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Oxford and Cambridge and the Royal Commission.

THE original application for Parliamentary grants, which led to the appointment of the Royal Commission on Oxford and Cambridge Universities, came in 1919 from the heads of the scientific departments of Oxford. Not only were the immediate needs stated and the provision necessary to enable work to be continued, as it had been carried on before the war, but also a great development of the departments was foreshadowed with increasing difficulties in the absence of outside assistance. The Commissioners take the view that a great opportunity has come for Oxford science greatly to strengthen its position if the University and Colleges will take determined action and if funds can be made available. Far from accepting the idea that Cambridge should be allowed to develop as a "Science" University while Oxford becomes still more pronouncedly the home of the "Humanities," the Commissioners emphasise the great value of the "juxtaposition, intellectually and socially, of the best minds in diverse subjects, and the constant interaction of the Humanities and Science on one another." Accepting this point of view completely, we propose to examine their report to see how it will help the full development of science in the two universities.

Foremost in the changes recommended by the Commissioners we place for this purpose the proposals with regard to fellowships. The development in the range and character of university studies has not been accompanied by a corresponding growth in the number of college fellowships available for distinguished teachers. At Cambridge, where on the whole the newer subjects are much more strongly placed than at Oxford, there are university professors for whom no college fellowships are available. The recommendation of the Commission to create fellowships without stipend in the colleges for senior university officers—for whose stipend the university is responsible—both meets this anomaly and leaves vacancies in college fellowships for younger teachers and researchers. Many college societies will be greatly strengthened by the additions that they will thus be able to make to their body. And here we might say that it would have been a great gain to Oxford and All Souls College alike if the Commissioners had made specific provision for the inclusion of scientific studies among those to be supported by that college. Co-ordination between the University teaching by Faculties and the college teaching by tutorial supervision will be improved under the proposed scheme. The Commissioners make very few revolutionary proposals, preferring to build on the sure foundations laid by tradition and experience, and they recognise the great value of the personal contact of the college tuition in Oxford and Cambridge. But difficulties have arisen and will arise between self-governing colleges choosing their own teachers and university faculties controlling departments of study, and the Commissioners have hit on a happy solution of the problem. Colleges retain their freedom to select their own staffs but are penalised financially if a fellow elected to a teaching post is not acceptable to a University Faculty for the position of University Lecturer or University Demonstrator.

Closely tied with the proposals about official fellowships is the scheme for increasing the number of unofficial research fellowships. Coupled with an increase in the number of studentships in the Universities, which would become possible if the recommendations of the Commission as to grants is adopted, this scheme will increase greatly the development of post-graduate research work in the Universities. The Commissioners rightly lay great stress on the importance of this, but point out that it must be impracticable unless the number of teachers is increased and the directors of research are freed from some of the heavy burden of routine teaching. Each proposed reform in turn falls back upon the imperative need for financial assistance: the recommendation of a grant of 100,000*l.* a year to each university in place of the present grant—now become a recurring grant—of 30,000*l.* will have to be accepted before any large proportion of the Commission's proposals can be put into action.

Certain sections of the Commission's report do not deal directly with science but call for brief mention here. The present control of the University by Convocation or the Senate is to be greatly restricted. Congregation or the House of Residents—University

and College officers—is to be the ultimate authority, its decision being checked, in the event of a strong opposing minority, by an appeal to the larger body of non-residents. A second affirmative vote by the resident body is, however, to be decisive. Unless a minority recommendation, signed by two of the Cambridge committee, calling for immediate Parliamentary action is adopted, the position of women at Cambridge is left for decision by the new House of Residents. The Commissioners do, however, support a scheme for full membership, with restriction in numbers to 500,—essentially scheme A rejected by the Senate in December 1920. Special grants, earmarked for the women's colleges, of 4000*l.* a year to each University for a period of 10 years should be a great help to them in their present financial difficulties and a great incentive for a renewal of appeals for benefactions from the public.

Other special grants recommended are 6000*l.* a year to each University for the development of the valuable extra-mural teaching, and special arrangements are suggested for allowing selected adults to join the University without passing the entrance examination to be imposed on all ordinary undergraduates. The importance of the non-collegiate body of students is emphasised as being economical, especially suitable for certain types of students and historically the oldest form of residence in both places. The minimum cost at Oxford in 1920, in cheap lodgings of non-collegiate residence, including board and lodging, is given in the report as 65*l.*

A summary of the report has already appeared in our columns (April 1, p. 428). It is impossible to enter here into all the important questions raised as to the cost of living and the regulations as to college finance. It is equally impossible to conclude this article without reference to the enthralling historical survey of the growth of the Universities with which the report opens.

The First European Civilisation.

The Palace of Minos: A Comparative Account of the Successive Stages of the Early Cretan Civilisation as Illustrated by the Discoveries at Knossos. By Sir Arthur Evans. Vol. 1, *The Neolithic and Early and Middle Minoan Ages.* Pp. xxiv + 721 + 18 plates + plans, etc. (London: Macmillan and Co., Ltd., 1921.) 6 guineas.

THE excavations at Knossos were described by Sir Arthur Evans in detailed reports which appeared in the Annual of the British School at Athens from 1900 to 1905, and were reviewed from time to time in these columns. For years afterwards he and his adjutant, Dr. Mackenzie, were engaged in supplementary work, which involved much digging, in addition to the laboratory processes of cleaning, restoring, and classifying an enormous mass of finds. The history of successive rebuildings was unravelled, and the sequence of pottery-types verified by new trial-pits. Meanwhile discoveries on other sites have filled gaps and supplied chronological data, so that the rise of Cretan civilisation can be correlated step by step with that of Egypt. The magnificent volume before us is the first of three in which Sir Arthur Evans proposes to embody his mature conclusions; it covers two of the three main periods into which he divides the Cretan Bronze Age, and the introduction includes an outline sketch of the whole course of Minoan culture. Much of the material, as of the interpretation, is new. The book is abundantly illustrated, with plans and sections by Mr. Theodore Fyfe and Mr. C. C. T. Doll, drawings by the two Gilliérons, Mr. Halvor Bagge, and Mr. C. T. Lambert, and many excellent photographs. Even more impressive than the extent of the excavation is the skill with which it has been carried through. One wishes that this enterprise, to which the author has so long devoted his private fortune and his unrivalled insight into prehistoric problems, had been more liberally backed by public subscription.

In a notice such as this, one can touch only on a few aspects of the story which the author unfolds. He emphasises the continuity of Cretan civilisation; "from the earliest Minoan stage to the latest there is no real break such as might be naturally explained by conquest from abroad." The Neolithic strata at Knossos are 23 ft. deep, the accumulated debris of several thousand years. If the incised pottery and nude female idols recall those of Anatolian sites, this points to a common heritage rather than to intercourse between distant tribes. Over a vast area of Europe and Western Asia the same low level of rude culture had endured for many centuries without notable progress. The sudden quickening of the Cretan stock which made their island the cradle of European civilisation, came from pre-dynastic Egypt. "It may well be asked whether, in the time of stress and change that marked the triumph of the dynastic element in the Nile Valley, some part of the older population may not have made an actual settlement on the soil of Crete"—a daring hypothesis which future discoveries may confirm; the south coast and western half of the island have been little explored and certainly hold surprises in store.

Pre-dynastic stone vases seem to have reached Knossos before the accession of Menes, for which the author accepts Eduard Meyer's date, 3315 B.C.

"E.M. I.," the First Early Minoan sub-period (roughly 3400–2800), sees the transition from stone to copper implements, and from copper to bronze. On the isthmus of Hierapetra, a short cut across the island for early trade, we meet with rectangular, many-roomed houses of sun-dried bricks framed in timber, with roofs of reeds and clay such as the peasants there still use. In the next stage (2800–2400) the walls are protected with plaster containing 40 per cent. of carbonate of lime; Mr. Noel Heaton's analyses show how this developed into the fine white stucco of almost pure lime on which the fresco-painters worked a thousand years later. Knossos was now importing diorite bowls from Egypt, and imitating them in liparite brought from the Æolian Islands north of Sicily; otherwise this period is scantily represented there, and the author draws freely on the graves found by Mr. Seager at Mochlos, rich in finely wrought jewelry and vases of variegated stone. Gold eye-bandages anticipate the gold masks worn by the dead warriors of Mycenæ, and a votive double axe shows that Minoan religion had already chosen its characteristic emblem.

In "E.M. III." (2400–2100) the centre of interest shifts to the fertile plain south of Mount Ida. Sir Arthur Evans publishes a series of ivory seals found in "tholos" tombs of this region by Dr. Xanthudides, the Cretan Inspector of Antiquities, the motives of which include apes, lions, scorpions, and meander-patterns, carved by native hands, but closely related to designs current at this time in the Delta. From a similar deposit, excavated by Prof. Halbherr, came a seal on which the author recognises an adaptation of the Egyptian draught-board sign (Fig. 1) with draughtsmen of characteristic form, and he is able to assign to this period some three- and four-sided bead seals with scenes from daily life. Before the close of this period huge works were being undertaken at Knossos; a round subterranean chamber, hewn to a depth of 53 ft. below the rock-surface, and entered by a step-way curving about its circumference, shows remarkable constructive skill. Whatever their purpose, this and another "hypogæum" (as yet unexcavated) were disregarded when the First Palace was built in the First Middle Minoan period (2100–1900). It was the Age of Palaces. Alike at Knossos and at Phaistos there rose a great complex of state-apartments, sanctuaries, and store-houses; both were laid in ruins by some catastrophe, due to invasion or revolt, at the close of "M.M. II." (before 1700), and both were rebuilt with greater splendour soon afterwards, to be overthrown again at the close of "M.M. III." (about 1580). The Late Minoan phases, in which the art of Knossos attained its acme and declined, lie outside the scope of this volume.

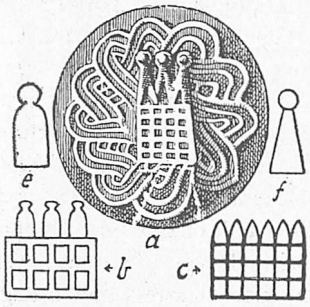


FIG. 1.—*a*, Draught-board and pieces on E.M. III. ivory signet (Fracture restored). *b*, *c*, Early types of Egyptian draught-board sign (*men*). *e*, *f*, Egyptian pieces. From "The Palace of Minos at Knossos."

From "M.M. I." onwards Knossos seems to dominate Crete. The buildings about the central court were planned with an eye to defence, notably the tower-like "Early Keep" which flanked the north entrance and had deep dungeons or store-pits in its basement. The neighbouring Peak-sanctuary on Mount Iuktas, frequented at this period, yielded votive offerings like those of Petsofà, above Palaikastro; these "high places" seem to have been sacred to the Mountain Mother, the supreme deity of Minoan religion, worshipped in the Palace as the Snake-Goddess. The remodelling of the Palace in "M.M. II." suggests elaborate provision for the ritual purification of those who entered it; from the first it was a sanctuary, ruled by priest-kings, who drew revenues in kind from large territories and exported oil and other produce to Egypt. The gay-coloured "M.M. II." pottery is dated within narrow limits by finds at Abydos and Kahun, and it may be that Cretan workmen settled at Kahun and worked for the Pharaohs, and even that the very ancient wharves and breakwaters off the island of Pharos, near the later site of Alexandria, which have been explored in recent years by M. Jondet, were constructed by Minoan engineers. Cretan art owed some of its technical accomplishment to this intercourse, but developed on its own lines, tending more and more to naturalism.

After the destruction of Knossos and Phaistos at the close of "M.M. II." a new dynasty took control, as the author infers from the introduction of a new linear script, not a direct outgrowth of the hieroglyphic system, and new methods of sealing; but the sacred character of the Knossian palace persisted, and a large part of the six acres which it covered was devoted to "lustral basins" (the "bath-rooms" of earlier reports), "pillar-rooms," and shrines. The state-apartments of the period, built on the hill-side east of the central court, are preserved to a height of two stories; the excavation of this region, and its reconstruction by the substitution of new beams and pillars for the carbonised ancient timbers, were feats of which Sir Arthur Evans and his staff may be proud. The elevation of the Grand Staircase (Fig. 2) illustrates the spacious dignity of Minoan architecture at its best. Of the fresco-paintings two examples are reproduced in colour, but the larger pieces are reserved for a Knossian Atlas to be published hereafter. Other colour-plates represent the faïence Snake Goddess, the famous inlaid draught-board of ivory, gold, and

crystal, and the polychrome pottery which in "M.M. II." attained a marvellous perfection of both form and design, but fell off in the succeeding period when other arts, notably that of the gem-engraver, were making rapid progress. Apparently the growing wealth of the new dynasty provided an abundance of table-ware in more precious materials, and pottery "was nothing accounted of"; the same cause led to the formation of a Palace Treasury in the west wing. Some of the magazines were walled off, and a series of lead-lined strong boxes was built under their floors. All were plundered when the palace was sacked, only scraps of gold foil and fragments of inlaid caskets being left. The author shows that the richest of the Mycenæ shaft-graves belong to this period, and that their contents, gold, silver, and faïence, may be part of the spoils of Knossos.

The book lights up many other problems; it makes known an early art of extraordinary freshness and beauty, and since it justifies in detail the "Minoan" system of classification and nomenclature, it lays a broad foundation for future research.

R. C. BOSANQUET.

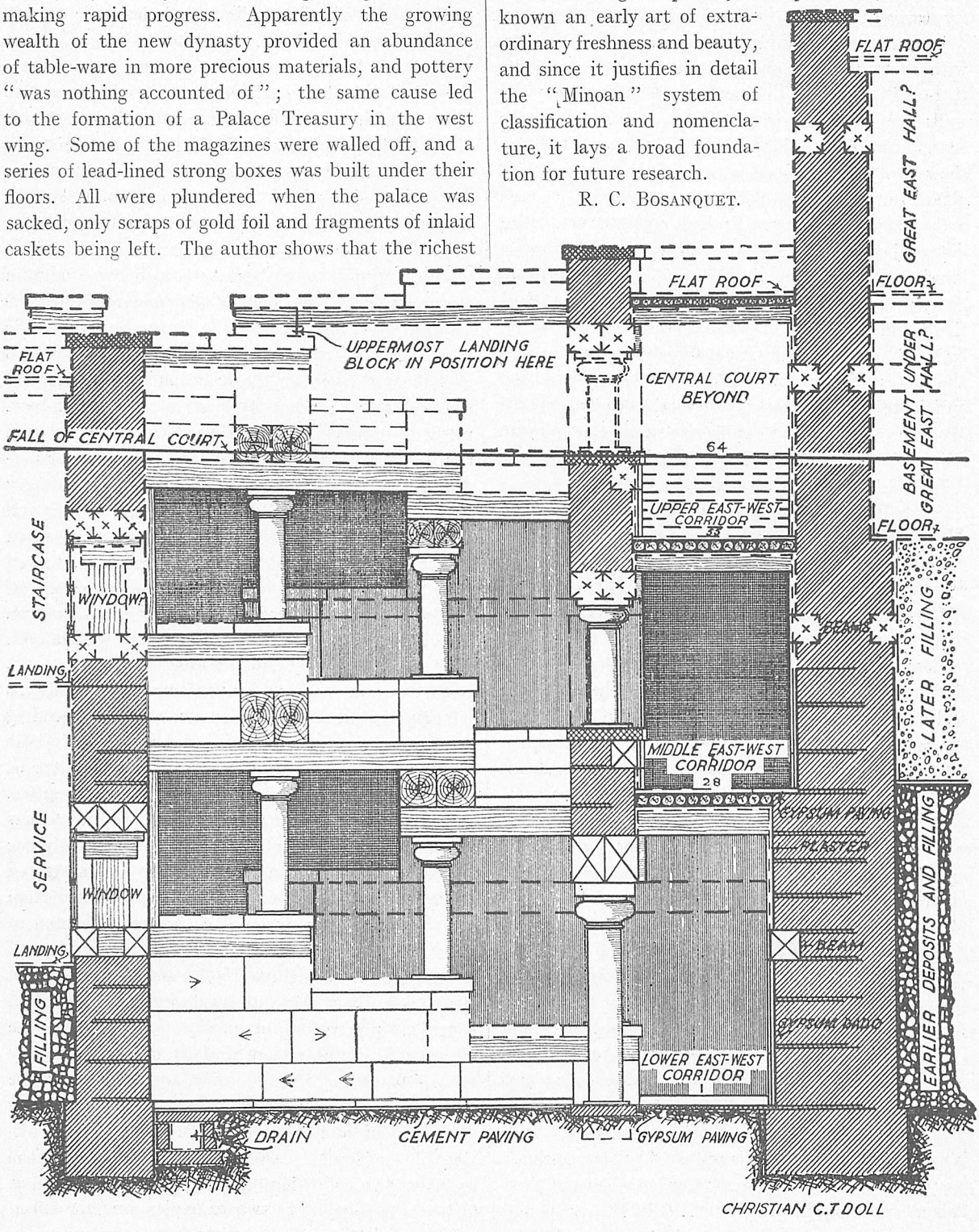


FIG. 2.—Reconstructed Elevation of the Grand Staircase at Knossos. From "The Palace of Minos at Knossos."

Turbulence as a Meteorological Agency.

Die Zirkulation der Atmosphäre in den gemässigten Breiten der Erde. Grundzüge einer Theorie der Klimaschwankungen. By A. Defant. Pp. 209-266. (Stockholm: Geografiska Annaler, 1921.)

THE study of turbulence as an agency of direct numerical importance in meteorological phenomena had its beginning before the war in the investigations of Åkerblom Hesselberg, G. I. Taylor, Barkow and W. Schmidt, and it is not surprising that it should have been developed independently on either side of the front during the war: on one hand by Taylor, L. F. Richardson, F. J. W. Whipple, D. Brunt, and H. Jeffreys, and on the other hand by W. Schmidt, F. M. Exner, and A. Defant. On both sides there has been the recognition of a common mathematical form of transmission upward or downward, through the agency of turbulence, of various elements with numerical coefficients that can be measured without entering into the details of the process by which the transmission is effected.

With us the study has been specially useful as applied to the eddy motion recognisable in winds and fogs, which is due to the friction of the ground and to the consequent deviation of the surface wind from the geostrophic wind; while on the other side the conception has tended to the general law of "Austausch," the passage upward or downward of heat or momentum in consequence of the ascertained conditions of equilibrium of adjacent columns. Both groups in different ways have come to recognise that transference by irregular turbulent motion is a principle of very general application, and that turbulence may range step by step, perhaps discontinuously, from the ultra-microscopic scale of molecular turbulence which we measure as viscosity to the gigantic scale of the eddy motion of the great cyclonic depressions or even of the general circulation of the whole atmosphere. L. F. Richardson has expressed the generality in a manner which easily sticks in the memory:—

> Big whirls have lesser whirls that prey on their velocity;
> They again have smaller whirls, and so on to viscosity.

In course of time we may have a view of the same idea of the universality of the ways of eddy motion from the Japanese point of view. The present article is concerned with an attempt on the part of Prof. A. Defant of Innsbrück to use the turbulence of the cyclonic depressions of middle latitudes to explain the distribution of temperature over the earth's surface and suggest explanations of climatic oscillations without entering at all into the details of the turbulent motion by which the effects are produced. It is an important and suggestive chapter in a new volume of meteorological theory. It deals with *turbulente Strömung grossen Stils*, a greater scale than has been used hitherto. Its basis is an extension of Schmidt's idea of Austausch of mass, and its accompanying properties in the vertical, to the Austausch of mass in a horizontal surface along meridians in consequence of the turbulent horizontal motion which is expressed by the irregular barometric changes in middle latitudes, between 40° N. and 70° N. These are the first stages of smaller whirls on the back of the great general whirl, and we read, with some curiosity as to the further development of the next following stages, "Alle Druckstörungen pflanzen sich mit derselben Fortpflanzungs Geschwindigkeit der aussertropischen Zirkulation."

With the aid of an equation, belonging to what is now a recognised family, a formula is obtained for the normal flow of heat across a vertical square centimetre near the ground which, with an Austausch coefficient A equal to 10^8 gcm.$^{-1}$sec.$^{-1}$ gives a flow of heat northward of 100 gram calories per sq. cm. per minute. The value of A is supported by the integrated components of wind, north and south, at Potsdam, and we are allowed to infer that the general circulation of the atmosphere west to east goes on all the time and is crossed by a flow alternately north and south due to turbulence which on the average of the year gives the numerical result specified.

From that conclusion Defant proceeds to calculate the disturbance of surface temperature for latitudes north of 30° from the balance which would result from radiation alone; thence to calculate the distribution of temperature when the turbulence is taken into account and to compare the results with Hann's normal mean temperatures for successive latitudes. Finding that a uniform value for the coefficient of Austausch gives notable discrepancies, he adjusts the coefficient to bring calculation and observation into agreement, and thus arrives at the following values for A: 10^8 at lat. 30°, 5×10^8 from 40° to 65°, and $1{\cdot}7 \times 10^7$ at 85°, with intermediate values for the intermediate latitudes; agreement being thus obtained, he claims that the variation of turbulence with latitude gives a satisfactory picture of the conditions so far as he knows them.

Having thus arrived at an explanation of the steady state, he proceeds to discuss the effect of a sudden permanent increase of temperature in the intertropical belt, such as might be assumed to represent the effect of the activity of sun-spots. He finds that the Austausch would cause a corresponding change of diminished amplitude with little difference of phase in more

northern latitudes, and finally discusses periodic alterations of the three elements upon which the distribution of temperature must be based, namely, the temperature of the intertropical belt, the radiative power of the air, and the intensity of the general circulation. He thus outlines a general theory of climatic changes.

The processes of reasoning are mathematical, and are set out with exemplary clearness; in order to get numerical results a great number of assumptions are necessarily made. So long as the discussion is confined to the consideration of the earth as a whole and normal temperatures are treated as a simple function of the latitude, a good deal of liberty may be allowed in the other assumptions; but when we get to close quarters with current meteorological experience some of them will naturally need adjustment. It seems odd that in dealing with periodic changes the best known periodic change from winter to summer did not challenge the author's curiosity. It seems nearer at hand than the influence of sunspots or Brückner's cycle.

The justification for using the Austausch A as a numerical symbol of the effect of the whole irregular atmospheric motion of middle latitudes would be complete if it could be shown that its measure from time to time would do instead of the study of the motion itself. From that point of view the winds at Potsdam can be regarded only as a beginning, and not a very good one. The winds at Bergen would certainly tell a very different story. The next step appears to be a closer examination of some data for Austausch.

One more point is noteworthy. Prof. Defant is apparently under the impression that in consequence of the conservation of momentum winds of 300 m./sec. are a meteorological possibility from the occurrence of which we are saved by the turbulence of middle latitudes. What we thought to be the causes of our worst gales appear as our safeguard against being blown away completely by winds of tenfold velocity. But in our practice we have become accustomed to regard winds as inevitably related to pressure differences. Prof. Marvin, of the United States Weather Bureau, has recently pointed out that the idea of winds of 300 m./sec. is one of the common fallacies about the atmosphere that not even the *cognoscenti* have escaped, and that in face of the "geoidal slope" they could not occur, turbulence or no turbulence. It is, therefore, a little disconcerting to find that Prof. Defant deploys the power of the Austausch to destroy them: disconcerting for this reason, that we are apparently put in possession of an engine that is powerful enough to reduce winds of 300 m./sec. to 20 m./sec. if it were wanted, and it is not wanted. What then becomes of its power? Has the power of the engine been over-estimated, or has it other work to do?

It is true that Prof. Defant's remark is merely an *obiter dictum*, and has no influence upon his reasoning; but the same idea stares one in the face from the diagrams of Ferrel, J. Thomson, and others, and is quoted by more recent authors. It is time it was cleared off the field of meteorological theory.

NAPIER SHAW.

Forensic Chemistry.

Forensic Chemistry. By A. Lucas. Pp. viii+268. (London: Edward Arnold and Co., 1921.) 15*s*. net.

MR. A. LUCAS, who is the director of the Government Analytical Laboratory and Assay Office, Cairo, claims that his book is the first of its kind in English, with the possible exception of a small work on legal chemistry which he published in 1920, out of which the present work has grown. In a limited sense the claim may be valid, although the distinction between forensic chemistry and forensic medicine, on which latter subject there are many well-established treatises, is one of degree rather than of kind. Hitherto works on forensic medicine have included forensic chemistry. The expert on forensic medicine has usually been a medical man with knowledge and experience of the detection of chemical substances, such as poisons, which may form the subject of criminal investigation. Strictly speaking, the two branches are, however, perfectly distinct, and there has been a growing tendency within recent years to differentiate them. The criminal who contemplates murder, for example, has far more means at his disposal nowadays than formerly. Science has furnished him with methods unknown to former generations, and these can be combated and checked only by methods of science. It was inevitable, therefore, that public security should require the establishment of a special class of expert whose duty should be the study and application of methods of detection and recognition by chemical means of the many agents and appliances which may now form the subject of criminal inquiry.

But forensic or legal chemistry, as Mr. Lucas points out, may be concerned not only with examinations for the presence or absence of particular substances, such as poisons, but with questions which are only partly chemical, as the examination of blood-stains, questioned documents, counterfeit coins, fibres and textile fabrics—in fact, any problem of criminal

investigation in which chemistry may be of service in the administration of justice and with which medicine as such may have little or no concern.

Mr. Lucas's book, as might be expected, is largely based upon his experience of the methods of the criminal of the East, who, although he may not have all the appliances of his Occidental *confrère*, is scarcely less resourceful. Indeed, some of the instances of ingenuity and cunning to which Mr. Lucas incidentally refers may be recommended to the notice of writers of detective stories. Invested with all the glamour of the Orient, they would form a new departure in that class of literature.

The book is eminently practical, although it omits details of manipulation and methods of examination to be found in standard treatises on chemical analysis. It presupposes, in fact, that the chemist who embarks on the subject of forensic chemistry is a well-trained analyst with a sound knowledge of general chemistry. At the same time, it gives in detail the special methods needed by the expert. In a short introductory chapter the author offers very wise advice on the practice of forensic chemistry, evidently based upon personal experience and a wide reading of notable trials. Legal procedure, it must be admitted, is at times eminently unscientific. It might be supposed that the practice of the law would tend to the cultivation of the scientific spirit in its practitioners, but observation shows that this is far from being uniformly the case. This fact constitutes a difficulty with which the chemical expert has occasionally to contend. The rules of conduct which Mr. Lucas lays down may enable him to meet it. The value of the expert's testimony depends largely upon the manner in which he presents it and upon the soundness and extent of knowledge with which he is able to support it. The lengths to which cross-examination may go are almost limitless, and side-issues may be developed which require wide and accurate general knowledge to deal with satisfactorily. At the same time, the forensic chemist must never forget that he is not an advocate or a partisan; his single object should be to assist the court to a just decision.

Every kind of criminal investigation with which the chemist may be called upon to deal, such as the testing of blood-stains, the analytical examination of bullets and other projectiles for firearms, of clothing, counterfeit coins, documents, explosives and explosions, fibres, finger-prints, fires and firearms, poisons and narcotics, etc., is covered in Mr. Lucas's book. As regards blood-testing in legal cases, the author rightly insists that it should be undertaken only by those who have considerable experience of the work. The sources of error are frequently many, and the issues may be most serious. The chapter dealing with this subject is an excellent example of the care and caution with which the author approaches any question of chemical jurisprudence. Dealing with projectiles, it is only necessary to recall the Monson trial to realise how much may depend upon the analytical examination of projectiles, wads, and cartridges, the number and width of marks made by the rifling of the barrel, the direction of its twist, the presence of rust, etc. As regards clothing, the author shows how the examination of a waistcoat led to the detection and conviction of a German spy during the war of 1914–18.

Counterfeit coining seems to be very prevalent in Egypt. The coins are usually struck, and many, we are told, are excellent imitations. A few illustrative cases are given, some of which display considerable ingenuity in adapting primitive appliances and apparatus intended for other purposes. The examination of suspected documents in cases of substitution or forgery may require the testing of the paper for the nature of the fibre, the recognition of water-marks, the analysis of the ink employed, the style of pen used, etc. Cases met with in Egypt evidently present difficulties not usually present in European countries.

Knowledge gained during the war has undoubtedly led to a great extension of the use of high explosives for criminal purposes, especially in the form of bombs as a means of assassination, and the chemico-legal expert is not infrequently called upon to examine them in connection with attempts at murder. Such examinations are, of course, often attended with danger, and need to be made with circumspection and care. The precautions to be taken are set out in some degree of detail. Of recent years Egypt has been particularly fruitful of instances of the kind, in which Mr. Lucas or his assistants would seem to have had ample scope for the exercise of their courage, skill, and ingenuity.

But the "tyranny of space" forbids any further attempt to illustrate the possibilities of chemistry as applied to the detection of crime. For other examples the reader may be referred to the book under review. The possibilities are, in fact, boundless. Mr. Lucas shows how the chemical examination of stains and marks, dust and dirt, even of tobacco, may afford clues which may lead to the conviction of criminals. Indeed, one rises from the perusal of his book with the feeling that the ideal forensic chemist would be a combination of Sherlock Holmes with a comprehensive compendium of general and analytical chemistry such as might be embodied in a person of whom fiction has hitherto afforded no example.

The "Index Kewensis."

Index Kewensis Plantarum Phanerogamarum. Supplementum Quintum Nomina et Synonyma Omnium Generum et Specierum ab Initio Anni MDCCCCXI usque ad finem Anni MDCCCCXV Nonnulla Etiam Antea Edita Complectens. Ductu et Consilio D. Prain, confecerunt Herbarii Horti Regii Botanici Kewensis Curatores. Pp. iii + 277. (Oxonii: e Prelo Clarendoniano, 1921.) 76*s.* net.

THERE is probably no publication which is awaited with such interest and impatience as the issue from time to time of the supplements of the "Index Kewensis." Had it not been for the interruption of the war, the list of genera and species published, or the publication of which was ascertained, in the five years 1911–15, would doubtless have been available to botanists less than six years after the second date. This delay was inevitable, but it may be assumed that Supplement 6, comprising the years 1916–20, is well on the way and will be available for workers before another five years have passed. Some names published abroad during 1914 and 1915 were not noted in time for insertion in the present supplement, but will be included in the next.

A rough estimate shows that the present volume indexes more than 33,000 species-names, and a perusal of a few columns indicates the large number and great variety of the books and periodicals which have been searched during the compilation of the work, which, so far as one can judge by inspection and trial, maintains the high standard of accuracy and completeness of the parts previously issued. It is a great help to have a note of the date of publication of the book or periodical cited; the absence of this was a disadvantage in the earlier volumes. Similarly the practice adopted in the previous supplement of not attempting to distinguish between species and synonyms, often a matter of personal opinion, has again been followed, and the work maintains its character purely of an index. Attention is directed in the preface to the fuller geographical citations as compared with previous volumes; thus in American species the name of the State follows the indication U.S.A.; in Chinese, the name of the province, and so on; this additional information is a distinct gain.

To the botanist a perusal of the columns is of special interest as marking the progress of botanical exploration generally; thus the large number of genera and species quoted as from China, especially the south-western provinces and the Philippine Islands, suggests the important work being carried on in those areas by British and American collectors and investigators. The progress of standard floristic works, such as the "Flora of Tropical Africa," or series of monographs, such as the "Pflanzenreich," is also recorded in these cases under the genera of families specially concerned.

The numerous entries under certain well-known European genera, such as Hieracium, which fills ten pages, and Rubus, which fills eight, recall the intensive study of species and their segregation, which will doubtless continue to supply material for future supplements. The many unwieldy trivial names, sometimes running into eight syllables, indicate the difficulty of finding new names for species when these run into the hundreds in individual genera. The occasional appearance of names from periodicals antedating the special period shows the great difficulty of sweeping up all the literature. Thus a harvest of new names has been supplied by Hegetschweiler's "Flora der Schweiz" (1839), previously overlooked, and the recognition of Philip Miller's "Abridged Dictionary of Gardening" (edition of 1754), in which many genera were carefully defined, necessitates the reference of some well-known genera to Miller instead of to later authorities.

In the method of citation the recommendation of the latest International Code of Rules is followed in the use of the capital letter only for species-names derived from a personal or a generic name. In the manner of production, from the irreproachable Latin preface onwards, the volume upholds the credit of the Oxford University Press.

Mental Measurement.

(1) *The Essentials of Mental Measurement.* By Dr. W. Brown and Prof. G. H. Thomson. (The Cambridge Psychological Library.) Pp. x + 216. (Cambridge: At the University Press, 1921.) 21*s.* net.

(2) *How to Measure.* By Prof. G. M. Wilson and Prof. K. J. Hoke. Pp. vii + 285. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1920.) 12*s.* net.

(1) ELEVEN years ago Dr. William Brown published as a thesis for his doctorate a suggestive and original monograph on the use of the theory of correlation in psychology. Later, by adding one or two chapters of introduction and two or three others on the so-called psychophysical methods, he expanded this monograph into a compact manual entitled "The Essentials of Mental Measurement." Now, in turn, after another and a longer interval, the manual itself has developed into a guinea royal-octavo volume, extensively enlarged and exhaustively revised.

The larger additions consist for the most part of a detailed series of mathematical arguments, examining what is termed the "hierarchical theory," and bringing

together the substance of important controversial papers on this subject published from time to time by Prof. Godfrey Thomson during the war. There are, however, several other new insertions. There is a long and lucid chapter on the elementary theory of probability and a shorter and more abstruse one upon skewness and heterogeneity in psychophysical data—a chapter in which, as indeed all through the volume, Prof. Karl Pearson's views and manner of approach are plainly reflected.

In the present stage of its development the book is an interesting though composite production. From the title one would expect some description of the recent methods of individual measurement—methods for assessing intelligence and for estimating the capacities and attainments of the mind. Instead we have critical prolegomena upon statistical adjuncts, and the writers have in view, not so much general mental testing, as the testing of the mental tests themselves. The book opens with a general chapter headed "Mental Measurement," which seems to promise the broad survey characteristic of a general text-book, but most of the pages in the second portion of the book, and most of the paragraphs in its two independent prefaces, are simply brilliant contributions to a special controversy. The three doctrines chiefly attacked are those connected with the name of Prof. Spearman. It is, however, highly satisfactory to learn that Dr. Brown finds elements of truth in the views that he disputes, and feels himself to be "more convinced than ever that the work of Prof. Spearman's correlational psychology is epoch-making in its significance."

The heterogeneous character of the volume has been severely criticised by at least one eminent statistician.[1] But perhaps the best defence to this criticism is the simple circumstance that at present the whole subject of mental measurement has itself arrived at a somewhat heterogeneous stage. In any case, the mixed and controversial quality of the book does not lighten or alleviate the difficulties of a topic already intrinsically perplexing. The treatment is of necessity technical. From first to last the pages of the book are dotted with algebraic formulæ and symbols, and the description of methods is at times extremely condensed. Indeed, to any but a mathematician little but the general gist of discussion can at times be comprehensible. However, a third section to the book is promised, summarising in non-mathematical language both theories and results for the general reader.

Meanwhile no research student who thinks of employing the statistical methods here described and discussed can ignore this treatise. It is, indeed, considering the intricacy of the subject, a work of great lucidity and compression, and, whether the criticisms urged against previous workers are insuperable or not, objections to their views certainly required statement at length and in detail.

(2) The volume by Prof. Wilson and Prof. Hoke is altogether different from that by Dr. Brown and Prof. Thomson. It is written for American teachers, and describes in simple phraseology some of the methods in vogue for individual measurement. The chapters consist mainly of an account of the various tests recently standardised for measuring attainments in the chief subjects of the school curriculum—reading, writing, drawing, arithmetic, and the like. A few pages are added on the measurement of intelligence and on statistical methods and terms. The book is published in the hope of encouraging the teachers themselves to apply to their classes the diagnostic methods that hitherto, for the most part, have been handled by psychologists alone. It is one of the many popular volumes that have appeared and are likely to appear upon the practical educational applications of these psychological methods.

[1] G. U. Yule, *Brit. Journ. Psych.*, vol. 12, pp. 100-107—an article which is itself of much importance as a contribution to the points at issue.

Statistical Method.

A First Course in Statistics. By D. C. Jones. (Bell's Mathematical Series.) Pp. ix+286. (London: G. Bell and Sons, Ltd., 1921.) 15*s.* net.

THE needs of the student of social statistics form the prime consideration in this "First Course," but, as the author states, illustrations have been drawn from all sources, and it will serve very well as a brief introduction for students in other branches of science. The volume has been divided into two parts. Part I. is elementary in character, and in the main can be followed by a reader with little mathematical knowledge. The notions of measurement and of variables are explained, and the conceptions of the frequency distribution, of classification and tabulation are briefly discussed, and a couple of chapters follow on the simpler forms of average and the weighted mean. Dispersion comes next, accompanied by a more detailed discussion of the frequency distribution. The following chapter is on graphs, an unusual feature in this chapter being the inclusion of sections on interpolation and on supply and demand curves. A treatment of the correlation of two variables on simple lines concludes the first part of the book. Part II., though it begins simply, is of a more advanced mathematical character. The first few chapters are on probability, sampling, and probable errors. Prof. Pearson's generalised probability curves are then dealt with, and the method of moments; two chapters on the normal curve and the

normal correlation surface conclude the volume. An appendix of some sixteen pages deals with a number of incidental points, and short notes are given on certain current sources of social statistics and on tables as aids to calculation.

The book seems very competently done, and we have noted few points for criticism that are worthy of individual comment.

A criticism of a general kind may, however, be made, namely, that the author has not kept in mind sufficiently carefully the type of reader whom he is addressing. The initial chapters of Part I. are written in a very simple style, adapted to a reader of little ability and practically no mathematical knowledge; but in the chapters on correlation differentiation is used, and in Part II., when Prof. Pearson's curves are explained, the reader will require a fair knowledge of and ability to use the calculus. The result is that parts of the book are beyond the elementary reader, and others almost too elementary in style for the more able student. It should, however, prove a useful addition to the small, but growing, number of books on the theory of statistics, for the same ground is not covered by any other volume. The printing and general get-up of the book are admirable, but author and editor of the series are to blame for not including an index.

G. U. Y.

Surveying for Oil Geologists.

(1) *Field Mapping for the Oil Geologist.* By C. A. Warner. Pp. x+145. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 13*s.* 6*d.* net.

(2) *Field Methods in Petroleum Geology.* By Dr. G. H. Cox, Prof. C. L. Dake, and Prof. G. A. Muilenburg. Pp. xiv+305+11 plates. (New York and London: McGraw-Hill Book Company, Inc., 1921.) 24*s.* net.

THE great increase in the demand for combined geological and topographic mapping of oil-fields has led to the issue of books to teach the rudiments of geology to surveyors and of surveying to the geologist. These two manuals belong to this group. (1) The smaller, by Warner, is written with special reference to the conditions of the central oilfields of the United States, and it includes tabular summaries of their geological sections. The geology is otherwise so elementary that no oil company would be well advised to trust to geological surveys by men whose knowledge of the subject is so limited that they would gain any help from the chapters thereon in this book. Its concise mathematical tables, simple explanations of surveying methods, instructions for the preparation of convergence maps and for the verification of oil scums on seepages, may, however, render it useful to geologists who have had no special training in oil prospecting and may be called on to take part in this work.

(2) The work by Messrs. Cox, Dake, and Muilenburg, three professors of the Missouri School of Mining and Metallurgy, is a larger work, and its geology is more advanced. The mathematical tables are fuller, and the account of geological structures may be read with great advantage by students of geology in schools which do not give much attention to the structural side of the subject. It has an admirable glossary, which explains among other facts that the term "wild-cat" in oil mining is not the same term of contempt as in metal mining, as it is applied to all well-sinking in unproved territory. This development of the term suggests that American opinion regards all oil boring in unproved ground as so speculative that the expression is used for it which the metal miner adopted for forlorn hopes and reckless gambling. In a book in which conciseness is so indispensable it seems unnecessary to have included the history of the mariner's compass and of the barometer.

Neither book gives any help in the use of fossils. The Missouri manual refers to fossils as if their evidence were too difficult for use by any but an expert; considering, however, the importance of fossils in oil work and the value of the indications often given by the simplest of palæontological evidence, some instructions how to recognise and collect fossils might usefully have been included.

The Fourth Dimension.

The Fourth Dimension Simply Explained. A Collection of Essays selected from those submitted in *The Scientific American's* Competition. Pp. 251. (London: Methuen & Co., Ltd., 1921.) 7*s.* 6*d.* net.

THE fourth dimension and non-Euclidean geometry have achieved a prominence quite unprecedented for mathematical topics. In train, bus and tram, over lunch and at the theatre, intelligent man is discussing the fundamentals of his physical consciousness. Mathematicians have sprung a surprise on the man in the street—and on one another, and the former has some reason to complain. He remembers, perhaps with pain, the tyrannical ukases of Euclid, and, if he did not acquire an enthusiastic love for the old Greek, he was at any rate pleased to think that the puzzles of geometry had been settled by something approximating to incontrovertible authority; he was grateful that he need not worry about the doctrine of parallels, or the three angles of a triangle, or about the up and

down, to and fro, right and left. Suddenly the man in the street finds himself floundering in a morass of sceptical ignorance.

How much good it would have done him if it had been impressed upon him early enough that geometry "is a matter of experiment and of experience," that it "shows what would be true if certain other things were true," if he had realised that Euclid was a guide in the interpretation of ordinary space experience, and not a royal promulgator of irrevocable decrees! He would have been spared some of the journalistic sensationalism of the past two years, and have been better equipped to think clearly and without prejudice.

Of course the fourth dimension of relativity is not the same as that suggested by the older conception of four-dimensions, although it is still a common experience to hear somebody complain that it is nonsense to suggest that time is $\sqrt{-1}$ times a length. Nevertheless this book of essays will be read with interest. The book was worth publishing if only for the clear and excellent introduction by Prof. Manning.

Some of the essays are distinctly good, although they all suffer the inevitable consequence of having a lot of information crammed into a small space. Several are impartial, others seem to look with favour on the possibility of a fourth dimension, while a few speak of it with scant respect. There is very much repetition, as is bound to be the case in such a publication, and a considerable amount of the sort of speculation that finds indications of the fourth dimension in spiritualistic phenomena, that makes the fourth dimension a constituent of life-force, that sees the fourth dimension suggested in Ephesians iii. 18, and that thinks it possible that many of the small objects each of us loses disappear by rolling out of three-dimensional space into the fourth dimension! S. BRODETSKY.

Our Bookshelf.

Imperial Institute: Monographs on Mineral Resources with Special Reference to the British Empire: Petroleum. Prepared jointly with H.M. Petroleum Department with the co-operation of Dr. H. B. Cronshaw. Pp. x+110. (London: John Murray, 1921.) 5*s*. net.

A NEW "red" book dealing with petroleum has appeared recently as a small volume uniform with the well-known monographs of the Imperial Institute. It is a type of publication that was much needed, since it embodies in summary form the main geographical, geological and economic features of the world's oil-fields. At the present time this information is very scattered, more particularly in connection with British resources, so that a scientific discussion of the subject, at once lucid and easily accessible, forms a welcome addition to official technical literature.

The volume is divided into three sections, the first reviewing briefly the more theoretical phases of oil technology, such as the origin, migration, and accumulation of petroleum, the second dealing with British, Colonial, and mandatory resources, and the third with foreign resources. Several statistical tables concerning production of oil in various countries are included, the information under this heading being brought up to 1920 in most cases; the results of distillation of typical crude oils are given, together with certain physical characteristics. A small map of the world showing the principal oil-bearing localities and a short bibliography are appended.

A somewhat unfortunate attempt has been made to tabulate the characteristics of the oil regions of the United States, a task requiring no little care and a great deal more space than has been allocated to it; one would scarcely describe the prevalent structure of the Appalachian region as anticlinal, while the omissions in the same connection under the headings of Lima–Indiana and the Rocky Mountains are difficult to understand. With this exception, the text is remarkably good in every way. H. B. MILNER.

Peoples of All Nations. Edited by J. A. Hammerton. No. 1. Pp. xxiv+112. (London: The Amalgamated Press, Ltd., 1922.) 1*s*. 3*d*. net.

THIS is the first instalment of a popular work to be issued in fortnightly parts which, when complete, will give an account of all the nations of the world in alphabetical order. It is a remarkable piece of journalistic enterprise. The whole work promises to be of great interest and of some considerable educational value as a work of reference for the class of reader for whom it is intended. In the present number Sir Arthur Keith contributes a foreword on the "Dawn of National Life," which deals with racial origins and the development of culture. The nations described are Abyssinia, Afghanistan, written partly by Sir Thomas Holdich, Albania, in part by Miss Durham, and Algeria. Each article is divided into three parts, of which the first deals with geography and ethnology, the second is historical, each of these being by a recognised authority, and the third gives statistical and other data. In view of the limited amount of space available, the articles are extremely well done and give the salient facts in readable and attractive form. The chief feature of the publication, however, is the illustrations, which are remarkable both in number and quality.

Tables, Factors and Formulas for Computing Respiratory Exchange and Biological Transformations of Energy. By T. M. Carpenter. (Publication No. 303.) (Washington: Carnegie Institution.) 2 dollars.

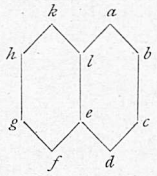
PUBLICATION No. 303 of the Carnegie Institution contains not only a number of tables for the expression of the results of gas analyses but also those of Benedict and his colleagues and of Aub and Du Bois for the estimation of basal metabolism. Some of these tables are inaccessible and all are scattered through a variety of journals and monographs, so it is a great convenience to the investigator to have the whole series in a single handy volume. This work will take its place beside "Chambers," "Barlow," and "Tables for Statisticians and Biometricians," on the shelves of most workers.

Letters to the Editor.

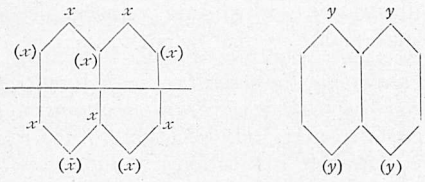
[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Atomic Vibrations in the Molecules of Benzenoid Substances.

SIR WILLIAM BRAGG has recently suggested (Presidential Address to the Physical Society, Proc. Phys. Soc., 1921, 34, 33) that in the molecule of crystallised naphthalene the carbon atoms are arranged so that in the accompanying figure the centres of atoms at *h*, *l*, *b*, *g*, *e*, *c* lie in a plane, whilst those at *k* and *a* lie above the plane and those at *f* and *d* an equal distance below it.



If this were the normal stable arrangement in naphthalene and its simple derivatives, enantiomorphism would result in the case of all monosubstituted, and in the majority of the higher substituted compounds, the special examples of symmetry being obvious on inspection. Since, however, all the available evidence tends to show that the molecules of naphthalene derivatives are identical with their mirror images, it follows that the structure suggested by Sir William Bragg represents a phase of an oscillation of the relatively unrestricted molecules of the fused or dissolved substance in which the pairs of carbon atoms *k*, *a* and *f*, *d* appear alternately above and below the plane containing the six remaining atoms. At the first glance such a process appears peculiar and unsymmetrical, but this objection disappears when it is noticed that an identical result is obtained if all the atoms are supposed to be in motion in such a way that adjacent atoms move in opposite directions and to an equal distance from the plane of the original ring. If the component perpendicular to the plane of the ring is x, then the condition arrived at is shown below, x and (x) signifying, respectively, above and below the plane of the ring.



By rotating about the axis figured, the second position is obtained with six atoms in the plane of the original ring and four arranged as indicated ($y > x$ and $< 2x$). A similar vibration of the phenanthrene molecule would demand in the case of an isolated phase that the atoms lie in two planes parallel with that of the original ring, and also in four parallel planes containing carbon atoms to the number of two, six, five, and one, respectively. The above argument is circular to the extent that the naphthalene configuration was partly derived by analogy with the hexagonal rings of the graphite layers, but the point is that if independent evidence is forthcoming that an individual naphthalene molecule in a crystal has the arrangement of atoms put forward by Sir William Bragg, then at the same time at least one mode of vibration of the benzenoid molecules will be clearly indicated.

R. ROBINSON.
Chemistry Department, The University, St. Andrews.

Transport of Organic Substances in Plants.

IN a letter in NATURE of February 23, p. 236, under the above title, Prof. H. H. Dixon and Mr. N. G. Ball put forward the view that the wood of the vascular bundles provides the main path for the removal of the organic materials formed in foliage leaves to places of storage or conversion, the structure, form, and arrangement of the bast (phloem) being regarded as precluding any important longitudinal transmission within it.

I venture to doubt if the view that the phloem may serve as an important carbohydrate-conducting tissue merits such summary dismissal as the writers of the letter would appear to suggest.

In the first place, it is somewhat misleading to state that this belief . . . "seems to be based entirely on ringing experiments," unless this statement is intended to apply only to the "older writers." In an article on the Translocation of Carbohydrates (*Science Progress*, October 1910, January 1911) I attempted to bring together the available evidence from anatomical and experimental studies, and a perusal of that paper should show the wider basis for the view put forward by Czapek in 1897 that the phloem is to be regarded as the chief tissue concerned in the conduction of organic material in the plant. In later papers (*Annals of Botany*, 1915, 1917) I dealt with many of the points which call for consideration in any investigation of this problem, and indicated the nature of results obtained by the application of Senft's method of locating sugars by the formation of their osazones. Unfortunately, the war and the heavy pressure of departmental duties have held up the work, and it has not yet been possible to publish results in detail.

The following comments may be made, however, in connection with the view put forward by Prof. Dixon and his collaborator. The sugars are described as having to traverse the cross-partitions (of phloem cells) as a stream if they use this tissue as a conduit. It may be doubted whether the movement can be compared to the mass movement of water in a tube, and other considerations have been urged in the later paper referred to above.

Experiments made by Czapek (referred to in my last paper, pp. 293, 294, 303) showed that removal of starch from an attached leaf continued if a short length of the petiole was plasmolysed (but not killed), that a killed (boiled) portion of petiole prevented translocation permanently, but that a narcotised portion only temporarily interrupted the process, which was renewed on recovery of the tissues. Though perhaps not altogether excluding the possibility of conduction in the wood, such experiments appear to point to the activity of living cells in the transportation, and I have suggested a possible explanation of the continuance of the process in plasmolysed (living) cells, assuming the sieve-tubes to be the channels concerned (*loc. cit.*, p. 303).

Various histological features of sieve-tubes and their associated cells appear to harmonise well with the view that they serve to conduct carbohydrates, *e.g.* their continuity, distribution, and degree of development in different types of plants, the structure of the sieve-plate, the distribution of connecting-

threads, the relation of sieve-tubes in the parasite Cuscuta to those of its host, etc.

A particularly interesting piece of evidence in favour of the phloem view is to be found in a paper by Schneider-Orelli on a leaf miner of the apple (*Centralb. f. Bakt.*, II Abt., 1909, 24, p. 158; cited by Schroeder, *Zeitschr. f. Bot.*, 1911, pp. 770-71). Where the caterpillar had bored through strong veins the destruction of the tissue affected the storage of starch in the leaf. It was found that the destruction of the xylem and the greater part of the bundle sheath could be brought about without causing an accumulation of starch in the distal part of the leaf (by interrupting the conducting channels), but that injury to the phloem resulted in an accumulation of starch proportional to the extent of the injury. Similarly, it has been found by Quanjer and others that the phloem necrosis associated with the leaf-curl of potatoes interferes with the transport of starch from the leaf, with the result that the tubers fail to develop properly.

It may also be noted that in a paper on the biology of a species of Aphis, Davidson (*Annals of Applied Biology*, v. 1921, p. 60) states that the phloem of the vascular bundles is especially sought for by these insects when tapping the plant for nutriment, and that this point is undergoing further investigation.

Although the case of Lepidodendron undoubtedly presents difficulties (a possible solution was suggested by me, *loc. cit.*, pp. 307-9), the difficulties are scarcely less on Prof. Dixon's view in the case of various aquatic plants which normally produce no xylem or only discontinuous traces.

I look forward with very great interest to the results of the work which Prof. Dixon and Mr. Ball have in hand, as the problem is a long-standing one. An urgent need is for more data on which to elaborate a theory of translocation in general.

SYDNEY MANGHAM.
Botanical Department, University College,
Southampton, March 28.

Pricked Letters and Ultimate Ratios.

IT is the purpose of this note to point out an earlier use of "pricked letters" to denote infinitesimals and of the phrase "prime and ultimate ratios" than is recorded in our histories of mathematics.

It will be recalled to mind that as early as 1665 Isaac Newton used "pricked letters" to denote fluxions or velocities. He did not permit his notation to appear in print before 1693. Between 1693 and 1704 the dot came to be used by other English writers, but nearly all of them departed from Newton in interpreting $\dot{x}$ to mean, not a velocity, but an infinitely small quantity or increment, like the Leibnizian *dx*.

Recently the present writer has noticed that as early as 1668 Nicholas Mercator used the dot to mark an infinitesimal, in an article in the Philosophical Transactions,[1] which contains illustrations of his "Logarithmotechnia" of 1668. Mercator uses in his article the letter I with a dot over it to indicate an infinitesimal difference.[2] This date, 1668, marks the earliest use of the dot for this purpose known to us. It was long before Newton allowed any part of his fluxions to appear in print and before Leibniz began to develop his calculus. Mercator could not have regarded the dot simply as part of the letter I, for (though the type is not quite clear) it appears to have been the capital letter. Moreover, in computing logarithms he writes the dot over a number (64, for example), to serve as a reminder that 64 is the coefficient of a power of an infinitesimal.

In the same article Mercator used a terminology[3] resembling the famous phrase "prime and ultimate ratios," used by Newton in his "Principia," 1687 (Bk. i. Sec. i. Lem. xi., Scholium). Mercator writes "ratiunculae" or little ratios, while Newton uses "rationes" or ratios. Mercator says "primae et ultimae ratiuncularum," Newton speaks of "rationes primae," and "rationes ultimae." We observe also that in 1695 Edmund Halley (Phil. Trans.) used "ratiuncula," and that in 1706 William Jones ("Synopsis Palmariorum," p. 174) made the statement: "Let $\dot{x}$ be a Ratiuncula or Fluxion of the ratio 1 to $1+x$."

It appears on the surface as if there had been a giving and receiving. In his letter to Oldenburg, dated October 24, 1676, Newton mentions Mercator's "Logarithmotechnia," but he nowhere refers to Mercator's illustrative article from which we have quoted. That article is of minor importance. It is not reproduced in the abridged edition of the Philosophical Transactions, and is not mentioned in the biographical sketches of Nicholas Mercator that we have seen. Whether in private Newton had used the phrases "prime ratios" and "ultimate ratios" on or before 1668 we have no means of knowing. He first used them in print in 1687. For some years after 1660 Mercator lived in London, where he became a member of the Royal Society. Newton became a member in 1672. As Newton lived at Cambridge (except during the Plague, when he was in the country), the chances that Mercator received information of Newton's work through private channels are reduced. After 1669 both Mercator's "Logarithmotechnia" and his illustrative article were in print. It is therefore possible that Newton may have adopted the phrase "prime and ultimate ratios" from Mercator. Newton's dot-symbol antedates Mercator's.

FLORIAN CAJORI.
University of California, March 18.

Einstein's Aberration Experiment.

IN the *Sitzungsberichte* of the Berlin Academy of December 8 last, which has recently come to hand,

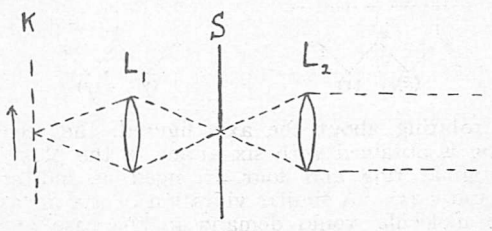


FIG. 1.

Einstein describes an ingenious arrangement which he suggests might serve to decide between the

[1] Phil. Trans., London, vol. 3, p. 759 ff. Reprinted in Maseres, *Scriptores Logarithmici*, vol. I, p. 231.

[2] The passage in question relates to the use of the infinite series for finding log (1±I) and is as follows: "Quare posito maximo termino=1, et parte infinitissima (sic) differentiae=I, et mensura rationis minimae itidem I." He gives proportions like the following:

"1−İ . 1 :: İ . İ+İİ+İ³+İ⁴, etc."

Here the fourth term of the proportion is an infinite series; ratio is indicated by (.) placed at the lower edge of the line.

[3] The passage in Mercator is, " . . . non nisi semisse primae et ultimae ratiuncularum a prioribus terminis contentarum, id est, ratiuncula minori, quam quae ullis numeris exprimi possit."

classical theory of light and the theory in which light is regarded as made up of single quanta of energy emitted discontinuously from luminous atoms. Fig. 1 (reproduced from the paper) illustrates the proposed experiment. K is a stream of canal rays, L_1 is a focussing lens, S is a screen containing a slit which serves to isolate a definite pencil of light, and the lens L_2 renders the emergent beam parallel. The emergent pencil is observed through a telescope focussed for infinity, so that the image of the slit in the screen S would be seen sharply focussed in the field of view. Since the atoms in the canal rays emitting light are in motion, the Doppler effect comes into evidence, and the rays proceeding at any instant from individual luminous atoms in different directions should, according to the wave-theory of light, be of different frequencies. Einstein suggests that the rays passing through the slit S and incident on the upper and lower parts of the lens L_2 should consequently be of different frequencies. If, therefore, a layer of a dispersing medium such as carbon disulphide be placed between the lens L_2 and the observing telescope, the different rays would travel through it with different velocities. Hence the wave-front should suffer an aberration and the image of the slit seen in the focal plane should shift through an extent proportionate to the thickness of the dispersing layer introduced. Einstein conceives that according to the quantum theory of light, on the other hand, such displacement should not occur, and he believes that the proposed arrangement furnishes an *experimentum crucis* to decide between the rival theories.

I wish here to direct attention to a fallacy which is present in Einstein's reasoning and invalidates it. It is clear that in the proposed experiment what would be observed are not the moving luminous atoms but the fixed edges of the illuminated slit in S, and it is easily shown that even according to the principles of the wave-theory no aberration of the image of the latter could be expected. To make this evident we may conceive the slit to be extremely narrow, or in the alternative, if it be wide, regard it as divided up into a large number of very narrow elements each of which, according to Huyghens's principle, would operate as a secondary source of light. The light from any small portion of the lens L_1 arriving at the slit would spread out by diffraction in all directions in the form of cylindrical waves, so that the waves reaching L_2 would consist everywhere of *superposed* wave-fronts of all the frequencies reaching the slit, and not, as Einstein supposes, of different frequencies at different points of L_2. The waves diverging from S would thus pass through L_2 and the dispersing medium behind it according to the ordinary laws of geometrical optics, and no shift or aberration of the image of the slit would occur. The error in Einstein's reasoning lies in his having ignored the vitally important part which diffraction plays, according to the wave-theory of light, in the theory of the formation of images of illuminated apertures by optical instruments.

C. V. RAMAN.

210 Bowbazaar Street, Calcutta, March 16, 1922.

The Weathering of Mortar.

MR. RICHARDSON'S letter (March 9, p. 310) anent the above calls, I think, for some further remarks. My observations never led me to conclude that the growth of moss was in any way responsible for the development of the ridge-and-ring markings upon the surfaces of old and exposed mortar. I have seldom seen moss growing thereon, but lichen is very often present, covering the whole surface, and not limited to the linear concavities. There is a row of fishermen's cottages at St. Ives, Cornwall, fully exposed to the sea, and the old mortar in the walls shows the markings in unusual perfection, but there is no evidence that moss ever grew upon it.

In 1896 I suggested that the phenomenon was a physical effect due to the expansion and contraction —or perhaps the former only—set up by alternations of temperature in a substance like mortar. Strains and stresses along lines of least resistance would tend to destroy compaction along such lines, rendering them more liable to be deepened by atmospheric erosion. Possibly the expansion and contraction in the stones themselves may also affect the stability of the mortar.

FIG. 1.

The accompanying photograph (Fig. 1), taken many years ago, shows some ridge-and-ringed mortar at the base of an old wall near Corfe. The wall faced south, and was built of Purbeck limestone. During its construction some thin pieces were placed vertically between the two masses of mortar. The penny fixes the dimensions of the mural components. The structure here was very conspicuous, but, with lapse of time, the photograph has faded somewhat.

C. CARUS-WILSON.

March 17, 1922.

Metchnikoff (Měčnikov) and Russian Science in 1883.

I HAVE read with the greatest interest the review of the "Life of Elie Metchnikoff" published in NATURE of February 9. In NATURE of November 17, 1921, I gave an account of the present state of science in Russia and its "proletarisation," and I beg to be permitted to say a few words on the state of science under Russian absolutism.

According to the above review, the book referred to says that the government of the university of Odessa became more and more reactionary; but it was not for political reasons that Metchnikoff left the university—the reasons were "scientific."

Following an invitation, I took part in the Congress

of Naturalists which was held in Odessa in August 1883, and of which I am the only foreign survivor. I became acquainted with the most prominent professors of that University and found that they were first-rate men of science, without a trace of anything "backward and reactionary." And yet this reproach is correct, but it refers to the State director of the university. A man, unsympathetic, gloomy, reactionary, every inch a bureaucrat, and fairly old, inaugurated the first general meeting with the following severe words: "You came here to speak of science and I hope that you will speak *only* of science!" After this rose Metchnikoff and gave a brilliant account of his recent and unpublished work on phagocytosis, which was received with enthusiastic applause by the whole assembly.

I congratulated my Russian colleagues and the University upon having such a professor, but they replied with regret that he no longer belonged to the University, and upon asking for reasons I was given the explanation: Metchnikoff as a professor of zoology announced a course of lectures "On the Theory of Evolution." And now the very reverse took place of what I described four months ago (see above). The director summoned Metchnikoff to his office and said to him: "It appears that you are going to lecture on Darwinism? If it is so, then you must submit your written lectures to my censorship and I will tell you what I allow you to say to the students and what not!" Metchnikoff did not accept this explanation of the "Lehr- und Lernfreiheit," he did not submit his notes to the curator; he resigned the professorship. Russia was not the soil for such a genius, and it was good fortune for him and for science that he left for Paris and for Pasteur.

BOHUSLAV BRAUNER.

Bohemian University, Prague, March 9.

The Accuracy of Tide-predicting Machines.

UNDER the above title in NATURE of February 23, Dr. A. T. Doodson comments on my letter that appeared in the issue of NATURE for February 2 under the same title. Unfortunately, Dr. Doodson is dealing with a matter outside the scope of my letter, and his statement that he is not "convinced by the tests recorded by Mr. Marmer" in no way invalidates any of the statements in my letter.

As specifically stated in my letter, it was prompted by a desire to prevent the possible misconstruction, on the part of *those not familiar with tide-predicting machines*, of a statement to the effect that tide-predicting machines are subject to "serious errors in their results." Occasion was also taken to direct attention to the different types of tide predictors and to a table showing the differences between computed and predicted heights for one day in the case of Hong Kong.

With none of the statements relative to these matters does Dr. Doodson appear to be in disagreement. What he does question, however, is something outside the scope of my letter, namely, whether the tide predictor with the operation of which I am familiar is or is not suitable for predicting hourly heights for *research purposes* within 0·05 ft. for a spring range of 30 ft. Not being concerned with that question at the time, there appeared no occasion for the tests, "exhaustive and convincing," that Dr. Doodson desires.

In his letter Dr. Doodson states that the tide predictors at his command were found unsuitable for use in the elimination from the observed tide of the tide due to a number of constituents. Nevertheless, this does not invalidate the general proposition that in such problems "the tide predictor should very materially lessen the laborious computations involved."

H. A. MARMER.

U.S. Coast and Geodetic Survey,
Washington, D.C., March 18.

IT seemed to me that Mr. Marmer's first letter left the impression that the U.S.A. machine is one that is free from serious errors of the order of magnitude of those of the British machines, and I raised the question of proof. I said that I should be very glad to know that this machine could produce hourly heights to within 0·05 ft. with a spring range of 30 ft. I *questioned* whether it would or would not give errors of 0·4 ft. in such a case. If my doubts are warranted, then the U.S.A. machine also is subject to serious errors, which, as I suggested, would prohibit its use for the research work mentioned above in Mr. Marmer's last paragraph.

A. T. DOODSON.

Tidal Institute, University of Liverpool,
April 3, 1922.

Pythagoras's Theorem as a Repeating Pattern.

IT may not be generally known that the Theorem of Pythagoras, Euclid I. 47, is closely connected with the Theory of Repeating Patterns in space of two dimensions. The simplest proof by dissection of that Theorem establishes at once that any two squares placed in contact as in the accompanying diagrams (Fig. 1) constitute a figure such that a number of them can be assembled so as completely to fill flat space.

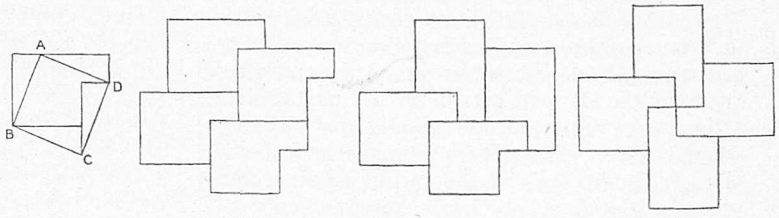


FIG. 1.

Fig. 1 (i.) shows the proof by dissection. Also the large square, regarded as a base, shows by the Principle of Transformation in the Theory of Repeating Patterns that the figure formed of the two squares is a repeating pattern. The transformation consists of cutting out the triangles the bases of which are BC and CD and erecting them upon the sides BA, AD. This nature of transformation yields an infinite number of repeating patterns of a particularly interesting kind, because of this category each member has the property that the assemblages can be carried out in three different ways, namely, so as to exhibit 1, 2, or 4 orientations or aspects of repeat respectively. In the present case of the Pythagorean Repeat the three ways of assembling are shown in Fig. 1 (ii., iii., and iv.).

PERCY A. MACMAHON.

27 Evelyn Mansions, Carlisle Place, S.W.1.

The Age of the Earth.[1]

By PROF. J. JOLY, F.R.S.

"THE Age of the Earth" is a somewhat ambiguous phrase. From the geological point of view it is generally understood to mean the age of the ocean: in other words the age of the earth since the beginning of those geological surface changes which are due to denudation. But another meaning may be ascribed to the term. We may assume the beginning to date from the cooling of a highly heated surface to the point of solidification. In this case we include in the age those long periods of Archæan time during which the activity of water played a subordinate part and volcanic commotion prevailed among the semi-fluid, rocky constituents of the globe. Yet a third interpretation refers the birth time to a still more remote and indefinite epoch when the world became differentiated as a planet by activities, of the nature of which we are ignorant. Astronomical deductions and speculations regarding the Age are mainly concerned with the last period.

What I have to say will be restricted, almost entirely, to the first interpretation of the term. I mean by the age of the earth the period which has elapsed since its surface became the scene of world-wide denudative forces and the foundations of organic evolution were laid.

In virtue of these denudative forces we find ourselves possessed of certain methods of estimating the Age which are valid upon the assumption that denudation proceeds in our time at a rate not greatly differing from its mean rate over geological time.

The bases of this assumption are as follows:—

(*a*) That the chief factor in denudative activity being the rain supply falling on the land, solar heat and atmospheric circulation are primary causes. The life on the globe since very early times and the narrow temperature limits conditioning protoplasmic existence and activity show that great extremes of solar radiation cannot have affected denudation for long periods in the past. Mere climatal extremes do not sensibly affect solvent denudation. Atmospheric circulation, being largely conditioned by the earth's rotation and the distribution of solar heat, cannot have varied to any effective extent.

(*b*) That a considerable percentage of the existing land area being rainless, changes in continental area cannot greatly affect the amount of denudation: the belt undergoing denudation being merely displaced outwards or inwards. The evidence derived from palæography and from the extent of sedimentary deposits in all ages shows that the present land area is not greatly different from the past mean area.

c) That the minor factors affecting solvent and detrital denudation being very many and of very different character are unlikely to combine at any time, and for any long period, in one direction, so as to create a considerable departure from the mean.

Time will not permit a discussion of these statements. I shall refer but briefly to the methods by which the statistics of solvent and detrital denudation are used to afford the age of the ocean.

(1) The chemistry of the ocean and of the rocks is the key to our position. As the result of a comparative study of the primary or igneous rocks and the secondary or sedimentary rocks we find that, say, n grams of sodium are shed into the ocean for each tonne of igneous rock converted into sedimentary rock, and in the ocean we find N grams of sodium. The total denudation over geological time has, therefore, been N/n expressed in tonnes of denuded igneous rock. Our study also tells us the average total loss attending the conversion of the primary rock into sediment, and so we get the total of the secondary rocks in tonnes. We now go to the principal rivers of the world and availing ourselves of estimates which have been made of the amounts of sediment—*i.e.* of secondary rock material—which they transport from the land in a year, we calculate the number of years which it would take to lay down in the ocean the great mass of sediment generated in the past ages. After certain allowances this comes out as about 100 million years.

(2) Again the total of oceanic sodium may give us the Age in another and more direct way. We know that by far the greater part of this sodium was carried into it by the rivers during geological time. We turn to the analyses of river water and estimate the total annual supply of this element to the ocean. Dividing the latter into the former and making certain allowances we find an Age which is about 100 million years.

(3) A third and more difficult method is independent of our knowledge of chemical denudation. We estimate the maximum thickness of the integral sedimentary deposits, and knowing the burthen of sediment conveyed per annum by the rivers, we estimate the maximum thickness of deposit annually derived from the same; we divide the latter into the former and find an age which, again, is about 100 million years.

Of these methods, that which involves the sodium modulus only is the most direct. Of course the reason for selecting this particular element as a modulus is because of its great solubility, on account of which it alone among the dissolved oceanic constituents has been preserved from organic abstraction or chemical precipitation. This method has been examined by many critics. Notably by Sollas, who, in a presidential address to the Geological Society in 1909, subjects it to searching examination. He concludes that a period of 175 millions of years may be reached upon certain assumptions, and that this must be very nearly the maximum allowable. My own examination of this method has led me to believe that it is *possible* that 150 millions of years may be indicated by it, and that 200 millions of years would not be reconcilable with our present knowledge of the factors involved. This would, as I have already stated, apply only to the duration of sedimentation. It cannot be compared with data which apply to an age dating back into the Archæan.

[1] Discourse delivered at the Royal Institution on Friday, February 24.

There was, indeed, some scanty sedimentation in Archæan times. We cannot form any estimate of its effects either upon our numerator or upon our denominator save that we seem entitled to conclude that they were small. "The Archæan was essentially a period of world-wide vulcanism, and in the relative proportions of rocks of igneous and sedimentary origin represents a departure from the uniformity of conditions of later geological time." I quote from the monograph of Van Hise and Leith.

Before passing on to the results based upon radio-activity I must refer to one point in particular which has been urged against accepting present-day rates of denudation as a basis of time measurement. It is said we live in a period of abnormal continental elevation which, it is asserted, involves excessive solvent denudation. A little attention to the nature and conditions of solvent denudation should have sufficed to forestall the argument. But a ready method of dealing with it is available. The continent of North America has a mean elevation of 700 metres: it is being denuded at the rate of 79 tonnes per square mile per annum: for South America the corresponding figures are 650 metres and 50 tonnes. Now Europe has a much lower mean elevation—300 metres. Its rate of denudation is, however, 100 tons per square mile per annum. The rate of solvent denudation is, in fact, by measurement found to be *less* for the more elevated land, as, theoretically, it should be. The argument then, if it has any basis, would indicate that the age as found from solvent denudation is excessive.

Prior to the advent of those methods for investigating the earth's age, which are based on radio-active changes in the elements, no serious objections to the results reached by the geological methods were raised, so far as I know. There were some, indeed, who regarded the age as excessive. Thus Becker arrived at a lesser figure by taking into account the progressive impoverishment of the surface materials during geological time. The validity of the correction is, however, open to doubt. Others considered that the organic changes recorded in the rocks required a longer period. Sollas gave, as I think, a clear answer to this objection in his "Age of the Earth." Both Lyell and Geikie, and Poulton, had in past years upheld the doctrine of Uniformity. But the advent of the radio-active method, as founded on the uranium family of elements, seemed to point to a vastly greater Age; leading, in fact, to the extraordinary conclusion that the present rate of solvent denudation is not less than four times and may be eight (or even more) times in excess of the average rate obtaining during the past.

The earliest suggestion of the possibility of using the stored-up products of radio-active change came from Rutherford. He, and later Strutt (now Lord Rayleigh), applied the accumulation of helium to the evaluation of geological time. Strutt laid out a geological chronology, the first of its kind, but considered he was dealing with minor limits. Boltwood used the residual product of uranium—lead—and for Archæan (?) materials reached as much as 1640 million years. As I have already said, the denudative method cannot be regarded as extending to those remote times. But such results as 430×10^6 years for Silurian or Ordovician deposits, and 1200×10^6 years for Post-Jatulian are quite out of harmony with the denudative method. To-day the matter stands thus:—A number of results are available based upon the use of carefully selected material, and when the material is thus selected the ratio of lead to uranium—the "lead ratio" as it is termed—increases as we go downwards and diminishes as we go upwards in the strata, preserving a fair degree of agreement even for widely separated localities.

Those who would rest content with this result, however, can do so only by ignoring the very interesting and suggestive fact that when we base the results on the lead ratio of selected thorium minerals, we arrive at ages which are in substantial agreement with the results reached by the denudative method. On the face of it this agreement gives strong support to the conclusions reached by methods absolutely different in nature.

For long it was known that thorium minerals—such as thorite—gave persistently lower ages than uranium minerals. It became the custom with some to treat these ages as untrustworthy. But we know now that this attitude is not justified, but rather that the onus of explaining away the impressive agreement between the indications of thorium lead and denudative statistics rests with those who would reject the Age supported by both.

Soddy's determination of the atomic weight of the thorium lead isotope, in 1917, afforded material for an age determination on a very large scale, and from the nature of the research, one of special value. The material was a thorite from Ceylon; from rocks immediately overlying the Charnockite series. The latter is extremely ancient—Lewisian or Lower Archæan. Upon reading in NATURE Prof. Soddy's account of his determination of the atomic weight of the lead derived from these rocks, I estimated that the quantity of lead extracted from the thorite gave an age of 130 millions of years for the time since this mineral had been generated; and on communicating with Prof. Soddy I found that he had reached a somewhat similar conclusion.

At this time, however, there was the possibility that thorium lead was not altogether stable. Suspicion fell more especially on thallium as the final product. Two experimental results, however, laid this doubt to rest: experiments upon a thorianite made in my laboratory by J. R. Cotter failed to detect even spectroscopic traces of this element, and there was insufficient thallium found in the thorite dealt with by Prof. Soddy. In a subsequent letter to NATURE Prof. Soddy states that a research carried out at the Radium Institute of Vienna supported the view that the lead isotopes derived from thorium were both stable. I shall refer presently to yet additional evidence that the transformations of the thorium family cease with lead.

Writing to NATURE in support of the hypothesis then under discussion—*i.e.* that thorium lead was unstable—A. Holmes cited a result on a selected specimen of uraninite, showing that the rocks in which Soddy's thorite occurred were, according to the uranium-lead ratio, 512 millions of years old. Previous uranium-lead ratios had assigned a much greater age

to them. Here, then, the results join issue: the uranium result is just four times as great as the thorium. We notice, too, that on the uranium-scale of time this thorite must be older than Silurian or Ordovician, which have been determined by uranium lead as 430 millions of years ago. Probably its age dates back to Cambrian or even to pre-Cambrian time. From what we have already inferred we cannot regard 130 millions of years for early Palæozoic time as irreconcilable with the maxima which denudative methods afford. More recently, lead derived from a Norwegian thorite of Langesundfiord—also of lower Palæozoic age—seems to reveal an age of 150 millions of years. In this case, also, there is the added security of a determination of the atomic weight of the lead.

We cannot discredit these results on the score of radio-active instability of the lead. Why, then, set them aside in favour of results reached on uranium lead, which are in hopeless contradiction with the indications of the record of the surface activities of the globe? It is, indeed, not too much to say that the whole position is now reversed and that to-day suspicion attaches to the uranium-lead ratio. And, as we shall see, there is much unknown about the earlier radio-active sequence in the uranium series; while the discovery of isotopes opens the way to possibilities unthought of in the earlier days of radio-active science.

I shall, however, now turn to the evidence of the pleochroic halo on this matter.

The halo affords a means of investigating certain facts respecting the break-up of the radio-active elements in the remote past. For the dimensions of the halo—minute though they be—can be determined with considerable accuracy, and these dimensions are conditioned by the added effects of the several α-rays emitted by the transmuting elements. Bragg and Kleeman observed and measured just such integral ionisation effects in air. In the rocks the ionisation curves, owing to the great stopping power of minerals, are on a scale 2000 times as small. They are very faithful hieroglyphics, however, and carry back our knowledge over an appalling vista of time.

One single α-ray produces a well-known curve of ionisation determined by Geiger. The range of the ray does not affect the general nature of the curve. If we imagine uranium or thorium as parent elements contained in a minute crystal—of zircon, for instance—we must picture the various α-rays affecting the surrounding substance—mica, we may suppose—in such a way as to build up concentric spherical shells more or less overlapping and corresponding to the radial distances at which the ionisation of the several rays is at a maximum. As seen in section upon cleaved flakes of the mica, we find concentric coloured rings representing the ionisation due to the rays.

In order to arrive at the theoretical location of these rings we must add up the several ionisation effects as observed in air. This involves assigning a Geiger curve to each ray according to its range and adding up the ordinates.

Let us consider first the case of the thorium halo. Fig. 1 is a curve arrived at in the manner I have just described. Its ordinates are proportional to the integral ionisation effects of those radio-active elements in the thorium series which emit α-rays. And above it I have marked, calculated into the range in air, the positions of the coloured rings which in biotite we observe encircling a minute mineral particle containing thorium and all the successive products of its transmutation. This, of course, necessitates magnifying the halo enormously—rather more than 2000 diameters. You perceive that the halo very faithfully conforms to the features of the air-curve. It may be of interest to mention that the finding of the third ring led to the discovery of the prominence on the curve which accounts for it. This part of the curve had originally been plotted from an insufficient number of ordinates. This close agreement really reveals a very important fact. The air-curve depends for its dimensions on the ranges of the several α-rays as we measure them to-day in the laboratory. The halo-measurements refer to radio-active effects which began their record in this mica in Carboniferous times—possibly long before. The halo reveals no sign of change in the several ranges concerned. As you are aware, the rate of break up, the transformation constant of the element, is related to the range. We are, therefore, in the case of the thorium family, entitled to read in these minute and ancient records a guarantee that the accumulation of the final product—the thorium isotopes of lead—was in the remote past effected at just such a rate as we have inferred from the splendid researches of our day. The thorium halo gives us this guarantee. It also tells us that it is improbable that the resulting lead is unstable. For if it were we must find room for rays additional to those we have used in deriving the ionisation curve. True, a coincidence of range might enable a ray to lie concealed in the halo; but the fit of the halo is so absolutely faithful to every feature of the curve that this seems improbable.

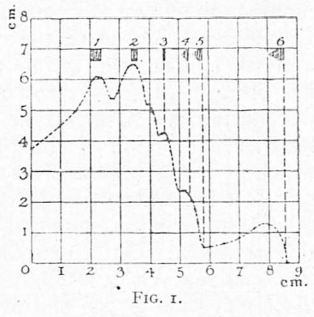


FIG. 1.

It is also possible to observe the successive stages of development in thorium haloes. The first rings to appear are those corresponding to the two conspicuous crests of the curve, Fig. 1. If the central nucleus is small or feeble, nothing more may be developed.

We now turn to the uranium curve. The eight contributory ionisation curves are placed according to the range of each ray, and Fig. 2 shows the curve produced by adding up the ordinates. Above it are laid out the several rings observed in the uranium halo.

Looking at these rings, we notice that the outer features of the halo seem in fair agreement with the present-day ranges. But the innermost ring has a larger radius than would be expected from the curve. Much care has been expended in verifying this point. In the Devonian mica of County Carlow these haloes are found in every stage of development according to the size or activity of the nucleus. The uranium halo

begins as a single delicate ring surrounding the minute central nucleus. It can be measured from a stage bordering on invisibility to a stage when its central area is beginning to darken up and the first shadowy signs of the outermost ring of all—that due solely to radium C—appear. A large number of readings on these embryonic haloes, made recently by various observers, confirm the me an value of is radius as cited in a paper communicated to the Royal Society in 1916. The discrepancy with the theoretic curve is small; 10 or 12 per cent. of the external radius. The allowance for, and measurement of, the nucleus is sufficiently difficult to introduce some uncertainty.

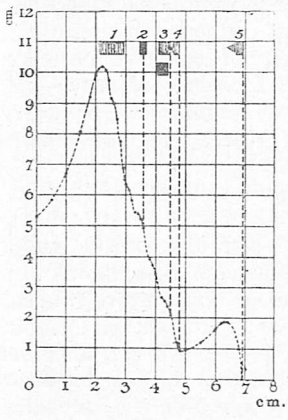


FIG. 2.

This misfit may be of considerable significance. I have already reminded you that the range of the α-ray emitted by a transforming element is related to its rate of break-up. The range is longer for the shorter lived elements. Now here the first ring of the uranium halo in mica shows a longer range than we would expect from the air-curve as observed to-day. The agreement between the two in other cases appears to show that this is not due to any unknown effect influencing the retardation in mica. The location of the first uranium ring is mainly referable to those short-range α-rays arising from the initial transformations of the uranium series. We infer that one or more of these rays must have had a longer range in past times and, of course, that the corresponding transformation periods must have been shorter. A specially influential ray is that slowest of all the rays—that which is emitted in the break-up of uranium 1. The discrepancy might be due to this ray possessing a greater range in early geological times. But, whatever the cause, the nature of the misfit suggests evidently that formerly the rate of transformation of uranium to lead was faster than it is to-day.

It is with some reserve that I refer here to measurements made lately on haloes of comparatively recent and of very remote geological ages. I say "with reserve," for not only are the results of a nature calling for very adequate confirmation, but the measurements present considerable difficulty. The point at issue may be stated in a few words :—Is the abnormality observed in the dimensions of the uranium halo dependent in amount upon the antiquity of the rock in which the halo is developed ?

I had sought occasionally for uranium haloes in rocks younger than the Leinster granite—which is of early Devonian age. The granite of Mourne, which is of Eocene or early Tertiary age, for long refused to reveal any haloes suitable for measurement. However, recently, I was so fortunate as to find a few of these early halo rings which I was able to measure. Further search has revealed a few more; but htey are excessively scarce and rather difficult to detect. The nuclei of these haloes are only rarely zircon—they seem to be apatite—possibly allanite—and their average size is greater than the zircon nuclei of the Carlow mica. Both the mineral nature of the Mourne nuclei and their dimensions involve, therefore, a bigger subtractive correction on the observed radius than is required in the case of the Carlow haloes. But in addition to this, there appears to be a small difference in the external radius of the Eocene halo and that of the Devonian halo. According to a large number of readings by several observers, some of whom were not acquainted with the question at issue, the external radius of the Eocene halo-ring—no allowance being made for the nuclear radius—is 0·0135 mm. The same observers obtained for the Devonian halo 0·0146 mm.—without allowance for the nucleus. The nuclear correction, as I have said, would have increased the discrepancy, but the correction is a difficult one. There is no reason to believe that *more* than 1 per cent. of this difference can be ascribed to the chemical composition or density of the micas, both of which have been investigated.

Still more recently I have found these primary ring-haloes in the micas of Arendal and Yitterby, which are said to be of Archæan age, and which are certainly extremely ancient. These haloes appear to possess a radial dimension of 0·0160 mms., or a little less. Here, again, the nature of the mica does not appear to be responsible. According to these measurements it would appear that the radius of the Eocene halo-ring must be increased by about 7 per cent. to attain the size of the Devonian halo-ring, and that this is, in radial dimension, about 10 per cent. smaller than the Archean. It would seem as if we might determine a geological chronology on the dimensions of these halo-rings !

The foregoing results, if confirmed, would give strong support to the view that some factor, variable over geological time, had affected the ranges and periods of certain elements concerned in building up the uranium halo. However, too much stress must not be placed on these measurements till they are confirmed by haloes in yet other micas. Pending further investigations, I return to the fact that the uranium halo of Devonian age does not conform to the ionisation curve of the uranium family as determined on present-day measurements. Serious discrepancy seems confined to the shorter ranges, more especially with that primary range which is most influential in determining the rate of production of uranium lead.

We do not appear to be in a position to deny the possibility that uranium 1 may have slowed down in its rate of decay over geological time. Such laboratory observations as can be extended to the case of short-lived elements would not, probably, shed any light on the matter. It is a possibility long ago suggested by Rutherford. But if this is the explanation we must admit that in the case of thorium any corresponding effect must have been much smaller. On the whole the former influence of one or more isotopes of uranium —which possibly may almost have disappeared—seems the more probable explanation. Hypothetical isotopes of uranium have been invoked by highly competent authorities to meet the difficulties affecting the ionisation accounts of the uranium family of elements. Boltwood suggests as "not impossible"

that what we now call uranium consists of three radio-elements; a parent element and two isotopic products all emitting α-rays (*Phil. Mag.*, July 1920). In 1917, A. Riccard put forward the view that the parent of actinium is a third isotope of uranium not belonging to the uranium family and having an atomic weight of 240. This view is regarded favourably by Soddy and Cranston. It clears up the difficulty respecting the atomic weight of uranium and fits in with the atomic weights of radium and of uranium lead. Soddy and Cranston remark that in order to explain, in this case, the constant ratio of actinium to uranium observed in minerals we must suppose the period of uranium 1 and of the hypothetical isotope to be the same. This difficulty, however, is removed if we may assume that the ratio varied over geological time.

A somewhat similar theory to Riccard's may be invoked to explain the abnormality of the Devonian uranium halo. We have these facts to go on:—The age indicated by uranium for Lower or Pre-Palæozoic rocks is about 4 times too great as compared with the age indicated by thorium. We assume, therefore, that three-fourths of the lead as measured in uranium minerals is derived from a certain isotope. This isotope, not having been detected in our time by its primary α-radiation, we must suppose to be now sensibly exhausted. We, therefore, have a known mass of this isotope transforming to lead in a known time—130×10^6 years. Assuming that only 1 per cent. of it is left we get its transformation constant ($3{\cdot}5 \times 10^{-8}$), and by Geiger and Nutall's relation we find the corresponding range as 2·6 cms. at 0° C.; or about 2·75 cms. at 15° C. To-day the α-radiation of the hypothetical body would be only $\frac{1}{1000}$ of that due to uranium 1, but during the period since the Devonian there will be about 3 α-rays from the short-lived isotope to 1 from the long-lived. The integral curve of ionisation as modified by these hypothetical results would be in agreement with the Devonian halo. We have to assume that the ranges of the rays emitted by the successive disintegrating products of the supposed isotope were such as to leave the outer features of the halo sensibly undisturbed. This seems not improbable.

The salient facts which appear in the study of radio-active haloes are:—firstly, that the agreement of our laboratory measurements of to-day with the features of the Palæozoic thorium halo is such as to support the view that the periods of the several elements concerned in its genesis have remained unchanged over 130 millions of years. This fact, taken along with the stability of thorium lead, seems to render its reading of geological time authentic in a high degree. Its indications are confirmed by the consistent testimony of the denudative processes which have progressed on the earth's surface. Secondly, it appears that the uranium halo is not in conformity with the period we ascribe to-day to uranium; a disagreement which is emphasised by the failure of uranium-time to conform with the united testimony of thorium-time and denudative-time; as well as by much that remains unexplained respecting the earlier changes in the uranium family of elements.

The complete tale is not yet told, but I think the balance of probability is in favour of an age between 150 and 200 millions of years for the earliest advent of geological conditions upon the globe.

Astronomical investigation on the subject of the age of the earth deals, generally, with that greater age which must be ascribed to the earth as a planet. For this age vast periods have been claimed. But it is possible to reconcile superior ages for the earth as a planet with comparatively brief geological time. And—to my mind—in doing so we proceed upon what is no more than a necessary deduction based on our knowledge of the radio-activity of terrestrial materials. I would go further—still, as I believe, logically,—and ascribe to radio-active energy an influence on planetary and stellar evolution much greater than has hitherto been admitted.

The only planet we can investigate at all closely is, of course, our earth. And what do we find? In its surface materials there are sufficient of the radio-active elements, as Lord Rayleigh first showed, to account for the observed average temperature gradient if the surface conditions extend a little way, about 19 kilometres, inwards. It is, for many reasons, in the highest degree improbable that such a definitely defined radio-active layer exists. Nor is it probable that the earth's interior is free from radio-active substances. We find both uranium and thorium in meteorites containing a large percentage of iron and nickel, and, although they have not as yet been found in meteoric iron, we know from the mean density of the earth that its interior cannot be composed of pure iron. It is probable that a considerable proportion (some 40 per cent.) of siliceous materials are intermingled: and when such exists in meteorites invariably we find the radio-active elements. By what conceivable activity was all the uranium and thorium separated out and brought to the surface?

The view that radio-active elements exist in the earth's interior is sometimes met by a formal denial that the earth can be getting hotter within. Upon what evidence is this denial based? If the central core of the earth for a radial distance of 2000 kilometres—say—had risen in temperature by 1000° C. over geological time—and upon a low assumption of the interior radio-activity it might reach this temperature in 150 million years—would we be aware of the fact? Would the day be appreciably lengthened? Would there be any effect at all if the outer parts were cooling due to loss of primal heat? We have further to consider that only over the short period of historical time would any observations be available. The denial is quite baseless so far as my estimates go.

Well, then, if our earth is heating up within, is there not an impending termination to our geological age? Kelvin showed how complete is the thermal isolation of the earth's interior, and it is certain that interior heat is not now escaping. The rise of temperature within must go on till the present epoch succumbs to the accumulated energy. Then must ensue a period of vulcanicity which will end life upon the globe, and probably reverse the chemical work stored up by ages of denudative and organic activity. The whole sequence of events—rapid cooling by radiation, restoration of the oceans and, possibly, re-birth of life and of its evolutionary history—would begin all over again. On this view the Age we have been studying

may be one of many and will inevitably attain its three score and ten; terminating in labour and sorrow. But there must come a rejuvenation, and the rejuvenation, possibly, may one day be pondered by other Minds than ours. Remember that after some ten thousand millions of years there still survives 50 per cent. of the heat-generating elements, and the effect of their diminution is only to lengthen out the recurring geological ages. Our planetary companions may be in various stages of such cyclical changes.

Recovery of Hughes's Original Microphones and Other Instruments of Historic Interest.

By A. A. CAMPBELL SWINTON, F.R.S.

FROM the perusal of David Hughes's note-books recently bequeathed to the British Museum by Mrs. Hughes, and sent to me for examination by the Keeper of the Manuscripts (see NATURE, March 9, 1922, pp. 315-316), it became obvious to me that Hughes must at one time have possessed numerous original instruments, mostly constructed with his own hands. Having been informed that the note-books had been rescued from "an incredible accumulation of useless lumber," it occurred to me to try to locate this "lumber" if still existent, and to see whether it comprised any of the instruments. To make a long story short, a room in a furniture depository not far from the Tottenham Court Road was found to be filled with Hughes's personal effects, which had been stored there since his death in 1900, when Mrs. Hughes returned to America. Having interested Col. H. G. Lyons, F.R.S., Director of the Science Museum, in the matter, the effects were carefully examined, when not only were there discovered eight more note-books—one containing an illustrated account of Hughes's invention of the microphone—but also numerous instruments.

These comprise a number of microphones, of which several are different-sized instruments of the well-known pivoted-lever type. Others consist of pointed carbon pencils, loosely held at their ends between fixed carbon sockets, the whole being mounted on sounding-boards, which in one case takes the form of an inverted Japanese ash-tray. Several more consist of carbon pencils suspended pendulum-wise by paper strips, so as to bridge other carbon pencils mounted on vertical sounding-boards, while others, again, consist of glass tubes containing either carbon blocks held together by a light spiral spring, or carbon granules. Finally, among the microphones, there is the one consisting of three French nails that has served to illustrate many a text-book.

In addition, there is an induction balance, probably the first one that Hughes made, together with the actual instruments with which he practised wireless telegraphy in 1879. They are all readily identified from the illustrated descriptions in the note-books, and include the clockwork with which currents from a single-cell battery, connected to one of the coils of the induction balance, were interrupted so as to transmit wireless signals. There are also two Bell telephones, evidently made by Hughes himself, together with two more which he says were made for him by Sax, which he used for wireless reception in connection with a water-tight pocket battery, and a special microphone that seems to have acted as a self-decohering coherer. This latter is contained in a glass bottle, the loose contact being made between a steel needle and a wire loop, which latter Hughes says he made more sensitive by coating it with soot from the flame of a spirit lamp.

With these simple pieces of home-made apparatus Hughes not only prepared the way for the modern telephone transmitter, but also transmitted and received wireless signals over distances up to 300 yards no less than 43 years ago.

All these instruments have been made over to the Science Museum, South Kensington, by Mrs. Hughes's trustees, and are now on view in Room No. 10.

Obituary.

WE learn from the *British Medical Journal* that Dr. Harris Graham died at Beirut, Syria, on February 27. Dr. Graham, who was in his sixtieth year, was of Canadian birth and was educated at Toronto and Michigan Universities. Going to Turkey as a missionary he served four years at Aintab Medical College. On its closure, he was called to Beirut and joined the American University there in 1889. During various leaves of absence he worked in Berlin and Vienna, and advanced evidence that a Culex mosquito is the carrier of dengue fever. He had an extensive practice and spoke all the principal languages of the Levant. Dr. Graham will be much missed, for he was an energetic and inspiring teacher and a physician of great acumen.

THE *Chemiker Zeitung* of March 25 announces the death, at the age of eighty-four years, of Prof. A. Naumann. Prof. Naumann was one of the first workers in the field of what is now called physical chemistry. His researches on dissociation, thermochemistry, and mass action, and his text-book had great influence on the science; his name is prominent in all the earlier work in this field.

THE death is announced, at the age of fifty-one years, of Dr. George Vincent Wendell, who had occupied a chair of physics at Columbia University since 1910. From 1892 to 1907 he held various posts at the Massachusetts Institute of Technology, and from 1907 to 1910 he was professor of physics and head of the department at the Stevens Institute of Technology, New Jersey.

WE deeply regret to record the death on April 9, at seventy-seven years of age, of Sir Patrick Manson, G.C.M.G., F.R.S., whose pioneer work on tropical diseases opened up fields of research of profound significance both to science and civilisation.

Current Topics and Events.

THE centenary of the birth of Pasteur occurs this year, and the University and town of Strassburg, the scene of so much of Pasteur's early work, propose to celebrate the event by organising an exhibition of hygiene and bacteriology from May to October 1923, and by setting up a statue of Pasteur before the University. The exhibition will be designed to illustrate the advances in science made as a result of Pasteur's discoveries, and a congress for the discussion of questions relating to the prevention of disease will also take place. In this country a committee, consisting of Sir Charles Sherrington (chairman), Mr. A. Chaston Chapman (treasurer), Mr. H. E. Field, Prof. P. F. Franklin, Sir John M'Fadyean, Prof. C. J. Martin, Sir W. J. Pope, Sir James Walker, and Sir Almroth Wright, has been formed to forward the project and an appeal for support has been issued. Contributions to the memorial fund, which will be closed at the end of June, should be sent to Mr. Chaston Chapman, The Institute of Chemistry, 30 Russell Square, W.C.1, or to the general secretary and treasurer of the fund, M. T. Hering, 6 rue des Veaux, Strassburg. Prof. Borrel, 3 rue Koeberlé, Strassburg, is in charge of the arrangements for the exhibition and would be glad to hear from British firms who are interested. The Académie de Médecine has decided to celebrate the centenary on December 26 next, but representatives of the academy will be present at the celebrations to be held at the Institut Pasteur on December 27 next and at Strassburg on June 1 of next year.

THE centenary of the birth of Gregor Mendel is to be celebrated in Brünn (Czecho-Slovakia) on September 22-24 of this year, and subsequently, on September 25-27, a congress of geneticists is to be held in Vienna. The circular of invitation recalls the erection of a statue to Mendel there in 1910. Since that date the significance of his discovery and the extraordinary importance of his work in its bearing on the fundamental conceptions of biology and the practice of breeding have been so widely recognised that international support on the present occasion is confidently invited. Those who are disposed to take part are asked to communicate with Dr. H. Iltis, Bäckergasse 10, Brünn.

WE have received from the authorities a preliminary circular announcing the celebration this spring of the seventh centenary of the University of Padua, one of the oldest and most famous of the Italian universities, immortalised by Galileo and his successors. In connection with the celebrations a very interesting historical account of the University is published in the February number of *L'Emporium*, the leading art journal of Italy, showing the bearing of the University upon education in the Italy of past centuries, and the vicissitudes through which the institution passed down the ages. In spite of its associations with the great names of the past, Padua is a very modern university in so far as concerns present-day needs, ample proof of this being the large and well-equipped school of electrotechnics.

SINCE the School of Hygiene and Public Health of Johns Hopkins University, Baltimore, was opened in 1918, the Rockefeller Foundation has furnished funds for its maintenance from year to year. Now the Foundation has presented a sum of 1,200,000*l*., and the trustees of the University are to assume full responsibility for the future needs of the School. In this new type of institution emphasis is laid upon the development of preventive medicine and the training of health officers. Instruction is provided in bacteriology and immunology, sanitary engineering, chemical and physiological hygiene, medical zoology, epidemiology, vital statistics and public health administration, and the regular courses of study lead to the degrees of doctor of public health and doctor and bachelor of science in hygiene. The present gift, in addition to providing endowment, will make possible the erection of the new building for the School on a site adjacent to the Johns Hopkins Medical School and Hospital.

PROF. A. WOLF, of the University of London, delivered a lecture on the Humanism of Spinoza at a special session of the Spinoza Society held at the Hague on Tuesday, March 28. The Spinoza Society ("Societas Spinozana") is the offspring of an older society founded more than forty years ago when the Spinoza monument was erected in the Hague as an international tribute to the great philosopher. Among the leading spirits of both societies are Sir Frederick Pollock, of London, Prof. L. Brunschvieg, of Paris, Prof. H. Hoeffding, of Copenhagen, Dr. C. Gebhardt, of Frankfurt, Dr. W. Meyer and Mr. H. G. van der Tak, of the Hague. The Spinoza Society has now in the press the first number of an Annual to be called "Chronicon Spinozanum," to which all the above-mentioned Spinoza scholars and others have contributed important essays. The promoters of the new society and its annual are prompted by the feeling that a wider knowledge of the philosophy and personality of Spinoza may be of special help in these difficult times, and they hope that the society may become a rallying point for those thinkers who still share Spinoza's faith in the ultimate unity and rationality of mankind.

IN appointing an advisory Committee in Seismology, the Carnegie Institution of Washington has taken an important step in the promotion of the study of earthquakes in the United States. The preliminary report of the committee recognises that, as compared with England, Germany or Japan, the country has not yet taken a sufficiently active part in seismological research. At the same time, in the State of California, it possesses almost unexampled opportunities for the study of crustal movements, while several public

bodies are prepared to co-operate in such a study. The committee make several useful suggestions. Detailed surveys, it is urged, should be made of the San Andreas rift and other Californian faults. The Coast and Geodetic Survey should be invited to undertake a system of primary triangulation and precise levels in the regions most subject to movement, and to connect them with an appropriate zone of no movement east of the mountains, and also to erect new lines of columns at right angles to the San Andreas and San Jacinto faults, a time like the present being more suitable for the measurement of crustal drift than the months immediately following a great earthquake, such as that of 1906. Southern California, especially, is a region of intricate faulting, in which many of the faults are still active, and it is also one in which no primary triangulation has yet been made. The committee also indicates the value of gravity observations in connexion with the measurement of displacements along the great faults.

SIR ARTHUR NEWSHOLME delivered a course of three Chadwick lectures at Birmingham on March 27-29. The subject of the first lecture was "Values in Preventive Medicine historically considered: General and Specific Sanitation." The lecturer dealt with the value of various measures against disease in their historical development. He deprecated strongly the undiscriminating call for retrenchment in public health expenditure, though urging a careful survey of the cost of all measures in vogue. The epidemiology of typhoid fever, cholera, typhus fever, and others was considered, and the lessons taught by the methods of control were surveyed. In the second lecture on "Current Values in Preventive Medicine: Relation between Prevention and Treatment," Sir Arthur Newsholme reviewed the possibilities of preventing the chief infectious diseases. The acute notifiable diseases cause only 3·1 per cent. of the total mortality, though the greater part of administrative care is devoted to them. In childhood more than half the deaths are due to infections, and in a large measure adult health is determined by disease or absence of disease in childhood. The chief object of preventive medicine is to postpone death, and this would be greatly aided if every adult submitted himself to periodical medical examination. In the third lecture, methods of evaluating public health activities were considered. Empiricism in analysis of social conditions was deprecated, as, for instance, in statements on malnutrition of school children, without further attempt to ascertain the cause. The amount spent on public health in large English and American towns averaged 5*s*. per head per annum, or, in England, from 4 to 8 per cent. of the total rates collected per head. The importance of minimum standards was emphasised, each town to receive a government grant only when it fulfilled certain minimum conditions. The lecturer concluded that the greatest return in health for money expended—apart from the ordinary sanitation of a city—was to be had in respect of maternity and child welfare, and on the prevention and treatment of tuberculosis and venereal diseases.

THE *Times* reports the opening on April 5 of a lock and weir at Blanchetown, South Australia, the first of a series of such structures which will ultimately number 26, and directs attention to the very important scheme of navigation and irrigation, of which they form part, entered upon by the States of New South Wales, Victoria, and South Australia, with the sanction of the Federal Government. The rivers Murray and Murrumbidgee are to be regulated by a lockage system which will make it possible to navigate their waters for a distance of 1066 miles above the mouth of the former, and at the same time will increase greatly the area of irrigable land. Of the total number of locks, nine will be constructed by the New South Wales Government on the Murrumbidgee, eight by the Victorian Government on the Murray, and nine by the South Australian Government on the same river. The Blanchetown lock, which has been named after Mr. W. R. Randell, one of the pioneer navigators of the river, is situated 170 miles from the sea, and marks the limit of free deep water, for which reason it was chosen as the initial feature of the undertaking. The work, which was begun seven years ago, has been much impeded by floods and industrial troubles, so that the lock was only completed in September last.

LECTURES at the Royal Institution after Easter will be resumed on Tuesday, April 25, when Sir Arthur Keith will begin a course of three further lectures on "Anthropological Problems of the British Empire," Series II.: "Racial Problems of Africa." The Tyndall Lectures will be delivered this year by Prof. W. Bulloch on "Tyndall's Biological Researches and the Foundations of Bacteriology," and Sir Percy Sykes will give two lectures on Persia. On Thursday afternoons there will be two lectures by Prof. E. H. Barton on "Audition and Colour Vision"; two by Prof. F. Keeble on "Plant Sensitiveness." On Wednesday, April 26, Prof. D. H. MacGregor gives the first of two lectures on "Industrial Relationship," and on Wednesday, May 24, Dean Inge begins a course of three lectures on "Theocracy." On Saturday afternoons there will be two lectures by Prof. O. W. Richardson on "The Disappearing Gap between the X-ray and Ultra-violet Spectra"; and three by Sir Hugh Allen on "Early Keyboard Music," with musical illustrations by Mr. Harold Samuel. The Friday evening discourses will be resumed on April 28, when Dr. Arthur Harden will deliver a discourse on "Vitamin Problems." Succeeding discourses will probably be given by Dr. M. Grabham, Dr. H. H. Dale, Sir William Bragg, Prof. W. E. Dalby, the Hon. Maurice Baring, Mr. J. Barcroft, and other gentlemen.

AT the anniversary meeting of the Royal Irish Academy held last month Prof. T. H. Morgan (New York) and Prof. Jules Bordet (Brussels) were elected honorary members in the section of science.

IT is stated in the *Chemiker Zeitung* of March 23 that Prof. W. Nernst will take over on April 1 the duties of Director of the Physikalisch-Technische Reichsanstalt, but will continue to act as Rector of the University of Berlin until October 15.

ACCORDING to a brief despatch from Valdivia published in the *Times* of April 6, great volcanic eruptions occurred in southern Chile, to the south-east of Puerto Montt, and close to the Argentine border. They were accompanied by violent earthquakes. Much damage was caused to grazing lands on the Argentine side of the frontier, which for thirty leagues was covered with volcanic ashes.

WE learn from *Science* that a meeting to initiate the Gorgas Foundation Memorial, founded in memory of the late Maj.-Gen. W. C. Gorgas, who accomplished noteworthy work in connection with tropical diseases in Panama, was held at Birmingham, Alabama, on March 4 last. Among the speakers was the British ambassador, Sir Auckland Geddes, who said: "The name Gorgas will live long after the peoples of earth have forgotten the heroes of the world's greatest war."

AT the annual general meeting of the Chemical Society held at Burlington House on March 30, the following new members of council were declared elected: Vice-Presidents, who have filled the office of President: Prof. H. B. Dixon and Prof. P. F. Frankland; Vice-Presidents, who have not filled the office of President: Prof. E. C. C. Baly and Prof. T. M. Lowry; Ordinary Members of Council: Dr. C. Dorée, Dr. J. J. Fox, Prof. I. M. Heilbron Prof. J. W. McBain, Dr. W. H. Mills and Prof. J R. Partington.

UNDER its new constitution the Association of Assistants in Pathological and Bacteriological Laboratories is now admitting, as associate members, laboratory assistants from laboratories other than those of pathology and bacteriology. The organisation was founded in 1912, its chief object being to improve the status of the laboratory assistant by endeavouring to raise the standard of technical knowledge through the medium of an educational programme, culminating in an examination and the granting of a certificate of proficiency in laboratory technique. An official organ, *The Laboratory Journal*, is issued to members quarterly, and, in addition to Association news, the journal contains original articles and abstracts of technical interest to laboratory workers; there is also an employment bureau. From the first the founders had in mind the inclusion ultimately of all laboratory assistants in one federation, and it is hoped that the present movement will lead to the formation of sections embracing other branches of science. The Honorary Associate Secretary is Mr. F. C. Padley, 2 Eldon Place, Reading, from whom further information may be obtained.

Our Astronomical Column.

EVENING STARS.—After sunset the sky now presents some interesting planets for observation. At the middle of April Venus will be brilliantly displayed in the western sky, and sets about an hour and a half after the sun has gone down. Jupiter will be visible in the south-east sky and will pass the meridian at an altitude of about 35° soon after 11 P.M. Saturn crosses the meridian 35 minutes before Jupiter, as it is situated 9° westwards.

Mars will not be visible in the early hours, but rises at midnight at the middle of the month, and will remain visible throughout the morning hours. Jupiter and Saturn may now be very successfully observed in telescopes, as they reach a fairly good altitude, but Mars is very low in Scorpio and only 15° above the horizon when due south. The latter planet will continue so far south during the ensuing summer that its markings will scarcely admit of satisfactory investigation by European observers. When the planet is nearest to the earth on June 18 next, it will be only 42 millions of miles distant from us, but its greatest altitude will not exceed 12°. In such circumstances good definition of delicate features is almost impossible when high magnifying powers are employed on telescopes.

THE DISTANCES OF THE SHORT-PERIOD CEPHEID VARIABLES.—Bull. No. 8 of the Astr. Inst. of the Netherlands contains an important research on this subject by J. C. Kapteyn and P. J. van Rhijn. They note that the Cepheids may be divided into two classes with periods greater and less than 16 hours. Excluding those in clusters, there are 39 and 94 stars belonging to these classes respectively; the first class shows no galactic concentration, while the second shows it strongly, an argument for the relative proximity of the former. Provisional proper motions are deduced for 14 of these stars, chiefly from astrographic plates with a time-interval of some 25 years. The mean parallax deduced is 0·0065″, while the mean magnitude is 10·3; the parallax is 7·6 times as great as that given by Shapley's formula. It is pointed out that Schouten reached in 1918 the same factor 7·6 for Shapley's parallaxes of the clusters; he based this on the assumption that the luminosity curve for the stars in the clusters is identical with that found for the stars as a whole. It should be observed that neither method affects the relative distances of the clusters investigated by Shapley; it simply divides all of them by a factor. Further, the Cepheid method was only one of several used by Shapley in deducing his distances; hence it appears somewhat unlikely that they need division by so large a factor as 7·6.

Kapteyn and van Rhijn also reinvestigate the mean parallax of the long-period Cepheids, obtaining 0·0029″ from 17 stars, of mean magnitude 5·32, which is in good agreement with Shapley's 0·0034″ from 11 stars. They express the hope that trustworthy proper motions for all the 39 short-period Cepheids will be available in a few years, and ask for a suspension of final judgment on the distances of the clusters till that time.

Dr. Shapley gives some evidence on the other side in Harvard Coll. Observ. Bull. No. 765. He states that the light curves of several short-period Cepheids in the Small Magellanic cloud (mean period 0·64 days) give a mean median magnitude 16·1, closely agreeing with the value 16·2 predicted by his curve. He claims that this supports his previous estimate of the absolute magnitude of these stars.

Research Items.

AN ARTIFICE OF NECTAR-SIPPING BIRDS.—In a communication sent to us by Mr. P. M. Debbarman of the Royal Botanic Gardens, Sibpur, Calcutta, he records that the flowers of *Castanospermum australe* are visited by the nectar-sipping bird *Mirafra assamica* in India. The beak of this bird is not sufficiently long to reach the nectar in the calyx cups, so the bird appears to have adopted the practice of biting off the fleshy petals which obstruct it. The tree is not a native of India but is of Australian origin, and it would be interesting to know whether any nectar-sipping birds attack the blossoms of this tree in Queensland, where it is native.

ICE IN THE ARCTIC SEAS IN 1921.—The annual publication of the Danish Meteorological Institute (*Isforholdene i de Arktishe Have*) shows that ice conditions last year in the Barents and White Seas were somewhat unusual. The eastern part of the Barents Sea was free from ice early in May, while in the north the edge of the pack was more northerly than usual throughout the summer. The White Sea was easily accessible and almost free of ice as early as April. On the west coast of Spitsbergen, there was considerably less ice than usual during the winter 1920–21. The fjords were frozen only for short periods and pack-ice did not appear off the coast in any quantity before May, but throughout the summer months there was a belt of loose pack off the south-west coast, which in October increased in width to some 70 miles. This occurrence was associated with the prevalence of easterly winds in the Barents Sea in summer. The same winds caused the ice to be packed against the east coast of Greenland in July and August. The distribution of ice in the Greenland Sea was normal except in this respect, which made the east coast of Greenland singularly unapproachable. On the Newfoundland banks icebergs were very numerous in May and again in July, when they drifted rather far south. In the Bering Sea, the edge of the pack seems to have been more northerly than usual in spring. In the Beaufort Sea a whaler reached Banks Land in August.

SEISMOLOGICAL STATIONS OF THE WORLD.—A valuable catalogue, and the most complete so far issued, of the seismological stations of the world has been compiled by Mr. H. O. Wood under the auspices of the Section of Seismology of the American Geophysical Union (published by the National Research Council of the National Academy of Sciences, Washington, 1921). The total number of stations is about 315, and for each is given, when known, the position and the nature of the foundation, the names of the director and of the supporting institution, the types of seismographs used and the constants of each, and the method of obtaining correct time. With regard to more than 90 of them (including all the Russian stations), however, no recent details have been communicated. Arranging the stations according to countries, we find that Japan heads the list with 55, followed by the British Empire and Italy with 42 each, the United States with 32, and Germany with 21. The instruments used are almost as diverse as the countries. The most popular is the Wiechert inverted pendulum, of which there are 72 in use with masses varying from 80 kg. to 17,000 kg. at Göttingen and Tacubaya (Mexico) respectively. Then come the Omori horizontal pendulum, extensively used in Japan, the Milne seismograph, chiefly at British stations, and the Vicentini seismographs, employed as a rule in Italy. The costly, but effective, Galitzin seismographs are in working order at not less than eight stations. Two points of some interest are the large number of stations founded during and since the war and not in neutral countries only, and the gradual replacement of the older instruments by others of more recent and accurate types.

THE CEMENT OILFIELD, OKLAHOMA.—A recent addition to our knowledge of the Mid-Continental Oilfield region of North America has been made by Mr. F. Reeves in Bulletin 726-B of the United States Geological Survey, wherein he deals with the geology of the Cement Oilfield, Caddo County, South-west Oklahoma. The area described occurs to the north of one of the main uplift masses (Wichita Mountains) which form such a conspicuous feature of the country bordering northern Texas, and the local tectonics of the field have intimate connection with this larger element of structure. The surface geology is mainly Permian (Red Beds), forming a vast plain surrounding the Wichita Mountains. This formation consists of shales, sandstone, gypsum and limestone, and, according to the author, has a total thickness of 1500 feet. Beneath it lies the Pennsylvanian Series, and it is presumed that the oil is obtained from the upper beds in this series, though some difference of opinion is manifest as to where the line of junction should be drawn, the transition from the older to the newer rocks being very gradual. The principal structural feature of the Cement area is the Cement anticline with its complementary synclines, the Cobb on the north and the Cyril on the south. The trend of these folds is approximately N. 70° W., a strike direction characteristic of the Wichita Mountains. The wells are located practically on the crest on the Cement fold, and have an average daily production of about 100 barrels; twenty-six wells have at present been drilled. The oil is of uniform quality with specific gravity ranging from 0·84 to 0·85. The prospects of the field are good, though it is unlikely that any startling developments will take place in the future, as the productive area is not great and the tendency seems to be for the wells to give low production with slow decline, the rate of decrease averaging 2 per cent. per month. Four gas wells have been drilled and the initial production was good, but the rate of decline of these wells was very rapid. The Bulletin itself is quite up to the usual standard of Survey publications in the matter of descriptive text and particularly in the maps and plans accompanying it.

LAND AND SEA BREEZES IN THE GULF OF LIONS.—An article by Prof. M. Moye is given in the *Meteorological Magazine* for March on land breezes and sea breezes on the French and Catalonian coasts of the Mediterranean Sea. They are stated to be a distinctive feature of the summer climate in these parts, and are said to be much more marked than on the Channel and Atlantic shores. From a discussion by Prof. E. Fontséré, it is shown that at Barcelona sea breezes begin in March, when they blow on about four days out of ten. In April and May they blow on more than six days out of ten, and from July 15 to August 15, sea breezes are recorded on nine days out of ten. In September they are less frequent, and by the end of October they practically disappear. At Montpellier sea breezes are said to be rare before mid-May and after September. The sea breezes generally begin after a short period of calm. During the night and in the early morning land breezes blow gently. The sea breeze begins from the south and south-

west, and the direction is from south-west or west-south-west in the afternoon. The land breezes at night blow from north-west or north. Sea breezes generally blow more strongly than land breezes. A normal sea breeze at Barcelona corresponds with 4 or 5 on the Beaufort wind-scale, whilst at Montpellier the breeze is rather lighter, not exceeding force 3 or 4. Land and sea breezes are said to be essentially surface currents and they are supplemented by a return circulation in high atmosphere. These points have been tested by pilot balloons and the results given are decidedly instructive.

UNITED STATES TEMPERATURES. — The U.S. *Monthly Weather Review*, for November 1921 has an article on "Some Characteristics of United States Temperatures" by Prof. Robert De C. Ward, of Harvard University. The author has had access to maps prepared by the U.S. Weather Bureau for the new Atlas of American Agriculture. The temperatures are not reduced to sea level. In the opinion of the author the isothermal maps of the United States will supersede all previous maps and will for years to come remain the "standard set." Isothermal lines are given for each 5° F., and those for midwinter and midsummer run fairly smoothly and symmetrically to the east of the Rocky Mountains, but the effects of the Appalachian topography warp the local irregularities of the lines. Over the western plateau and mountain area, the isotherms are most irregular, and it is there that the new charts, which show actual temperatures, are so great an advance on those previously drawn. The greatest differences in temperature in different parts occur in the winter. In January, going southwards the temperatures increase about 2°·5 for each degree of latitude. Very different conditions exist in midsummer, when the distribution of temperature is far more uniform and the difference of temperature for each degree of latitude amounts only to about 1° F. Highest and lowest "record" temperatures are given on separate maps produced from the results at about 600 stations. These extreme temperatures are of considerable interest, and if they do not show the world's highest and lowest readings, they give very valuable results. In the United States, especially in the eastern parts, very low temperatures commonly penetrate far to the south into latitudes where the winters are distinctly mild.

SUBMARINE PERISCOPES.—The current number of the Transactions of the Optical Society contains a paper by Dr. Alexander Gleichen on the path of rays in periscopes having an inverting system comprising two separated lenses, in which results are given of a theoretical investigation carried out by the author for Messrs. C. P. Goerz of Berlin-Friedenau. The paper is devoted generally to the design of periscopes as regards the best arrangement and sizes of the various optical parts involved, with the object of making the best possible use of the available space, which in the case of submarine periscopes particularly is very limited. The characteristics of these instruments are their comparatively great length and small diameter. In particular it is shown how the magnification, the field of view, and the illumination in the centre and at the edge of the field of view, depend on the length and diameter of the instrument, in order to derive therefrom the most advantageous optical arrangement. A feature of submarine periscopes which limits the design to an important extent is the reduction of the diameter of the upper portion which may be extended above the surface. Formulæ for the determination of the path of the rays in periscopes of this type are given and also a brief statement regarding the external form of the submarine periscope.

CRYSTAL STRUCTURE OF COMMON ELEMENTS.—In a paper published in the Journal of the Franklin Institute for February under this title, A. W. Hull gives a very useful summary of the results of X-ray crystal analysis. The methods of analysis which were first developed (analysis by means of a Laue photograph, or with the X-ray spectrometer) can be used only if a single homogeneous crystal of appreciable dimensions is available. It was impossible to examine the structure of a large number of the elements and simple compounds, which could be obtained only in a finely divided crystalline form, until the "powder method" of analysis was developed by Debye and Scherrer, and by Hull. A mass of powdered crystalline material is placed in the path of a narrow beam of monochromatic X-rays and the crystal structure is deduced from the manner in which the rays are diffracted. The technique of the powder method of analysis has been brought to a very high degree of perfection by Hull, who has examined a large number of elements and compounds. We now know the crystalline structure of thirty-five of the elements, twenty-nine having been determined by Hull himself. A number of binary compounds have recently been analysed by Davey, using the Debye-Hull method. A list of all crystals whose structures have been completely determined is given by Hull. The powder method of analysis will certainly become a most powerful means of studying the structure of solid bodies. It can be applied to any crystalline substance, and in addition, it can be used to analyse constituents of a mixture of crystalline bodies, so that to the metallurgist it will be of the highest importance. The paper concludes with an interesting discussion of "atomic diameters."

THE LIGHTING OF PUBLIC BUILDINGS.—An interesting paper on this subject was read by Messrs. E. H. Rayner, J. W. T. Walsh, and H. Buckley of the National Physical Laboratory, at the meeting of the Illuminating Engineering Society on March 28. The paper was devoted mainly to experiments undertaken in co-operation with H.M. Office of Works, one noteworthy installation being the semi-indirect lighting in the new Pensions Offices at Acton. The tabulated data show that the level of illumination provided in public buildings has arisen considerably during recent years, values from 3 to 4·5 foot-candles now being general. Another section of the paper was devoted to some experiments on the lighting of picture galleries, where the avoidance of reflected images in the glass on pictures is a difficult problem. Diagrams were presented showing a new arrangement of the skylights which, while occasioning some loss in light, seems to give a much more satisfactory distribution of illumination. The authors also described a special building erected at the National Physical Laboratory for the purpose of experiments on illumination, which has some interesting features. Following the presentation of the paper Capt. J. W. Liberty, Public Lighting Inspector to the City of London, showed a number of photographs of recent lighting installations in certain public buildings, where architectural and decorative considerations play an important part. Amongst such interiors may be mentioned the Guildhall, the Marylebone Town Hall, and the new Port of London building. Some of these interiors, notably those panelled in very dark walnut, present interesting lighting problems. The arrangement adopted in the main office at the Port of London building, where gas-filled lamps giving 20,000 c.p. are assembled in a vast white dome, is particularly striking, and it is hoped to present fuller details of this installation when completed.

Auxiliary International Languages.[1]

By PROF. F. G. DONNAN, F.R.S.

AT the present day the rights of all nations to unity, to the preservation and independent development of national life and customs, are fully recognised and admitted. Partly as a result of the war, long dormant hopes and moribund languages have awakened to a new period of life and activity. We live amidst a remarkable efflorescence of national diversity and national pride.

At the same time, the material means of intercommunication by land, sea, and air are rapidly increasing in speed, efficiency, and cheapness. You can lunch quietly and leisurely in Amsterdam and the same afternoon have tea with a friend in London. Science and industry are advancing with giant strides, and in rapidly increasing measure all nations are taking part in this work. The modern world is thus a vast arena of conflict between separating and intermixing forces. In the loom of life a myriad coloured threads are intertwined in the strange fabric of modern civilisation. But where are the integrating influences that will give us that *unity in diversity* which all wise men seek?

It is not a monotonous unison of thought that I mean, but a harmony of independent notes—an integration, and not a unification, of separate ideas. What is it that, while conserving the independent life of nations, will produce a common liberality of thought and action? There is only one answer—the intercommunication, the internationalisation of thought. Men have dreamed of a common political organisation of the world, of a human family one in government, speech, and religion. Such things may perhaps come to be, but they lie in the shadowy realm of a very distant future. The practical problem of to-day is the problem of mutual intercomprehension, of unity of understanding, amidst variety of thought, speech, and action. The solution of this problem lies in the existence of an auxiliary language common to all the nations of the world; what we may therefore call an auxiliary international language.

As late as the eighteenth century, Latin served the purpose of an auxiliary international language for the learned world, whilst French has long held sway as the common language of diplomacy (though recent events have tended to give English an equal rank). It may come to pass in the distant future that one of the great modern languages will be gradually accepted by all nations as a common auxiliary tongue known to and used by all. Many Englishmen fondly believe that this high destiny is reserved for their mother language. The very unphonetic character of English spelling presents a great difficulty in this connection.

Those who have given the greatest amount of study to this subject have come to the conclusion that the world will not accept any living national language as a common medium of intercommunication. Feelings of national jealousy, prestige, and advantage are too strong. The international auxiliary language must be *neutral*. It must also be simple and regular, and simplicity and regularity are not qualities possessed by any living national language. From various points of view Latin would satisfy the condition of neutrality, and there are some who urge the claims of this language. But apart from other obstacles, the intrinsic difficulty of Latin is too great.

The object of an auxiliary international language is not to displace or replace existing languages, but to protect and supplement them. These qualities of neutrality, simplicity, regularity, and compatibility can be obtained only by means of an *artificial auxiliary language*. Now this word *artificial* shocks and frightens people. We are so accustomed to the historical and analytical treatment of languages that we have never dreamt of the possibilities of synthesis. The chemists and physicists have analysed nearly all the things they have found in this world. But if they had rested content only with analysis, the practical world would have much less to thank them for. We may not like synthetic butter and synthetic milk, but we have no objection to synthetic soap or synthetic glass. Why not then a synthetic language? So far as the languages of North and South America and of Western Europe are concerned, the problem is mainly one of the synthesis of existing elements, since amongst these languages there exists already a very large international vocabulary. As Dr. Cottrell has aptly expressed it, our problem is nothing less and nothing more than the science of synthetic linguistics. Looking at the matter from this point of view, we see that the word "artificial" is a misnomer. It is true that the first attempts to solve the problem of an auxiliary international language might be fitly termed artificial. They take us back to the seventeenth century. Impressed by the logical manner in which mathematical symbolism represents complex trains of thought in a form at once intelligible to mathematicians of all countries, some of the greatest philosophers and mathematicians of that century conceived the idea of an international language which would be a logical algebra of general thought. Descartes in 1629 discussed this idea in a letter to his friend Mersenne. Leibniz devoted many years to the problem, though he considered that for immediate practical purposes a simplified and regularised grammar applied to the word elements of Latin would provide the best solution.

Language systems of this sort are called "philosophical" or *à priori*. In their construction we might endeavour to make a list of all the primary ideas, and assign arbitrary written symbols, which may be also pronounceable sounds, to these. With the various permutations and combinations of these symbols we might then form all derived ideas. It is clear that from a very few symbols we can easily, by means of their permutations and combinations, form thousands of derivatives. When the number of primary ideas or elements is relatively small, such systems are of great use and are largely used. The various special codes used in international commerce are examples of this method. Another example of such an international code language may be seen in the nomenclature and symbolism of chemistry.

Thus "H_2SO_4" and "para-nitro-anilin" are intelligible to chemists of every nationality. But for general purposes such systems would become exceedingly complex. Moreover it would be very difficult to draw up a simple and fixed table of primary and fundamental ideas, for although the fundamental data of sense may remain invariable, the intellectual activity of the human mind is constantly penetrating the screen of sense-perception. Thus new concepts and ideas in accord with our progressive discovery of the real structure and activity of the world are constantly being formed.

The inventors of *à priori* philosophical languages have, however, usually proceeded in a somewhat different fashion, their object being to construct a vocabulary that would be based on a rational system of classification corresponding to our knowledge of things. Thus in the seventeenth century a

[1] From a discourse delivered at the Royal Institution on Friday, March 24.

Scotchman, George Dalgarno, and also the celebrated Bishop Wilkins—one of the founders of the Royal Society—produced two such philosophical systems. That of Bishop Wilkins was entitled "The Essay towards a Real Character and a Philosophical Language" (London, 1668). In the eighteenth century the disciples of Condillac, the Ideologists, took up the problem of an artificial language considered as a classification and notation of ideas; whilst in the middle of the nineteenth century the learned Spanish professor, Bonifacio Sotos Ochando, published a very perfect system of this type, in which both the grammar and the vocabulary were very fully worked out.

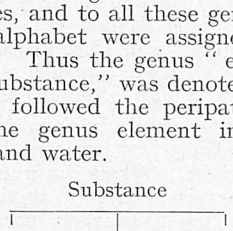
In his "Lectures on the Science of Language" delivered before the Royal Institution fifty-nine years ago, Max Müller discussed the possibility of an artificial language, and gave an account of the system of Bishop Wilkins. Speaking in this connection he said: "It is the fashion to laugh at the idea of an artificial, still more of a universal language. But if this problem were really so absurd, a man like Leibniz would hardly have taken so deep an interest in its solution. That such a language should ever come into practical use, or that the whole earth should in that manner ever be of one language and one speech again, is hard to conceive. But that the problem itself admits of a solution, and of a very perfect solution, cannot be doubted."

In order to understand the method employed by Bishop Wilkins, I give here the basis of his system of classification:—

SYSTEM OF BISHOP WILKINS.

	A. Transcendental Notions	Divided into 6 Genera.
Five Categories of Logic	*B*. Substances *C*. Quantities *D*. Qualities *E*. Actions *F*. Relations	Divided into 34 Genera.

These 40 fundamental genera were subdivided into numerous species, and to all these genera and species letters of the alphabet were assigned in a regular ordinal manner. Thus the genus "element," one of the types of "substance," was denoted by De. Now Bishop Wilkins followed the peripatetic philosophy and divided the genus element into the species earth, air, fire, and water.



De = Element; Due = elementary.
Do = Stone; Duo = stony.

Fire thus became Deb, and flame, a variety of fire, became Deba. Grammatical function was indicated by appropriate letters, *e.g.* De = element, Due = elementary. Do = stone, Duo = stony.

We can perceive here two of the fundamental objections to all such philosophical systems. In the first place all such classifications are fleeting and transient. At best they can but reflect the knowledge and science of their day. But as this is constantly changing there is no finality. We no longer accept the earth, air, fire, and water of the Aristotelian-scholastic philosophy as a satisfying classification of elementary substances. Even the chemical elements of twenty-five years ago are dissolving before our eyes into the electrons, protons, and neutrons of a newer philosophy. But even were there a finality of knowledge, such classificatory symbolisms would be very difficult to memorise. We should have to remember not only the symbols and their meanings, but also the whole ordinal system of assignment. In practice we should have to learn the system empirically as we do natural living languages. Thus all the hoped-for advantages would disappear. To a child *Deba* might soon come to mean flame, but if we came across this mysterious word in later life we should have painfully to de-code it.

The modern era, the era of synthetic or *à posteriori*, as contrasted with purely *à priori* languages, began with Volapük. This was the discovery of Monsignor Johann Martin Schleyer, a Roman Catholic priest of Baden in Germany, and was given to the world towards the end of the year 1880. His vocabulary consisted of root-words, derived words, and compounds. Schleyer endeavoured to borrow his root-words from the international stock, so that the greatest number of persons might have the fewest unfamiliar words to memorise. He stated himself that the Volapük Lexicon was based mainly upon the English language, because it was spoken by 100 million people. Unfortunately for the 100 million, these roots were so changed by Schleyer that a very large number of them became unrecognisable in the written language. There were several reasons for this. His system was a phonetic one, but the sounds corresponding to several of his letters were so chosen as to destroy the international appearance of the roots. No stem or root which was declinable could end in the sibilant consonants *c*, *j*, *s*, *x*, and *z*, since the plural was formed by the letter *s*. Monsignor Schleyer held that the letter *r* offered such difficulty of pronunciation to children, Englishmen and Chinese—a majority of mankind—that it had to be very largely eliminated. For *r* he substituted very often the letter *l*. Finally he made his roots as monosyllabic as possible.

The net result of these transformations was that many roots chosen from English, or other languages, on account of their internationality, became unrecognisable.

Volapük belongs to the class of "mixed" languages in which borrowed and arbitrary elements are more or less logically combined. Nevertheless, in spite of its many difficulties and its *à priori* elements, it represented an enormous advance on the purely artificial or *à priori* systems of Wilkins, Sotos Ochando, and many others. It presents us with the first great attempt to build up from a small stock of existing root-words a synthetic auxiliary international language based on an autonomous system of word-formation and on a perfectly regular inflexional grammar. In its day, it had a great success. At first it spread slowly, but about 1885 it was actively taken up in France, its chief partisan and exponent being Dr. Auguste Kerckhoffs, professor of modern languages at the School of Higher Commercial Studies in Paris. From France it spread to all parts of the world. Three international Congresses were held, the third taking place at Paris in 1889. At that time there were 283 Volapük Clubs spread all over the world, 316 text-books had appeared, and there were some 30 periodicals appearing in Volapük or dealing with it.

The disappearance of Volapük was due largely to the internal dissensions of its partisans, some of whom, led by Dr. Kerckhoffs, wished to make it simpler and more adapted to the needs of commercial life.

These attempts at reform were, however, resisted by the learned originator. No doubt his system

was too complicated and intricate for the majority of people. Moreover, those who took an interest in the problem of an auxiliary international language were soon provided with the much simpler and more practical Esperanto.

The author of this language, Louis Lazarus Zamenhof, was born in 1859 at Bielostok, in what was then Russian Poland. Perceiving the racial and linguistic hostilities of his native country, as a young school student in Warsaw he already dreamed of a universal neutral language and of a universal brotherhood founded thereon. He graduated as a physician at Warsaw, but during the six years of his university course he worked constantly at his secret project. At first he thought of reviving Latin, or of constructing an *à priori* or philosophical language. It was the study of English, however, that first showed him what could be done by means of a simple grammar, and how stems of different origins could be utilised in the construction of a harmonious and self-contained language. In 1885 his work was complete, but it was only in 1887 that he found a publisher. In that year there appeared in Warsaw a Russian pamphlet describing "La Lingvo Internacia de la Doktoro Esperanto," The international language of Dr. "Hopeful." In 1900 there appeared the "Universala Vortaro de la Lingvo Internacia Esperanto," by L. Zamenhof. In this dictionary the equivalents were given in five languages. The pseudonym "Esperanto," adopted originally by Dr. Zamenhof, has been transferred to the name of the language. The progress of Esperanto was at first slow. But in 1898, when the French took the lead, expansion became rapid. The Marquis Louis de Beaufront became the leader of this movement. In 1914, when the war broke out, there were over a hundred Esperanto periodicals, some appearing in Esperanto only, others in Esperanto and a national tongue. In 1905 an international Convention or Congress was held at Boulogne. Since then twelve other international Congresses have been held, the thirteenth at Prague in 1921. As an international auxiliary language, Esperanto has had an unparalleled success. It has done more to spread the idea of the need for and the possibility of an auxiliary international language than any other project.

The fundamental ideas of Zamenhof were very largely those of Schleyer: a phonetic system, a regular method of pronunciation, a vocabulary of root-words drawn from the international treasury, an autonomous system of word-formation, and a perfectly regular grammar. In other words, an *à posteriori* synthetic language. But in practice the contrast was enormous. Zamenhof did not transform and distort his international roots as Schleyer did. He carried out the choice of international stems on a much broader basis. His grammar was enormously more simple and practical. The inflexional richness of the work of the learned and scholarly Schleyer disappeared, and together with it most of his *à priori* and arbitrary elements. Zamenhof's autonomous system of word-derivation by means of affixes of fixed and definite meanings, and by means of root-combinations, was immensely superior. The arbitrary characteristic endings corresponding to a classification of ideas, a relic in Volapük of the earlier *à priori* philosophical systems, disappeared in Zamenhof's language. The idea of using only monosyllabic roots was given up, and so the international appearance of these could be much better preserved.

In spite of many obvious and indeed glaring defects, Esperanto is undoubtedly, so far as numbers are concerned, the greatest and most successful linguistic experiment that the world has yet seen. Let us not criticise too severely the work of a man who was neither a great scholar nor a great professional philologist, but let us rather admire the splendid effort which he made. His work has been of the greatest service in demonstrating to an indifferent world the practical possibility of an auxiliary international language.

So great was the interest taken in this branch of science at the Paris Exhibition of 1900, that under the leadership of M. Leau, a French professor of mathematics, a number of men of science and delegates from learned societies were gathered together, and on January 17, 1901, the "*Delegation for the Adoption of an Auxiliary Language*" was founded. After a great deal of preliminary work on the subject, the matter was submitted, through the kind offices of the Imperial Academy of Sciences of Vienna, to the International Association of Academies, which on May 29, 1907, declared itself incompetent to deal with the question. The Delegation then proceeded itself to elect a special Committee to study the problem. This Committee embraced a number of distinguished authorities on science and linguistics, and included the two secretaries, Profs. Couturat and Leau. After eighteen sittings held at the Collège de France, the following decision was arrived at:

"None of the proposed languages can be adopted *in toto* and without modification. The Committee have decided to adopt in principle Esperanto, on account of its relative perfection and of the many and varied applications which have been made of it; *provided* that certain modifications be executed by the Permanent Commission, on the lines indicated by the conclusion of the Report of the Secretaries and by the project of Ido, if possible in agreement with the Esperantist Linguistic Committee."

It appeared later that the "project of Ido" was an anonymous pamphlet proposing a number of reforms in Esperanto, the real author of which was the Marquis de Beaufront, until that time the most eminent supporter of Esperanto in the world. Messrs. Couturat and Leau had made a most exhaustive and scholarly study of all known auxiliary languages, their labours being embodied in a very masterly book entitled "Histoire de la Langue Universelle," and also in another one entitled "Les Nouvelles Langues Internationales." Their Report to the Committee indicated very clearly the lines along which Esperanto could be improved.

As the Esperanto Linguistic Committee declined to collaborate, the Committee of the Delegation appointed a Permanent Commission to carry out the reforms which they had in view, and as they were unable to use the name Esperanto, the reformed Esperanto was called "Ido."

In its basic ideas Ido is a language of the same type as Esperanto. It is a great pity that all parties could not have combined at an early stage in the development of Ido. If I may be allowed a personal opinion, I will say that most, if not all of the Ido improvements appeal to me very strongly. If we are to choose a language of the Esperanto type, and if the choice lies only between Esperanto and Ido, I would choose Ido. I do not say this for any propagandist purposes, and I say it with a full appreciation of the splendid early work of Dr. Zamenhof. But at the same time I have an equally great admiration for the splendid later work of Prof. Couturat and his collaborators.

Ido, like Esperanto, has had a very great success, and has been very thoroughly developed. Many general and technical dictionaries have been worked out. Before the war there appeared ten or twelve periodicals dealing with, or written in, this language. The International Ido Academy has done very fine

work in bringing it to as high a state of perfection as possible. Very many Ido clubs and societies have been formed in all parts of the world, and already a very considerable literature exists. We may say that the Ido, like the Esperanto, movement, has done immense service in familiarising the world with the practicability of an international auxiliary language. Both these great linguistic experiments are of profound interest and importance.

I must now lead your thoughts away from Esperanto and Ido and back to the International Academy for a Universal Language, which was founded by the two international Volapük Congresses of 1887 and 1889. This Academy continued to exist, and set itself to the task of reforming Volapük. Very important and scholarly work was done by Mr. Rosenberger, a Russian engineer, and his collaborators (Rosenberger was Director of the Academy from 1893 to 1898). They produced a vocabulary of root-words based on the principle of maximum internationality. The greater part of these roots are common to at least four of the seven chief languages — German, English, French, Italian, Russian, Spanish, and Latin. Largely as a consequence of the inclusion of Latin, the result was an almost exclusively Neo-Latin vocabulary—one much more Romanic than that of Esperanto. A very simple grammar and a regular system of word-derivation by means of derivative affixes were introduced. But autonomous word formation was not allowed to exclude international derivatives.

Thus was produced about 1903 the Language "Idiom Neutral," the descendant of Volapük, though scarcely any trace of the parental features remained.

Idiom Neutral has not achieved the practical success of Esperanto and Ido. This may be because it came too late. It appeals to educated people more than Esperanto and Ido on account of its more homogeneous vocabulary, which is practically exclusively Romanic. But it has not been so fully developed as Esperanto and Ido. As a separate and independent project, it may be said to have disappeared with the death of Mr. Rosenberger in 1918.

A language of the Neo-Latin type, somewhat similar to Neutral Idiom, is the "Panroman" (or "Universal") of the German positivist and pacifist, Dr. H. Molenaar. Various attempts, such as those of Mr. Henderson and of Dr. Rosa, have been made to introduce a sort of simplified Latin. But the man who has defined most clearly the Neo-Latin principle, and who has worked not only the hardest in this field but has also grouped and organised many isolated workers of kindred views and affinities, is Dr. Giuseppe Peano, professor of mathematics in the university of Turin. In 1908 he became Director of the International Language Academy. In the "Discussiones" of that body he has published from year to year the work of himself and many collaborators. A very large amount of scholarly work has been done in the discovery of the international vocabulary common to Latin, Italian, French, English, and German. The result of this etymological study may be seen in Professor Peano's important "Vocabulario Commune," the second edition of which appeared in 1915. Following the indication given by Leibniz, Peano has built on an exclusively Neo-Latin basis so far as the main vocabulary is concerned, though modern words acquiring international usage may be accepted.

For many scientific purposes Peano's flexionless Latin is ready for use. He has himself employed it for many years in his own journal, *The Mathematical Review*.

The true solution of the problem may consist in selecting the most international roots according to the fashion of Peano, but also the most international affixes of derivation. With these natural elements, derivatives and compounds will then be formed according to simple and invariable rules. Thus the advantages of the Neo-Latin or Anglo-Latin vocabulary of stems will be combined with the regular and autonomous word-derivation of Ido. This is the view held by Prof. Guérard, who has just published a most valuable book entitled "A Short History of the International Language Movement" (Fisher Unwin, 1922). As Prof. Guérard points out, these two sets of fundamental ideas are embodied in the language project of M. Albert Michaux, entitled "Romanal."

Needless to say, Romanal is not the last word on the subject, nor is it free from debateable points. But it represents the combination of an "etymological Anglo-Latin" root vocabulary with regularity of word-derivation and simplicity of grammar.

In the preceding discussion I have endeavoured to give a very brief account of some of the principal efforts to solve the problem. The large amount of research work already done and the practical success of Esperanto and Ido prove that the problem is not an insoluble one. At first one might be inclined to think that the production of an international auxiliary language is a sort of parlour game, or at best a pure matter of caprice. Attentive study of the problem shows that this is quite a false view. Whatever may be the final solution, it is already clear that some of the fundamental principles have been elucidated. There *does* exist a science of synthetic linguistics, compounded of logic, psychology, and philology. It has been argued that the field hitherto traversed, at all events in the later systems, is too narrow; that the so-called international vocabularies are not really international and apply at best only to two groups of existing languages. What comfort, it is argued, can a word such as "amico" bring to the Basques, Finns, Hungarians, Turks, Japanese, Chinese, etc.? What special comfort, I would then ask, does the learning of English, French, German, Italian, Spanish, Dutch, Swedish, and Russian bring to a young Japanese gentleman? Are we then to go back to Sotos Ochando and bring comfort to nobody? I think not. But the objection is not one to be passed over lightly. It may be that the world will require more than one auxiliary language. Two, or even three, would be better than the necessity of having to learn a hundred living languages. Only time and prolonged study and investigation can settle questions of this order. The whole civilised world must collaborate in this investigation. There is plenty of time. We have been using an alphabet for, say, eight or ten thousand years at most, and as this planet is reckoned to be over a thousand million years old, it will probably continue to be habitable for some considerable time.

Meanwhile the problem is a very pressing one. Those who have to do with science, industry, and commerce feel this very acutely. Before the war I attended several international scientific congresses. On these occasions it was open to any one to speak in English, French, German, or Italian. When the language of the speaker or lecturer changed, one half of the audience usually adjourned to the refreshment bar. I could follow German, but when it was a case of Italian or Parisian French I also used to get thirsty. I am going to an international scientific congress in June of this year. The representatives of at least thirteen different nations will be present, and I expect at least four languages will be used. As the language of the country where the congress is to be held is not one of these, one ought really to know five languages. I am glad to say that the civilised world is at last beginning to take a real interest in this

problem. We may, indeed, say that, since the war, the whole question has entered on a new phase. Learned and scientific bodies of international influence and repute are beginning to study the matter seriously. The present organised movement in this direction may be considered as dating from the adoption, by the International Research Council at their meeting at Brussels in July 1919, of the following resolutions :

(*a*) That the International Research Council appoint a Committee to investigate and report to it the present status and possible outlook of the general problem of an international auxiliary language.

(*b*) That the Committee be authorised to co-operate in its studies with other organisations engaged in the same work, provided that nothing in these resolutions shall be interpreted as giving the Committee any authority to commit the Council to adhesion to or approval of any particular project.

This Committee is now at work. Its chairman is Dr. F. G. Cottrell, and its headquarters are at the offices of the National Research Council of the United States, 1701 Massachusetts Avenue, Washington, D.C. This Central Committee has already done an immense amount of work in securing the organisation of committees and working groups in the national academic organisations and educational institutions, and in co-ordinating this work and serving as a clearing-house for the exchange and distribution of information and plans. The first national response to the appointment of the International Committee was by the British Association for the Advancement of Science, which, at its Bournemouth Meeting in September 1919, appointed a Committee "to study the practicability of an International Language." This British Committee has been very active, and at the Edinburgh meeting of the British Association in September last, presented its report. Its conclusions may be summarised very briefly as follows :

(1) Latin is too difficult to serve as an international auxiliary language.

(2) The adoption of any modern national language would confer undue advantages and excite jealousy.

(3) Therefore an invented language is best. Esperanto and Ido are suitable ; but the Committee is not prepared to decide between them.

The Committee is continuing to study the problem. The American Association for the Advancement of Science appointed a Committee in April 1921, and this Committee has presented a Report, which was accepted by the Council of the Association at Toronto on December 29 last. The Committee recommended that the American Association for the Advancement of Science :

(*a*) Recognises the need and timeliness of fundamental research on the scientific principles which must underlie the formation, standardisation and introduction of an international auxiliary language, and recommends to its members and affiliated Societies that they give serious consideration to the general aspects of this problem as well as direct technical study and help in their own special fields wherever possible.

(*b*) Looks with approval upon the attempt now being made by the National Research Council and the American Council of Learned Societies to focus upon this subject the efforts of those scholars in this country best fitted for the task, and to transmit the results to the appropriate international bodies.

(*c*) Endorses the heretofore relatively neglected problem of an international auxiliary language as one deserving of support and encouragement.

(*d*) Continues its Committee on International Auxiliary Language, charging it with the furtherance of the objects above enumerated, and reporting progress made to the Association at its next meeting.

The American Council on Education, the American Classical League, the American Philological Association, and the National Research Council of America have also appointed Committees. Furthermore, the American Council of Learned Societies has authorised the appointment of delegates to confer with the Committee of the National Research Council. Thus the national American representatives of science and the humanities are uniting to study the problem.

Both the French and the Italian Associations for the Advancement of Science have also appointed Committees to examine and report on the international language question.

On September 13 last, the following resolution was presented to the Assembly of the League of Nations by delegates representing twelve States :

"The League of Nations is well aware of the Language difficulties that prevent a direct intercourse between the peoples, and of the urgent need of finding some practical means to remove this obstacle and help the good understanding of nations ;

"Follows with interest the experiments of official teaching of the international language Esperanto in the public schools of some members of the League ;

"Hopes to see that teaching made more general in the whole world, so that the children of all countries may know at least two languages, their mother tongue and an easy means of international communication ;

"Asks the Secretary General to prepare for the next Assembly a Report on the results reached in this respect."

With regard to this motion, the special Committee dealing with the inclusion upon the Agenda of Motions submitted to the Assembly reported to that body on September 15 last, as follows :

"The above-mentioned delegates have proposed the introduction of Esperanto as an auxiliary international language into public schools, in order to facilitate direct intercourse between all nations throughout the world.

"The Committee are of opinion that this question, in which an ever-increasing number of great states are interested, should be attentively studied before it can be dealt with by the Assembly."

As a result of this, the secretariat of the League have been instructed to investigate the experiments already made and ascertain the actual results attained.

On November 20 last, some Swedish gentlemen interested in the question of an international language formed a Committee to promote this subject and to unite the various interests concerned. This Committee has brought the matter before the Swedish Parliament and has also addressed a request to the League of Nations.

From all this it will be evident that the existence of the problem, and the urgent necessity for its study and investigation, are now fully admitted and recognised by the learned, scientific, and political organisations of the highest national and international status. Before definite action can be taken by national governments, there must be, however, another period of prolonged and exhaustive linguistic research and experiment. This work must be, as we have every reason now to hope and expect, co-ordinated and supported internationally. Those who have laboured manfully in the past, and the many who have given their adherence to this or that special solution, must be prepared to co-operate without bias and without sorrow. The subordination of self and of the most dearly held, the most beloved possessions of the mind in the interest of intellectual advance and the common good of humanity is the spirit of true science.

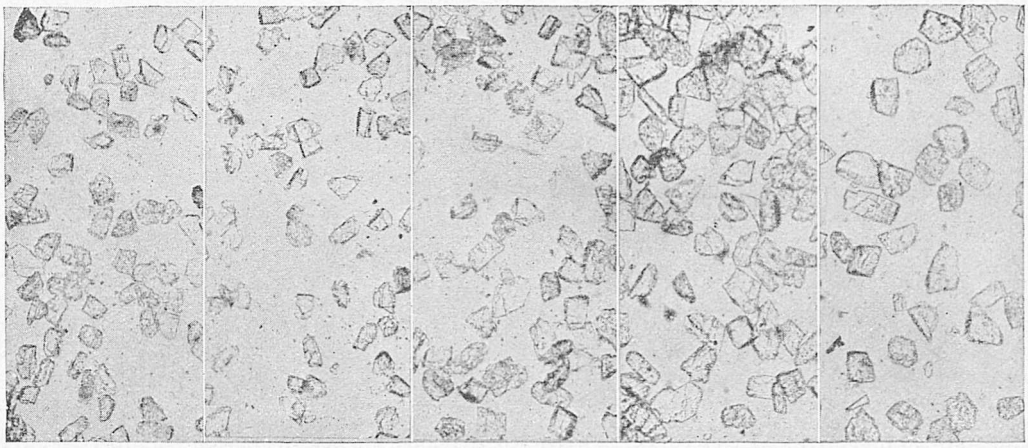
The Properties of Powders.

CONSIDERABLE interest attaches, both on the scientific and on the technical side, to the study of powders which are sufficiently fine to differ markedly in their properties from massive crystals, while they are sufficiently coarse to differ equally widely from colloidal suspensions. One important property of powders, namely the caking of salts (a phenomenon which was responsible for the disastrous explosion at Oppau), was discussed at a joint meeting of the London Section of the Society of Chemical Industry and of the Faraday Society on March 1, 1920. This has now been followed up by a joint meeting of the Faraday Society and the Oil and Colour Chemists' Association, held at Burlington House on March 9 last, when the material presented was sufficiently abundant to call for an adjourned discussion on March 23.

The principal subject discussed was the grading of powders by elutriation, a process which has proved of great value to the geologist and to the agriculturist, as well as to the manufacturer of pigments and of food products where artificial grinding is required in order to produce minute subdivision.

The formal papers presented to the meeting were four in number. Prof. Lowry and Mr. L. P. MacHatton, in a paper on "The Grading of Powders by Elutriation," submitted a new series of experimental data as to the diameter of the particles of barytes and of quartz which are just lifted by a vertical current of water at velocities ranging from 4 to 8 mm. per second (Fig. 1). The data for barytes are more concordant than those for quartz, probably because the particles of barytes are, in the main, cleavage-fragments of fairly uniform shape, whilst in the case of quartz the natural conchoidal fracture produces much more irregular particles. In the case of barytes it was possible to show that the use of a vertical tube one inch in diameter lifts particles which are 5 per cent. smaller than when a half-inch tube is used; but the grading is also much more uniform as a result of the more uniform velocity of the water in the tube. The temperature-coefficient was also measured and shown to correspond with a decrease of 0·4 per cent. only in the diameter of the particles for each degree of rise of temperature; and an empirical relationship was deduced between the velocity of the water and the size of the grain of barytes lifted by it.

Prof. Boswell presented a paper on "The Separation of the Finer Constituents of Sedimentary Rocks," in which the geological applications of elutriation are described. One of the principal problems here is to devise a method of summarising the mechanical analysis of a sediment, containing particles of many different sizes, in such a way that the results can be expressed by means of one or two numbers. The use of a single number is impracticable, since in addition to the fineness of the material, its uniformity must be represented by a separate coefficient. A satisfactory solution appears to have been provided by Dr. H. A. Baker, who makes use of the term "equivalent grade" to express the average of the diameters of the particles, whilst a "grading factor" serves to express the deviation of the particles from the average. Prof. Boswell has had much experience in the practical application of elutriation, particularly in the mechanical analysis of the sands and rocks used in glass-making, and his notes on the difficulties and errors encountered in the process are of considerable value. Dr. J. W. French, who has made use of water-separation for the grading of emery and carborundum for use as polishing powders in grinding lenses, contributed to the same meeting a paper on "Abrasives and Polishing Powders for Glass."



(*a*) 4 mm. (*b*) 5 mm. (*c*) 6 mm. (*d*) 7 mm. (*e*) 8 mm. per sec.

FIG. 1.—Elutriation of Barytes. (× 50.)

Dr. R. S. Morrell, the president of the Oil and Colour Chemists' Association, opened the discussion, by emphasising the value of elutriation to colour-users, as a method of controlling the materials which they purchased from the pigment-makers and grinders.

The adjourned discussion was opened by Dr. C. A. Klein of the Brimsdown White Lead Company. While Prof. Lowry had been working with a range of sizes down to about 0·07 mm., Dr. Klein's work had dealt with grades in which this was more nearly the maximum than the minimum size of the particles; they therefore presented greater experimental difficulties, more particularly as a result of flocculation. In addition to describing a number of points in connection with the practical use of the elutriator, Dr. Klein stated that a specification had actually been put forward by a user of pigments who was calling for the supply of some hundreds of tons of a product in which the largest particles would have a diameter not exceeding 0·1 mm., whilst the average size of the particles was not to exceed 0·027 mm. This specification was being worked to and material conforming to it could be supplied.

Prof. Lowry then showed "A New Elutriator for Rapid Use," especially adapted for use in factories. The gravimetric determination of the residue of coarse particles is here replaced by a simple measurement of the height of the column of grit in a narrow tube, and tests can therefore be made even where the ordinary facilities of a chemical laboratory are not available. Lieut.-Col. J. V. Ramsden, of Shropshire Mines Ltd., stated (at the previous meeting) that with the help of this instrument he had been able, whilst using the same grinding plant, to reduce the residue in ground barytes from 6 per cent. to 0·5 per cent. Prof. Lowry added that since this instrument was introduced two years ago the relative merits of British and imported samples of ground barytes had been reversed completely, with the result that the finest products that he had tested recently were of British manufacture.

Mr. W. J. Palmer referred to the practical importance of fine grinding in the paint industry, both in the preparation of enamels and as a means of preventing the hard setting of paint in cans which were sent abroad or stored for some years before being used. Mr. Noel Heaton contradicted the general impression that the ball-mill tends to produce round particles, since when the glass was ground in this way, even to 0·003 or 0·004 mm. diameter, the particles when examined by the microscope had the normal appearance of broken glass and were not in the least degree rounded.

Dr. R. Lessing mentioned some applications of elutriation in connection with the fire-brick, coal and metallurgical industries. Its application to metallurgy was described by Mr. Holman in connection with tin slimes, where a loss of 10 to 15 per cent. was traced to the carrying away of very fine particles in a current of water.

Mr. Tate, of the Government Laboratory, referred to elutriation as a process of analysis in the separation of cocoa from husk in the ground product; a paper on this aspect of the subject was also submitted by Mr. R. Whymper of Messrs. Peek, Frean & Company.

Mr. B. A. Keen, of Rothamsted, criticised the method of elutriation as applied to the mechanical analysis of soils, largely on the ground that the shape of the particle was as important as the size in determining the velocity of water required to lift it. In dealing with very fine particles the simpler process of sedimentation was to be preferred.

Prof. Porter, the President of the Faraday Society, in closing the discussion, referred to centrifuging as a means of grading fine powders, and commented on the relationship which Prof. Lowry had put forward between velocity and grain-size. He also referred to the utility of the discussion and especially to the value of bringing together workers from different fields, who could present information which, although well known to one section of individuals, might not be known at all to other groups represented at the meeting.

The International Petroleum Commission.

AT the ninth annual General Meeting of the Institution of Petroleum Technologists, held on March 14, Prof. J. S. S. Brame delivered his presidential address, taking for his subject the proposals for the re-establishment of the International Petroleum Commission. International Petroleum Congresses were held in 1900, 1904, and 1908, and committees were appointed to establish methods of testing products. Little was actually achieved, and in 1909 an International Petroleum Commission of wider scope was established. The organisation of an English National Section was referred to the Institution of Petroleum Technologists by Engler and Ubbelohde, but the intended meeting of the Commission at Bucharest in 1914 was prevented by the outbreak of war.

At the first annual meeting of the Petroleum Products section of the Société de Chimie Industrielle at Paris in 1921, M. Schmitz suggested the reconstitution and endowment of this Commission to be centred at the University of Strasburg. He spoke somewhat bitterly of the Americans "profiting by the general disorganisation to seek to abandon the analytical methods previously decided upon, in favour of their own."

Prof. Brame expressed grave doubts as to the wisdom and the justice of M. Schmitz's address. He could not believe that the largest oil-producing country, which had created such splendid organisations as the Bureau of Mines and the American Society for Testing Materials, was likely to depart from the methods of oil analysis it had elaborated and adopted. He outlined the development of these Institutions and the standard methods of petroleum testing they had recommended, and spoke of the cordial relationship between the Standardisation Committee of the Institution of Petroleum Technologists and these American organisations, from which collaboration he hoped would result an agreed system of nomenclature and specifications of the greatest mutual advantage. Such agreement he considered of much greater value to the two countries having by far the largest interests in petroleum than could be gained by the reinstitution of an International Petroleum Commission.

Facilities for Foreign Students in American Colleges and Universities.

THE Bureau of Education of the Government of the United States have issued under the above title, as Bulletin No. 39 of 1920, a revised and enlarged edition of a valuable handbook by Dr. S. P. Capen first published in 1915. It presents in a concise and readily intelligible form a comprehensive survey of a subject concerning which few people in this country have more than a very fragmentary knowledge. After a brief account of the organisation of education of all grades and a historical summary of the college and university systems, the Bulletin gives a description of the parts and working of the typical university and draws a comparison between American and other educational institutions. Next follow particulars of the cost of living and travel, athletics, clubs, etc., and lists of institutions of collegiate or professional grade located in the principal metropolitan centres of higher education, namely, New York, Chicago, Philadelphia, St. Louis, Boston, Baltimore, San Francisco, New Orleans, and Washington. Forty-five pages are devoted to a detailed definition of the requirements of the College Entrance Examination Board, an organisation formed by some 30 colleges together with the principal associations of colleges and secondary schools, which holds examinations in almost every State and in several foreign countries, including Canada, England, and France.

Colleges (and the collegiate, or undergraduate, divisions of universities) have, we are informed, come by common consent to express their entrance requirements in terms of "units," a unit representing "a year's study in any subject in a secondary school, constituting approximately a quarter of a full year's work. A four-year secondary school curriculum (the normal preliminary to admission to a college) should be regarded as representing not more than 16 units of work." Accordingly the definition of requirements includes not only examination syllabuses but also outlines of secondary school courses of study. Accounts of some approved methods of instruction and typical time-tables are added. As pointed out in the article on America in the Universities Year-book, 1922, "a peculiarity of the American system of grading, both in secondary and in higher institutions, is the weight attached to the length of time spent under instruction, a degree being attainable by gradual accumulation of a specified number of 'credits' (certificates of definite periods of time spent successfully under instruction) which thus largely replace the examinations used in other countries for testing the student's capacity at various intervals."

More than half of the Bulletin is devoted to descriptions of 74 universities, colleges, and technical and professional schools which have already been frequented by foreign students or which give courses likely to prove of special interest to such students. The descriptions deal with courses, degrees, equipment, expenses, strength of staffs, number of students, number of foreign students, and miscellaneous items of special interest to foreign students. There are also statistical tables for 1918 relating to State universities and certain agricultural and mechanical colleges, schools of mines, and other technological schools, and a list of medical colleges rated as Class A by the council on medical education of the American Medical Association. A few copies of the Bulletin are available at the Universities Bureau, 50 Russell Square, and can be obtained on payment of 1*s*. 3*d*. to cover the price (15 cents) and postage.

University and Educational Intelligence.

BIRMINGHAM.—The University has received from the Trustees of the James Watt Memorial Fund the sum of 5000*l*. towards the establishment of a Chair of Research in Mechanical Science to be known as "The James Watt Chair."

Mr. James Couper Brash has been appointed professor of anatomy, to fill the vacancy occasioned by the lamented death of Prof. Peter Thompson. Mr. Brash held the position of acting professor during the leave of absence granted to the late professor. The appointment of Mr. Cyril A. Raison as part-time assistant in anatomy has been confirmed by the Council.

CAMBRIDGE.—The family of the late Mr. J. M. Dodds have founded at Peterhouse a studentship to be known as the J. M. Dodds studentship for the promotion of advanced study or research in the subjects of mathematics or physics. The first election will be held in June 1923.

LONDON.—Application for grants from the Dixon Fund for assisting scientific investigations must be made before May 15 to the Academic Registrar, University of London, South Kensington, S.W.7.

Prof. J. A. Fleming has been compelled, on account of illness, to cancel all engagements for the present, and will consequently be unable to deliver the course of lectures on "Modern Improvements in Telephony" at University College which had been announced to begin on April 26. It is hoped that Prof. Fleming will be able to deliver the course in October.

MANCHESTER.—Prof. J. W. Smith has intimated his intention to resign, as from the end of the present session, the Chair of Systematic Surgery, which he has held since 1911. The following appointments have been made in the Faculty of Technology: Lecturers in Mechanical Engineering, R. M. Anderson, H. Threlfall; Lecturer in Spinning, J. Winterbottom; Demonstrators in Chemical Technology, W. H. Brindley, W. Hubball, W. H. Kelly, Esther Levin, and J. D. Mounfield; Demonstrator in Metallurgy, G. Mohn.

SHEFFIELD.—A course of five lectures on coal will be given in the Department of Applied Science on April 27 and successive Thursdays at 5·30 P.M. The first lecture, to be delivered by Dr. Marie Stopes, will deal with the palæobotanical aspects of the constitution of coal; the second, by Mr. F. S. Sinnatt, with the preparation of coal for the market; the third, by Dr. R. Lessing, with the carbonisation of coal; the fourth, by Mr. M. Wynter Blyth, with the manufacture of crude benzole; and the fifth, by Prof. J. W. Cobb, with the nitrogen in coal and its recovery as ammonia.

THE Education and the Parliamentary Committees of the British Science Guild have had under their careful consideration the recommendations of the Geddes Committee so far as these affect education. Their report, which has received the approval of the executive committee of the Guild, embodies certain proposals with the object of effecting reduction in expenditure where it can be shown to be without detriment to the legitimate purposes of educational expenditure. They desire to suggest one or two changes in such expenditure whereby economy in time and money can be achieved. It is essential that financial control shall be the duty of both State and local education authorities. The first consideration is, how much can be raised annually, both locally and Imperially, in respect of education and its ancillary needs, and next, how it can best be allocated in accordance with the legitimate claims of each department. The second essential is that the education committee to which the administration of education is delegated by the local authority shall be held responsible for the use of the funds. The present method of allotment of State moneys, namely 50 per cent. of the permitted local expenditure, is not peculiar to education but prevails in other State departments, and is under review with regard to its continuance. It is alleged that it multiplies unduly public officials, increases expense both of time and money, and that it is subversive of the principle of local control. The suggestion in the Geddes Committee's Report that the lower limit of compulsory age should be raised from five to six is commended, but with the proviso that it shall be accompanied by the institution of nursery schools for young children under the age of six years. A modification of the present scholarship system is suggested whereby only children of exceptional capacity, and whose parents cannot pay for their further education, shall be eligible for free places and for maintenance grants, available in schools of widely varying type. It is recommended that the practice of duplication of inspectorships should be abolished. One set of inspectors would be found quite efficient. If these reforms were carried out, much of the time now taken by unnecessary clerical work on the part of the highly paid staff of teachers and officials would be saved, and their efforts be devoted to more fruitful educational results.

Calendar of Industrial Pioneers.

April 13, 1742. John Lofting died.—Born in Holland about 1659, Lofting removed to London in 1688, where he became well known as a successful inventor and maker of fire-engines.

April 13, 1874. James Bogardus died.—An American inventor, Bogardus made improvements in clocks, constructed a delicate engraving machine, invented the dry gas meter, a deep-sea sounding machine, and a dynamometer, while his plan for manufacturing postage stamps was accepted by the British Government.

April 13, 1894. William Haywood died.—For forty-eight years Haywood was chief engineer to the Commissioners of Sewers in London, and he was also the constructor of the Holborn Viaduct. He introduced the use of asphalt for city roads.

April 15, 1908. J. Wigham Richardson died.—The founder of an important shipbuilding firm on the Tyne, Richardson contributed much to the advancement of the building of large mercantile vessels and served as President of the North-East Coast Institution of Shipbuilders and Engineers.

April 17, 1899. Sir James Wright died.—The successor of Thomas Lloyd as Engineer-in-Chief of the Navy, Wright held this position from 1872 to 1887. Trained at Dundee, he became an assistant in Woolwich Dockyard in 1845, and was transferred to the Admiralty two years later. He was intimately connected with the adoption of the compound engine, twin screws, forced draught, high pressures, and the triple expansion engine.

April 18, 1916. Sir John Durston died.—One of the few fellows of the Royal School of Naval Architecture and Marine Engineering, Durston entered the Royal Navy in 1866 as an assistant engineer and rose to be the Engineer-in-Chief. Taking office in 1889, at a time of great difficulty, Durston held office till 1907, and to him was mainly due the introduction into the Navy of the water-tube boiler and the Parsons steam turbine.

April 18, 1920. Rudolph Messel died.—Educated at the University of Tübingen, where he studied chemistry under Strecker, Messel after the Franco-Prussian War came to England, where he joined Squire. He worked out a method for the manufacture of fuming sulphuric acid, and with Squire erected important chemical works at Silvertown.

April 19, 1904. Sir Clement Le Neve Foster died.—From the Royal School of Mines Foster passed to the Mining Academy at Freiburg, and in 1860 joined the Geological Survey. He was an inspector of mines from 1872 to 1901, and in 1890 succeeded Warington Smyth as professor of mining in the Royal College of Science. His important work on "Ore and Stone Mining" appeared in 1894. In 1903 he was knighted.

April 19, 1914. Alfred Noble died.—After serving in the American Civil War, Noble studied civil engineering in the University of Michigan, and became an eminent constructor of canals, docks, and bridges. He was a member of various commissions appointed to report on the feasibility of a ship canal across the Isthmus of Panama, and he played an important part in solving some of the engineering problems connected with the Panama Canal. He served as President of the American Society of Civil Engineers, and in 1910 received the John Fritz medal for "notable achievements as a Civil Engineer."

E. C. S.

Societies and Academies.

LONDON.

Royal Society, March 30.—Sir Charles Sherrington, president, in the chair.—The late W. G. **Ridewood**: Observations on the skull in fœtal specimens of whales of the genera Megaptera and Balænoptera. Five fœtal skulls were described. The presence of an interparietal bone in some whales, and the meeting of the parietals in a median suture in others, is of little use in taxonomy. Syncondyly is associated with suppression of the atlanto-epistropheal joint. There is no separate foramen for the hypoglossal nerve. The periotic bone shows no separate centres of ossification, but a diffuse endochondral granular deposit. The orbitosphenoid ossifies independently of the presphenoid. In whales there is no "external pterygoid plate" of alisphenoidal origin; the alisphenoid is the ossified ala temporalis. The growth of the malleus and of the tympanic bone, and the relations of the great bulla to the primary annulus tympanicus, were described.—W. L. **Balls**: Further observations on cell-wall structure as seen in cotton hairs. The daily growth rings consist of large numbers of fibrils, spirally arranged, with frequent reversals of the direction of the spirals. This arrangement is predetermined for the secondary cellulose of the growth rings by the initial pattern laid down in the primary wall. The individual fibrils have a cross-sectional area of the order of 0·05 square microns. Some of the evidence suggests stereo-isomerism in cellulose.—L. T. **Hogben** and F. R. **Winton**: The pigmentary effector system. I. Re-action of frog's melanophores to pituitary extracts. The posterior lobe of the pituitary gland contains a specific stimulant which, if injected into the frog, brings about a condition of general and complete expansion of the dermal melanophores. A minute dose induces a darkening of the skin readily visible to the naked eye. The pituitary melanophore stimulant is not destroyed by pepsin or boiling. It is rapidly destroyed by trypsin but not so quickly by acid hydrolysis. After cocaine, curare, atropine and apocodeine it still evokes its characteristic response, and therefore acts directly upon the melanophores. The results confirm the endocrine significance of the condition of general pigmental contraction found by Allen and others to follow removal of the pituitary gland in tadpoles.—Agnes **Arber**: On the development and morphology of the leaves of palms. The leaf-stalk is the basal or proximal region of the true petiole while the "fan" or "feather" limb is a modification of the distal region of the true petiole. The complex plication of the limb arises through the development of a series of invaginations penetrating the leaf-stalk tissue between the bundles. The "ligule" and "dorsal scale" of the fan-palms represent adaxial and abaxial distal margins of the uninvaginated proximal region of the petiole. The palm leaf, as a whole, is a petiolar phyllode with a pseudo-lamina.—H. E. **Roaf**: The acidity of muscle during maintained contraction. Records of electrical changes by a manganese dioxide electrode in combination with a calomel electrode show that: (*a*) In a veratrinised muscle the acidity remains as well as the tension. (*b*) In decerebrate rigidity reflex inhibition is accompanied by a decrease in acidity. Thus acidity and tension are related and a single mechanism is sufficient to account for both tetanus and tone.

Geological Society, March 22.—Prof. A. C. Seward, president, in the chair.—Sir Charles J. **Holmes**: Leonardo da Vinci as a geologist. Leonardo was the

first to have a large and accurate conception of the causes underlying the physical configuration of the earth. His studies of aqueous erosion, the formation of alluvial plains, the process of fossilisation, and the nature of stratification, led him to a logical conviction of the immensity of geological time, far in advance of the dogmatic thought of his age, and exposed himself to the charge of atheism. Caution compelled him to work in isolation, and to keep his results concealed. He had no scientific instruments, no correspondents to furnish him with observations on geological conditions elsewhere; yet his grasp of the physical history of the portions of Italy which he had visited was sound, and entirely in accord with modern knowledge. Leonardo left a record of his discoveries in his paintings, generally in the backgrounds. There are found pictures of the primeval world as he imagined it, when seas and lakes ran up to the foot of the mountains, to be slowly displaced and silted up by the detritus which the rain carried down from the summits.

BRUSSELS.

Royal Academy of Belgium, March 4.—M. A. Lameere in the chair.—C. **Servais**: The geometry of the tetrahedron, Pt. 4. The cubic surface of Cayley.—P. **Martens**: The cycle of the somatic chromosome in *Paris quadrifolia*.

Diary of Societies.

FRIDAY, APRIL 14.

MALACOLOGICAL SOCIETY (at Linnean Society).

WEDNESDAY, APRIL 19.

ROYAL METEOROLOGICAL SOCIETY, at 5.—W. T. Russell: The Relationship between Rainfall and Temperature as shown by the Correlation Coefficient.—R. A. Fisher: The Correlation of Weekly Rainfall.—Prof. S. Chapman and Miss E. Falshaw: The Lunar Atmospheric Tide at Aberdeen, 1869–1919.

ROYAL MICROSCOPICAL SOCIETY, at 8.—C. Beck: The Photometry of a Bull's-Eye Lens for Illuminating Microscopic Objects.—Dr. S. C. Harland and J. H. Denham: The Use of the Microscope in Cotton Research.—Dr. R. S. Ludford: The Morphology and Physiology of the Nucleolus.—H. Sutcliffe: The Use of the Microscope in the Rubber Industry.

THURSDAY, APRIL 20.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.

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

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.

INSTITUTE OF METALS (London Section) (Annual General Meeting at Shaftesbury Hotel, Great St. Andrew Street, W.C.1), at 8.—H. Moore: The Ball Hardness Test.

FRIDAY, APRIL 21.

INSTITUTE OF TRANSPORT (at Royal Society of Arts), at 5.—J. K. Bruce: The Operation of a Large Tramway Undertaking, with reference to Capacity and Cost under given Conditions.

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