of Indian life must be, with the general poverty of the people, their exhaustion by malaria, and their inability to resist periodical scarcity. The soil is ineffectually cultivated by weak plough cattle, the produce is extremely low when compared with that of other more fortunate countries, and much of the scanty manure is used as fuel. Here is the chance of science. Why not have a chemical examination of the soils of each district to find out what constituents are lacking? Why not establish a fuel reserve in each village? Why not lay down at every peasant's door wood from the Himalayas or coal from Bengal? Why not use electricity to pump water from the wells? Why not fill every puddle and so abolish malaria?

These are admirable schemes, but unfortunately the Government does not possess the means of raising enormous loans, paying the interest, or maintaining a new army of officials, in the hope that some day it will be repaid for the cost of 7,000,000 tons of superphosphates which he proposes to import, even if such a demand did not upset agriculture all the world over. It is very well to say, spend a few millions as a beginning, but this would do little to improve the situation, and, as he admits, there is little use in giving ignorant people superphosphates if you do not at the same time supervise their use by a corpus of experts. Even to make a fuel reserve in a village means taking up arable land for this purpose, and the peasant does not like reserves because they shelter wild pig, monkeys, and green parrots, his greatest enemies.

Mr. Lupton honestly admits that the Government is not to be blamed because every Hindu marries and rears a family, resulting in congestion of the population. He hopes vaguely that public opinion will check this abuse, but he admits that the educated Indian gentleman knows or cares little about the peasantry, and that "if the Indians govern themselves, we may be sure that their government will be bad." Mr. Lupton is to be commended for his good intentions, his fine sense of humanity, but it needs practical wisdom to consider the problems which he has attempted to solve.

The West Riding of Yorkshire. By Bernard Hobson. Pp. xii + 188. (Cambridge: At the University Press, 1921.) 3*s*. 6*d*. net.

MR. BERNARD HOBSON had a difficult task to describe the West Riding of Yorkshire owing to the wealth of the material. The term "Riding" means one-third, so that the area dealt with is only one-third of the county of Yorkshire; but as it includes the densely populated coalfield to the south and the limestone moors to the north-west, it contains areas of special importance and interest. Mr. Hobson has not only compiled an instructive summary of the geography, geology, and history of the West Riding, but has also presented it in a form interesting throughout. The most important geographical feature of the area is the Pennine Range, forming its western highlands, which is unique in England from the extent of its subterranean river system. The industrial districts include many important cities; the author's account of Sheffield is of especial interest. The history of man in the area dates from Neolithic times, for Mr. Hobson tells us that no undoubted trace of Palæolithic man has yet been found, though abundant remains occur only three miles from the Yorkshire border. The area is especially rich in archæological and historical monuments. In the chapter on the architecture it is remarked that the professional architect arose in the period of James I., before which building had been in the hands of the builder and the craftsman. Apparently, therefore, the end of the great age of building in England synchronises with the rise of the professional architect.

A Laboratory Handbook of Bio-Chemistry. By P. C. Raiment and G. L. Peskett. Pp. 102. (London: E. Arnold and Co., 1922.) 5*s.* net.

THE book before us would be more appropriately entitled physiological than bio-chemistry, as in its scope it is almost entirely limited to the elementary physiological chemistry usually taught to medical students. A short theoretical account of each subject precedes the practical work. Much of this is quite sound, but the text is frequently marred by looseness or inaccuracy of statement, which requires stringent revision before the book is placed in the hands of a student. Examples of this will be found in the account of the action of acids on soaps (p. 45), the precipitation of globulins (p. 24), the properties of the albumins (p. 16), and elsewhere. Again, histidine is omitted from the list of amino-acids derived from proteins, vitamin B is stated to be associated with the fatty radicles of milk, and so on.

The practical work is almost entirely confined to qualitative test-tube experiments, the chief exceptions being the quantitative methods of urine analysis, and, in an appendix, Kjeldahl's method and the methods for estimating reducing sugars. These experiments are clearly described and easy to perform.

We do not, however, believe that practical bio-chemistry can be satisfactorily taught in this way. Preparative work and, especially, quantitative methods are essential even in the earliest stages. Unless this kind of exercise is freely introduced the student will acquire no real grip of the subject, but will regard it simply as another dreary course of "test-tubing."

A. H.

Meteorological Office: Air Ministry. British Rainfall, 1921. The sixty-first annual volume of the British Rainfall Organisation. Report on the distribution of rain in space and time over the British Isles during the year 1921, as recorded by more than 5000 observers in Great Britain and Ireland. Pp. xxiv+300. (London: H. M. Stationery Office, 1922.) 12*s.* 6*d.* net.

RAINFALL statistics over the British Isles have now been collected and published annually for a sufficient period to render the observations of very great value, thanks to the foresight and persistent perseverance of the late Mr. G. J. Symons. Where observations do not exist, a shrewd approximation of the average fall can be obtained by means of neighbouring measurements.

The essential feature of the volume is a discussion of the drought in 1921, which was more remarkable for persistence than for intensity over short periods, although June and July were probably drier than any two consecutive months in living memory. In England and Wales 1921 was probably the driest year since 1788, and in London it was the driest for at least 148 years. The south-east of England experienced the greatest severity of the drought, and a part of Kent had for the year less than 50 per cent. of the average rainfall. A coloured map opposite to page 150 shows graphically for the British Isles the relation of rainfall in 1921 to the average of 1881–1915.

Rainfall is discussed in connexion with scarlet fever, and there is an article at the end of the volume on the fluctuations of annual rainfall.

C. H.

Design in Modern Industry: The Year-Book of the Design and Industries Association, 1922. With an Introduction by C. H. Collins Baker. Pp. 157. (London: Benn Bros., Ltd., 1922.) 15*s.* net.

THE Design and Industries Association, of which this appears to be the first Year-Book, is concerned with liaison work between the artist, the manufacturer, and the distributor, and aims at the improvement of British design through the intelligent and liberal use of the artist, both for ideal reasons and to meet foreign competition. The Association holds that good design is tested first and chiefly by fitness, and secondly by pleasantness in use. A teapot, for example, should have a spout that does not drip, a handle and spout that do not project unnecessarily (to save room in the cupboard and reduce risk of fracture), the lid should be securely held while the pot is in use, there should be the fewest, if any at all are necessary, of crevices and sharp angles, as these hold dirt and are difficult to clean, the cost should be reasonable, and so on. The illustrations include furniture, pottery, fabrics, kitchen equipment, metal work, printing, signs, tablets, shop fronts, etc. The designs as a rule are distinctly pleasing, and are appreciated by critical artists. The photographic reproductions are, with few exceptions, excellently done, but we hope that the Association in its second Year-Book will be able to introduce colour reproductions where they appear to be essential.

Alcohol in Commerce and Industry. By C. Simmonds. (Pitman's Common Commodities and Industries.) Pp. xii+119. (London: Sir Isaac Pitman and Sons, Ltd., 1922.) 3*s.* net.

THE late Mr. Simmonds had produced a larger and more detailed treatise on alcohol before undertaking the present small volume. It would therefore be anticipated that his treatment of the subject would be most expert. The present volume, in fact, is a wonderfully concise and complete account of the manufacture and uses of alcohol, and is well illustrated. It is perhaps scarcely realised by those not familiar with recent progress in chemical industry and engineering how many uses are found for alcohol, and how many more promise to be discovered. Mr. Simmonds's book will supply this information to the general reader, and the chemist will also find much that is useful in it.

Mathematics for Engineers. By W. N. Rose. (The Directly-Useful Technical Series.) Part I., including Elementary and Higher Algebra, Mensuration and Graphs, and Plane Trigonometry. Pp. xiv+514. (London: Chapman and Hall, Ltd., 1922.) 10*s.* 6*d.* net.

THE first edition of this work appeared in 1918, and was reviewed in our columns (NATURE, vol. 101, p. 463). It has now been put to the test alike by teachers and students, and has proved its value. The third edition, now before us, has been thoroughly revised; there are few additions, but we note one on elementary determinants which contains enough to enable the reader to understand certain methods employed in works on aerodynamics.

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.*]

On the New Element Hafnium.

IN a former letter to NATURE (January 20, p. 79) we announced the discovery of a new element with atomic number 72, for which the name hafnium was proposed. Evidence was given that this element is a homologue of zirconium in accordance with theoretical expectations (Bohr, " Theory of Spectra and Atomic Constitution," p. 114, Camb. Univ. Press, 1922). Continued experiments enable us to complete the statements in the former letter. By the addition of a known quantity of tantalum (73) to our samples, and by a comparison of the intensity of the Ta-lines with the Hf-lines, a closer estimate of the amount of hafnium present has been obtained. We have investigated a great number of zirconium minerals from different parts of the world. They all contained between 5-10 per cent. of hafnium. In samples of commercial zirconium oxide investigated, we have found the new element, amounting in one case to as much as 5 per cent. Starting from the latter substance, by means of a chemical method which is also adapted to separate zirconium from the other tetravalent elements, we have been able to obtain several grams of a preparation in which the presence of about 50 per cent. of hafnium could be established. Conversely, we have succeeded in preparing zirconium in which no hafnium lines could be observed. Further particulars about the method of preparation and provisional determination of the atomic weight will be published shortly in the communications of the Copenhagen Academy.

D. COSTER.
G. HEVESY.
Universitetets Institut for teoretisk Fysik,
Copenhagen, January 31.

The Latent Period in Lubrication.

SOMETIMES in a scientific inquiry results accrue which are called, in laboratory slang, " pretty " ; the pieces of the puzzle have fallen together in a fashion so pat as to give artistic pleasure.

Most lubricated surfaces have the curious property that the friction falls after the lubricant has been applied, until a steady state is reached after an interval which may vary from a few minutes to a few hours. For example, a clean surface of glass lubricated with pure heptoic acid, the slider being in position, the initial value of the coefficient of friction at 12° was $\mu=0\cdot51$, but in 40 minutes it had fallen to its steady value, $\mu=0\cdot40$.

This latent period, as it may be called, is shortened by a rise in temperature and, apparently, by mechanical agitation ; and is manifested by surfaces lubricated only by a film of insensible thickness as well as by those flooded with liquid.

The most striking fact, however, is the influence of the slider. The final steady state is never reached unless the slider is in position. Surfaces which have been freely exposed to vapour or to an excess of fluid resting on them always have high friction when first put in contact. The lowest value is given only by a film of lubricant which has been enclosed for some time between two solid faces. Such is the puzzle, and the explanation is curiously simple.

A molecule of an aliphatic acid or alcohol is like a rod loaded at one end. Putting a drop of one of these substances on a clean surface is like flinging a handful of such rods, picked up at random, at it ; some hit and stick by the loaded ends, others by the unloaded ends. Condensation from the vapour is similar except that the rods are flung singly.

It is practically certain that friction is lowest when all the rods are orientated in the same way, a condition which will be reached only when the wrongly orientated molecules have had time to evaporate off into the fluid or vapour and have been replaced by molecules rightly orientated. The latent period is the time occupied by this readjustment.

So long, however, as the layer is exposed to fluid or vapour it is always losing or gaining molecules by evaporation and condensation, and some of those arriving will be wrongly orientated. The layer will reach a steady state, but it will not be that of least friction because at any moment a fraction of the molecules will be wrongly orientated. Orientation will be as perfect as possible and friction at its lowest only after a layer has been for some time shielded from evaporation by being enclosed between solid faces.

If this explanation be correct there should be no latent period when both ends of the rods are alike. This is so. In normal paraffins both ends are alike, *and in no circumstances do surfaces lubricated by normal paraffins show a latent period.*

The fact that a latent period exists is of importance to practical lubrication. The molecular process which causes it is, we believe, of importance in the mechanics of living matter. Physiologists will note how it recalls du Bois Reymond's theory of muscle and nerve.

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January 23.

The Rule of Priority in Nomenclature.

IN NATURE for February 3, p. 148, Mr. F. Chapman mentions three distinct proceedings that may affect the stability of nomenclature in zoology. Concerning those that arise from differences of opinion as to the classificatory value of certain shapes or structures, or those that depend on the advance of knowledge, on corrections of fact, or on the need for breaking up unwieldy groups, it is useless to argue. No system of classification and nomenclature devised by man can cope with such inevitable changes.

The third proceeding, with which alone I venture to deal here, is the discovery that a name in general use was predated by a name that hitherto has been left in obscurity, and the consequent enforcement of the law of priority. On this point Mr. Chapman's letter overflows with good sense ; but it has all been said before. His laments, however, will not have been entirely wasted if you will permit this consolatory reply—namely, that in the year 1913, at the International Congress of Zoologists in Monaco, an agreement was reached in the largely attended section on nomenclature and confirmed in plenary session, by which the International Commission on Zoological Nomenclature was given power, on certain conditions, to suspend the rules in those cases where their operation was contrary to the general convenience. The Commission has, on the request of various zoologists, already taken action in several cases. It has, for example, recommended, but not yet passed, the suspension of the rules in the case of Holothuria *versus* Physalia (Opinion 76), and is at the moment preparing to adjudicate on the name of the common house-fly (see NATURE, January 27, p. 115).

The Commission has also—urged thereto by its devoted secretary, Dr. C. W. Stiles—attempted to draw up for various groups lists of agreed and unalterable names, *Nomina conservanda*.

If, owing to the war and the peace, so thorough a worker as Mr. Chapman can have, apparently, forgotten or remained ignorant of the Commission's work, there must be many in the rising generation to whom it is equally unknown. If they cannot find what they want in the Report of the International Congress of Zoologists or, more accessibly, in the American periodical *Science* and in the Smithsonian "Miscellaneous Collections," they may like to know that the present members of the Commission in this country are Dr. Hartert and Dr. Jordan of Tring Museum, Dr. W. E. Hoyle of the Welsh National Museum, and myself at the Natural History Museum; also that the Commission is seeking to fill one of its vacancies with an Australasian representative.

F. A. BATHER.

The Formation of Coloured Bows and Glories.

WHEN favourably situated, a person may see rings of coloured light round the shadow of his own head, as cast upon a neighbouring fog-bank or cloud. These coloured rings or glories, as they are called, have been explained by previous writers as merely coronas due to particles near the surface of the cloud scattering light reflected from deeper portions of the cloud; in other words, the effect is regarded as of the same nature as the ordinary corona but due to secondary scattering. That this explanation cannot be accepted as correct is definitely shown by experimental observations made with artificial clouds.

The experimental arrangement is the same as that used by Mecke (*Ann. der Phys.*, vol. 61), and if the eye of the observer be placed on the same side of the cloud chamber as the source, so as to look down very nearly along the path of the beam passing through it, a succession of colours is seen along its track through the cloud. These colours also change as the angle of observation is changed; and the smaller the particle the greater is the angle from which they can be seen. The complete system of rings is obtained on illuminating the cloud with a beam of sunlight, and may be viewed in a perpendicular direction with the aid of a plane sheet of glass held at 45° in front of the cloud chamber, so that the observer's head does not screen the cloud chamber from the illuminating pencil. The observations prove that the phenomenon under discussion is shown by every position of the cloud, and therefore really arises from *primary* scattering by the droplets of water.

That the glories or brocken-bows arise in a way which is quite different from that of the ordinary transmission coronas is proved by the fact that the sequence of colours in the brocken-bows and in the transmission coronas due to cloud particles of the same size are far from being identical. The normal corona, due to larger drops, shows a central white field with a brownish-red edge, which is surrounded by the familiar coloured rings, but in the brocken-bows the arrangement is different and varies somewhat with the size of the drop. It is sometimes found that just round the central spot (which is the image of the source of light reflected from the first surface of the observing flask) there is a distinct minimum of intensity exhibiting colour; then the intensity increases, the colour being greenish-white bordered by a brownish-red edge, and then follows the usual succession of coloured rings as in the coronas. It is sometimes found that round the central spot there is a clear maximum, and then a belt of minimum intensity, and then again a maximum; in other words, there is an oscillatory distribution of intensity; in the central field of the brocken-bow only red and green rings or belts are present in different intensities, whitish-yellow colour being totally absent, while in the corresponding coronal rings the central field is yellowish-white or nearly without colour.

In order to understand how the glories are formed, we have to consider the light which travels back towards the source from the droplets. This arises in two ways: (*a*) by reflection from the front surface of the droplets; (*b*) by two refractions and one internal reflection. When a plane wave falls on the spherical particles and is reflected back at its external surface, the reflected wave front is strongly divergent, and, as a result, it merely adds a little to the general illumination of the field and does not give rise to any notable diffraction effect. But the wave front (*b*) formed by internal reflection is not so divergent as in (*a*), and is limited by a cusped edge, at which it is doubled back. When the droplet is small the path differences between back and front of the wave near the cusped edge are very small. Hence we may, without appreciable error, consider the wave front to be a simple spherical cap of appropriate radius. As a sufficient approximation, we may assume the centre of this spherical cap to be the image of a point placed on the axis at an infinite distance, produced by two refractions and one reflection. We have to find in directions making a small angle with the axis back towards the direction of the primary source the aggregate effect of this wave cap. The problem now is the same as the diffraction produced by a small circular opening in the screen on which light is propagated in spherical waves from a point source. We take as the axis of symmetry the line drawn from the source to the centre of the opening, and it is required to find the intensity of illumination at *any point* of a plane screen parallel to the plane of the opening and at a distance from the later. The detailed mathematical treatment of this problem is given in Gray and Mathews's "Treatise on Bessel Functions and their Applications to Physics," chapter xiv., and the result is applied in this case for the measurements of the positions of the maximum and minimum in the glory-rings. Considering the experimental difficulties and assumption in the theory, the results agree fairly well with the observations.

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December 13.

The Definition of Limiting Equality.

IN teaching the calculus to students of applied mathematics and physics I have found that the definitions of *limiting value* and of *limiting equality* given in practically all our text-books are unsatisfactory, and in my opinion inadequate. According to these books the test of limiting equality of two magnitudes is that their difference shall become less than any assignable *quantity*, however small. But this condition is satisfied by any two quantities whatever if they vanish simultaneously, and it affords no justification for the use of statements such as $dy = f'(x)dx$; on the other hand, if the quantities remain finite in the limit the test appears scarcely to be necessary or useful in teaching elementary classes.

I consider that the proper test of limiting equality is that the difference between two quantities should become (numerically) less than any assignable *fraction of one of the quantities*, however small, in other words that $x - a < ae$ where e is any *fraction of unity*, however small (instead of $x - a < e$ where e is any *quantity*, however small), *the present definition being assumed to hold good even if the two quantities vanish or become infinite at the limit.*

If this condition be accepted as the definition of limiting equality, the same condition will hold good for any multiples or submultiples, however large or small, of quantities which tend to limiting equality, and also to sums of such quantities; thus if $x_1 - a_1 < a_1 e$, $x_2 - a_2 < a_2 e$, etc., then $\Sigma x - \Sigma a < e \Sigma a$ under all conditions. Such statements as $dy = f'(x)dx$ are to be interpreted as statements of limiting equality according to this definition, and we arrive at a definition of an integral as the limit of a sum of products, which is applicable not only to integrals of functions of a single variable, but also to integrals taken over areas, volumes, and indeed any of the *concrete magnitudes* which commonly occur in problems on mechanics and physics. Roughly speaking, this definition may be worded somewhat as follows:

Let x be any magnitude which can be divided into elements Δx, however small, y a measure associated with it such that if y_1 and y_2 are the greatest and least values of y associated with any element Δx, y_1 and y_2 tend to limiting equality when the magnitude Δx diminishes indefinitely. Then, since $(y_2 \Delta x - y_1 \Delta x)/y_1 \Delta x = (y_2 - y_1)/y_1$, the products $y_2 \Delta x$ and $y_1 \Delta x$ also tend to limiting equality, and by the theorem for the limit of a sum, the sums of the products $y_2 \Delta x$ and $y_1 \Delta x$ taken over all the elements also tend to limiting equality and their common limit is defined as the integral $\int y dx$. Any single product can be legitimately designated by ydx in any equation, provided that this equation is interpreted as a statement of limiting equality in accordance with the above definition. A subsequent proof is required to cover cases of discontinuity such as occur, *e.g.* when finding the volume integral of a function which changes by a finite amount in crossing a surface.

In defining a differential coefficient and proving the formula for the differentiation of a product, I follow Fricke's method to a great extent. Fricke, however, defines $f'(x)$ by putting $x_1 \to x$ in $\{f(x_1) - f(x)\} \div (x_1 - x)$, but I consider it preferable to consider the more general fraction $\{f(x_2) - f(x_1)\} \div (x_2 - x_1)$. If this fraction tends to a unique limit when x_1 and x_2 approach a common limit x by any process whatever, this limit is defined as the differential coefficient of $f(x)$. This condition covers the cases where either x_1 or x_2 is first put equal to x and the other variable becomes equal to x subsequently.

G. H. BRYAN.

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Museums.

THE article in NATURE of December 9 on "A Suggested Royal Commission on Museums" leads me to offer a few comments, based on recent experiences. It is trite to say that all museums are understaffed, but it may be worth while to point out some of the consequences of this condition. Being a student of wild bees (Apoidea), I have long been interested in the available collections of these insects. In 1920–21, I made a catalogue of all the species of bees in the British Museum, and also listed those at Oxford and Cambridge. Returning to America I catalogued the bees in the U.S. National Museum and the American Museum of Natural History. One of my principal objects was to bring about exchanges between these institutions, so I noted in most cases the size of the series. The authorities everywhere were extremely cordial to the exchange idea, and it was evident that if each museum would distribute its duplicates, which were often actually in the way, all would be greatly enriched, to the advantage of students on both sides of the Atlantic. Up to the present, it has been impossible to carry out the proposed plans, because the curators have been fully occupied in other ways. The prospects will necessarily remain unfavourable, so long as each man has many more duties than he can attend to. The staffs should be increased, and should include at least two types of men—those who are principally concerned with research and those who are primarily curators. The latter type, with a passion for collecting and arrangement, is not to be found everywhere, and is not produced by the universities. It involves, however, a high grade of ability, and should be zealously sought by heads of museums.

In their zeal for economy, many will object to increasing museum staffs. They ought to consider the matter as they would a factory or other commercial plant. A great deal of capital, material and otherwise, has been put into our museums. With a moderate increase of funds they can be made to function far more efficiently and develop more rapidly. The public policy has too generally been like that of a man who had built a house, and decided that he could not afford a roof. In some cases sheer poverty may afford an excuse, but even the United States, with all its wealth, treats its National Museum in the most niggardly manner. The truth is, that in a democracy the public will is the driving force, and an ignorant public has no will. It is the duty of scientific men to carry on a campaign of publicity, which need not involve anything detrimental to their self-respect.

One reform which I should much like to see at the British Museum (Natural History) is the establishment of a room of British entomology, with a special curator who made it his business to know the species of the country. As things are at present, the average collector is interested primarily in British species, but on going down to the Insect Room he has to appeal for help to a world-specialist in some group, who is perhaps monographing a particular family of beetles. Any one with a conscience hates to take much of the time of such a man for his relatively insignificant matters, and the specialist himself probably does not know the British Staphylinidæ or weevils. By assembling the British series in one room, in charge of a special man, or preferably two or three, the work of the amateur would be greatly facilitated, and young naturalists would not be blighted in the bud by a sense of the trifling character of their pursuits. This is not a criticism of the existing curators, whose courtesy and good nature under stress have often caused me to marvel.

Just to show the spirit of the place, I will relate a couple of amusing instances, which I myself witnessed. A man came to the department of insects with an account of a proposed patent for catching fleas by entangling their feet in the supposed perforations in diatoms. The nature of the markings on the siliceous framework of diatoms, and their relative size to the feet of a flea, were explained in all gravity and kindness, and presumably the new flea-powder never appeared on the market! Another day, a man came to the department of geology with a clay model of an ox or some such animal, and I shall never forget the courteous way in which an eminent palæontologist assured him that the specimen should really go to the Museum at Bloomsbury, since a fossil would show only the bones, and not solidified flesh. The public certainly gets all it pays for, and more; but it could be much better served if it would pay enough to bring out the latent possibilities of the museum, which are doubtless greater than any of us can yet clearly imagine. T. D. A. COCKERELL.

University of Colorado.

Spiranthes Autumnalis.

IN the summer holiday of 1921, Mr. Mayland and I were astonished to find in the woods round Carrbridge, Inverness-shire, very sporadically but at two stations about a mile apart, specimens of the small orchid, *Spiranthes autumnalis*. We took some, and for two or three days their characteristic scent and spiral spikes interested our table in the hotel. I regret now that we did not preserve specimens: but I am pretty sure we were not mistaking the identity of the plant, as it was repeatedly the subject of remark, and I have known it since I was a boy.

I mention this non-recorded record because Sir Herbert Maxwell, who in September 1920 wrote to NATURE (vol. 106, p. 79), telling of a similar experience on Lower Spey-side; but in a later letter (vol. 106 p. 409), he expressed some uncertainty as to the identity of his plant as apart from *Goodyera repens*. Now when so acute an observer as Sir Herbert has arrived independently at the same conclusion as we did, I think the probability is strong that both diagnoses were correct, and that, though the specimens were not preserved as evidence, *S. autumnalis* has been found in an unexpected, non-calciferous locality.

Mr. Mayland tells me he sought it again in the following summer without result. F. O. BOWER.

The University, Glasgow, January 17.

The Scattering of X-Rays in Liquids.

IN various notes published last year I dealt with the scattering of light in transparent media, and showed that its study initiated by the late Lord Rayleigh in his theory of the colour of the sky has other fascinating applications in the explanation of the colour of the sea and other transparent waters, and of the colour of ice on glaciers. The thermodynamic theory of "fluctuations" developed by Smoluchowski and Einstein formed the starting-point in the discussions, but I was careful to emphasise the important complications arising from the anisotrophy of the molecules in fluid media and showed how the necessary corrections in Einstein's theory may be made. A considerable measure of success was attained in attempting to correlate the behaviour of substances in the liquid and gaseous states in this respect, and in predicting the effects due to alterations of temperature and pressure. The study of the changes in the intensity and states of polarisation of the scattered light in passing from the liquid to the solid crystalline state and their explanation forms another important line of inquiry in which some progress has also been made.

The purpose of the present note is to point out the relation between the optical effects referred to above and the very interesting recent work of Keesom and Smedt, who have obtained Laue photographs of various liquids traversed by a *homogeneous* pencil of X-rays (Proc. Roy. Soc. Amsterdam, 1922, page 119), and the similar work by Hewlett (*Physical Review*, December 1922, page 702), who used the ionisation method. Keesom and Smedt found that many of the liquids studied gave a well-marked diffraction ring at a considerable angle with the direct pencil. With liquid oxygen and argon, the first ring was formed at an angle of 27°. A weak second ring was also observed at 46° with oxygen, and at 49° with argon. With water, on the other hand, the second ring was very broad and diffuse and practically abutted on the first.

Keesom and Smedt have attempted to explain their results by various special assumptions regarding the relative positions of the neighbouring molecules, while Hewlett suggests that liquids possess something of a crystal structure. To the present writer it appears that the experimental results may be explained without any such special assumptions. As in the optical case, the liquid molecules may be regarded as the diffracting centres which are arbitrarily orientated and distributed uniformly in space subject only to such variations as give rise to density fluctuations in accordance with the Einstein-Smoluchowski formula,

$$\overline{(\Delta\rho)^2} = \frac{RT\beta}{V} \cdot \rho_0^2$$

where ρ_0 is the mean density $\overline{(\Delta\rho)^2}$ the mean square of its fluctuations, R the gas constant, T the absolute temperature, β the compressibility of the liquid, and V the elementary volume under consideration. When traversed by a homogeneous pencil of X-rays the wave length of which is smaller than the average molecular distance, such a structure must give rise to diffraction rings which are more or less well defined according as the fluctuations of density are small or large. If in the expression for the density fluctuation, we take V to be a small cube with a molecule at each of its corners, the average fluctuation in its size and the resulting weakening of the diffraction pattern can be calculated somewhat on the same lines as in Debye's theory of thermal effect in X-ray reflection by crystals. In Keesom and Smedt's experiments, the low temperature in the case of liquid oxygen and argon, and the consequently diminished fluctuations of density must have helped in improving the definition of the diffraction ring of the second order. C. V. RAMAN.

"Artificial" Vertical Beam.

THE vertical beam through a low sun is generally referred to the reflection of sunlight from the basal surfaces of thin plates of ice which are falling through the atmosphere with their crystal axes vertical and horizontal. It has been the writer's good fortune to examine such reflections from individual "plates" that were slowly falling within a metre or so of the observer. Most of the plates were asymmetric portions of flat crystal growths, and they spun rapidly as they fell, with a motion resembling that of a falling maple-key. In this case, the vertical beam was observed to spread out slightly as it receded from the sun, and the angle subtended by the edges of the beam was obviously the complement of the vertical angle of the "cone" swept out by the rapidly rotating, but slowly falling flake.

An interesting "artificial" example of (probably) this phenomenon, was noted by many observers at the burning of two buildings at the Sydenham Military Hospital at Kingston, Ontario, on the night of January 3, 1923. The structures burned fiercely in the brisk north-east wind and lit up the snow-covered country for miles around. The unusual brightness may be judged from the credible report that people more than a mile from the fire easily read newsprint by its light. A very light snow-fall was barely noticeable from time to time during the evening. Out of the glow of the fire-lit smoke clouds there appeared to rise a vertical parallel beam of light, that with varying distinctness was visible for the three or four hours during which the fire raged. It was visible from points near the fire—a few hundred yards—but was more striking from points a quarter to a half a mile away, from which the flames themselves could not be seen. It seemed to vary with some atmospheric condition (more or fewer snow crystals in the air ?) as it might be dim when the diffuse reflection of fire-light from the low-lying clouds would be brightest, and might be sharp and bright during a lull in the flames. It was, however, often most striking when the conflagration was at its height.

It was not due to shadow of the still-standing walls —the light coming from the burning interior—for it was first noticed when the roof had just caught fire and most of the light came from the burning shingles —a case where no wall shadow was possible. Further, the beam was sensibly parallel-sided. A wall-shadow would have given a broadly diverging beam. The explanation offered is that of reflection from falling flat snow crystals, which, of course, were not over the burning building but were distributed in the atmosphere between the observer and the source of light.

The official record at the Queen's University station of the Canadian Meteorological Service, taken just before the fire broke out and less than a mile from Sydenham Hospital, gave "Temperature 12° Fht., Wind N.E. 20 miles per hour, Light Snow." In fact, the snow-fall was so light that the record of precipitation over the twelve hours, including the time of the observations on the beam, was only 0·03 inch.

WILL C. BAKER.

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January 8.

Unusual Crystals.

THE following may be of interest to readers of NATURE:

I have a bottle of pure phenol which has not been opened for a dozen years. During this period I have been interested to watch the growth of crystals from the sides of the empty portion of the bottle by sublimation. These crystals are cylinders or prisms many of them between two and three centimetres in length and as many millimetres in diameter. The ends are not pointed but neatly trimmed off by an oblique plane.

On closer examination these crystals prove to be thin walled tubes. The stalk attached to the bottle is solid for a few millimetres. Then a fine capillary appears, spreading out conically until the wall is about a half millimetre thick and then continuing as a uniform tube. The explanation is of course that within the tube the air is just saturated with phenol vapour while outside it is slightly supersaturated.

I do not remember meeting any published description of such crystals. G. H. MARTYN.

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Hampstead Garden Suburb, N.W.11.

January 19.

Science and Armaments.

WHAT Dr. Martin regrets, in his letter to NATURE of January 20, p. 82, is to me a consolation—to know that scientific men in our universities are still working for the safety of the realm, for across the Channel there are fierce black clouds and ominous rumblings of strife that seem almost beyond control.

Dr. Martin says: "So may the temple of science be kept free from echoes of human quarrels," and instances the sojourn of Davy and Faraday in Paris. Is the example fortunate? Davy was irresistibly attracted to Paris by reports of a detonator of fearful violence that had already deprived Dulong—its discoverer—of an eye and a finger. He spent much of his time there investigating another discovery of a manufacturer of salpetre, a substance not unknown to Ministers of Munitions.

It was this very journey that occasioned the human quarrel that we seek to forget when contemplating the lives of these two great priests of the temple of science. JAMES WEIR FRENCH.

Anniesland, Glasgow, January 22.

The Opacity of an Ionised Gas.

IN a paper read before a joint meeting of the American Physical Society and the American Astronomical Society, in December, I pointed out that theoretically the absorption of radiation by free electrons should render an ionised gas highly opaque. The organised vibrational energy, due to the radiation, of the free electrons is transformed by collisions into disorganised thermal energy of translation. A tentative application of the methods of the well-known free electron theory of the optical properties of metals to conditions in an ionised gas gives the following equation for the volume opacity coefficient K. The quantity K is such that in distance z centimetres through the gas the intensity of the direct beam is reduced to e^{-Kz} of its initial value.

$$K=(6\cdot 7\times 10^{26})\frac{\lambda^2 A^2 ip^2}{T^{\frac{?}{}}(1+i)^2}.$$

Here λ is the wave-length of the radiation in centimetres; i is the ratio of the number of free electrons to the number of atoms and ions; p is the gas pressure in atmospheres, including the partial pressure $ip/(1+i)$ of the free electrons; T is the absolute temperature, Centigrade; and A is the radius in centimetres of an atom or ion (assumed equal in size—a very rough approximation). This type of opacity increases as the square of the gas pressure, while the opacity due to general scattering increases only as the first power of the pressure. Even at fairly low pressures, however, the effect of absorption predominates in an ionised gas.

The above equation follows from the following assumed equation of motion of a free electron in an ionised gas through which radiation is passing:

$$m\frac{du}{dt}+2rmu=eX,$$

where m is the mass, and e the charge of an electron, and u is its component velocity in the direction of the electric vector X of the radiation. The term $2rmu$ represents a pseudo-frictional resistance due to collisions between electrons and atoms or ions; r is the number of such collisions per second per electron. The usual assumption is made that the velocity of an electron after colliding with an atom is independent of its velocity before collision; and collisions between electrons are neglected. (When the scattering of radiation by free electrons is dealt with a term involving $-d^2u/dt^2$ is added to the left-hand member of the equation.) The average rate at which energy is absorbed from the radiation by each electron is the average value of $\int eXudt$; and, remembering that the intensity I of the radiation is $cX_0^2/8\pi$, where X_0 is the amplitude of X, K is easily found. The number of collisions per second per electron is taken as $\pi NA^2\sqrt{3RT/m}$, where N is the number of atoms and ions per unit volume, and R is the gas constant per molecule. This relation assumes equipartition of energy between free electrons and the other molecules in the gas.

The well-known experimental work of Dr. Anderson at Mt. Wilson has shown that the opacity of the vapour of an exploded iron wire under certain conditions is such that light is cut off in a distance not greater than a few centimetres. Application of the above equation for K indicates that the absorption of radiant energy by the free electrons in the doubly ionised iron vapour produces an opacity of this order of magnitude. Thus, estimating T as 20,000 degrees absolute, i as 2, A as 5×10^{-8} cm. (doubtful), and $p/(1+i)$, the partial pressure of the iron ions, as 20 atmospheres (doubtful), K comes out as 1·7 for $\lambda = 6 \times 10^{-5}$ cm. The electrical conductivity of the vapour theoretically is 1/1500th that of metallic copper.

Application of the equation for K to conditions in the outer regions of the sun, employing Saha's theory to calculate the ionisation as a function of the unknown gas pressure, makes it seem probable that at a depth in the sun where the pressure is as great as 0·01 atmosphere the ionised gas is sufficiently opaque to cut off radiation from farther down. This is, then, indicated as the approximate pressure in the solar photosphere; and pressures in the solar atmosphere are much lower. Thus the sharpness of the Fraunhofer lines may be explained. I hope soon to publish these results in detail. The astrophysical importance of the matter is obvious.

Naturally it will require a great deal of study to develop more than a rough theory of the opacity of an ionised gas. Radiation is selectively scattered by bound electrons; it is non-selectively scattered by free electrons; and it is absorbed by free electrons. The part played by bound electrons in absorbing radiation (that is, in transforming it to heat) seems at present far from understood. Prof. Eddington's recent discussion (*Observatory*, December 1922) of the absorption of radiation by quanta in the deep interior of stars perhaps opens a new line of attack on the general problem.

JOHN Q. STEWART.
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January 8.

The High Temperature of the Upper Atmosphere as an Explanation of Zones of Audibility.

THE work of Lindemann and Dobson on the theory of meteors,[1] with the remarkable conclusion that the temperature of the atmosphere at heights such as 80 kilometres is about the same as that near the earth's surface, will be far-reaching in its influence. May I be allowed to point out that one of the phenomena for which an explanation will probably be provided is the occurrence of zones of audibility and zones of silence, surrounding the scenes of great explosions.

If, as Lindemann and Dobson find, temperature increases rather rapidly at about 60 kilometres, then sound waves penetrating that region will be refracted back to earth, the comparatively rapid curvature of the sound rays making the phenomenon almost equivalent to reflection as is the case with the light rays which occasion mirage.

If we assume a sharp transition of temperature from 220° A. to 280° A. we find a refractive index for sound rays passing from the lower level to the upper of $\sqrt{280/220}$ or 1·13. Total reflection takes place with an angle of incidence 62°, and if the reflection is at 60 kilometres the minimum radius for the outer zone of audibility is $2 \times 60 \times \tan 62°$ or 155 kilometres.

This rough estimate is of the right order of magnitude, as may be seen by comparison with the most recent example, the Oldbroek Explosion of October 28, 1922, for which the corresponding limit is stated to have been "about 180 or 200 km." (NATURE, January 6, p. 33).

There should be no great difficulty in adapting the theories worked out by von dem Borne and de Quervain to the new hypothesis. The drift of meteor trails shows that there is considerable horizontal motion of the atmosphere at such heights as 60 kilometres, and this motion will have to be taken into account. It is not unlikely that monsoonal changes in the upper winds produce the seasonal variation in the direction of audibility which was so noticeable during the war. The number of known observations of meteor trails is too small (*cf. Meteorological Magazine*, vol. 56, p. 292, 1921) to throw any light on this question.

Further progress in our knowledge of the temperature of the outer atmosphere and of its motion would be made if Prof. Goddard could send up his rockets. The times of passage of the sound waves from the bursting rockets would give immediate information as to the temperature of the air. Perhaps it would be more practicable to use a "Big Bertha" to send up a bursting shell. Mr. Denning could say, no doubt, whether there are any instances in which the disruption of a meteor has been heard and the time interval between sight and sound has been recorded.

With regard to the theory suggested by Lindemann and Dobson in explanation of the high temperature of the outer atmosphere, it should be pointed out that the atmosphere is only exposed to solar radiation during the day-time. It would seem that the equation by which the authors determine the steady temperature should be modified considerably. Annual variation in the temperature of these outer layers of the atmosphere is to be anticipated; it is not unlikely that examination of the statistics regarding meteors will reveal it. According to the theory meteors should reach much lower levels in winter than in summer.

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[1] A Theory of Meteors, and the Density and Temperature of the Outer Atmosphere to which it leads. F. A. Lindemann and G. M. B. Dobson (Royal Society Proceedings, vol. 102, 1922, p. 411).

Fixation of Nitrogen by Plants.

IN NATURE of January 20, p. 95, reference is made to an announcement in *Science* by Lipman and Taylor that they have proved conclusively the fixation of atmospheric nitrogen by the wheat plant. Should the detailed evidence, when available, show that their claim is well founded, it should not be forgotten that similar results on other plants were obtained in this country some little time ago by the late Prof. Benjamin Moore and his co-workers. In two communications to the Royal Society (Proc. Roy. Soc., B, vols. 91 and 92, 1920), he argues strongly in favour of such fixation, supporting his views by convincing experimental proof on both fresh-water and marine algæ. The work was incorporated in his book "Biochemistry" (1921), and in the Hugo Müller memorial lecture delivered before the Chemical Society in June of that year—one of his last public utterances—he reiterates in the strongest language his belief, founded upon no inconsiderable amount of experimental work, "that both the lower and higher plants do build up nitrites and nitrates and form organic nitrogenous compounds from the free nitrogen of the atmosphere."

I may say that in their article in *Science* Messrs. Lipman and Taylor give references to Moore's work as to that of other previous observers.

EDWARD WHITLEY.
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January 24.

Insulin, Diabetes, and Rewards for Discoveries.

By Sir W. M. BAYLISS, F.R.S.

A NUMBER of problems, some of great scientific interest, others of practical importance in various ways, have been brought to notice by the somewhat sensational statements in the daily press relating to the Canadian treatment of diabetes by a preparation extracted from the pancreas and known as "insulin" (see NATURE, November 25, p. 713; December 9, p. 774). In order to understand the state of affairs, it is necessary to review briefly our present knowledge of the physiological processes concerned with the utilisation of carbohydrate food. This will also serve to direct attention to gaps which need filling up, and the opportunities afforded by a trustworthy preparation of the hormone of the pancreatic "islets." If such a preparation shows itself to be of value in the treatment of diabetes in man, it is clear that difficulties of several kinds arise in the ensuring of an adequate commercial supply of an active product. We shall see further that the question of due rewards for discoveries which involve the cure of disease arises in the present case in an acute form.

If we look at tables drawn up to indicate a reasonable proportion between the constituents of a normal diet, we notice how large a part of the total energy required is supplied by carbohydrate. In that of the Royal Society Food Committee, for example, more than 65 per cent. is from this source. The justification is given by the fact that evidence of various kinds shows that the material from which muscle directly derives the energy for its activity in normal conditions is glucose. This is burned up with consumption of oxygen, while the products finally leave the body as carbon dioxide and water. Since measurements of the "Respiratory Quotient" in muscular work form a part of the evidence and are of importance in judging the properties of insulin, a word may be useful here as to the meaning of this number. If glucose is burned in the ordinary way in air, and the amount of oxygen consumed and of carbon dioxide and water produced is determined, the volume of carbon dioxide is found to be equal to that of the oxygen used. This is of course due to the fact that carbohydrate contains sufficient oxygen in its molecule to oxidise the hydrogen. Fat or protein, on the other hand, requires more oxygen, to burn part of the hydrogen as well as the carbon. The respiratory quotient expresses the ratio of the volume of the carbon dioxide produced to that of the oxygen consumed, so that if carbohydrate alone is burned, the value is unity, and it decreases in proportion to the amount of the fat or protein burned. If it rises, due attention being paid to absence of retention of carbon dioxide, we are justified in concluding that more carbohydrate is being oxidised.

Glucose is also known to be consumed in other organs—the secreting glands, for example—and probably in the tissues generally. It is supplied by the blood, although only present therein in very low concentration, about 0·1 to 0·15 per cent. Being a crystalloid and filtering through the glomeruli of the kidney, a large quantity would be lost were it not that as this filtrate flows along the renal tubules, the glucose is almost entirely reabsorbed, along with other constituents of value. If, however, the concentration of sugar in the blood rises above the normal value (hyperglycæmia), owing to a large amount of carbohydrate in the food, or an incapacity on the part of the tissues to consume it to the proper degree, then the absorptive power of the kidney is insufficient, and sugar appears in the urine (glycosuria). The glycosuria resulting from excess of blood-sugar owing to diet is in itself harmless; glucose is often added to gum-saline for intravenous injection in cases of traumatic shock. When glycosuria, on the other hand, is due to failure to consume glucose, we have the morbid state known as diabetes mellitus, in which there are involved other consequences of this defect, themselves giving rise to serious symptoms.

Since the supply of sugar from the digestive canal is intermittent and in excess of the immediate demand, while this demand is constant, it is clear that some means of storage is needed. This is provided by the liver, which deposits glucose in its cells in the form of the insoluble glycogen. From this store it is released as required. The muscular tissues, especially that of the heart, are also able to store glycogen to some extent. Now in diabetes it is found that the liver has lost this power, although the muscles retain it. It is not obvious why this loss of storage power in the liver should be connected with failure of the tissues generally to consume glucose, but so it is; and there is another rather remarkable fact. If the food given to a diabetic animal is devoid of carbohydrate, glucose is produced from certain amino-acid components of proteins, although it is not utilised, and escapes in the urine. It may be that the consumption of glucose is never completely absent in diabetes, but is dependent on a high concentration in the blood. This minimal consumption being absolutely essential to life, it is provided from protein, if no other supply is available. Hence the great wasting of body substance present in diabetes.

In the year 1889, a paper by Von Mering and Minkovski was published, in which it was shown that if the pancreas was removed from dogs, a condition like that of diabetes was produced. They found further that if a small piece of the pancreas had previously been grafted under the skin, removal of the rest of the pancreas was ineffective until this graft was also removed. It was also found that ligature of the ducts of the pancreas did not produce diabetes. These results pointed clearly to an internal secretion from the pancreas as being necessary for the utilisation of sugar. It was found that the residue of pancreatic tissue left in both the cases referred to consisted of the structures known as "Islets of Langerhans," and it was advocated by Sharpey Schafer that these organs are responsible for the internal secretion. Further evidence confirmed this view, although there are still some differences of opinion as to the independence of the islet tissue and the ordinary secreting tissues. The discovery of Diamare that in many teleostean fishes the islet tissue exists in organs separate from the pancreas is important evidence that this tissue is not in the adult formed from the pancreatic cells. In Lophius, according to Diamare, these masses of islet tissue may be as large as peas. But, for some reason or other, extracts of the pancreas have only occasionally been found to have any influence when given to diabetic animals. The active constituent is destroyed by some other substance, possibly trypsin, contained in such extracts.

Since the cells which produce trypsin degenerate after tying the ducts, it occurred to Dr. Banting, rather more than a year ago, that extracts of such organs might contain the active principle sought for, free from destruction. Dr. Banting was then in medical practice at London, Ontario, but gave up his practice and went to Prof. Macleod's laboratory at Toronto to make the necessary experiments on animals. Here he was joined by Mr. Best, an assistant in the laboratory, by Prof. Macleod himself, and at a later date by Dr. Collip and others. The experiments were successful. In another way it was found possible to prepare active extracts. It had been noticed that the presence of a fœtus protects the mother. The islet tissue, as it appears, begins to be functional at an earlier date than the secreting cells, so that by taking the pancreas of a fœtal calf at the appropriate age, the destructive agent was absent. But it was clear that these methods could only afford a small supply. Hence attempts were made to discover a means of preparation from the ordinary ox pancreas. Dr. Collip was finally successfully by making use of alcohol. The active principle, which it is proposed to call "insulin," is soluble in alcohol of a strength such as to precipitate enzymes, proteins, and probably other substances, although, like secretin, it is insoluble in absolute alcohol. This latter fact gives opportunity for further purification from lipoid. It is finally obtained in solution in physiological saline, suitable for subcutaneous injection. The absence of protein is necessary for clinical use, because of the possibility of anaphylactic shock, if the injections were omitted for a time and then resumed.

Passing next to the properties of insulin, it was found that if injected subcutaneously into animals made diabetic by removal of the pancreas, or indeed hyperglycæmic in any way, the sugar content of the blood was reduced and the glycosuria abolished. Moreover, a very interesting fact was discovered. The blood sugar can be reduced in normal animals by insulin, but if it falls below a certain level (about 0·045 per cent. in rabbits), nervous symptoms come on, and the animal may die in convulsions. These symptoms are at once removed by injection of glucose. Thus the normal activity of the central nervous system depends on the presence of a sufficient concentration of sugar in the blood. It is probable, therefore, that sugar is burned in the brain, and possibilities of investigating the energy value of the cerebral processes associated with mental activity open before us. The fact, however, causes a difficulty in the clinical use of insulin. If too large a dose be given, or it be absorbed too rapidly, nervous symptoms make their appearance. Fortunately, they are unmistakable by the patient, who can at once have recourse to the sugar basin.

Another important action of insulin is to reduce or abolish the presence of acetone and its derivatives in the blood and urine—a characteristic sign of the diabetic state. These compounds have a toxic action on the nervous system, finally leading to coma and death. They are the result of incomplete combustion of fat, and are present whenever insufficient sugar is being oxidised—in carbohydrate starvation as well as in diabetes. It is an interesting fact that neither fat nor protein can be properly utilised without carbohydrate. The oxidation of the former appears to be a kind of "coupled reaction" with that of sugar, and we therefore ask what is the common component? Pyruvic acid or aldehyde, as a stage in the oxidation of both, has been suggested. Vahlen put forward the view some years ago that the function of the pancreatic hormone was to convert glucose into a simpler compound more easily oxidised. These possibilities may be accessible to experiment *in vitro* by the use of concentrated solutions of insulin. According to some recent work by Winter and Smith in the Biochemical Laboratory at Cambridge, it seems that γ-glucose, the reactive ethylene-oxide form of glucose, is the first stage, insulin acting as the activator of some enzyme in the tissues. In the normal state, the blood sugar is in the γ-form, presumably not in diabetes.

The failure to make use of protein in the absence of concurrent oxidation of glucose may have some bearing on another characteristic of the diabetic state—the imperfect healing of wounds. It is pointed out by Dr. Formiguera in the *British Medical Journal* of December 9 last that insulin will be of much value in making possible the performance of necessary operations in the diabetic—a matter otherwise not to be done. Prof. Starling has suggested that its use may also make it feasible to transplant grafts of fœtal pancreas into such cases. Although the work of Leo Loeb has made it clear that tissues from another individual, unless a very closely related one, degenerate sooner or later when transplanted, embryonic tissues are not so extremely individualised, and the experiment is worth trial.

Insulin confers on the diabetic liver the power of storing glycogen.

Since the capacity of oxidising glucose is deficient in the diabetic animal, an injection of glucose does not raise the respiratory quotient; whereas if insulin be given at the same time this happens. Thus we have the proof that glucose is actually burned and not caused to disappear in some other way. It is further shown by Hepburn and Latchford that the excised heart of the rabbit consumes more glucose if insulin be added to the perfusing solution. Unfortunately, it was not shown that the respiratory quotient was raised, and the authors have overlooked the fact that Starling and Evans in 1914 found in some cases that the respiratory quotient of the diabetic heart was raised by the addition to the blood of an acid extract of the pancreas. It may be remarked that trypsin being inactive in acid solution, it was thought to avoid destruction of the hormone in this way. Indeed, although it is actually destroyed in an alkaline solution of trypsin, it is not certain whether it may not be oxidised, or destroyed by some agent other than trypsin itself.

Insulin, given to diabetic patients by subcutaneous injection, is found to have the same effects as in animals, together with an unmistakable improvement in condition. Apart from its relieving the serious symptoms actually present, it is greatly welcomed in place of the " starvation " treatment of Allen, the only other treatment of value. But it is evident from what has been said above that there is much to be found out in respect to its practical use. Since only a small dose can be given at one time, because of the nervous effects of too great a reduction of the blood sugar, and since the effect only lasts about twelve hours, it is clear that two subcutaneous injections per day are necessary. Although it may be said that people addicted to morphine or cocaine use the process as often as this, the difficulty is not to be overlooked. If the morbid condition of the pancreas has not advanced too far, it may turn out that insulin " relieves strain," as it were, so that the normal state may ultimately be restored. But this has not yet been ascertained. Destruction by the pancreatic juice makes insulin ineffective if taken by the mouth. Perhaps some method may be found by which it may be caused to be absorbed by the stomach before being destroyed. The supply on a large scale involves problems, moreover, which do not arise in the small scale operations of the laboratory.

Here we meet with the knotty question brought into prominence by the action of the University of Toronto in taking out a patent and offering the rights in this country to the Medical Research Council. According to the statement published by this body in the *Times* of November 17 last, the gift has been accepted, and application for a patent in this country has been made by the University of Toronto. It may well be that this University does not altogether realise the fact that there is a strong feeling here against patenting products of value in the cure of the disease, so that the action of the Medical Research Council is viewed with some degree of misgiving. It is plain that the more work there is done both on the properties and on the modes of preparation of pancreatic extracts the better. While it would be absurd to suggest that the Medical Research Council has any desire whatever to obstruct such research, the necessity for any laboratory being unable to do this except by arrangement with the patentees does not seem desirable. The best modes of large scale preparation would surely be discovered in the shortest time by ensuring that any firms having the necessary plant may be free to make any experiments that may seem promising. Every credit must be given to the Medical Research Council in its desire to protect the public from the results of putting on the open market preparations of unknown potency, some inactive, others too powerful. The words used by the Council may be quoted: " The intention of the Council is to promote, in the light of recent experience in Canada, and of such new knowledge as research will gain, whatever enterprise or organisation is best fitted for securing the earliest production of the Insulin extract under proper conditions of safety and control, and so to facilitate, with the least possible delay, a thorough and scientific trial of the new treatment in this country."

We may ask, would not the best way to effect these objects be to announce that the Medical Research Council were prepared to test and certify preparations sent to them? It may be objected that a large amount of work would be involved in the testing of numerous small batches, since the only method known as yet requires the use of rabbits. Here is room for investigation, but in the meantime the difficulty might be avoided by refusing to certify any but large batches. If the Medical Research Council were satisfied that a particular firm had the facilities for making such tests themselves, they might agree to accept this firm's own tests, it being always understood that any preparation was liable to control, and a failure to confirm the makers' statement would be ruinous to their reputation.

But there is a further reason that seems to the writer to make such a course the wiser one. The well-meant gift of Toronto University has unquestionably put the Medical Research Council in a somewhat awkward position. In view of the facts referred to in the earlier part of this article, namely, that active extracts have already been made in this country and methods published, it is clear that any general patent could not be upheld. If Collip's special process were patented, it would be open to a maker to vary the solvent, say by using acetone. The writer has found that acetone is less injurious to enzymes than alcohol is, and it might be worth testing for the purpose of preparing insulin. Even if a patent were granted, it would be a very costly and troublesome process to prosecute for infringement, whereas failure to satisfy the Medical Research Council's test would prevent the sale of any worthless preparation. It is indeed quite possible that the objection taken to the apparent policy of this Council is based on a misunderstanding, and that it will turn out that this policy is essentially what is advocated here.

There is another aspect of the matter which has been brought to notice somewhat acutely by the special circumstances of this case. Whatever may be the object of the University of Toronto, there can be no manner of doubt that those who have given time to, and been put to pecuniary loss by work for, the benefit of humanity ought not to suffer. I am informed that Dr. Banting gave up his medical practice to devote his whole time to the research. It may perhaps be objected that if he returns to practice with the reputation gained, large numbers of patients will come to him. But this does not affect the principle. If discoveries in the medical sciences are not to be patented, the question arises as to how their discoverers are to be rewarded. It is absurd, as well as deterrent, to allow the mental capacities which applied to industry would have brought a fortune, to go unrewarded in science. Men of science do not expect fortunes, but freedom from worry is essential for good work, and would well repay the comparatively small expenditure involved.

It may be remembered that about three years ago a combined committee of the British Science Guild and the British Medical Association considered the problem, and a deputation from them was sympathetically received by Mr. Balfour (now Lord Balfour). Subsequent needs for economy prevented any further action. Naturally, many difficulties as to points of detail arise, such as whether a single gift, on the lines of the Nobel prizes, or annual grants, would be the better method. Again, it may be said that a particular discovery is necessarily based on the work of many predecessors. Or a man's work may not lead at once to any discovery of practical value, although the foundations of future valuable discoveries may be laid. There is much to be said in favour of rewards for good work done, as well as for providing means for doing it. It would probably be found in practice that the difficulties are not so great as might appear. It may be suggested that funds might be voted to the Medical Research Council and to the Department of Scientific and Industrial Research for the special purpose indicated.

The Identity of Geber.

By E. J. Holmyard, Clifton College.

It is generally agreed that the masterpieces of medieval chemical literature are the "Investigation of Perfection," the "Sum of Perfection," the "Invention of Verity," and the "Book of Furnaces," ascribed to "Geber, the Most Famous Arabian Prince and Philosopher." They are written in clear and definite language and are free from the enigmas and allegories which disfigure so large a proportion of alchemical books, and they contain much precise chemical information. The earliest Latin manuscripts of these works appear to be of the late thirteenth century, and they profess to be translations from the Arabic of Jābir ibn Ḥaiyān, who lived in the eighth century A.D.

The Arabic origin of Geber's works was universally accepted until the middle of the nineteenth century, when Kopp first expressed doubts as to their authenticity. Kopp, however, knew no Arabic and was not acquainted with any Arabic works of Jābir, so that his suggestion was merely tentative. Additional evidence was secured by Berthelot, who caused translations to be made of a few Arabic manuscripts containing works ascribed to Jābir ibn Ḥaiyān, and compared these translations with the Latin works mentioned above. He came to the conclusion that Geber's works were European forgeries of the thirteenth century and could certainly not be regarded as translations of works of Jābir ibn Ḥaiyān. Up to the present no one has challenged Berthelot's conclusion, and all historians of chemistry have followed him blindly, without critical examination of the material upon which his conclusion was based. I hope to show in the present article that there is a good deal more in the problem than Berthelot seemed to realise, and, while not claiming to have proved definitely that Geber and Jābir are identical, I believe that the evidence now accumulated renders this identity extremely probable.

It is necessary in the first place to consider the data which Berthelot had at his disposal, and to estimate their value; and secondly, to enumerate the definite points in his argument. A fact of prime importance is that Berthelot was completely ignorant of Arabic and was therefore not in a position to draw conclusions from considerations of style—yet this is what he continually attempted to do. This habit of Berthelot's has been severely criticised by von Lippmann ("Entstehung und Ausbreitung der Alchemie," Berlin, 1919), and I need not enlarge upon it here.

Berthelot's acquaintance with Arabic alchemy was limited in two senses, for, in addition to his want of knowledge of the language, he knew even in translation only thirteen small works, nine of which are attributed to Jābir. While, therefore, one has the greatest admiration for Berthelot's invaluable pioneer work, one is justified in holding that the foundation of the edifice which he reared is somewhat insecure. The more I investigate the subject the more do I feel, with Berthelot's countryman Prof. E. Blochet, that "il faudrait des années d'un labeur ininterrompu pour tirer des manuscrits la doctrine arabe de la chimie."[1]

According to the "Kitāb al-Fihrist," a Muslim encyclopædia of the tenth century A.D., Jābir wrote at least five hundred books, some large and some small. About fifty of these are known to exist, and I have no doubt that many others could be found by diligent search. A study of the extant manuscripts shows that Jābir was very catholic in his learning—he was at once philosopher, physician, mystic, and chemist. It so happens that Berthelot came upon some of the more mystical of Jābir's works, and was therefore led to a wrong conclusion as to his attainments in chemistry.

To come now to the definite points in Berthelot's argument. It will be convenient to give these so far as possible in his own words ("La Chimie au moyen âge," tome i.).

1. La première et la plus essentielle, c'est que le texte arabe renferme certaines des doctrines précises sur la constitution des métaux, que nous trouvons dans les textes latins réputés traduits de l'arabe et attribués [à Geber]; tandis qu'une autre partie de ces doctrines manque complètement dans les traités arabes et paraît dès lors appartenir à une période plus moderne. Ainsi la doctrine des qualités occultes, opposée aux qualités apparentes, est formellement exposée dans les textes arabes de Djâber [Jābir]. . . . Au contraire, aucune allusion n'est faite dans les textes arabes précédents à la théorie de la génération des métaux par le soufre et le mercure.

2. On ne rencontre . . . dans les œuvres arabes de Djâber, de recette précise pour la préparation des métaux, ou des sels, ou de quelque autre substance.

3. Dans ces traités arabes, le langage est vague et allégorique.

4. Aucune doctrine ou fait précis n'est énoncé, aucun personnage n'est cité.

5. (No direct quotation of Geber is made by Albertus Magnus or Vincent de Beauvais, the presumption being that the Latin works of Geber were therefore not known to these two alchemists.)

6. La *Summa* ne contient . . . aucune des formules musulmanes . . . dont [Jābir] est prodigue.

7. (The *Summa* contains an account of the arguments of those who denied the possibility of transmutation. Of this "on n'en trouve aucune trace dans les opuscules arabes de Djâber.")

8. (The style of the *Summa* recalls that of the Schoolmen.)

9. L'auteur (of the Latin works) dit que, d'après lui, il existe, en réalité, trois principes naturels des métaux: le soufre, l'arsenic qui lui est congénère,

[1] Private communication to the author.

et le mercure. Ce sont là, en réalité, des théories nouvelles, postérieures à celles d'Avicenne.

10. (All the *Summa*) "est d'une fermeté de pensée et d'expression, inconnue aux auteurs antérieurs, notamment au Djâber arabe."

11. There is no mention in the Arabic work of nitric acid, *aqua regia*, or silver nitrate, all of which are described in the Latin works.

It will be observed that all these arguments are negative ones, and rest upon the difference between the Latin works and the Arabic opuscules of Jābir known to Berthelot. Up to the present I have not found any Arabic works which can be considered as the originals of the Latin treatises, but that there is much to be said against Berthelot's conclusions will be apparent from the following remarks, which I have numbered to correspond with the preceding quotations.

1. Jābir enunciates the sulphur-mercury theory of metals in the first book of his "One Hundred and Twelve Books" (quoted by Al-Jildakī in vol. i. of the "Nihāyat aṭ-Ṭalab"). He says very definitely that "the seven fusible bodies are composed of mercury and sulphur." Compare this with chap. ii. of the "Investigation of Perfection": "All metallick bodies are compounded of argentvive and sulphur." This is expanded in the "Book of Properties," section 12 (B.M. manuscript), where Jābir advances the theory that all minerals, whether metallic or not, are composed of mercury, sulphur, gold, and sal-ammoniac.

2. Jābir can be quite definite when he likes; the three preparations given below are taken from the "Book of Properties."

(*a*) Section 36. "Take a pound of litharge, powder it well and heat it gently with four pounds of wine vinegar until the latter is reduced to half its original volume. Then take a pound of good *qalī* (crude sodium carbonate) and heat it with four pounds of fresh water until the volume of the latter is halved. Filter the two solutions until they are quite clear and then gradually add the solution of *qalī* to that of the litharge. A white substance is formed which settles to the bottom. Pour off the supernatant water and leave the residue to dry. It will become a salt as white as snow." (*b*) Section 38. "Take a pound of litharge and a quarter of a pound of soda, and powder each well. Then mix them together and make them up into a paste with oil and heat in a descensory. (The metal) will descend pure and white." (*c*) Section 36. "To convert mercury into a red solid. Take a round glass vessel and pour a convenient quantity of mercury into it. Then take a Syrian earthenware vessel and in it put a little powdered yellow sulphur. Place the glass vessel on the sulphur and pack it round with more sulphur up to the brim. Place the apparatus in the furnace for a night, over a gentle fire . . . after having closed the mouth of the earthenware pot. Now take it out and you will find that the mercury has been converted into a hard red stone of the colour of blood. . . . It is the substance which men of science call cinnabar."

3. That many of Jābir's books are couched in allegorical language no one will deny, but in others there is scarcely any trace of allegory (*e.g.*, the "Book of Properties") and Jābir is quite capable of sustaining a closely reasoned argument. Lack of space prevents me from illustrating this point as fully as I could wish, but I may perhaps refer to the "Book of Balances," where he says, "It must be taken as an absolutely rigorous principle that any proposition which is not supported by proofs is nothing more than an assertion which may be true or may be false. It is only when a man brings proofs of his assertion that we say, your proposition is true." Similarly, he is at pains in the "Book of Properties" to make it clear that he is describing his personal experiences; "we have described only that which we ourselves have seen, and not that which was told us or what we heard or read." Jābir is very precise, again, in his "Book of Definitions."

4. Berthelot's fourth argument is sufficiently answered by the evidence I have brought forward in 1, 2, and 3. In his "Book of the Divine Science," Jābir refers to Pythagoras and Plato, and defines chemistry as "that branch of natural science which investigates the method of formation of the fusible bodies" (*i.e.* the metals). His views on the structure of cinnabar, given in the same book, are so precise, and refute Berthelot's charge of vagueness so well, that I cannot refrain from quoting them here.

"When mercury and sulphur combine to form one single substance it has been thought that they have essentially changed and that an entirely new substance is formed. The fact is otherwise, however. Both the mercury and the sulphur retain their own natures —all that has happened is that their parts have become attenuated and in close approximation to one another, so that to the eye the product appears uniform. But if one could find an apparatus to separate the particles of one sort from those of the other, it would be apparent that each of them has remained in its own permanent natural form and has not been transmuted or changed. We say, indeed, that such transmutation is not possible for natural philosophers."

5. If Albertus Magnus and Vincent de Beauvais knew no Arabic, and if the *Summa, etc.*, (supposing that they were originally Arabic) had not yet been translated into Latin, the absence of mention would be explained. In any case, the argument *a silentio* is always unsatisfactory.

6. It is here that Berthelot's ignorance of Arabic has led him astray. As a matter of fact, the *Summa* is full of Arabic phrases and turns of thought, and so are the other Latin works. It is obvious that a full discussion of this point would require far more space than is available here, and I hope to treat of it elsewhere. I will, however, quote one or two passages of Russell's English translation of Geber which are of unmistakable Arabic origin. "Our Art is reserved in the Divine Will of God and is given to, or withheld from, whom he will, who is Glorious, Sublime, and full of all Justice and Goodness." ". . . transmute with firm transmutation" (a well-known construction in Arabic). "This Divine Art, which is both necessary and known." "Now let the high God of Nature, blessed and glorious, be praised, who hath revealed to us the Series of all Medicines." "We have dispersed the special things pertinent to this Praxis, in diverse Volumes" (often said by Jābir). "Gold Obrizon" (d̲hahab ibrīz). "One part tingeth infinite parts of Mercury into most high Sol, more noble than any natural Gold." "Festination is from the Devil's part."

7. So far, I have not found in Jābir any mention of the arguments against the possibility of transmutation

to which Berthelot refers, but Jābir is never tired of pointing out the errors of other chemists and insisting upon the superiority of his own theories and methods. He even curses them in the manner of the Latin works.

8. The style of the Latin works does indeed resemble that of the Schoolmen, but so does that of many of the Arabic works of Jābir. I would refer especially to the first twelve sections of the "Book of Properties," and to the "Book of Definitions."

9. Arsenic as one of the principles of metallic bodies is referred to by Jābir in Book I. of the "Hundred and Twelve Books" (quoted by Al-Jildakī in vol. ii. of the "Nihāyat aṭ-Ṭalab"). "Arsenic" here refers of course to the arsenic sulphides, realgar and orpiment. It will be noticed that the Latin Geber does not insist upon the necessity of arsenic; in this he is in agreement with Jābir. Both agree in regarding the prime constituents of metals to be sulphur and mercury.

10. I have explained Berthelot's insistence on the difference in style between the Latin works and the Arabic treatises as due to the fact that Berthelot was unlucky in his choice of the latter.

11. I cannot say whether the Arabic Jābir definitely mentions nitric acid, *aqua regia*, and silver nitrate. It is unfortunate that the pages referring to solutive waters are missing from the British Museum MS. of the "Book of Properties," especially as I believe this MS. to be unique. Al-Jildakī mentions a "solutive water" (*ma' al-ḥilāl*) which was used to dissolve out silver from a gold-silver alloy; I presume this must have been nitric acid. Al-Jildakī, however, lived after the date of the earliest MSS. of Geber's works.

I ought to say that I have hitherto examined by no means all of the available material, and that in the present article I have only very roughly sketched out the case for the identity of Geber and Jābir. I hope to deal with the subject much more fully in the future, but the question of the identity of Geber is so important for the history of chemistry that it seemed desirable to publish a preliminary account of some of my conclusions.

The Alleged Discovery of the Virus of Epidemic Influenza.

THE recent report in the daily press that the cause of influenza had been discovered by Drs. P. K. Olitsky and F. L. Gates, of the Rockefeller Institute, N.Y., might lead the layman to believe that the problem was solved. There is no published evidence to show that this is correct. The facts are briefly these. Influenza is the greatest pandemic disease known and may be traced to the most remote periods of which we have historic data. One of its great outbursts (1889–1890) coincided with the bacteriological epoch in science, and by means of the technique devised by Robert Koch, one of his assistants, R. Pfeiffer, distinguished by the accuracy of all his work, isolated (1892) a small rod-shaped microbe since universally called *Bacillus influenzæ*. This microbe, not easy to cultivate, was missed by all the investigators before Pfeiffer, but his work was subsequently regarded as correct.

In succeeding years influenza as an epidemic disappeared and little was heard of Pfeiffer's bacillus in bacteriological literature. In 1918, under the title of Spanish influenza, the disease again appeared, and sweeping over the inhabited world like a prairie fire, caused immense morbidity and mortality everywhere. The microscopes of bacteriologists were riveted on the disease processes of the plague. The results of tried investigators varied, but with prolonged experience and suitable methods the bacillus of Pfeiffer was found almost everywhere in cases of the disease. Dissentient voices were, however, raised here and there, partly owing to inability to find the bacillus, partly owing to the fact that when found it was difficult to prove its causal relation to influenza, as animals are by no means so susceptible to the disease as man.

It was believed and stated, in fact, that Pfeiffer's bacillus was not and could not be the cause of influenza, which was to be sought in some hitherto unknown or unrecognised agent. Among those who held this view must be mentioned Gibson Bowman and Connor, who, attached to the B.E.F. in France, published statements (1919) to the effect that influenzal secretions which had been forced through bacterial-proof filters, gave rise in monkeys, rabbits, mice, and guineapigs to a disease closely resembling that of human influenza. They claimed to have transmitted the disease from animal to animal in series. They believed that the virus was a "filter passer." Independently, Bradford, Bashford, and Wilson made similar claims, which they afterwards withdrew. Following the same lines, Maitland, Cowan, and Detweiler of Toronto recorded entirely negative results and directed attention to grave errors which might arise in interpreting results believed to be positive. What were described as typical effects by the supporters of the filter-passing-virus theory were shown by the Canadians to occur in animals that had never been inoculated at all but which had been intentionally killed. This fact has since been abundantly confirmed by Branham (1922) and shown by her to occur when death is brought about by a blow on the neck. It is along the same route that the Rockefeller investigators have proceeded, from whose work it is now claimed that the etiology of influenza is settled, and it is claimed that the virus is a body called by them *Bacillus pneumosintes* (σίντης, injurer or devastator—from its supposed deleterious effect on the lungs).

In the last two years Olitsky and Gates have published a long series of papers in the *Journal of Experimental Medicine*, giving the results of their inquiries. Their claims are based on the following statements. (1) Influenzal throat secretions diluted and filtered through Berkefeld filters produce symptoms which cannot be produced by similar filtrates from normal persons. The symptoms—in rabbits—are fever, conjunctivitis, and a diminution in the number of leucocytes in the blood, a symptom which is very characteristic of the influenza disease in man. None of the animals died of the experimental disease, but on being killed, the lungs were found mottled and hæmorrhagic. (2) The lesions in the lungs are said to be transmissible in series. (3) Although none of the experimental animals died, they are stated to have been rendered more susceptible to a later infection by Pfeiffer's bacillus. (4) In the filtered washings peculiar "bacilloid" bodies were found measuring 0·15–0·30 μ in their long dimension. The nature of these bodies—at first uncertain—was ultimately believed to be micro-organismal. Hence the name *Bacillus pneumosintes*. (5) Inoculation of cultures of the so-called bacillus followed by injections of *B. influenzæ* resulted in the production of consolidation of the lungs with hæmorrhagic œdema and emphysema. (6) A certain degree of immunity is stated to follow injections of *B. pneumosintes*. (7) Inoculation of the bacterium is stated to evoke certain antibodies which are of a specific character. It may be stated that "cultures" of the microbe were obtained only on the highly complicated Smith-Noguchi medium, and especially under anaerobic conditions.

Before assuming that all these statements are correct it may be stated with respect to this microbe—if it is a microbe—that bacilloid and other like bodies indistinguishable in appearance from *B. pneumosintes* may occur in tubes of Noguchi's medium which has never been inoculated at all and nevertheless is sterile. The "bodies" appear to be due to some transformation of the colloid material of the medium itself. Such transformations may occur in tube after tube and give rise to the erroneous interpretation of successful transmission of the culture. Further, it is remarkable that the "microbe" does not kill the experimental animals, but that when they are killed afterwards they show changes admittedly indistinguishable from those seen in killed animals never inoculated. One great obstacle to the successful study of influenza would appear to be that animals are much less susceptible than man, and that as soon as the question of human inoculation is introduced, great difficulties ensue in excluding other sources of infection. Recently, Lister in South Africa, working on lines identical with those of Olitsky and Gates, has found, like them, *Bacillus pneumosintes* or similar "culture," but on inoculating such unheated cultures into human beings, 13 in number, he had only one success, a typical attack of uncomplicated influenza, after a nineteen-hours incubation period. It may be that the cause of influenza has been located in *B. pneumosintes*, but before this can be accepted by the bacteriological world in general it will be necessary to adduce many more cogent reasons than have been forthcoming so far.

W. B.

Obituary.

Prof. Fritz Cohn.

FRITZ COHN, director of the Berlin Rechen-Institut, died on December 14 after an operation. He was born at Königsberg on May 12, 1866, and studied first at the Gymnasium and afterwards at the University there; after further study at the University of Berlin he was placed on the staff of the Königsberg Observatory in 1891 and remained there till 1909.

Cohn's work included a discussion of Bessel's observations between 1813 and 1819, and a determination of the declinations and proper motions of the stars used in the International Latitude stations. He published catalogues of the stars used for the Eros campaign in 1900–1, and of 4066 other stars observed with the self-registering micrometer of the Repsold transit circle.

In 1909, Cohn was appointed to the chair of theoretical astronomy at Berlin, and director of the Rechen-Institut. He took part in the Paris Conference of 1911 which arranged for combination of work between the national almanacks, to avoid needless duplication of labour. The time thus saved was devoted to investigations on the minor planets, and the Institut took the leading part in deducing their orbits, and in arranging plans for sharing the observing work among different observatories. He showed great skill in keeping up the necessary accuracy of computation without any waste of labour. He also carried on the Astronomisches Jahresbericht after the deaths of Wislicenus and Berberich, and left the MS. for the 1921 volume practically complete at the time of his death.

Cohn married a daughter of C. F. W. Peters, director of Königsberg Observatory, in 1898, and leaves a son and two daughters. A fuller account of his life and work is given by J. Peters in *Astr. Nach.* 5208.

Cohn was elected an associate of the Royal Astronomical Society in June 1913.

A. C. D. C.

Mr. P. C. A. Stewart.

It is with much regret that we record that Mr. P. Charteris A. Stewart, the well-known petroleum geologist and consultant to Viscount Cowdray's firm (Messrs. S. Pearson and Co.), met his death by drowning while bathing at Balandra Bay, Trinidad, B.W.I., during a recent short visit to the Islands.

For nearly twenty years Mr. Stewart has been connected with Messrs. Pearson's, and he had been closely associated with that firm in its important petroleum developments all over the world, more particularly in Mexico, Roumania, and Trinidad. Prior to this he held an appointment on the staff of the Geological Survey of Egypt.

Mr. Stewart's technical education was at the Royal School of Mines, where, in 1900 and 1901, he obtained diplomas in mining and metallurgy. Returning in 1904 he gained a further diploma in geology at the Royal College of Science in 1905. He was elected a fellow of the Geological Society of London in 1904, and was also a member of the Institution of Petroleum Technologists and the American Institute of Petroleum Geologists.

Mr. Stewart had travelled much, and by his wide experience and intimate knowledge of oilfield conditions in many countries he gradually built up a high reputation in his profession. His sound judgment in technical problems, backed by conscientious inquiry and skilful reasoning, made him an invaluable adviser to those whom he was privileged to serve. His death at the early age of forty-eight is a deplorable loss, one which will be keenly felt, not only by his colleagues, but also by his many friends, to whom he had endeared himself as a kindly, modest, and unselfish man.

H. B. M.

Current Topics and Events.

SINCE the publication of the letter "On the Missing Element of Atomic Number 72," by Dr. Coster and Prof. Hevesey, in NATURE of January 20, p. 79, it has been announced that Dr. Alexander Scott detected and separated the oxide several years ago. It appears that while examining in 1913 a specimen of titaniferous iron sand (75 per cent. Fe_3O_4, 25 per cent. TiO_2) from near Maketu in the North Island, New Zealand, Dr. Scott noticed that in the titanium dioxide separated in the ordinary methods of analysis there was always a small residue which resisted all attempts to get it into solution, either as sulphate, chloride, or nitrate. Neither would it go into solution after prolonged fusion with caustic soda. No trace of the many "rare earths" was found in the sand. The insoluble residue remaining after repeated and alternated fusions with sodium bisulphate and caustic soda was labelled "New Oxide" in 1918. Its properties and mode of occurrence indicated that it was an oxide of the titanium-zirconium group, and that it was the oxide of the missing element, of which the atomic number is 72. Some of its properties showed a resemblance to tantalum, its next neighbour, with the atomic number 73; but all traces of this element would be removed by the repeated fusions with caustic soda. As none of the ordinary salts were available for the purpose of determining the atomic weight, recourse was had to the double fluoride with potassium, which closely resembles those of titanium and zirconium. The rough determinations with material imperfectly purified for such a purpose indicated that the atomic weight of the element was between $1\frac{1}{2}$ and 2 times that of zirconium (90·6). The oxide resulting from these determinations was of a cinnamon-brown colour, not white as was expected. We understand that Dr. Scott wrote on January 28 to Drs. Coster and Hevesey offering to send them specimens of his separated material to compare with their own, and received a reply from them on Saturday night last (February 3) saying they would be very glad to do so. On Monday Dr. Scott sent to them practically all his purified material, and not only he, but also all scientific men, must await with keen interest the result of the searching examination by means of the powerful appliances in their hands for spectral analysis by X-rays. In view of the source of his oxide and its association with much titanium oxide, Dr. Scott has suggested, as Oceanus was one of the Titans, that "Oceanium" would be a suitable name for the element. This name would also recall that the sand came from Oceania, of which New Zealand is one of the component parts.

THE Bakerian lecture of the Royal Society will be delivered on February 22 by G. I. Taylor and C. F. Elam on "The Distortion of an Aluminium Crystal during a Tensile Test."

THE Duke of Devonshire will open the new Botany (Plant Technology) Building of the Imperial College of Science and Technology, South Kensington, on Friday, February 16, at 3 o'clock.

AT the meeting of the Chemical Society to be held at the Institution of Mechanical Engineers (Storey's Gate), on Thursday, February 22, at 8 P.M., Principal J. C. Irvine will deliver a lecture entitled "Some Constitutional Problems of Carbohydrate Chemistry."

THE Murdoch Trust, Edinburgh, grants donations or pensions to indigent bachelors and widowers of upwards of fifty-five years of age who have done something to promote or help some branch of science. Particulars are obtainable from Messrs. J. and J. Turnbull, 58 Frederick Street, Edinburgh.

A SOCIAL evening of the Royal Society of Medicine will be held on Wednesday, February 28, beginning at 8.30. It will be devoted to the celebration of the centenary of Pasteur. At 9 o'clock the president, Sir William Hale-White, will deliver an address on "The Life and Work of Pasteur." This will be followed by an illustrated lecture by Dr. G. Monod on "Pasteur as an Artist."

ON Tuesday next, February 13, at 3 o'clock, Prof. A. C. Pearson will deliver the first of two lectures at the Royal Institution on Greek civilisation and to-day —(1) The beginnings of science, (2) Progress in the arts; on Thursday, February 15, Prof. B. Melvill Jones will begin a course of two lectures on recent experiments in aerial surveying; and on Saturday, February 17, Sir Ernest Rutherford will commence a course of six lectures on atomic projectiles and their properties. The Friday evening discourse on February 16 will be delivered by Prof. A. V. Hill on muscular exercise; and on February 23, by Prof. A. S. Eddington on the interior of a star.

NOTICE is given by the Royal Society of Medicine that the William Gibson research scholarship for medical women will be awarded in June next. The scholarship is of the value of 250*l.* for two years and is not necessarily for research, the selected scholar being free to travel. Full particulars will be sent on application to the Secretary of the Society, 1 Wimpole Street, W.1.

DURING the making of the new road between Dover and London numerous sarsen stones were found among the remains of the Lower Tertiary formations overlying the chalk near Maidstone. Two of these, selected by Mr. G. E. Dibley, were sent to the British Museum (Natural History), where they are now exhibited in the geological department close to the stratigraphical collection. They are remarkable for their botryoidal concretionary form.

A MEETING of national importance has been arranged by the British Science Guild to be held at the Mansion House, London, on Tuesday, February 27, at 3.30 P.M., to direct public attention to the importance of promoting efficiency and economy in industry, commerce and all Imperial affairs by the progressive use of science and scientific method. The Right Hon. the Lord Mayor will preside, and will be supported by the Right Hon. Lord Askwith, president of the Guild. The speakers will include Sir Joseph Thomson (Master of Trinity College, Cambridge), Sir Robert A. Hadfield, Bart. (Vice-President of the Federation of British Industries), and the Right Hon. Sir Joseph Cook, G.C.M.G. (High Commissioner for Australia). Tickets may be obtained from the Secretary, British Science Guild, 6 John Street, Adelphi, London, W.C.2.

THE president and council of the Royal Society have appointed Prof. E. H. Starling first Foulerton professor in accordance with the terms of the bequest of Miss Lucy Foulerton, who left the residue of her estate to the Royal Society. The duties of the professor are to conduct such original researches in medicine or the contributory sciences as shall be calculated to promote the discovery of the causes of disease and the relief of human suffering. Prof. Starling's work will be carried out at University College, London. Dr. H. W. C. Vines, fellow of Christ's College, Cambridge, has been appointed to a Foulerton research studentship, the duties being to conduct researches in medicine or the contributory sciences. Dr. Vines is carrying on his researches in the Cambridge Medical School.

AT the annual general meeting of the Association of Economic Biologists held on Friday, January 26, the following officers and council for the year 1923 were elected: *President*: Prof. E. B. Poulton. *Vice-Presidents*: Prof. V. H. Blackman and Sir John Russell. *Treasurer*: Dr. A. D. Imms. *Secretaries*: (General and Botanical): Dr. W. B. Brierley; (Zoological) Dr. J. Waterston. *Editors*: (Botany) Dr. W. B. Brierley; (Zoology) Mr. D. Ward Cutler. *Council*: Dr. W. F. Bewley, Prof. V. H. Blackman, Mr. F. T. Brooks, Mr. A. B. Bruce, Dr. E. J. Butler, Dr. J. W. Munro, Sir John Russell, Prof. J. H. Priestley, Prof. J. H. Ashworth, Dr. T. Goodey, Mr. A. D. Cotton, and Mr. W. E. Hiley.

A JOINT meeting of the Society of Public Analysts and the Nottingham Section of the Society of Chemical Industry was held at Nottingham on January 17 for the discussion of methods of estimating arsenic. The chair was taken by Mr. Burford, chairman of the Nottingham section, and the discussion was opened by Mr. A. Chaston Chapman, who described his experience during the last twenty-five years with the zinc-acid process, and gave an outline of his procedure, more particularly in the use of cadmium to render the zinc sensitive. He was followed by Mr. Wilkie, secretary of the Nottingham section, who demonstrated the use of his electrolytic method of estimating arsenic, in which the reversibility of the reaction was prevented. Dr. Monier-Williams showed an electrolytic Marsh apparatus modified from that in use in the Government laboratory. Mr. H. Droop Richmond attributed the want of sensitiveness of the zinc in the zinc-acid method to the presence of iron, and Mr. J. Webster described an experiment indicating that the total amount of arsenic in a large organ such as the liver was correctly estimated by multiplying the amount found in the Marsh test by a factor.

THE New York correspondent of the *Times* states that an earthquake of considerable violence was recorded in the United States on February 4. A sea wave 12 feet high is reported at Hilo Harbour, Hawaii, and a number of small boats were lost at Waiakea. Four waves passed over Haleiwa, some thirty miles from Honolulu, which does not appear to have suffered important damage. The cable between Midway Island and Guam appears to be broken, and attempts to reach Samoa by wireless were unsuccessful. Mr. J. J. Shaw, of West Bromwich, Birmingham, states in the *Daily Mail* that the primary movement began on Saturday afternoon at 4 h. 13 m. 15 s., and the secondary at 4 h. 23 m. 4 s., indicating a distance of 5300 miles. The earth tremors continued for upwards of six hours. The needle was thrown off the record several times. Mr. Shaw states that the disturbance is the biggest recorded since the Chinese earthquake of December 1920.

THE annual meeting of the Iron and Steel Institute will be held on Thursday and Friday, May 10 and 11, at the Institution of Civil Engineers, Great George Street, London, S.W.1. The council has received a very cordial invitation from Mr. G. E. Falck, president of the Associazione Fra Gli Industriali Metallurgici Italiani, for the members of the Institute to meet in Italy in the autumn of this year. Subject to final arrangements with the Italian Association, the general meeting will be held at Milan about the middle of September, and on its conclusion it is proposed that visits should be paid to the principal metallurgical centres and to the hydro-electric power stations in Italy. The tour will also include visits to Rome, Naples, Genoa, and Turin, and is expected to occupy altogether about nineteen to twenty days from the time of leaving London until the return.

AT the recent annual meeting of the American Association, held at Boston, the Association as a whole declared itself unqualifiedly in favour of the metric system of measurement with one of the strongest resolutions ever passed by that body on this subject. The resolution is as follows: "Whereas the metric system of weights and measures has not yet been brought into general use in the United States, and whereas the American Association for the Advancement of Science has already passed resolutions favouring the adoption of the metric system of weights and measures in the United States; therefore be it resolved: That the American Association for the Advancement of Science reaffirms its belief in the desirability of the adoption of the metric system of weights and measures for the United States, and recommends that the units of the system be used by scientific men in all their publications, either exclusively or else with the customary non-metric units in parenthesis."

THE exhibition of facsimiles and reproductions of old maps in the Whitworth Hall of the University of Manchester during the last week of January coincided with the news that the Council of the University decided at the last meeting to recommend to the Court the institution of an honours school of geography within the faculty of arts. The exhibition, arranged jointly by the Manchester Geographical Society and the University, was opened by Sir Frederick Lugard, and the occasion was taken to bring before the public the appeal for funds which the Society is making to endow a chair of geography in the new honours school. The collections of maps, which have been placed on loan at the University by Col. D. Mills and Mrs. Booker, include facsimiles of such maps as the Madaba Mosaic, the Peutinger Table, the St. Sever copy of the Beatus map, 14th and 15th c. portolani, the Catalan world map of 1375, and the series of maps reproduced principally under the direction of Prof. E. L. Stevenson, illustrative of geographical discovery in the period between the time of Juan de la Cosa's portolan (1500) and the world map of Hondius (1611). The Booker collection contains many typical country and county maps from Norden and Saxton to Cary, Greenwood, and Bryant, while the reproductions of London and Paris views and maps (Mills collection), made by the London Topographical Society and the French Government respectively, form excellent material for the study of these two cities. In addition, the exhibition includes a number of regional maps of the various parts of the world extending over a considerable period of time, of which those of Russia and the Far East are the most extensive. There is every prospect, with these maps as a nucleus, of a great development of all phases of cartographical studies within the University.

MESSRS. W. WATSON AND SONS, LTD., of 313 High Holborn, W.C.1, have issued a new edition of Parts 1 and 2 of their microscope catalogue. Included in the list is a new model, the "Kima," which is specially designed for students and sold at a reasonably low price. The instrument, which is somewhat similar to, but smaller than, the now well-known "Service" model, complies with the specification of the British Science Guild except in regard to the position of the fine adjustment milled heads. Various models—for example, the "Royal," the "Van Heurck"—suitable for research or general high power work, as well as binocular microscopes for both low and high powers are described in detail and a complete list of eyepieces, objectives, condensers, and other accessories is given. A welcome reduction in prices is noticeable in nearly all the items. There is also listed a horizontal or reading microscope consisting of a microscope body of large diameter fitted with a micrometer eyepiece and a 2-inch objective. The body is surmounted by a sensitive bubble for levelling purposes. Vertical adjustment is made by a rack and pinion, the pillar being divided into millimetres and fitted with a vernier.

THE Pasteur lecture delivered before the Institute of Medicine of Chicago on November 24 last, by Dr. Jacques Loeb, is reproduced in the issue of *Science* dated December 29. The lecture is devoted mainly to a consideration of the osmotic equilibrium of gelatin in the presence of various concentrations of acid and alkali.

WE have received the new issue of the chemical catalogue of British Drug Houses, Ltd. In many cases there has been a considerable reduction in prices of chemicals in everyday use, and some substances required by research workers are now listed which did not appear in former catalogues. Biological stains are included, and the catalogue should find a place in every laboratory.

IN the January issue of the Research Defence Society's pamphlet, *The Fight Against Disease* (Macmillan and Co., price 6*d*.), the story of bubonic plague, by Surg.-Gen. Bannerman, is retold (the Society first published it in 1910). An excellent account is given of the ravages of bubonic plague and its transmission from rats to man through the intermediary of the rat fleas. Some data are also included of the efficiency of plague vaccine in the prevention of the disease. The general article on Pasteur which appeared in NATURE, December 23, is also reprinted.

Our Astronomical Column.

FIREBALLS IN FEBRUARY.—Mr. W. F. Denning writes: "This month though it does not supply meteors in abundance has furnished a number of large fireballs, some of which have been of exceptional character. The Mon. Not. R.A.S. for March 1922 contained a list of the remarkable meteoric phenomena recorded in recent years between February 7 and 22. Two of the most singular fireballs ever seen occurred, one on February 22, 1909, which left a long streak in the sky for two hours and drifted on upper wind-currents to north-west at the rate of 120 miles per hour. The other, on February 9, 1913, consisted of a stream of bright meteors which passed over North America, and had a luminous flight extending over at least 5500 miles.

"It is impossible to foretell the time of appearance of any individual fireball, and it is necessary that observers should be specially on the alert during the present month, for the prospect of observing a large meteor is very good, especially during the periods February 7, 10–14 and February 19–22. There are several active radiants at this time of the year, such as those at $147° - 11°$, $167° + 33°$, $73° + 42°$, and $106° + 52°$. In the event of any bright meteors being seen, the particulars should be carefully noted, and their apparent paths among the stars recorded as accurately as possible."

ASTRONOMICAL CIRCULARS.—There is a class of astronomical announcements—discoveries of comets or of novae, unusual markings on planets, etc.—the early circulation of which is of importance to observers. In the last century Lord Crawford started the Dunecht and Edinburgh Circulars, but they were not continued after his death. The only resource up to the present for those who find the price of astronomical telegrams too high has been the series of circulars issued by Prof. Strömgren at Copenhagen, or that of the *Astr. Nach.* at Kiel. These take some days to reach this country. The British Astronomical Association has now decided to issue a series of circulars when news of an urgent character comes to hand. Non-members of the B. A. A. can obtain these circulars at a charge of a few shillings per annum on writing to the secretary. They will include the latest ephemerides of comets in addition to discovery announcements.

Research Items.

THE FAROE ISLANDS.—The Faroe or Sheep Islands, lying half-way between Iceland and the Shetlands, are inhabited by people of Norwegian descent. In these islands an energetic linguistic movement has recently arisen, aiming at elevating the local idiom to the rank of a language, a movement which is not political, but suggested by the declaration in 1918 of the independence of Iceland. Mr. J. Dyneley Price, in the Proceedings of the American Philosophical Society (vol. lxi. No. 2, 1922), describes the linguistics and phonetics on information furnished by Miss M. E. Mikkelsen, a Faroese lady now resident in Copenhagen. It is curious that this movement extends to a new form of spelling which, like the stereotyped archaic spelling of modern Gaelic, ignores the modern phonetics of the spoken dialects.

AN ANCIENT AUSTRALIAN SKULL.—Anthropologists will read with considerable interest a paper in the *Journal of Anatomy* (vol. lvii. part 2) by A. N. St. G. H. Burkitt and Prof. J. I. Hunter on "A Description of a Neanderthaloid Australian Skull." This was that of a female, and was "Neanderthaloid" only in so far as the calvarium was concerned. The excessive development of the supraorbital ridges of this skull the authors ascribe largely to the action of the masticatory muscles; but their arguments in favour of this interpretation, which are shared by others, are not convincing. In the conclusions at which the authors have arrived, we hoped to find some expression of opinion as to the precise relationship of this skull—and of the Australian aborigines in general—to Neanderthal man. But on this matter no direct views have been advanced. The authors applied several tests to discover the alveolar index of this skull. "Flower's Gnathic Index," they remark, "places it well within the limit of orthognathic skulls, the index being 95·23." The base line devised by Pycraft gives an index of 96, when applied to the photograph of the skull on Plate I. We venture to think that the authors have laid undue stress on the "Neanderthaloid" characters of this skull, and we are puzzled by the cryptic statement that "we must regard the cranial resemblances as an expression of the principle that descendants of a common ancestor show a tendency to develop independently similar features."

NITROGEN FERTILISERS FOR THE SUGAR CANE.—In the *Archief voor de Suikerindustrie in Nederlandsch Indië* (1922, Mededeelingen No. 3) J. Kuyper describes experiments carried out in Java on the relative value of several nitrogen fertilisers for sugar-cane cultivation. The trials have been carried out for several years in comparison with sulphate of ammonia, of which the average amount used is about 380 lb. per acre. In all cases the same weight of nitrogen was given in the different manures. Urea and nitrate of soda proved to be equal in value to ammonium sulphate, but the nitrate is too hygroscopic for convenient use. The same objection applies to ammonium sulpho-nitrate, especially in the tropical rainy season. Nitrolim or cyanamide and beancake are both of less value. Beancake does better on some soils than others, and is improved by the admixture of a certain proportion of sulphate of ammonia.

PASTURE GRASS IN TROPICAL AFRICA.—It is difficult to overestimate the importance of the contributions to colonial development that may be made by the work of institutions such as the Royal Botanic Gardens, Kew. The *Kew Bulletin* (No. 10, 1922) contains a typical example of the type of information which the resources of such a central institution can so readily place before various interested outliers of Empire. In western tropical Africa one of the difficulties in the way of pasturing fertile country lies in the ravages of the tsetse fly and the epidemics it engenders. Mr. T. M. Dawe, making an agricultural survey of Angola in 1921, recognised in the native "Efwatakala grass" a fodder plant similar to a Brazilian grass already known to him as capable of fattening stock. This grass was widely distributed in the Portuguese Congo, and on its receipt at Kew it proved to be *Melinis minutiflora*, Beauv., *f. inermis*, already reported upon in the *Kew Bulletin* (1900) as "Brazilian stink-grass." Dr. Stapf's report in the present bulletin fully bears out Mr. Dawe's view that the grass should prove a rapid coloniser of open ground and then form a fairly permanent pasture. Its potential value lies, however, in the insecticidal or insect-repelling qualities of an oil secreted in glandular hairs upon the leaf-sheath and lamina. The grass has now been grown upon a small scale at Kew, and the Jodrell Laboratory supplies a note upon the structure of the glandular hairs while the Wellcome Research laboratories have made a preliminary study of the small quantity of oil that could be extracted from the available crop of the grass. Mr. Dawe apparently hopes that this grass may prevent the spread of the tsetse fly at the same time that it provides food for stock. If such anticipations are realised the ultimate possibilities of its cultivation in tropical Africa are incalculable. It would be interesting to learn why the attempt at its introduction into Australia, chronicled in the earlier note in the *Kew Bulletin*, seems to have been without result.

THE PALOLO WORM.—Dr. Glanvill Corney, who was for many years chief medical officer of Fiji, contributes an interesting paper to the Journal of the Torquay Natural History Society on the periodicity of the sexual phase of the "Palolo" worm in Fijian waters. This worm (*Eunice viridis*) lives in the coral skeletons and rocks of the reefs, riddling them with its burrows. Like most bottom-living marine animals, its eggs are cast on the mercy of the waves and currents to be distributed far and wide. While most boring worms are content merely to shed their eggs into the bottom waters, several kinds, including the Palolo, cut off the hinder parts of their bodies, which are crowded with generative cells; these float to the surface of the water, each segment rupturing and setting free its sexual cells: this is known as swarming. The first phase of development is a floating one, but the larvæ soon settle and form their burrows. Annually the worm sheds its hinder sexual part into the water and re-forms it. The peculiarly interesting feature of the life history is the regularity with which this phenomenon occurs. As usual in such forms, the generative organs are ripe in the spring of the year, when there is a peculiar outburst of all life. The Palolo swarm on the same day, the surface of the sea at dawn becoming thick with their bodies. The day selected at Fiji is recorded by Dr. Corney for 25 years and is shown always to be on the morning of the seventh to ninth days after full moon in November or early December; the interval between swarming is sometimes 353-6 days and at other times 382-6 days, either 12 or 13 lunar months. A few may swarm a month earlier at the corresponding neap tide, but this small swarm is often unrecognisable. The vast quantities of sexual Palolo in the surface waters, like a thick macaroni soup, is a striking phenomenon enough, but it is one greatly enhanced by other eunicids, other worms, many crustaceans, and other animals all breeding in the same days of lowest tides, when the reefs are subjected to the greatest amounts of heat and light; indeed, similar sexual correlations with solar and lunar phenomena have now been suggested in nearly every group of animals.

THE ETESIENS IN THE MEDITERRANEAN.—An article is given in the U.S. *Monthly Weather Review* for August 1922, by Mr. J. S. Paraskévopoulos, of the National Observatory, Athens, on the etesiens, the characteristic north winds which blow during the summer in the region of the eastern Mediterranean. The marked regularity of these winds was observed by the ancient Greeks and the name signifies "winds blowing periodically every year." The author has tabulated the data for several Greek meteorological stations, and for a period extending over 15 years, 1900–14; the observations are made three times daily, at 8 A.M., 2 P.M., and 9 P.M., while for Athens the observations are continuous from self-recording instruments. The etesiens blow generally from the second 10-day period of May until the middle of October, with two periods of maximum. During June the winds are interrupted; in July and especially in August they are much more steady and frequent. In Athens before the middle of July the etesiens blow during the morning and are replaced in the afternoon by the sea breeze. The principal features of these winds have been known since the time of Aristotle. The anemometric data at Athens show that the velocity of the etesiens undergoes a very distinct diurnal oscillation; the speed during the daytime varies from 11 to 27 miles per hour, and it seldom reaches 45 miles per hour. Information is given as to their origin, with respect to the distribution of atmospheric pressure, temperature, and humidity. As they contribute largely to the dryness of the soil, they raise by their motion great quantities of dust.

THE HUMBOLDT CURRENT.—Variations in the temperature of the Humboldt current have been noted for many years and were recently examined by Mr. R. C. Murphy, who contributes an article to the *Geographical Review* for January on the oceanography of the Peruvian littoral. The uniform temperature conditions of this current are carried southwards from Peru at least so far as Valparaiso. Throughout this extent the lowest surface temperatures are in the inshore waters and are due to the upwelling of bottom water which is the feature of this current. The steeper the coastal slope, the greater is the reduction of inshore temperatures. Irregular variations in temperatures, which occur locally throughout the year, have been generally attributed to a shifting in the course of the current. Mr. Murphy believes that the cause is to be found in the northerly winds which accompany these abnormal sea temperatures. These winds drive warmer waters inshore and temporarily check the upwelling. More prominent is the current known on the Peruvian coast as El Niño. This counter-current of tropical water is felt seasonally north of about lat. 8° 13′ S. Mr. Murphy demolishes the theory that El Niño is due to the waters of the River Guayas and holds that it can be correlated with changes in barometric pressure when the sun is south of the equator. The paper ends with some interesting correlations between the temperature variations of the Humboldt current, the distribution of plankton, and the valuable guano birds of the Pisco Bay region. The invasion of warm water destroys enormous quantities of plankton. The result is that the birds either migrate or have to face a loss of food supply. The latter course leads to a lowering of vitality and considerable reduction in numbers as the outcome of certain prevalent diseases which attack the weakened birds.

EARTHQUAKES OF THE EAST INDIAN ARCHIPELAGO.—In a recent important memoir (Konin. Magnet. en Meteorol. Observ. te Batavia, Verhandelingen No. 7, 1921) Dr. S. W. Visser has investigated the distribution of earthquakes in the East Indian Archipelago from 1909 to 1919. The positions of the epicentres were determined from seismograms at the observatories of Batavia, Malabar, Manila, Sydney (Riverview), and Zikawei. Earthquakes strong enough to be registered at two or more of these observatories (160 near Western Java and 120 in other parts of the Archipelago) are confined as a rule to four principal regions—the Indian Ocean off southern Sumatra and western Java, the Celebes Sea and the Pacific Ocean south of Mindanao, the southern and eastern borders of the Banda Sea, and the mountain ranges of New Guinea. With the exception of the last region, the seismic zones of the Archipelago coincide with the steeply sloping sides of oceanic troughs in the close neighbourhood of the islands. The bottoms of the Indian and Pacific oceans far from land are probably nearly or quite aseismic. In a second memoir (Verhandelingen No. 9, 1922) Dr. Visser studies the earthquakes with an inland origin in Sumatra and Java only, the materials for the other islands being insufficient. They are few in number. For example, during the thirteen years 1909–1921, 13 earthquakes out of 859 in Sumatra, and 6 out of 748 in Java, had an inland origin. The distribution of inland earthquakes in Sumatra is simple and regular. Most of the epicentral areas coincide with a long fracture which has given rise to an important series of longitudinal valleys in the Barisan mountain ranges. In Java the distribution is less regular. Violent earthquakes have occurred on the slopes of some volcanoes (for example, Mount Gede and Mount Tjerimai). They were, however, of tectonic origin, the proximity of volcanoes being only a coincidence or due to their connexion with the same zones of weakness. At the times of severe earthquakes the activity of the volcanoes was either slight or altogether absent.

TROUTON'S LAW.—When in 1884, in volume 18 of the *Phil. Mag.*, Trouton showed that for a number of liquids the molecular heat of evaporation at the normal boiling-point was 20 times the absolute temperature at that point, the data by means of which the law could be tested were scarce and the accuracy of the values available not great. Additional and more trustworthy data were provided by Louguinine in 1896–1902 and the law shown to hold to within 10 per cent. for groups of liquids of similar constitution, but to be sometimes 50 per cent. in error when, for example, alcohols were compared with organic acids. Further work has disclosed many exceptions and attempts have been made to find temperatures other than the normal boiling-points at which the comparison would give more consistent results. These have, however, been unsuccessful, and in the January issue of the *Phil. Mag.*, Mr. S. B. Mali, of the University of Calcutta, states that there is no temperature at which the law holds, that it has no theoretical significance, and that it is an accident that it appears to hold for some substances at their normal boiling-points. This may be the correct view, but it is still remarkable that many liquids should fall into the accidental group.

Can Gravitation really be absorbed into the Frame of Space and Time?

By Sir JOSEPH LARMOR, F.R.S.[1]

AN answer to this question in the negative has been advanced in a previous paper on the gravitational deflection of light (*Phil. Mag.*, Jan.). The destructive paradoxes concerned with the recent gravitation theory, which were unfolded by M. Jean Le Roux, professor at Rennes, in three notes in the *Comptes rendus* (Nov. 6, Dec. 4 and 22), after that paper was completed, were referred to in a footnote in support of this departure from the familiar answer. These objections require to be further considered; for at first sight they are destructive to all such theories, including the modification there substituted. If an orbit is postulated to be a curve of minimal length in a fourfold expanse of space-time, the element of length (or distance-interval) must be expressed for it locally, and can involve as variables only its own co-ordinates and their differentials. Yet in the cases that have been worked out, the element as determined involves also the concurrent co-ordinates of the other interacting masses; with all these variables present, it could not belong to a curve in a fourfold at all. This destructive dilemma applies very widely.

There may be a suggestion to evade it, in the theory as modified into one of dynamical Action, along the line (already indicated by A. A. Robb) that the idea of distance cannot subsist in the pseudo-space at all. For within an infinitesimal fourfold spherical domain with radius a very small interval *ds*, the co-ordinates would have an infinite range of values. The idea of locality, essential to real space, is thus absent. The fourfold expanse could still be utilised to express conveniently the domains of integration: but where distances have to enter they must be in threefold real space, though it can be variable and be associated with time also variable. Such real spaces and times would be locally not unique; they constitute a Lorentz group of interchangeable forms. The modified gravitational scheme of the previous paper, with its reduction of the influences on radiation to one-half of the accepted values, might, merely by avoiding the idea of fourfold interval interpreted as a geometric distance, possibly still manage to evolve as a dynamical formulation.

But this train of ideas need not be pursued; for in fact the criticism, which seems destructive of a quasi-geometric scheme for gravitation, does not inhere at all in the dynamical domain of Action. The type of procedure for minimising the total Action, when more closely exhibited, would run in principle as follows. Assume some approximate specification for the orbital paths in the fourfold, close of course to the Newtonian solution. The orbits thus assumed will determine the nature of the fourfold space-time expanse (namely ds^2) already adjusted to minimal Action, in which they exist. For each such specification calculate the density of Action in this fourfold expanse, after the manner of approximate modifications as developed by Einstein; and thence find by integration the total Action of the system corresponding to these assumed orbital forms. The forms of the orbits would enter in the expression for the linear element *ds* defining the space determined by these orbits and necessarily containing them. By taking varied forms of the orbits, different forms of *ds* and different values of the total Action would be obtained. The aim would be to adapt the forms of the orbits so that the Action thus determined from them should remain stationary for all slight variations. The way to carry this out would be to minimise the Action further for joint variation of all the orbits, exactly on the lines of the previous paper. The space itself, being determined by the orbits, also changes as the orbits are varied; and it is not at all involved that *ds* remains the elemental distance in the *same space* throughout the procedure.

It would appear then that the Minkowskian method of fourfold spatial analysis as generalised by Einstein for adaptation of gravitation into the optical and electrodynamic group of frames, can be saved from the destructive criticism of M. Le Roux. But to this end the postulate of absorption of gravitation into the spatial frame must be abandoned; and the principle of equivalence of gravitation and acceleration would disappear. The application of the mathematical spatial analysis to astronomy and optics would be reconstructed as a dynamical theory of normal type, unfolding itself in terms of a distribution of Action located ultimately throughout the region of the problem: but the results as modified would still require actual confirmation. If, however, any gravitational influence on light is finally established by the astronomical observations, this type of analysis by aid of a varying spatial frame may remain the most effective way to include it in theory.

[1] Abstract of a paper read on January 22 at the Cambridge Philosophical Society.

The Nature of Gels.

By Dr. S. C. BRADFORD.

IT has been known, probably from the earliest times, that when sufficiently concentrated solutions of certain substances, such as gelatin and agar-agar, are allowed to cool, instead of depositing crystals of the dissolved substance, the whole liquid turns into a jelly. It is natural, therefore, that speculations on the nature of jellies should have been rife long before Graham, in 1861, first pointed out the slow rate of diffusion of colloid substances which distinguished them from bodies which separate from solution in the ordinary crystalline form.

The many theories of gel structure fall naturally under three heads: (1) One-phase or molecular systems, (2) two-phase liquid-liquid systems, and (3) two-phase liquid-solid systems. To the first class belongs Proctor's hypothesis that a gel is a more or less solid solution of a liquid in the colloid substance, in which both constituents are within the range of molecular attractions. This view is very similar to the "super-cooled liquid" theory of glass, and, like that, has difficulty in explaining the loss of mobility which occurs on setting. Proctor suggests that the transformation consists in the formation of tenuous crystals, which interlace and possibly anastomose. Later experiments[1] show that gelation is really an extreme case of crystallisation, but this suggestion would bring Proctor's theory into the third class. In either case, however, his experiments are important, as they show that the swelling of gelatin in

[1] Bradford, *Science Progress*, 1917, 12, 62; *Biochem. Jour.* 1918, 12, 357; 1920, 14, 91; 1921, 15, 553; and "The Physics and Chemistry of Colloids," Discussion by the Faraday Society, etc., London, 1921.

acids can be explained by simple chemical and physical laws.

To the second class belong both Hardy's and Wo. Ostwald's theories that gels are composed of two liquid phases. Theories of this type present the same difficulty as those of the first class in explaining the increase of viscosity during gelation. No emulsions are known having properties really like those of gels. Nor can liquid-liquid systems be imagined with the elastic properties of gels. Moreover, no hypothesis in either of these classes is sufficient to allow the deduction of the various properties of gels, and there is little direct evidence for any of these suppositions.

The third type of theory, that gels contain both liquid and solid, is the most natural, and was the earliest to be proposed. The first definite suggestion appears to have been made by M. L. Frankenheim in 1835, who thought that jellies were aggregates of small crystals with pores between them. A similar view was adopted in 1879 by K. von Nägeli, that such bodies were composed of molecular complexes, or micellæ, with crystalline properties, separated by skins of water and forming meshes (or interstices) in which the water was contained by molecular attraction. From the use of the German word *Maschen* it has been inferred that von Nägeli intended a geometrical framework. But it is not necessary to assume that he meant more than that the water was held by molecular attraction in the interstices of the aggregates (within and between), and that the aggregates were separated by capillary skins of water. This view is almost exactly that which must be accepted as the result of recent experiments. However, since von Nägeli, a number of unsuccessful attempts have been made to devise a mathematical network which would account for the elastic and thermal properties of jellies; it has scarcely been recognised that such a framework must conform to the facts that the elastic properties of different gels differ greatly, and that the different directive forces inherent in the ultimate particles of different jellies must have some effect on their structure. On this account it seems unlikely that a single framework would be found to satisfy the different properties of different gels; it appears more probable that the structure of gels will be found to vary according to the nature of the gel substance.

O. Bütschli's extensive researches on foams and gel structure are well known. He came to the opinion that the properties of gels might be explained on the basis of a honeycomb structure, in which the walls were permeable to liquids because of their extreme thinness, although they might be porous. To this it must be objected that the use of alcohol and tanning reagents to bring out the microstructure, adopted by Bütschli, and later by Moeller, is open to objection, as being likely to alter the structure of the gels or to modify the gelation process. Moreover, Zsigmondy and Bachmann have demonstrated, from the vapour pressure isotherms, that gels must contain fine pores with a radius of from 2·5 to 5 $\mu\mu$, some 300 times smaller than Bütschli's honeycombs. From microscopic work on soap curds and gels, these workers and McBain have favoured a fibrillar structure. This view has also been adopted by Moeller for gelatin, and is supported by Barratt from experiments on fibrinogen gels. For the soaps and fibrinogen there is direct microscopic evidence that fibrils can be formed by the cooling solutions, indicating that the ultramicroscopic structure of their gels may be fibrillar. In other cases a globulitic structure is indicated. Menz observed the development of submicrons in gelating 2 per cent. gelatin, which increased from 4, showing Brownian movement, in a square division of the field with a side of 9 μ, to 80 or 100, at rest, in the same area. Hardy describes the appearance of microscopic spherites of 10 μ in gels of 5-dimethylaminoanilo 3 : 4-diphenyl*cyclo*-pentene-1 : 2-dione, and Bachmann showed that the ultramicroscopic appearance of gelatin gels deprived of water is globulitic.

Thus there is much evidence for the liquid-solid type of theory. Nor is Debye and Scherrer's X-ray analysis sufficient to show that the ultimate particles of gels are not crystalline, because the radial elements of the spherites, in which form experiments show gelatin and agar-agar to be deposited from solution, cannot be composed of many layers of molecules, and it is doubtful whether such complex molecules could produce appreciable interference of monochromatic X-rays.

But none of the theories mentioned is sufficiently definite to permit the deduction of the properties of gels and the explanation of the reversible sol-gel transformation. Nor do they suggest a reason why such substances as gelatin and agar-agar should occur invariably in the colloid state. The latter question proves to be a crucial one. Investigation shows that, in this respect, there is no fundamental difference between gelatin and other substances—that the same laws govern their solution and precipitation; and gelation is merely a limiting case of crystallisation.

In this connexion the researches of von Weimarn are of fundamental importance. From a great many experiments with such substances as barium sulphate and aluminium hydroxide he deduced an empirical formula,

$$N = K\frac{P}{L},$$

which expresses a relation between N, the "form coefficient" of the precipitate, and K, P, and L, respectively functions of the viscosity of the reaction medium together with the size and structure of the particles in solution, the excess concentration of the substance to be precipitated, and its solubility. Von Weimarn was able to show that as N increases, the precipitate passes through stages in which it appears as (1) large complete crystals only after some years, (2) ordinary crystals in a short time, (3) growth figures or needles, (4) amorphous precipitates frequently showing microscopic spherical grains, and (5) as a gel which cannot be differentiated by the microscope. The formula suggests at once that gelation is merely an extreme case of crystallisation, and that gelatin is a substance the properties of which lead naturally to a high value of N. This is completely borne out by experiment. Not only do the properties of gelatin sols coincide with those of supersaturated solutions, but by reducing the value of N, gelatin is readily obtained as a precipitate, with particles microscopically visible. The solubility of ashless gelatin in water is found to be 0·12 grm. per 100 grm. solution at room temperature, *i.e.* about 18° C. More recently Fairbrother and Swan found the value 0·07 per cent. at 18° for another brand containing 2·24 per cent. of ash. Such a solution is perfectly clear. At 0·13 per cent. gelatin forms a metastable solution, which remains in the supersaturated stage on account of the very low diffusion constant of the substance. This solution has a beautiful bluish opalescence and may be regarded as a typical sol. A further slight increase in concentration brings about the precipitation of the excess of gelatin as a gelatinous mass appearing in the microscope like grains of sand. Many of the particles can be separately distinguished; they are spherical in form and up to about 2 μ in size. With increase of concentration, the bulk of the precipitate grows and the particles decrease in size until, at about 0·7 per cent., the precipitate fills the solution and forms a white, slightly opaque jelly. The opalescence gradually disappears as the gel particles become smaller with increasing concentration. Gelatin jelly is therefore a gelatinous precipitate of gelatin of at least 0·7 per cent. concentration.

The size of the particles can be increased by allowing them to grow by spontaneous evaporation of the solution, subject to the necessary precautions. After one month the precipitate is buff-coloured, and appears as a mass of perfectly spherical microscopic grains exactly like Perrin's grains of mastic. From these and many similar experiments, in conjunction with the ultramicroscopic appearance, it may be concluded that a gelatin jelly is a mass of ultramicroscopic spherites of gelatin in which, as von Nägeli suggested, the water is held by molecular forces. These forces are the cause of the swelling in water, and the heat of swelling can be calculated roughly on this supposition. The structure fits exactly Zsigmondy's analysis of the vapour pressure isotherms. Experiments on the relation between the excess concentration and the size of particle are being made and may lead to a more definite form of von Weimarn's equation. But, in its present state, the formula is sufficient to explain the occurrence of gelatin in the colloidal state. The molecular weight is unknown, but Dakin's recent analyses suggest that it may be as great as 10,000, or more, a value which would correspond to a molecular diameter of 0·75 $\mu\mu$ and bring its molecules up to colloidal size. But, though the molecular weight should be much less, there is no doubt that the molecules are very complex, for this is the reason for the very low diffusion constant; moreover, as the viscosity also of the sols is considerable, the factor K must be very large. In addition to this, the solubility, L, is very small, and the excess concentration, P, is usually large, so that everything conspires to produce a maximum value of N corresponding to the colloid condition. The permanence of the jelly is due to the very small diffusion constant, which prevents recrystallisation. But this does occur slowly, as is shown by the gradual appearance of opalescence, and even of microscopic spherites, in gels kept for a long time in sealed tubes.

Since agar-agar also separates from solution in the form of spherites, it appears that the structure of gels of this substance and of gelatin is probably that of a pile of shot, while soap and fibrinogen gels may be fibrillar. Such a fine-grained structure is compatible with all the known properties of gels, except the heat of swelling of gelatin, 5·7 cal. per grm., and the so-called thermal anomaly. Re-determination of the former gave 33·25 cal., and investigation of the latter showed that it was unfounded. Two questions remain undecided: (*a*) The nature of the spherites and (*b*) whether they are joined together to produce a framework in the jelly. Spherites are known in every gradation, from the obviously crystalline form, built up of coarse radiating crystalline needles separately visible, through stages showing only a more or less radiating formation, but giving the well-known shadow-cross in polarised light, to apparently homogeneous spherical bodies giving no definite evidence of crystalline structure. Gelatin and agar-agar spherites appear to belong to the last class. Experimental evidence suggests that the spherites coalesce during gelation. They would seem either to aggregate crystallographically or to adhere by their mutual attraction; or, the apparent attraction may be due to the water molecules having a greater mutual attraction than the spherites. It will be admitted, however, that, in the case of such small particles, there can be very little difference between the two former methods of attachment, since the union must be due to the forces between the few molecules in the surface of contact. With two grains only, the coupling would be unstable, but it would become firm as more grains were added.

Since writing the above, evidence has been obtained that the gelatin spherites are really crystalline. Some of these, grown to a size of about 3 μ, by methods previously described, and mounted in glycerin, were examined with polarised light. When the Nicols were crossed they became brilliantly coloured and many showed shadow crosses, while grains of mastic prepared by Perrin's method and mounted in the same way became invisible. These experiments are being continued, but, without evidence to the contrary, it will be difficult to deny that gelation is merely an extreme case of crystallisation.

Physical Properties of Clay and Clay-Mud.

MUD and clay are materials, the properties of which are not only of concern to the meticulous housewife and to the children who make mud pies and clay engines; the geologist has found interest in their formation, and from the study of them is able to trace a large part of the history of the earth's crust. They have played their part in the æsthetic development of the race. They have been the architect's and engineer's friend for the making of building materials, and have filled them with concern and not infrequently dismay when they have desired to build upon them or when they desired to support them. The story of the development of buildings, bridges, and other types of structures, tells of many failures, because of the treacherousness and uncertainty of these materials, and partly, at least, because engineers and architects had not attempted to determine their properties in a scientific manner.

Mr. A. S. E. Ackermann has presented, during recent years, four papers to the Society of Engineers in which he has described experiments to determine the physical properties of clay and the effect of water content upon their properties.[1] He has shown that, like certain metals, clays have a certain measure of fluidity. When a disc resting on clay is loaded the disc sinks into the clay, the amount it descends depending on the load and on the time allowed; and when the load exceeds a certain amount, which depends upon the amount of water present, the rate and extent of penetration are considerably increased. The stress at which this occurs, Mr. Ackermann has called the pressure of fluidity. Mr. Ackermann's experiments have been directed toward determining the bearing power of soils, and the loads that can safely be applied to them.

The difficulty of reconciling experimental data on the properties of these materials is evidenced by comparing the results of experimenters. Mr. Ackermann states that the friction angle for wet mud varies as the square root of the pressure, while Crosthwaite says it is proportional to the square root of the pressure. A special committee of the American Society of Civil Engineers to codify present practice on the bearing values of soils for foundations, has issued a series of reports, and has emphasised the importance of the colloid content of clay, which consists of non-crystalline, hydrated, gelatinous aluminium silicates, gelatinous silicic and hydrated ferric oxides; rarely aluminium hydrate may also be present. Most of the grains of the minerals in the clay are enveloped by colloid, but quartz grains

[1] Society of Engineers Transactions, 1919–20–21–22.

do not, as a rule, have the colloid coating. The plasticity of the clay depends upon the amount of colloid present. To separate the colloidal from the granular material, the clay is revolved at 40,000 revolutions per minute in a separator.

Dr. Hubert Chatley, in a recent paper,[2] has discussed the properties of clay-mud, and states that it has three special features:

(1) A granulated structure of varying degrees of fineness.
(2) A semi-permanent water content, which gives it peculiar mechanical properties.
(3) A certain small reserve of chemical potential, which, under certain conditions, will cause it to change in various ways.

He discusses the methods of observing the granular matter by means of the microscope, and states that the plasticity depends upon the size of the products and the proportion of colloids present. He divides the water content into three classes.

Clay-mud containing 15 per cent. by weight of water has a tensile strength of 15 lb. per sq. inch, but doubling the water content reduces the tensile strength to one-third of this amount. With 28 per cent. of water, its viscosity is about the same as a heavy grease, corresponding to a shear strain of 1 radian per 100 seconds, under a shear stress of more than 100 grm. per sq. cm. It differs from heavy grease, however, in that water is extruded as the pressure is increased. It is not watertight, and dykes allow water to percolate very slowly, but if the surface of the dyke is dry, the surface tension may arrest the flow.

The results of the data indicate agreement with common experience that the water content of clay is of great importance, and they also indicate that, as with all other materials, the working stresses should be within the " elastic range."

[2] Society of Engineers, June 1922.

Silvanus Thompson Memorial Lecture.

AT the request of the Finsbury Technical College Old Students' Association, Sir Oliver Lodge gave the first of these lectures at the College on February 1, Sir Charles Parsons in the chair, to an audience numbering more than a thousand and including many eminent past students. After a reference to the splendid work of the College in the past, and its hopes for the future, the lecturer recalled the brilliant succession of teachers—Ayrton, Perry, Meldola—colleagues of Thompson. Of the latter he said: " The breadth of his outlook and width of his interests are almost proverbial; his facility in foreign languages enabled him to hold his own in assemblies abroad, and he had a real artistic faculty. He had a love of discoveries in their nascent stages, and became a recognised historian of science. To a man of his cosmopolitan feelings and pacific disposition, the war and its atrocities were a great distress; grief and worry and overwork overtook him, and he succumbed on June 12, 1916—a victim of the war—having been principal of Finsbury since 1885."

Proceeding to the subject of the lecture, " The Origins or Foundations of Wireless Communication," and confining himself to matters prior to 1896, Sir Oliver recalled that the term " inductance " did not at first exist; Lord Kelvin introduced it as a mathematical coefficient, Maxwell spoke of self-induction, and Heaviside originated the term now used. In the early work on the production and detection of electric waves in the ether, Kelvin, Maxwell, FitzGerald, and Hertz laid the foundations which made the present superstructure possible.

In 1875 Edison observed the possibility of drawing sparks from insulated objects in the neighbourhood of an electrical discharge; already in 1842, Henry, in Washington, had surmised—through a similar observation—that there was some similarity between the etherial disturbance caused by the discharge of a conductor and the light emitted from an ordinary high-temperature source. Early in the 'eighties David Hughes, working with the microphone and galvanometer, got something like a coherer, but was discouraged from pursuing the matter. In 1865 Maxwell gave the theory of electric waves, before their generation or detection was understood; he showed that they would travel with the velocity of light, that light was an electromagnetic phenomenon, that conductors of electricity must be opaque to light, and that the refractive index of a substance was intimately related to its dielectric coefficient.

This discovery aroused great enthusiasm, and one result was to influence the lecturer to devote his life to the study of electric waves; he discussed them with Fleming and FitzGerald, and spoke about them at the British Association in 1879 and later. In 1883 FitzGerald proposed the generation of the waves by using the oscillatory discharge of a Leyden jar, and the lecturer, in 1887, produced and detected them. The waves were received on wires adjusted to the right length for resonance. The experiments of Hertz, who received the waves on a nearly closed ring of wire having a short spark gap, were reported by FitzGerald at the British Association meeting of 1888, and Sir Oliver calculated the horse-power of the oscillator—about 100, for a millionth of a second; he exhibited many of the effects of the waves at the Royal Institution in 1889, but there was nothing akin to signalling; that was foreshadowed, in 1892, together with the possibility of tuning, by Sir William Crookes, who spoke of wave-lengths with which to signal to specific people, and alluded to Hughes's signals made from room to room without intervening wire.

In 1890 Sir Oliver employed a form of coherer to complete a bell circuit, and in 1893 heard of Branly's filings-coherer. In memory of Hertz, for whom Sir Oliver expressed the greatest admiration, both on account of his experimental skill and mathematical thoroughness, he gave a lecture at the Royal Institution on the work of Hertz; at this lecture actual signalling with a coherer was demonstrated. This work led to the grant of Lodge's patent in the United States, which was the fundamental patent of the American Marconi Company. The lecture stimulated Dr. Muirhead, Captain (now Admiral Sir Henry) Jackson, Admiral Popoff, Prof. Righi, and others to their experimental successes; in 1896 Mr. Marconi came to this country—and the rest is common knowledge.

After the lecture the audience was entertained at a conversazione in the laboratories. A beautiful collection of Dr. Thompson's paintings was on view, together with a number of his works, including a translation of Gilbert's " De Magnete " (1601) and a copy of the original. Coils constructed by Faraday, the first Nicol prism, a coherer made by Sir Oliver Lodge, acoustical and optical models, and many personal relics were lent by the late Doctor's family. Mr. W. M. Mordey, president of the Old Students' Association of the College, gave a demonstration of some effects of alternating magnetism on iron, nickel, cobalt, and ores of these metals, and on Heusler alloy. Prof. E. G. Coker showed the action of cutting tools working on a transparent medium by means of polarised light, using for this purpose Dr. Thompson's large Nicol prism, and Prof. C. H. Desch exhibited a number of lantern slides illustrating the structure of steel and non-ferrous alloys. Dr. Eccles, principal of the College, and a number of past students had interesting exhibits.

Pasteur.

ON Friday last, February 2, an address on the work and ideals of Pasteur was given in the rooms of the Royal Society by Dr. Pasteur Vallery-Radot, the grandson of Louis Pasteur. This was the first of a series of lectures, organised by the Alliance Française to be given by Dr. Pasteur Vallery-Radot in this country, in commemoration of the centenary of Pasteur, which is being celebrated this year. Sir Charles Sherrington, president of the Royal Society, was in the chair, and among those present at the meeting were Sir Anthony Bowlby, Sir Humphry Rolleston, Sir William Hale-White, Sir Charles Ballance, Prof. C. J. Martin, and Mr. Chaston Chapman.

Dr. Pasteur Vallery-Radot prefaced his remarks by saying how much he appreciated the homage which this country was paying to his illustrious grandfather, since it was in England, the home of Jenner and Lister, that Pasteur found some of his most ardent supporters. He contrasted the state of medicine before the advent of Pasteur with what it was at the end of the nineteenth century, showing what immense benefits had accrued to humanity at large from the brilliant researches of this great man.

In the short period of forty years, Pasteur lifted the study of infectious disease out of the morass of empiricism and placed it on a scientific basis. By his discoveries he opened up a new world, the realm of micro-organisms, and laid the foundations of bacteriology, which to-day occupies so important a position in medicine and many industries. The numerous investigations of Pasteur, commencing with his work on the tartrates and paratartrates at the age of twenty-six, were next rapidly passed in review. His fundamental discoveries in fermentation, his investigations on the disease of silkworms, chicken cholera, swine erysipelas, anthrax, these were all dealt with in logical sequence leading up to the masterpiece of this scientific genius, anti-rabies inoculation.

Perhaps to many this story was not new. It bears repetition, however, not only because of its enthralling interest, but because of the lesson which can be learnt from it. There are many, even to-day, who are only too ready to point the finger of scorn at scientific investigation or to oppose animal experiments. If only these misguided individuals were to make a study of the life and work of Pasteur, perhaps many of the grotesque criticisms of research would remain unuttered. To what did Pasteur owe his great success? We are told that as a youth at the Lycée he showed no promise of great achievement in life, that he was no more than an average pupil. He was, however, endowed with an imagination which served him well in planning his investigations. Coupled with this gift was a critical faculty which he applied rigorously to all he did—an unusual combination. It was, however, his faith in the experimental method, his fundamental honesty, his single-mindedness and his immense desire to advance knowledge and work for the good of humanity, which enabled Pasteur to achieve what he did. Inspired by this ideal, he went from one success to another, carrying all before him. Despite this, Pasteur remained simple and unostentatious to the end; he was indeed a great man.

Pasteur and Lister are perhaps the two most beautiful characters among the scientific men of the last century. Their lives should be read and studied by all those entering upon a career of scientific investigation. With such a model as Pasteur and fired by some of the idealism and enthusiasm of this great man, even those of mediocre attainments would achieve success. S. P. B.

University and Educational Intelligence.

CAMBRIDGE.—Another important development of the Agricultural School of the University is foreshadowed in an offer from the Ministry of Agriculture and Fisheries announced by the Council of the Senate. In the first instance the offer is of a sum of 30,000*l.* from the Development Commissioners to provide for a Chair of Animal Pathology. On the professor being appointed, he would be required to prepare a scheme for the development within the University of the study of the diseases of farm animals. For an approved scheme the Commissioners would be prepared to find a capital sum of about 25,000*l.* for buildings, the sites to be provided by the University. While the Corn Production Acts (Repeal) Act Fund lasts, *i.e.* till about 1927, annually recurring grants for maintenance and research would be met out of that Fund. After the Corn Repeal monies come to an end the Ministry confidently expect to find from other sources money to continue the work. In the event then of the necessary financial provision not being forthcoming, the University would be under no obligation to continue the Institute. Both the Schools of Agriculture and of Medicine stand to gain greatly from this new scheme, and work of the utmost importance for that side of agriculture which depends on live-stock will be initiated.

It is proposed to confer the degree of M.A., *honoris causa*, on Mr. Humphry Gilbert-Carter, director of the Botanic Garden.

LONDON.—A course of four public lectures on "Electric Fields in Atomic Physics" will be given at University College, at 5.15 on March 13, 15, 20, and 22, by Prof. E. T. Whittaker. Admission will be free, without ticket.

Applications are invited by the Senate for the University readership in cultural anthropology tenable at University College. The latest time for the receipt of applications (12 copies) is the first post of Thursday, February 22. They should be sent to the Academic Registrar, University of London, South Kensington, S.W.7.

OXFORD.—An examination will be held at Keble College on March 13 for two science scholarships, each of the annual value of 80*l.*, plus 20*l.* laboratory fees. The subjects of the examination will be chemistry or biology, with elementary physics, and, for biologists, elementary chemistry in addition. Information can be obtained from Dr. Hatchett Jackson, Keble College, Oxford.

Dr. R. A. Peters, lecturer in biochemistry in the University of Cambridge, has been elected to the Whiteley professorship of biochemistry.

DR. G. H. CARPENTER, professor of zoology at the Royal College of Science, Dublin, has been appointed keeper of the Manchester Museum.

DR. RAFFAELE ISSEL, son of the late Prof. Arturo Issel, the geologist, has been appointed professor of zoology in the University of Genoa.

IN the course of the annual dinner of the Honourable Society of Cymmrodorion on January 19, at which the Prince of Wales was the chief guest, Mr. Dan Radcliffe promised, in honour of His Royal Highness, to give 50,000*l.* for the benefit of the University of Wales.

THE Sydney correspondent of the *Chemical Trade Journal* writes that the secretary of the Victorian Chamber of Manufactures has informed the registrar of the University of Melbourne that the sum of 1500*l.* per annum for ten years has been contributed for the University funds "for the purpose of assisting in providing and maintaining professional chairs associated with arts and sciences which have relation to industries and production."

IN connexion with Battersea Polytechnic, Tate scholarships in engineering, science, and domestic science are being offered for competition in June next. The scholarships vary in value from 20*l.* to 30*l.* per annum, with free tuition, and are tenable for two or three years. The latest day for the receipt of applications is April 21. Further particulars are obtainable from the principal.

"THE continued neglect of science as a part of general education in schools" is lamented by the advisory committee on the textile industries and colour chemistry departments of the University of Leeds in a report for the year 1921–22. They are able, nevertheless, to congratulate these departments on being permeated as never before by the spirit of research. An illustrated account of one of their investigations—into the ancestry of the Suffolk Down sheep—appeared early last year in NATURE (vol. 109, p. 595). The number of students, though smaller than in the preceding year, was still large: day students 277, evening 131. More than 80 per cent. of students who completed their course in the department of colour chemistry and dyeing last session obtained either positions in factories or research scholarships; there is evidence of an increasing tendency for large manufacturing firms to engage only those students of the department who have obtained in addition to the honours degree some experience of research in pure science.

A USEFUL "Record of Educational Publications" is issued from time to time by the United States Bureau of Education. Those of May and September 1922 (Bulletins 21 and 33, 5 cents each) covering a period of about 8 months, contain some 800 titles of books and articles classified under such headings as: educational history, current educational conditions, educational theory and practice, educational psychology, psychological tests, etc. In many cases a brief synopsis of the contents is given. Eleven books and pamphlets, containing 1300 pages, and 50 magazine articles are devoted to the subject of intelligence tests, interest in which was greatly stimulated in America by their utilisation during the war for recruiting purposes. Under the heading of higher education appear notices of two works by French "exchange" professors, one being "Universities and Scientific Life in the United States" (Oxford University Press), by M. Caullery, who was exchange professor of biology at Harvard, and one, "Six mois à l'université Yale," by A. Feuillerat, which appeared in the *Revue des deux Mondes* for February and March 1922. *School Life* announces that seven American universities have combined to finance an exchange between Prof. Jacques Cavalier of Toulouse and Prof. A. E. Kennedy of Harvard and the Massachusetts Institute of Technology.

Societies and Academies.

LONDON.

Royal Society, February 1.—O. W. **Richardson**: The magnitude of the gyromagnetic ratio. The gyromagnetic ratio has the value m/e instead of 2m/e, the value calculated on the turning electron orbit theory of magnetism of the Langevin type; the discrepancy may be due to the rotation of the atomic nucleus. In iron it appears that the effective electron orbits possess altogether two quanta of angular momentum per atom and the nucleus a single quantum of angular momentum on this view.—Sir Richard **Paget**: The production of artificial vowel sounds. Plasticene resonators were used to imitate resonances heard by the writer in his own voice when breathing various English sounds. The first models, made in rough imitation of the oral cavity, gave two double resonances. The models were tuned by appropriate alterations of form until they gave recognisable breathed vowel sounds when blown through a small orifice at the back. An artificial larynx was made by means of a rubber strip laid edgewise across a flattened tube, and, when blown through this larynx, the models gave recognisable voiced vowels. The oral cavity behaves in every case as two Helmholtz resonators in series, and the remaining vowel sounds were reproduced by forming two separate resonators joined together in series, and made of such capacity and size of orifices as to allow for mutual reaction of resonators on their respective resonant pitch. Vowels may be produced by two resonators in series with a larynx between them, and a single tubular resonator may act as two resonators in series. Two resonators in parallel, blown by means of a single larynx with a bifurcated passage, produced vowel sounds indistinguishable from resonators in series.—F. **Simeon**: The carbon arc spectrum in the extreme ultra-violet. The arc-spectrum of carbon gives lines in the Lyman region at 1194, 945, 858, 687, 651, 640, 599, and 595, which have not been previously observed. They correspond with prominent lines in the "hot-spark" spectrum studied by Millikan. Groups of lines have been found at 1657, 1560, 1335, 1329, 1260, 1194, 1175, 1036, and 651, of which those at 1329, 1260, 1194, 1036, and 651 do not seem to have been observed by any other worker, and that at 1657 has not been completely resolved heretofore.—J. **Joly**: Pleochroic haloes of various geological ages.—H. A. **Wilson**: The motion of electrons in gases.—H. **Hartridge**: The coincidence method for the wave-length measurement of absorption bands. Measurements of the absorption bands of pigments by the ordinary spectroscope are inaccurate because of the breadth of the bands and the indefiniteness of their margins. The adjustment of two similar absorption bands into coincidence can be effected with considerable accuracy. If then a spectroscope is designed in which two spectra are seen side by side on looking down the eyepiece, but reversed in direction with one another, the measurement of the mean wave-length of the absorption bands can be accurately carried out. The quantitative estimation of pigments depends on the movement of the bands which occurs when the concentration of one pigment changes. In measuring the percentage saturation of blood with carbon monoxide from the wave-length of the α-absorption band, the accuracy of measurement is approximately 0·7 Å.U. The probable error in setting two absorption bands into coincidence is little greater than that of setting two sharp black lines into coincidence, or of making one line bisect the area between two others.—A. **Berry** and Lorna M. **Swain**: On the steady motion of a cylinder through infinite viscous fluid. The so-called "inertia" terms are neglected and a solution is found which satisfies the boundary conditions on the cylinder and makes the velocity only logarithmically infinite in one direction at infinity. The relative velocity increases comparatively slowly with the distance from the cylinder, and the solution should give a fairly good approximation to the motion at small distances from the cylinder. First, the elliptic cylinder is treated as a limiting case of the ellipsoid. The solution, which in the case of the ellipsoid satisfies the boundary conditions and those at infinity, leads to a solution for the elliptic cylinder. The plane laminæ, both along and perpendicular to the stream, are considered as limiting cases, and further, the motion due to the circular cylinder is deduced as a special case of the elliptic cylinder. Secondly, the solutions for the elliptic and circular cylinders are obtained directly from the equations of motion. Finally, stream-lines, curves showing variation of velocity along stream-lines and curves of constant velocity are drawn for three limiting cases.—W. **Jevons**: The line spectrum of chlorine in the ultra-violet (Region λ 3354-2070 Å.). Observations of the spectrum of the chlorine discharge tube, which have not hitherto extended lower than λ 3276 Å. (Eder and Valenta), have been continued so far as λ 2070 Å. by means of 10-feet grating and quartz-prism spectrographs. Wave-lengths and wave-numbers of nearly 200 newly observed Cl lines are recorded, together with the effects of variations of capacity on the intensities of more than 100. The constant differences ($\Delta\nu$) 40·4, 67·1, 107·5, found by Paulson in pairs and triplets above λ 3276 Å. recur in a few pairs below that point. The significance of these separations in relation to the analysis of the spectrum, however, appears doubtful, since there is no apparent regularity in the intensities of the lines involved, and no triplets having these separations have been detected in the region under investigation.—M. H. **Evans** and H. J. **George**: Note on the adsorption of gases by solids and the thickness of the adsorbed layer. The amount of carbon dioxide adsorbed by unit surface of glass, at a pressure approximating to one-sixth of an atmosphere, suggests that the carbon dioxide is condensed on the surface of the glass in a liquid layer having a thickness equal to between five and six times the diameter of the molecule of the gas. By combining this result with the published figures of Mülfarth (*Ann. d. Physik*, 1900, vol. 3, p. 328) on the relative adsorption by glass of the gases acetylene, nitrous oxide, carbon dioxide, sulphur dioxide, and ammonia, it is found that these gases are adsorbed by the surface to such an extent that if they were present as liquid layers, the thickness of the layers would vary from (in the case of acetylene) three, to (in the case of ammonia) forty molecular diameters. A direct determination of the degree of adsorption of ammonia gives a value of the same order as that calculated from Mülfarth's data. The results are in disagreement with Langmuir's recent generalisation that the forces of attraction exerted by a surface do not extend to a distance greater than the diameter of one molecule.

Linnean Society, January 18.—Dr. A. Smith Woodward, president, in the chair.—G. H. **Wilkins**: (1) A dried vegetable mass made from a variety of wild plants, Chenopodium and others. The plants are now important in the food-supply of the Russian peasantry; they are dried, pounded to a fine flour, and mixed with rye to make coarse cakes. (2) The Shackleton-Rowett expedition in the *Quest* to the Antarctic Regions. On St. Paul's Rocks no plants save a few Algæ were found, but at South Georgia, an island about 100 miles long and 20 miles broad, a considerable collection was made, and reindeer thrive. Lichens and mosses only were observed on Elephant Island; at Tristan da Cunha 16 species were gathered.—E. G. **Baker**: The flora of Gough Island; 20 flowering plants and 10 ferns are known. The only small trees on the island are Phylica and Sophora. There is a new species of Apium allied to *A. australe* Thouars, but having broad cuneiform segments to the leaves. The widely-spread fern *Lomaria Boryana* Willd. reaches a height of from 2 to 3 feet.—Miss Helena **Bandulska**: The cuticular structure of certain dicotyledonous and coniferous leaves from the Middle Eocene flora of Bournemouth. Three new species of dicotyledonous leaves are described from their cuticular structure. The name Dicotylophyllum is proposed for such leaves of uncertain affinity. The cuticles of some fossil conifers were compared with known recent and fossil forms. Thus *Araucarites Göpperti* Sternberg, *Taxodium europæum* Sap. and *Sequoia Tournalii* Sap. are considered on the evidence of cuticular structure to be specifically distinct.

Aristotelian Society, January 29.—Prof. A. N. Whitehead, president, in the chair.—Rev. Leslie J. **Walker**: A new theory of matter. The general trend of scientific thought seems to indicate a return to the basic principles of the Aristotelian philosophy, a philosophy in which the concept of energy is no less fundamental than it is in modern scientific theory. On the other hand, the atomic theory, the electron theory, and still more especially the quantum theory, would seem to indicate that we shall sooner or later be forced to give up the notion of an infinitely divisible continuum, and to substitute in its place a continuum composed of definite and indivisible units. There was, prior to Aristotle, a theory which treated the continuum as a structure composed of unit-magnitudes in immediate relation or "contact" one with the other. It is possible to develop this theory on Aristotelian lines, taking as the basic assumption that the characteristic of ether-particles is to be in immediate relation with six and only six other particles, and that the characteristic of mass-centres is that they may be in immediate relation with either more or fewer than six other particles, possibly with four as a minimum and eight as a maximum. The primary type of change would thus be a change in the immediate relation of particles one to another, and the primary law governing such change an ever-increasing approximation towards equal distribution of the ether-particles with respect to the mass-centres. The theory gave rise to several features analogous to those which are of primary importance in the electron theory.

EDINBURGH.

Royal Society, January 8.—Lord Salvesen in the chair.—J. S. **Dunkerly**: Encystation and reserve food formation in *Trinema lineare*. The paper showed that the process of conjugation and encystment in the rhizopod, *Trinema lineare*, is followed by nuclear fusion, and the formation of reserve food material in the cyst is apparently due to the activity of the extra-nuclear chromidial mass.—Lancelot **Hogben**: Photo-micrographs were shown illustrating a new technique for removal of the pituitary gland in frogs and toads; also photo-micrographs of changes in melanophore response incident to partial and total extirpation of the gland.

SHEFFIELD.

Society of Glass Technology, January 17.—Prof. W. E. S. Turner, president, in the chair.—W. H. **Hatfield**: Stainless steel, with some consideration of its application to the glass industry. Stainless steel can now be made direct into castings, into sheet steel which is very malleable—a development of the last two years—and into tubes, so fine that hypodermic needles are now largely made from stainless tubes. Stainless steel contains 12-14 per cent. of chromium. The carbon content varies a little with the different types but is generally about 0·30 per cent. Stainless steels could be made use of in the glass industry on account of their resistance to scaling and strength at high temperatures. Stainless steel has a high tensile strength, a high fatigue range, and can be hardened and tempered. It might be utilised for parison and blow moulds; many parts of feeder devices might be usefully produced in such material, and also blowing irons, rolls, belt conveyors, lehr chain pins, and other things, including knives for cutting viscous glass. The ends of blowpipes might also be made of stainless steel as well as wire brushes. Stainless steel is being used for mirrors for scientific purposes.—S. **English**: Some measurements of the viscosity of glasses near their annealing points and a critical review of some recent literature on the annealing of glass. Strain in glass cannot always be detected by using polarised light; the most sensitive position is that in which the direction of the strain in the glass is at 45° to the plane of polarisation. The selenite plate is more sensitive than plain crossed nicols only when a very poor source of light is used; it is not possible to distinguish between tension and compression stresses by the use of such a plate. The rate of change of mobility of glasses at their annealing points is approximately constant, most requiring a rise of temperature of 9° to cause a doubling of the mobility. In some cases this temperature interval rises to 11°. At 100°-150° above the annealing points the temperature interval required to double the mobility was generally rather longer than that required at the annealing points. The mobility of glasses is not a logarithmic function of the temperature. The working properties of lead glasses and other soft glasses are probably determined more by the rate of radiation of heat than by rate of change of viscosity with temperature.

PARIS.

Academy of Sciences, January 15.—M. Albin Haller in the chair.—The president announced the death of M. van de Sande Bakhuyzen, corresponding member for the section of astronomy.—L. **Lindet** and P. **Nottin**: The evolution of the starch grains in the tuber of the potato.—W. **Kilian** and F. **Blanchet**: The ammonites collected by the *Pourquoi-Pas?* Emmanuel de Margerie was elected corresponding member for the section of mineralogy in the place of the late M. Œhlert.—Martin **Ålander**: Integral functions which have all their zeros on a straight line. —G. **Sagnac**: The periodic variable spectrum of double stars: the incompatibility of the observed phenomena with the theory of general relativity.—J. **Haag**: The problem of *n*-bodies in the theory of relativity.—Edouard and Rémy **Urbain**: The separation of liquid mixtures by combined distillation and atmolysis. The preparation of practically pure ethyl alcohol and nitric acid. The alcohol is boiled in a flask fitted with a porous tube as reflux condenser. Round this tube is an outer glass tube in which the pressure is reduced. More water than alcohol vapour diffuses through the porous tube, and the alcohol in the flask can be strengthened to 99·8 per cent.—Ch. **Bedel**: A polymer of hydrocyanic acid. The crude polymerisation product of hydrocyanic acid is extracted with ether, and the brown crystals deposited by this solution purified by solution in hot water and treatment with animal charcoal. Its composition is $(HCN)_4$ and appears to be aminopropanedenitrile hydrocyanide.—Alfred **Schoep**: Parsonite, a new radioactive mineral. This is found associated with chalcolite from the Belgian Congo; and has the composition $2PbO . UO_3 . P_2O_5 . H_2O$. It is radioactive.—Mlle. Germaine **Cousin**: The prolongation between Belfort and Thann of the tectonic accidents of the secondary border situated to the south of the Vosges *massif*.—Ch. **Dufour**: Values of the magnetic elements at the station of Val-Joyeux (Seine-et-Oise) on January 1, 1923.—Odon **de Buen** and José **Giral**: The hydrographic tables of Knüdsen, normal water and the limits of error in the analysis of sea water.—Louis **Besson**: The loss of light in Paris and its neighbourhood. Curves are given showing the proportion of light received at nine observing stations as a function of the direction of the prevailing wind.—G. **Mangenot**: The starch of the red Algæ.—A. **de Puymaly**: New mode of cell division in the Desmidaceæ.—Emile **Haas**: New experiments on the phenomenon of Broca and Sulzer (fatigue undulation). —A. **Goris** and A. **Liot**: The importance of organic ammoniacal salts in the production of pyocyanine by the pyocyanic bacillus.—J. P. **Aversenq**, L. **Jaloustre**, and E. **Maurin**: Some effects of thorium-X on diastases and micro-organisms. Thorium-X clearly increases the activity of the hydrolysing or oxidising properties of the enzymes studied (pyalin, amylase from pancreatic juice, amylase from germinated barley, emulsion, ammonia ferment, oxydases of the blood and saliva), and also increases the vitality of certain pathogenic organisms.—Georges **Bourgignon** and Henri **Laugier**: Variations of the neuromuscular excitability under the influence of the suppression and re-establishment of the circulation of a limb in man.

WASHINGTON.

National Academy of Sciences (Proc. vol. 8. No. 12, December 1922).—O. **Veblen**.—Projective and affine geometry of paths.—W. F. **Hamilton**: A direct method of testing colour vision in lower animals. Two Hilger wave-length spectrometers used as monochromatic illuminators were arranged to throw beams of light on the opposite ends of a horizontal glass tubular cell containing Drosophila which had been kept in the dark overnight. The intensities of the beams (of different wave-lengths) were regulated so that the flies showed no orientation. One beam was then screened for a time, and on again exposing it, the flies definitely moved towards it showing differential fatigue. The smallest difference of wave-lengths showing a stimulating effect was used, and over the range 385-500 $m\mu$, hue-perception is a maximum between 410 $m\mu$ and 450 $m\mu$, possibly indicating two receptor systems, one for the blue-violet and one for the blue-green.—L. L. **Nettleton**: Characteristics of a short wave oscillator at very low pressures. A three-element tube was left permanently connected with the vacuum pumps, and currents up to 300 milliamps. at 700 volts were used. The oscillations were measured by a crossed wire thermocouple carried on a bridge sliding along the Lecher wires. Oscillations of wave-length 50-200 cm. were obtained. Both negative plate current and oscillations ceased abruptly at very low pressures (0·00005 mm.) in the tube as measured by an ionisation manometer. The curves resulting from plotting the voltage at the plate and the oscillations in the Lecher wires against the ionisation appear to show that some little ionisation is necessary for this type of oscillation, but the kind of gas present does not seem important.—Bergen **Davis** and H. M. **Terrill**. The refraction of X-rays in calcite. A water-cooled tube with a molybdenum target was used and measurements were made for the first three orders of the $K\alpha_1$

line. The results correspond to a shift of the first order line of 5″, so for this wave-length, the effect of refraction is slight. P. W. Bridgman.—The compressibility of metals at high pressures. The pressure range was 12,000 kgrm./cm.^{2}, and measurements were made at 30° and 75°. The compressibility of every metal decreases with rising pressure and, generally, increases with rising temperature; the order of magnitude of the change is the same for all the metals. Germanium and uranium are possible exceptions. Metals crystallising in a cubic form show the same compressibility in all directions, but the compressibility of, *e.g.*, zinc, measured in three directions perpendicular to each other, varied in the order, roughly, of 1 : 3 : 4. Tellurium shows a negative effect in one direction. The results accord with a theory of two interpenetrating lattices as the structural basis of most metals. There appears to be no simple repulsive potential relation between the atoms of metals which will account for the compressibility data.—Raymond Pearl and L. J. Reed: A further note on the mathematical theory of population growth.

Official Publications Received.

Annual Report of the Meteorological Committee to the Air Council, for the Year ended 31st March 1922. (M.O. 257.) Pp. 59. (London: H.M. Stationery Office.) 2s. net.

Ministry of Finance, Egypt: Coastguards and Fisheries Service. Report on the Fisheries of Egypt for the Year 1921. By G. W. Paget. Pp. vi+78. (Cairo: Government Publications Office.) P.T.5.

Catalogue of the British Industries Fair, The White City, Shepherds Bush, London, W.12, February 19–March 2, 1923. Pp. xxxii+256+180. (London: Board of Trade.) 1s.

Air Ministry: Meteorological Office, London. Southport Auxiliary Observatory (The Fernley Observatory of the Corporation of Southport). Annual Report, and Results of Meteorological Observations, for the Year 1921; with an Appendix containing Monthly Averages, for 10 years, of the Amount and Duration of Rainfall under Different Wind Directions. By Joseph Baxendell. Pp. 36. (Southport: Fernley Observatory; London: Meteorological Office.)

Diary of Societies.

MONDAY, FEBRUARY 12.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.—Surg. Comdr. R. J. M'Keown and Surg. Comdr. A. Gaskell: The co-operation between the Members of the profession and the medical services of the armed forces in peace and during war.—Discussion: Air Commodore D. Munro, Major-General C. E. Pollock, and others.

ROYAL SOCIETY OF ARTS, at 8.—Dr. H. P. Stevens: The Vulcanisation of Rubber (Cantor Lectures) (2).

SURVEYORS' INSTITUTION, at 8.—C. P. Sanger: The Law of Property Act, 1922.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—H. St. J. B. Philby: The North Arabian Desert.—Major A. L. Holt: The Future of the Desert.

MEDICAL SOCIETY OF LONDON, at 8.30.—Dr. E. F. Buzzard and others: Discussion on Psycho-Therapeutics.

TUESDAY, FEBRUARY 13.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. C. Pearson: Greek Civilisation and To-day (1): The Beginnings of Science.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section), at 4.30.—Prof. A. J. Clark: The Scientific Basis of Non-Specific Protein Therapy.—Dr. H. Blumgart: The Treatment of Diabetes Insipidus by Intra-Nasal Spraying of Pituitary Extract.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.—G. W. E. Gibson: Some Practical Notes on Oil Pumping.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Miss Ella Freeman Sharpe: The Super-sensitive Child at School. A Psycho-Analytic Study.

INSTITUTE OF TRANSPORT (at Institution of Electrical Engineers), at 6.—B. Wagenrieder: Railway Rules and Regulations.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—T. D. Madsen: Internal Combustion and Economy.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—A. E. Bawtree: Dangers to Eyesight in Domestic Electric Lighting and the Kinema Picture Display.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—D. T. Scourfield: Presidential Address.

INSTITUTE OF INDUSTRIAL ADMINISTRATION (at London School of Economics), at 8.—F. Mott: Practical Hints on Buying and Selling. (To be followed by a Discussion.)

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Dr. K. Wilson: Involuntary Laughing and Crying.

WEDNESDAY, FEBRUARY 14.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4.—Sir John Bland-Sutton: Hunterian Oration.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-section of Proctology), at 5.30.—P. Lockhart-Mummery: New Method of treating Ischio-Rectal and other Abscesses.

INSTITUTION OF AUTOMOBILE ENGINEERS, at 7.30.—J. L. Chaloner: High-speed Oil Engines.

ASSOCIATION OF ENGINEERS-IN-CHARGE (at St. Bride's Institute), at 7.30.—C. H. J. Day: Hydraulic and Electric Lifts.

ROYAL SOCIETY OF ARTS, at 8.—W. J. Rees: Progress in the Manufacture of Refractories.

THURSDAY, FEBRUARY 15.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. B. Melvill Jones: Recent Experiments in Aerial Surveying (1).

ROYAL SOCIETY, at 4.30.—E. R. Speyer: Researches upon the Larch Chermes (*Cnaphalodes strobilobius*, Kalt) and their bearing upon the Evolution of the Chermesinæ in general.—G. V. Anrep: The Irradiation of conditioned Reflexes.—M. Dixon and H. E. Tunnicliffe: The Oxidation of reduced Glutathione and other Sulphydryl Compounds.—J. C. Bramwell, R. J. S. M'Dowall, and B. A. M'Swiney: The Variation of Arterial Elasticity with Blood Pressure in Man.—L. J. Harris: The Existence of an undiscovered Sulphur Grouping in the Protein Molecule. Part I. The Denaturation of Proteins. Part II. The Estimation of Cystine in certain Proteins.—N. B. Laughton: Reflex Contractions of the Cruralis Muscle in the Decerebrate and Spinal Frog.

LINNEAN SOCIETY OF LONDON, at 5.—A. M. Altson: On the Method of Oviposition and the Egg of the Beetle *Lyctus brunneus*, Steph.—R. Paulson: Arctic Lichens from Spitsbergen.—F. H. Lancum: Strange Behaviour of a Female Butterfly, *Colias edusa*.—Canon Bullock-Webster: Exhibition of Thirty Varieties of *Chara hispida*.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Wing-Commdr. T. R. Cave-Brown-Cave: The Practical Aspects of the Seaplane.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss Richardson: M. Coué and his Work.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—J. Rosen: Some Problems in High-speed Alternators and their Solution.

CHEMICAL SOCIETY, at 8.—A. Chaston Chapman: Spinacene, its Oxidation and Decomposition.—R. H. Pickard and H. Hunter: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XIX. The Rotatory and Refractive Dispersion of *d*-γ-nonyl nitrite.—H. Hunter: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XX. The Rotatory Dispersive Powers of Oxygen Compounds containing the Secondary Octyl Radicle.

CAMERA CLUB, at 8.15.—Major F. C. B. Laws: Progress in Aerial Photography.

FRIDAY, FEBRUARY 16.

GEOLOGICAL SOCIETY OF LONDON, at 3.—Annual General Meeting.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—J. T. Marten: The Indian Census, 1921.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—G. J. Jenkins: Preliminary communication on Osteitis Deformans and Otosclerosis.

INSTITUTION OF MECHANICAL ENGINEERS (Annual General Meeting), at 6.—H. C. Young: Some Mechanical Problems in the Rubber Industry.

INSTITUTION OF ENGINEERING INSPECTION (at Royal Society of Arts), at 7.30.—H. T. F. Rhodes: Chemical Inspection as it is and as it should be.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—T. L. Allison: Notes on some Insulating Materials.

EUGENICS EDUCATION SOCIETY (at Prince's Restaurant), at 7.30.—Prof. Pigou: The Economic Importance of Eugenics.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Prof. Philippson: High-frequency Currents applied to the Study of Cellular Physiology.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. A. V. Hill: Muscular Exercise.

SATURDAY, FEBRUARY 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Projectiles and their Properties (1).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 10.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—E. Lovett: Household Appliances of a Hundred Years Ago.

TUESDAY, FEBRUARY 13.

GRESHAM COLLEGE, at 6.—Sir Frederick Bridge: Music. (Succeeding Lectures on February 14, 15, and 16.)

WEDNESDAY, FEBRUARY 14.

UNIVERSITY COLLEGE, at 5.—P. Leon: The Theory of Beauty. (Succeeding Lectures on February 21, 28, March 7, 14, and 21.)

KING'S COLLEGE, at 5.30.—Dr. D. H. Scott: The Succession of Floras in the Past.

FRIDAY, FEBRUARY 16.

LONDON SCHOOL OF ECONOMICS, at 5.—Prof. Graham Wallas: The Competition of the Sexes for Employment (Stansfeld Lecture).

UNIVERSITY COLLEGE, at 5.15.—P. A. Scholes: The Place of Music in the Education of the Future.

KING'S COLLEGE, at 5.30.—Dr. E. W. Scripture: Shakespeare's Verse in the Light of Experimental Phonetics.

SATURDAY, FEBRUARY 17.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. F. A. Bather: A Limestone Cliff and the Animals that built it.