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CONTENTS.

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Government Scientific Services.

IN a presidential address to the Washington Academy of Sciences [1] Mr. Alfred H. Brooks deals with the "Scientist in the Federal Service," and incidentally provokes comparison of Government scientific services in Britain and the States. The field to be covered, as he remarks, is continental in dimensions, and the needs of upwards of one hundred millions of people have to be met. So vast a proposition is beyond the powers of private enterprise and demands the systematised efforts of national bureaus. Washington, as the city of Government, formed the natural centre of Government research, and only during the last two decades became the home of other scientific institutions. In Paris, Berlin and London, science was fostered by old universities and learned societies, and it was only in researches for which co-operation on a large scale, and the maintenance of a permanent staff, were necessary, that the Government lent its aid.

The Federal scientific worker, we are told, giving his whole time to science, may tend to lose enthusiasm, and Mr. Brooks expresses a regret, with which we fully sympathise, that the non-professional man of science, with his enthusiasm and power to vivify science, is almost unknown in Washington and would fail to find there a congenial atmosphere. But in his fear that organised science leaves no place for the amateur and that competition with highly organised corps of professionals is impossible, surely he is unduly pessimistic. In Britain, at any rate, the amateur not infrequently leads the way and indicates the channels along which professional effort should be directed.

The Federal scientific service commenced about 1816. Now there are about forty institutions and upwards of 1500 investigators. At first the obtaining of funds depended largely upon the personality of the bureau chief. Pay was scanty, regulations were few, and appointments were made too largely under political influences. As practical applications of science increased, the bureaus were enlarged, and business methods were introduced, especially after 1906, as a result of the recommendations of the Keep Commission. Still more important was the realisation by the higher Government officials of the value of science in national economic problems. The demand for men began to exceed the supply, and whereas a bare living and a God-given love for his subject had been the scientific worker's only motives, the service became a profession for which the Universities graduated scores of highly trained specialists.

The tendency of a Federal service to collect facts without providing adequate interpretation, is inevitable. Organisation leads to uniformity, and, though a good

[1] *Journ. Washington Academy of Sciences*, vol. 12 (1922), pp. 73-115.

administrator may encourage individual effort in constructive thought, more consolation is found in the fact that the rare scientific genius cannot be suppressed, though there may be some danger of his applying his originality to financial and routine matters. Familiar indeed are the difficulties which scientific workers find in complying with the regulations controlling their expenditure, or accepting the limitations which a Treasury finds, or may think, necessary to place upon it. Regulations and limitations are regarded as personal insults, for the purpose only of hampering research.

The direction of a group of strongly individualistic investigators, including, it may be, a master mind, and almost certainly several hewers of wood and drawers of water, is no light task. Originality of thought has to be encouraged, but unity of purpose must be maintained in order to achieve the results demanded under the grant. The delinquents in such a group are usually unconscious of any delinquency, as for example the dilettante who flits from one problem to another and believes that he fulfils all obligations if he merely remains on the pay-roll; the brilliant mind that is so undisciplined that it cannot be made to formulate conclusions; or the hard-working procrastinator who dare not put forward his conclusions for fear of omitting some detail. Less deserving of sympathy are the pests who are as quick as a hair-trigger in publishing, and rush into print where more experienced men fear to tread, or the self-selected mouthpiece, who, unwilling to hide his light under a bushel, constitutes himself the agency by which science reaches the average man, and is too often taken at his own valuation. The "professional prominent scientist," another familiar type, at one time formed the popular authority in Washington. His dictum on any new problem was final, but he was more highly reputed by the public than by his colleagues.

A criticism passed on all men of science, not only by Mr. Brooks but also by literary men in Great Britain, relates to the form in which science is presented. The greatest need of the average American, and we may add of the British man of science, is to write clear English. He conveys his message to the people in language they cannot understand, and often he and his colleagues fail to understand one another. The development of such curiously similar types on the two sides of the Atlantic is interesting.

On the outbreak of war the Federal service proved its true worth. The bureaus formed the backbone of war service, for they were immediately available as storehouses of scientific facts and their great corps were quickly turned on to war problems. One result was to reveal the high commercial value of science, with the consequence that the ranks of the Federal service have been most seriously depleted. The best-trained men are now tempted away by the financial prospects of a commercial career, and the second choice only is left to the Government. It is suggested that the change may be due to the lowering of the ideals of the student, for the professor who is compelled to eke out a small salary by taking commercial work or writing text-books for profit, has not the same influence as a "revered master" in research. Without disparaging the high ideal attributed to the student, one is tempted to think that the possibilities of far higher emoluments in commercial service than could be justified in a Government bureau, are the principal inducement.

Pay, however, is not everything. Mr. Brooks reminds us that the young investigator who has obtained a post in the Government service, finds himself a member of a corps of well-trained enthusiastic professional men, whose actions earnestly express public duty and self-sacrifice. He will enjoy among them and in the non-professional societies congenial scientific companionship, and he will realise that the mere mass of such an army of investigators, whose ideals are not less lofty because they include the welfare of mankind, give an inspiration not excelled elsewhere.

A. S.

The Design of Electric Power Stations.

Power House Design. By Sir J. F. C. Snell. (Longmans' Electrical Engineering Series.) Second edition. Pp. xi+535. (London: Longmans, Green and Co., 1921.) 42*s*. net.

THE second edition of this important work will be welcomed by all engineers who are interested in power-station design. The author is the chairman of the Electricity Commissioners; he has been both a distributing and a consulting engineer, and has therefore studied the problem from all points of view. The book is a storehouse of facts which will be of great value to the designer. The general principles which should be followed are laid down and illustrated by clear descriptions of many modern power stations. It is interesting to note that these stations are of very varied design. This is doubtless due partly to the individual experience of the designers, but it also bears out the author's contention that every case must be considered on its own merits, and so the solution applicable in one case may be unsuitable in another. The apparatus inside a power station should be standardised as much as possible, but at the present time it would be inadvisable to attempt to standardise the station itself.

The modern fashion is to concentrate generating plant in large stations. This necessitates having a large supply of circulating water in the neighbourhood and it follows that capital stations are not necessarily situated near a pit's mouth. The most economical engines for driving dynamos are steam-turbines, provided they are worked at a very high vacuum, and in order to secure this we must have a supply of cold water equal to seventy times that required by the boilers. It is this consideration that rules out practically all the colliery sites in this country.

The author thinks that there should be at least two main generating stations to supply a large district. In addition he says that it generally would be found economical to generate part of the load at the points where the demand is greatest. It seems to us that the author does not lay sufficient stress on the fact that the cost of the network of cables required in a large distributing scheme may be 70 or 80 per cent. of the total cost of the undertaking. The main factor in determining the sites, therefore, will be the cost of the cables required. The cost of fuel transport and of the arrangements for circulating water may not vary much for different sites, but in general for a given supply the cost of the requisite cables will vary largely with the position of the power station. For commercial success it is very important that the capital cost of the cables should be as small as possible, and this can only be secured by a close study of the nature of the load required for industrial, domestic, and transport purposes, and then choosing the sites so that the cost of the cables is as small as possible. If the undertaking is to be a success, it is also necessary that the power-houses be capable of continual extension, so that the power available need never be much in excess of the demand. In the early days of the industry many of the stations built were much too large for the demand, and consequently years had to pass before they could pay dividends. It was difficult, therefore, to finance new schemes.

The following interesting comparison is made between the relative value of steam-engine and gas-engine plant. A boiler can easily evaporate 7·5 lb. of steam per lb. of coal consumed; a ton of coal will therefore yield 16,800 lb. of steam. A modern steam-turbine requires 8·2 lb. of steam per brake horse power hour developed. Hence a ton of coal will produce 2049 B.H.P. hours. With a gas producer operating on an average at a thermal efficiency of 75 per cent., a ton of coal of the same calorific value will yield power gas capable of producing 20,160,000 British thermal units. We may assume that on an average a modern gas-engine requires 9500 B.Th.U. per B.H.P. hour, and hence a ton of coal utilised in this way will produce 2122 B.H.P. hours. There is not much difference, therefore, in the amount of the mechanical energy obtained from the coal by the two methods.

It is pointed out that in certain cases an economy in fuel consumption can be obtained by using both steam and gas plant in the same station. The gas plant is almost immediately available, and so can be used to cope with any sudden temporary increases in the load, with consequent economies.

It has often been urged that it would be more economical to extract the potential by-products from the coal first of all and then utilise the resulting fuel products for power purposes. The author makes a careful examination of this procedure. He points out that serious thermal losses are involved in treating coal for by-product recovery and converting into coke or power gas or both. These losses range from 25 to 50 per cent. In the case of a power-house equipped with ammonia recovery producers for gasifying the whole of the coal, the total coal consumption would be from 70 to 80 per cent. greater than that of a corresponding coal-fired station. Considering it from the commercial point of view, he concludes that the prospects of obtaining through the medium of by-product recovery processes bulk supplies of electrical energy at a lower cost than coal firing are practically negligible.

Owing to the increasing attention devoted to the question of fuel conservation during the past twenty years, important developments in the utilisation of thermal products, which were formerly wasted on an enormous scale, have taken place. In particular, the surplus fuel gases produced at iron and steel works have been successfully utilised; for instance, at the important coke-oven works of Messrs. Pease and Partners, Durham, the waste heat is transformed into electrical energy by the supply company, and is "pumped" into the high-tension transmission mains for utilisation throughout the district.

The concluding chapter discusses hydro-electric power-houses, and important stations in America, Mexico, and Sweden are described. The attraction of cheap electric power has caused flourishing towns to spring up in the neighbourhood of some of the American waterfalls, but there are few cases where the hydro-electric power generated is transmitted to a considerable distance.

The author assumes that the reader is an engineer. The general reader, therefore, will occasionally have difficulty in understanding his nomenclature. The importance, for instance, of the load-factor of a station is emphasised, but even the engineer would appreciate being reminded that the load-factor is the ratio of the average load to the maximum possible load. The higher this factor, the more promising the commercial outlook of the station. Later on the notion of the diversity-factor is introduced, defined as the ratio of the sum of the maximum loads on the separate substations to the maximum load at the power-house. It is generally assumed that the higher the diversity-factor, the load-factor remaining the same, the better it is from the commercial point of view. It seems to the writer that these definitions should be examined from a rigorous mathematical point of view to find how far their numerical values can be considered as trustworthy guides of the commercial practicability of a projected scheme.

A "silo" is generally considered to be a pit or cave for storing fodder in the green state. Engineers apparently call a coal-store a "silo," and that at the Greenwich power-house has a capacity of 2000 tons. The coal is fed from the bunkers, into which the silo is divided, into gravity bucket conveyors, which carry it to the overhead bunkers feeding the furnaces. The weight of the coal is checked on weigh-bridges with five-foot dials. It is stated that with a load of 5 tons the maximum inaccuracy is only about 3 lb.!

A. RUSSELL.

Witch-Craft in Western Europe.

The Witch-Cult in Western Europe: A Study in Anthropology. By M. A. Murray. Pp. 303. (Oxford: At the Clarendon Press, 1921.) 16*s*. net.

IN her study of witchcraft in Western Europe Miss Murray has endeavoured to show, first, that the witch-cult was a definite organised religion, and secondly, that it is possible to deduce from the records the character of its ritual. The problem which Miss Murray has set herself is entirely new and has not hitherto been considered, much less attacked.

As regards the evidence upon which Miss Murray's investigations are based, her aim has been to arrive at an impartial statement by quoting the *ipsissima verba* of the witches in their confessions and at their trials as recorded by contemporary chroniclers, all comments of those who compiled the records being omitted. Early accounts of witchcraft, as she points out, are apt to be vitiated by too great credulity or an excess of scepticism.

Exception is not infrequently taken to the evidence of the witches themselves on the ground that it was elicited under torture, but Miss Murray meets this objection by pointing out that in the English trials and in many of the Scottish trials legal torture was not employed. It is true that she is concerned principally with witchcraft in this country and deals with the French evidence only for purposes of elucidation and amplification; much of the French evidence was the result of torture, and even in this country in some of the most important cases torture was employed. In the case of the North Berwick witches, who were accused of a conspiracy against James VI. in which Bothwell was implicated, two were subjected to the ordeal of having their nails pulled out with pincers, pins were stuck into the quick, and they were tortured with the boot. It is to be noted, however, that the confessions, whether elicited under torture or without it, display a remarkable uniformity in detail, although drawn from a wide area and spread over a considerable period of time. This lends strong support to the view that the evidence may be accepted as it stands.

Taking the evidence at its face value, Miss Murray has arrived at the conclusion that the witch-cult was a definite organised religion and, as such, was a survival of the primitive religion of Western Europe. It represents, she holds, the religion of a pre-agricultural people who celebrated their religious festivals in accordance with a pre-solstitial calendar. She argues, reasonably enough, that the wholesale conversions to Christianity in the early days of tribes and peoples were merely superficial and that the bulk of the people continued to follow their old beliefs and to practise their traditional ritual, more or less in secret. If it be conceded that the witches in their accounts of what took place at the Sabbaths were describing, not furtive assemblies for malicious evil practices and unlimited debauchery, but gatherings for performing the rites of an organised religion, their evidence takes on an entirely new significance. Taking this point of view Miss Murray is able to deduce from it the character of the god they worshipped, the nature of the rites, and the organisation by which the religion was carried on.

The god, who was confused with the devil by Christians, was regarded by his worshippers as incarnate in man, woman, or animal. The animal form varied, being sometimes a bull, sometimes a dog, a cat, a horse, or a sheep. The goat, common in France, does not occur in this country. Further investigation of this point might throw light on the early history and distribution of the cult. The god incarnate acted as the leader of the association in which there was an inner circle or council, the "coven," consisting apparently of thirteen individuals. Miss Murray is of the opinion that in certain instances it is possible to identify these leaders, and cites, among others, Bothwell, Joan of Arc, and her companion in arms, Gilles de Rais, the French "Bluebeard." Her suggestion that the god was sacrificed at stated intervals would account for certain peculiar features in the trials, such as, possibly, the line taken by Joan of Arc under examination, and the unsolicited confession of Major Weir, who was burned as a witch at Edinburgh in 1670. The evidence on this point would not be strong in itself, if it were not fully in keeping with Miss Murray's view of the witch-ritual. As is well known the central features of the Sabbath were a feast and sexual licence. This suggests inevitably that it was a fertility rite of the type familiar to anthropologists. It was only at a later date, and in the first instance by popular perversion that the function of the witch became the blasting of crops and herds as set forth in the famous Bull of Innocent VIII.

Many other topics are discussed in this important study which are of the greatest interest to anthropologists, and it bristles with points which call for further consideration did space allow. It has, however, one aspect to which reference must be made, and that is its bearing upon mediæval history. From this point of view it is a book which no historian or student can afford to neglect. The position of the Church and its relation to witchcraft before the beginning of the fifteenth century must be reconsidered first in the light of Miss Murray's conclusions and, secondly, with reference to the numerical strength the cult could command as an organisation—a point upon which Miss Murray does not touch.

The Riddle of Bird Migration.

Die Rätzel des Vogelzuges. Ihre Lösung auf experimentellem Wege durch Aeronautik, Aviatik und Vogelberingung. Von F. von Lucanus. Pp. viii + 226. (Langensalza: H. Beyer und Söhne (Beyer und Mann), 1922.) 30 marks.

THE migration of birds remains one of the most tangled problems, as it is one of the greatest marvels of the zoologist's world. In the old days known facts were few and hypotheses were correspondingly simple (and as a rule erroneous), but with multiplicity of data, theories, guesses and suggestions have so increased in number and complexity that they form in themselves a new problem for the seeker after truth. In the matter of precision of data the present generation holds a great advantage over its predecessors.

The institution of bird-ringing in Denmark by Mortensen in 1899, and its subsequent development in Germany by Thienemann and others, and in this country by the University of Aberdeen and Mr. Witherby, raised hopes of an early solution of many difficulties; while the development of air-craft and of their use in bird-watching, in which von Lucanus himself was a pioneer, has led to information which appeared once to be beyond man's grasp.

In the light of the results of these new methods, von Lucanus restates the problems of the origin and causes of migration, of its direction, height and speed, of its meteorological relations, and, most subtle of all, of the pathfinding of the birds, and re-examines the solutions which have been suggested. It may be said at once that there are here many new facts, and that in many respects the work of the former generation of observers has been superseded; but with it all, the reader is left with the feeling that while precision has been gained in problems of observation, the great problems of interpretation remain still beyond ken. Time after time the author is driven back for explanation upon an incomprehensible "migratory instinct" or "impulse" (Zugtrieb). Thus, having rejected, on account of their inadequacy as imminent causes of autumn migration, the fall of temperature, the shortening of the day, the lack of food, the changed atmospheric conditions due to the passing of the summer solstice, he concludes, "a bird departs as soon as the time for its departure has come and the migratory impulse has been awakened, without requiring any particular external stimulus.' Or again, having found tradition, warmer zones, anticyclonic conditions, wind guidance, a supposed magnetic sense, power of vision, each and all insufficient to account for the orientation of a bird's migratory flights, he says, "on its journey a bird requires no particular guidance, but follows an instinct which decides the direction automatically."

Von Lucanus has long been recognised as the champion of migration at comparatively low levels in the air, as against the idea of high-level migration which Gätke made popular. Many observations by airmen have been added to his early balloon observations, and he still regards the general height of migration to be under 400 metres, and flight at 1000 metres or over to be exceptional. Many records support his view, but conflicting evidence involves us in difficulties, for the author makes no mention of the observations of such of our airmen as Capt. Collingwood Ingram, who saw a flock of five hundred geese or ducks at about 11,500 feet, cranes (possibly) at 15,000 feet, birds resembling linnets at 10,000 feet, sandpipers at 12,000 feet, and so on. (*Ibis*, 1919, p. 321-5.)

The riddle of migration is not solved, but this volume, rich in observations and analyses, gives an excellent synopsis of the present state of knowledge, and points the way for future research. We may express the hope that the German bird-watching stations, disorganised owing to post-war conditions in Germany, may soon be able to resume their activities and add to the vast contributions they have already made to a fascinating study.

J. RITCHIE.

Modern Chemistry.

Traité de Chimie Générale. Par Prof. W. Nernst. 2e édition française, complètement refondue d'après la 10e édition allemande par Prof. A. Corvisy. Première Partie : *Propriétés Générales des Corps—Atome et Molécule.* Pp. viii + 620. (Paris : J. Hermann, 1922.) 30 francs net.

PROF. NERNST'S monumental treatise on general chemistry is so well known in this country and in America that no commendation of it is needed. It is a standard work in Germany, where it has already gone through numerous editions. In its French dress it has established a position in other parts of Europe and in Latin America. The volume under review—a large octavo of more than 600 pages—is the first part of the second French edition ; it has been thoroughly revised in conformity with the latest German edition. It deals with the general properties of matter and with atomic and molecular theories in the light of contemporary knowledge. In effect it is a treatise on the application of the fundamental principles of modern physics to chemistry, with due regard to inquiries wherever the study of chemical physics is actively pursued. Indeed, the wealth of bibliographical reference is one of the most commendable features of the work. This, of course, is as it should be. Science knows no national boundaries. This was not always so recognised in Germany. In times not so very remote it was not unusual to notice a tendency to make the world believe that the study and development of physical science, and particularly chemistry and physics, had become almost the exclusive function and prerogative of German professors. Instances were not unknown of actual appropriation of other men's work or of the wilful suppression of all mention of their labours. No such charge could possibly be brought against the author of this work. He apparently keeps his eyes open to all sources of knowledge and welcomes evidence from any quarter.

Although the general plan of the work is unchanged, the alterations and additions in the present French edition are very considerable. Many of the paragraphs have been greatly modified, and in some cases wholly rewritten ; others have been added ; some of the less important have been shortened and even discarded, so as to keep the book within bounds. Theoretical conceptions and new developments which found no mention in the first edition, such as the quantum theory, the constitution of the atom, the new thermodynamical theorem, the theory of relativity, atomic numbers, equations of state, the molecular theory of the solid state, the frequency of atomic vibrations, the elucidation of crystal structure by X-rays, radioactivity, isotopism, etc., now find their appropriate place and are dealt with at due length. The book is eminently readable, and the mathematical treatment in no wise deterrent. Prof. Nernst's excellence as an expositor has in no sense suffered by the clarity and precision of Prof. Corvisy's rendering. The book is remarkably free from typographical errors, although, as might be expected in a volume of its size, a few mistakes occur here and there. It will be news to many readers that a Lord Rayleigh developed a certain formula relating to gaseous mixtures so far back as 1587.

Text-books of Elementary Mathematics.

(1) *Elementary Calculus.* By Prof. William F. Osgood. Pp. ix + 224. (New York : The Macmillan Company ; London : Macmillan and Co., Ltd., 1921.) 12*s.* 6*d.* net.

(2) *Calculus for Beginners : A Text-book for Schools and Evening Classes.* By H. Sydney Jones. Pp. ix + 300. (London : Macmillan and Co., Ltd., 1921.) 6*s.*

(3) *A First Course in the Calculus.* Part 2, *Trigonometric and Logarithmic Functions of x, etc.* By Prof. William P. Milne and G. J. B. Westcott. (Bell's Mathematical Series for Schools and Colleges.) Pp. xv + 181-402 + xv-xxxix. (With answers.) (London : G. Bell and Sons, Ltd., 1920.) 5*s.*

(4) *Exponentials Made Easy, or The Story of "Epsilon."* By M. E. J. Gheury de Bray. Pp. x + 253. (London : Macmillan and Co., Ltd., 1921.) 4*s.* 6*d.* net.

(5) *Mathematics for Technical Students : Junior Course.* By S. N. Forrest. Pp. viii + 260. (With answers.) (London : Edward Arnold, 1920.) 7*s.* 6*d.* net.

(6) *Elementary Algebra.* Part 2. By C. V. Durell and R. M. Wright. (With answers.) (Cambridge Mathematical Series.) Pp. xxiii + 253-551 + xlvii-lxxxv. (London : G. Bell and Sons, Ltd., 1921.) 5*s.* 6*d.* net.

(7) *A Concise Geometry.* By Clement V. Durell. (Cambridge Mathematical Series.) Pp. viii + 319. (London : G. Bell and Sons, Ltd., 1920.) 5*s.* net.

(8) *Co-ordinate Geometry (Plane and Solid) for Beginners.* By R. C. Fawdry. (Bell's Mathematical Series for Schools and Colleges.) Pp. viii + 215. (London : G. Bell and Sons, Ltd., 1921.) 5*s.*

(9) *Elements of Practical Geometry : A Two Years' Course for Day and Evening Technical Students.* By P. W. Scott. Pp. v + 185. (London : Sir Isaac Pitman and Sons, Ltd., 1921.) 5*s.* net.

(1) PROF. OSGOOD'S "Elementary Calculus" supplies a need—the need of the young mathematician for a sound introduction to the differ-

ential calculus. The treatment is almost without blemish and is so simple and clear that the beginner should have no serious difficulty. Chaps. 1-4 introduce only algebraic functions; chaps. 5-8 are concerned with trigonometric and exponential functions and the corresponding inverse functions. The treatment of infinitesimals and differentials in chap. 5 is specially to be commended. The author has one or two hobby-horses. One that he ought not to have ridden here is the denial of the existence of "infinity." He says (p. 27): "We should not read 'Z approaches infinity,' . . . but 'Z becomes infinite'; . . . the statement sometimes made that 'Z becomes greater than any assignable quantity' is absurd. There is no quantity greater than any assignable quantity." This last remark contains a certain misunderstanding, and, in any case, such subtleties are not suited to beginners. Among minor points it is curious to note that there is no definition of a limit in the book. Some proof, or at least a reference, should be given for the proposition quoted on p. 113: "A convex curved line is less than a convex broken line which envelops it and has the same extremities."

(2) It is a pity that authors who do not "make reference to difficulties which seldom arise in the minds of elementary students" generally manage to make their subject so uninteresting. We do not ask for proofs. Mr. Sydney Jones effectually suppresses such an unreasonable desire by putting the word "proofs" in inverted commas in his preface. But could we not have a little colour? Let us take MacLaurin's theorem as a sample (p. 158). Mr. Jones says: "Assuming that a function $f(x)$ can be expanded in positive integral ascending powers of x . . . .

$$f(x) \equiv A_0 + A_1x + A_2x^2/1.2 + \ . \ . \ . \ ,$$

to determine the coefficients A_0, A_1, A_2, . . ." He then differentiates the series and determines the coefficients, as if this were a most ordinary and most dull proceeding. His pupils no doubt wonder vaguely, learn their lesson by rote, and pass on. If he would only pause to tell them what a wonderful theorem this is, or point out how great are the assumptions he is making, it would be well worth the space. Judging the book from the author's own point of view, there is little to find fault with in it. But he should not call a differential coefficient a "differential" (p. 18, etc.).

(3) This misuse of the word "differential" is a bad habit that appears to be gaining ground. The authors of "A First Course in the Calculus" are also addicted to it (preface and p. 215). Their text-book is mainly manipulative; it contains the usual treatment of the infinitesimal calculus, and concludes with a chapter on differential equations. The proof, depending on the area of a circular sector, for the limit of sin θ/θ (p. 181), is open to the objection that students are generally taught to use the limit in question for finding this area. It is not necessary to use a formula for an area at all (see, for example, Levett and Davison's "Plane Trigonometry," p. 82). Many mathematicians would be pained by the author's statement on p. 343: "If we proceed indefinitely, taking only a fractional part of a given object, it is perfectly plain that the fractional portion will soon be very small indeed." There is no doubt that an intelligent person can convince himself that the limit of x^n is zero, if x is less than unity, but a more exacting logician demands a proof of the proposition. The authors hope that "the student will have nothing to unlearn if he afterwards . . . proceeds to a rigorous course of modern analysis." But it would be a pity if he learnt to regard analysis as the proving of the "perfectly plain."

(4) Mr. Gheury de Bray calls his book a "little brother" of "Calculus Made Easy." We do not know whether the late Prof. S. P. Thompson would have been pleased with this facetious little relative. The only portion of the work that we can unreservedly recommend is a long preliminary quotation from Henri Fabre (pp. 1-12). There follow part 1 on indices, binomial series, etc., and part 2 on the exponential series, the equiangular spiral, the hyperbola (because its area is a logarithmic function), the catenary, the parabola (because it resembles a catenary), the probability curve, and "exponential analysis." The method consists in "talking round" the subject; something may be said for it, but it requires skilful handling, and in this author's hands it is often long-winded and obscure. The unwary should be warned that the method, which is stated on p. 55, is not "mathematical induction," but a kind of sampling; the statement on p. 147 that the centroid of a catenary arc is its middle point is, of course, incorrect. The last chapter is interesting, but too difficult for any one who would care to read the rest of the book. In sum the author had an excellent idea, which he has not quite managed to realise.

(5) "Mathematics for Technical Students" is designed for the first two years' work following on an elementary school course. The treatment is apt to be rather too formal in places—Mr. Forrest teaches algebra in the old style like a game of patience with x's and y's for playing cards, and only hints that algebra has something to do with the workaday world after his pupil has learnt to play the game. The treatment is, of course, still quite defensible, but it is now generally thought better to reverse this order

with technical students, who are only too apt to regard mathematics as a game instead of an essential part of their business. The book is, for the rest, well proportioned and quite suitable for its purpose.

(6) The subject known as "Elementary Algebra" has been so metamorphosed in the past ten or twenty years that its name ought to be changed. Graphs, differentiation, integration, and nomography are not algebra as understood by Salmon, Chrystal, or Weber. A little trigonometry and as much geometry as is required should be added and the whole called elementary mathematics. The breaking down of the watertight compartments into which school mathematics used to be divided is a development in the right direction.

The scheme of this book is interesting. The bookwork is only given in outline in the text or hinted at in the introduction. It remains for the teacher to fill in this framework according to his own lights. And then the text-book gives him examples that are both numerous and apposite. The scheme has much to recommend it, and will be welcomed by teachers who are accustomed to do their work thoroughly. The authors need not apologise for introducing a chapter on nomography, although this chapter will be found difficult without a much fuller treatment.

(7) It is a melancholy fact that examinations dominate and thereby spoil much of the education that they are intended to test and encourage. A considerable part of the education in this country has no higher purpose than the passing of a public examination at some future date. Mr. Durell, who is capable of much better things, says quite frankly that he has compiled a cram book, and we can recommend it for that purpose. The range is roughly that of the Cambridge schedule.

(8) The syllabuses for the Army entrance examinations and those conducted by the Oxford and Cambridge Joint Board have been assimilated, in the hope that Army classes at public schools may thereby be discontinued. This is a little unfortunate for Mr. Fawdry, whose "Co-ordinate Geometry" is written for Army candidates. But the book should prove quite suitable for the general classes into which the Army classes may be merged. Mr. Fawdry has the humanity to insert one or two historical notes (pp. 29 and 75). They are slight, but it is wonderful how much interest they add to the reading. We should like to see more of them.

(9) One of the difficulties of the teacher of modern elementary geometry is the devising of life-like examples. He will solve this difficulty if he gets Mr. Scott's text-book on practical geometry. The text-book is meant for young draughtsmen, and is full of such things as draughtsmen have to draw. The only general criticism we would make is that, while Mr. Scott gives clear instructions, he never justifies them, and we cannot believe that rule of thumb is a good rule even for draughtsmen. Chap. 8, about which the author is a little apologetic, is rather out of place. It contains some methods of constructing a "true length," when plan and elevation are given. The chapter is good in itself, but it stands at a different level from the rest of the book. The subject should be either left out or treated more fully. Standing alone, it will not be understood by the majority of readers.

H. B. H.

Studies in Symbiosis.[1]

Tier und Pflanze in intrazellularer Symbiose. By Prof. P. Buchner. Pp. xi + 462 + Tafel 2. (Berlin: Gebrüder Borntraeger, 1921.) 114 mk.

THE third section of Dr. Buchner's book deals with the highly controversial thesis that symbiotic bacteria are the cause of luminosity in many insects and marine animals. In this discussion, the author's critical faculty is at fault. He does not set out clearly the opposing lines of evidence nor does he do full justice to the work of Dubois, the protagonist of the "enzyme-theory" of animal luminosity.

Briefly, the issue is between the enzyme and the bacterial modes of light production. According to Dubois and Newton Harvey (whose work was reviewed in NATURE, October 6, p. 174), luminous animals contain two substances, one of which, when oxidised in the presence of the other, gives rise to light of an extremely "efficient" kind. The firefly's light is the standard—the most efficient light known, so far as the amount of light in relation to the expenditure of energy is concerned. One of these substances is a heat-stable, dialysable, oxidisable light producer, the other is not heat-stable, is non-dialysable, and is apparently a proteid. These substances are obtained by "dissolving" whole animals or their phosphorescent mucus in water or alcohol and precipitating with ammonium sulphate. No attempts appear to have been made to test the solutions for the presence of bacteria. An aqueous emulsion boiled in 20 per cent. hydrochloric acid for three hours retains the power of producing light when added to a cold-water emulsion. In the former the heat-stable "luciferin" has been separated from the unstable catalyst "luciferase," while both are present in the cold-water extract. The presence of the activator is necessary for light

[1] Continued from p. 539.

production which in that case accompanies the rapid oxidation of luciferin; otherwise the process occurs without the evolution of light. The cold-water extract glows for a time until its luciferin is completely oxidised, and it may be made reluminescent by adding some of the hot-water extract.

The bacterial theory of animal light, though possibly consistent with the enzymic one, is based on entirely different data. In its modern form, as an explanation of the phosphorescence of fireflies, glow-worms, and such marine animals as Pyrosoma and certain cuttle-fish, it is due to Italian zoologists, and especially to the work of Pierantoni. Dr. Buchner is a convert to this view and is a worker in this field. He gives a very interesting account of the evidence, which is of a biological, and not, as in the case of the enzyme school, of a chemical character. According to these observations, the luminous organs of cephalopods, be they never so complicated, are essentially cultures of bacteria in media suitable for their nutrition, and in situations favourable for obtaining oxygen.

In the common Sepia, for example, the organ (hitherto called the accessory nidamental gland and regarded as part of the egg-producing mechanism) consists of a modified part of the mantle within which different kinds of bacteria occur. Some are luminous, others are not. They also occur in the egg membrane before development, and Pierantoni describes the infection of the embryo by bacteria derived from those of the egg capsule. In a similar manner he explains the relationship between the luminosity of the egg of the glow-worm and that of the larva and adult beetle. The cells of the luminous organ of Pyrosoma contain structures that are also apparently symbiotic organisms. Noctiluca, however, has not yet been examined from this point of view.

The difficulty that many will feel in regard to this or the rival solution of an admittedly complex problem is the incompleteness of the explanation hitherto given of flash and occultation and of the apparent transmission of a mechanical stimulus from one part of a luminous animal (as in Pyrosoma) to another, lighting the "lamps" as it travels along. The solution seems to lie in the phases and disturbances not only of respiration, but of other controlling factors leading to continuous or alternating evolution of light.

Dr. Buchner has performed a signal service by collating much of what is known of intracellular symbiosis in animals, and his book is one that is most suggestive for further experiment and observation. It indicates the fruitfulness of border-line investigation, and should be widely known amongst biologists to whatever section of organic science they may belong.

F. W. GAMBLE.

Our Bookshelf.

Industrial and Power Alcohol. By Dr. R. C. Farmer. (Pitman's Technical Primer Series.) Pp. x+110. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 2s. 6d. net.

THE author has certainly contrived to include a very large amount of information regarding alcohol in this little book, which contains clear descriptions of the properties of the alcohols and the methods of production. There are interesting chapters on the technical applications and the use of alcohol for the development of power. By no means the least informative part of the book is the numerous references to government regulations and restrictions. Thus, after a statement of some of these restrictions, we read on page 31:—"Plant is stereotyped, and there is no encouragement to introduce improvements in method or in apparatus. Transport by tank is forbidden, and no distillery is permitted to be more than a quarter of a mile from a market town, whereas it would frequently be better to situate the distillery near to the raw materials." We can commend this book to any who are interested in the development of alcohol as a fuel.

Les Combustibles liquides et leurs Applications. Par le Syndicat d'Applications Industrielles des Combustibles liquides. Pp. iii+621. (Paris: Gauthier-Villars et Cie, 1921.)

ONE may liken this volume to the many similar pocket-book issues extant in this country as compendious guides to the various branches of applied science. It serves a double purpose as an epitome of petroleum technology and as a standard work of reference for immediate requirements in the field, refinery, and office, and although written essentially for the use of the French industries concerned with inflammable liquids, it deserves a much wider sphere of utility. This type of publication, though frequently condemned as inimical to the best interests of scientific work and commercial production, commands a degree of popularity for which it is not, perhaps, difficult to account.

H. B. MILNER.

The Development of Institutions under Irrigation; With Special Reference to Early Utah Conditions. By Prof. G. Thomas. (The Rural Science Series.) xi+293. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1920.) 16s. net.

PROF. THOMAS aims at tracing the evolution of water legislation in Utah from 1847, when the Mormon pioneers founded Salt Lake City, to the present time. He shows how the Mormons, if not the first people in America to practise irrigation, were certainly the first to establish it on an extensive scale, the whole of their civilisation practically resting on this type of agriculture. They showed the way to reclaim vast areas of arid land and on their pioneer attempts have been based the methods utilised in other parts of the United States. He also traces the influence of this type of agriculture on the plan and design of the cities of Utah. The book would have been improved by the addition of a map.

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 Buoyancy of the Sun-fish.

ABOUT the end of August numbers of sun-fish (*Orthagoriscus mola*) make their appearance off the north coast of Ireland floating passively on the surface of the sea. The positive buoyancy, while not so great as to prevent the fish from submerging when attacked, constitutes a constant upward drag which brings it back to the surface as soon as it stops swimming. So far as we know, the bodies of all other fish have a specific gravity greater than that of sea-water, and the swim-bladder, where it exists, contains the necessary amount of gas to compensate for this and bring the body of the fish to neutral buoyancy.

The sun-fish has no swim-bladder, and on cutting up a fish and throwing pieces of the various organs overboard, it was found that everything sank except the liver and the skin. The liver floats no doubt because of the large quantity of fat it contains. The skin is 2-2½ inches thick and, the fish being flat, forms a large proportion of the body: it is evident that the fish floats passively on account of this buoyant jacket.

The skin is made of a tough elastic material, slimy to the touch, resembling rather soft cartilage: as a whole it is stiff enough to form what may be described as a rigid coat. For more detailed examination a number of slices were preserved in sea-water formalin: the slices had not changed in their appearance or proportions, and this pickled material probably represents fairly the fresh condition apart from such features as the solubility of the mucus, etc. The epidermis is 1-2 mm. thick; internally the skin is bounded by the very thin parietal peritoneum: the rest is uniform in appearance and shows microscopically a felted mass of thin wavy fibres arising stellately from connective tissue cells. There are a few rather thicker straight fibres but nothing of the nature of trabeculæ or struts. A few canals—presumably mucous ducts—are found here and there. No stainable fat is present, nor can any be obtained from dried material by extraction with ether, chloroform, or petrol.

After washing out the salt in distilled water, the specific gravity of the substance of the skin was found to be 1013 to 1016 with a mean of 1014 by weighing in air and water and floating bits in salt solutions of different strengths. It is difficult to get very precise results since one has to start with pieces in the rather indefinite state of being "surface dry." The specific gravity of pieces soaked in 0·9 per cent. NaCl solution was 1021. This may be taken to be somewhat near the natural gravity since it is known that the concentration of the body fluids of teleostean fish corresponds with that of mammals and is much less than sea-water. Taking the gravity of sea-water as 1026, these figures are compatible with the observation that the whole fish is just buoyant.

The most remarkable thing is that the percentage of solids in the skin washed out in distilled water is only about 3·7 per cent., figures varying from 3·5 to 4·2 being given by different pieces while the loss of weight on drying *in vacuo* over sulphuric acid is practically the same as the loss in an oven at 95° C. Histologically the larger part of the skin substance appears to be made of connective tissue fibres, and it is extraordinary that 2 per cent. or less of the mucoid material can give, when it is swollen with water, a tissue the mechanical firmness and rigidity of the skin.

The specific gravity of the dried solids, by floating in chloroform-petrol mixtures, was 1·335. Calculation from this gives a specific gravity of 1010 or thereabouts for the undried material. The difference between this and the determined value of 1014 (involving a value of about 1·6 for the solids) may be an error of observation or indicative of a condensation of the mucoid material when it is swollen in water, such as is known to occur with starch, gelatine, and proteids (Chick and Martin, *Biochemical Journal*, vii. (1913), 92).

After formalin fixation, the mucus is not soluble in dilute sodium carbonate, and once the skin has been dried *in vacuo* it will not swell up again in water, dilute acid or alkali.

G. C. C. DAMANT.
A. E. BOYCOTT.

Thursford, East Cowes.

Haloes and Earth History.

IN continuation of my letter on this subject in NATURE of April 22, p. 517, fifty additional measurements of the small Ytterby haloes have been made. The same consistency among the readings is noticeable. The mean result is a radius of 0·0052 mm. Introducing two corrections not previously applied (for the somewhat higher stopping power of this mica and for the fact that in such measurements we do not generally deal with the extreme range) I find that the range in air might be as much as 1·4 or even 1·5 cm. The nuclear correction would reduce this a very little.

The consistency of measurements among these haloes is, I think, even greater than would be found to obtain among normal haloes. The law prevailing among halo-dimensions is only apparent upon comparison and classification. It is by no means *prima facie* evident. It was just for this reason that it for so long escaped notice.

There is evidence that some of the larger sized Ytterby haloes deserve consideration as constituting a true radioactive development. Their radius is consistently 0·0086 mm. The nucleus is far too small to account for the difference. With all allowances (save that for the nucleus) this comes out as 2·4 cms. in air at 15° C. This is suggestively like that of Ui (2·50). But we seem debarred from the tempting conclusion that hibernium may be a proto-uranium by the time-difficulties involved.

The paragraph in my letter referring to the possibility that the Ytterby haloes might date back to a prior geological era requires some explanatory amendment. It would be better to speak of the Archean as what (as I believe) it really is—the record of a past geological era; a material record finally brought to an end by thermal changes sufficient to evaporate the oceans. The reading of the halo—could we read it aright—would then assign a date to the formation of the containing mica. Upon the *prima facie* evidence this date is very remote. That is all I have to say upon this point.

There are, as I have intimated, possible alternatives to the view that very great time intervals are involved. The element responsible may emit α-rays the connection of the range of which with the radioactive constant may involve a very different constant from that which, with small modification, applies to the three known radioactive families. Still more fundamental would be the discovery of some other than a radioactive origin for these haloes. I have considered many alternatives. One naturally thinks of a chemical influence emanating from the nucleus. Apart from the difficulty of accounting for the consistent measurements, the existence of bleached haloes in this mica, which possess the characteristic dimensions of uranium and emanation haloes, seems a formidable difficulty. The relation between the radioactive staining and the bleaching is everywhere such as to suggest that the latter is a modification of the former. A quantitative difficulty also exists. The volume of the nucleus varies from the $\frac{1}{5000}$ to the $\frac{1}{15000}$ part of the halo-volume which it has affected. Yet the nucleus may be a limpid particle revealing no trace of loss or decomposition. Only radioactivity can confer on one atom the energy requisite to ionise many hundreds.

Of course some one of the known elements may be responsible for these haloes. Geiger and Nutall long ago pointed out the difficulty which would attend the discovery of radioactivity in elements having a radioactive constant proportional to such ranges. But here we have an integration such as far transcends the resources of the laboratory. Until this point is settled—if it ever will be possible to settle it—a distinguishing name seems desirable. To this name the addition of numerals would suffice to deal with such halo-developments as may be ascertainable.

J. JOLY.

Trinity College, Dublin, April 25.

Pythagoras's Theorem as a Repeating Pattern.

THE interesting communication from Major MacMahon on the above subject reminds me of a proof which I discovered over the chessboard a few years ago, of the well-known fact, that if the lengths of the sides of a right-angled triangle are 3 and 4, the length of the hypotenuse will be 5.

Placing pawns at A, B, and C (Fig. 1), we require to prove that A is equidistant from B and C. We put

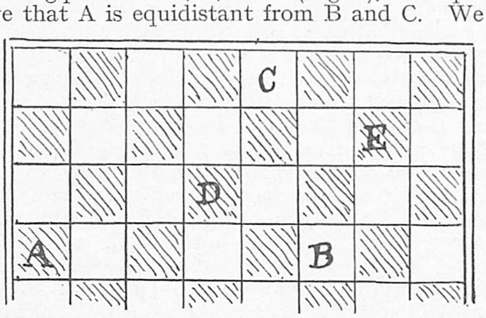

FIG. 1.

two more pawns at D and E, when it will be readily seen, even by a person unacquainted with Euclid, that A, D, E are in line and that CEBD is a square. Since any point on a diagonal of a square must, by symmetry, be equidistant from the extremities of the other diagonal, AB = AC.

The corresponding general proof of Pythagoras's theorem is as follows. Given $x^2+y^2=z^2$, we get

$$\frac{z+x-y}{x+y-z}=\frac{x+y+z}{z+y-x} \quad . \quad . \quad . \quad (1)$$

by algebra. Taking horizontal and vertical axes of reference through an origin O (Fig. 2), we mark down a point A the co-ordinates of which are $\frac{1}{2}(z+x-y)$, $\frac{1}{2}(x+y-z)$, and a point B the co-ordinates of which are $\frac{1}{2}(x+y+z)$, $\frac{1}{2}(z+y-x)$. By the given relation (1) OAB is a straight line. Through A and B draw ordinates PQ, SR, each equal to PS, and in the square PQRS inscribe the square ADBC by marking off RD = PC = SB. Then, drawing the ordinate DN, we have

$$DN = PS = \tfrac{1}{2}(x+y+z) - \tfrac{1}{2}(z+x-y) = y,$$
$$ON = OP + PA = \tfrac{1}{2}(z+x-y) + \tfrac{1}{2}(x+y-z) = x,$$
$$OD = OC = OP + SB = \tfrac{1}{2}(z+x-y) + \tfrac{1}{2}(z+y-x) = z,$$

which proves the theorem.

It is to be noted that in any special case where x, y, z are given integers (as in the case given above), it can be easily shown that OAB is a straight line

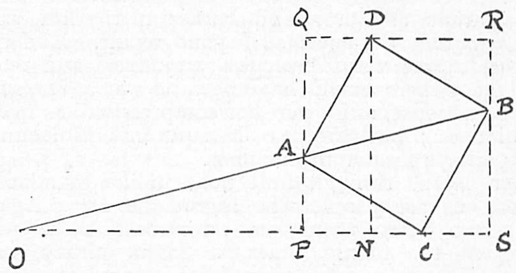

FIG. 2.

without knowing anything about proportion. Thus in such cases Pythagoras's theorem is proved without introducing areas. It has, I believe, been suggested that the ancient Egyptians must have been acquainted with Pythagoras's theorem, since they knew that a triangle with sides 3, 4, 5, is right-angled. But they may possibly have known only the special proof here given.

Lastly, it may be noticed that Euclid's axiom about parallels is tacitly assumed when we allow that a repeated pattern of squares can be constructed.

J. R. COTTER.

Trinity College, Dublin, April 15.

Man.

MAN is a social animal through habit, not instinct. Religions, morals, taboos, customs, conventions, which he learns through imitation, supply him with rules of thought and conduct. Without them human society could not exist. But there are two sorts of rules. The one kind binds the body, limits action, supplies rules of conduct, and impels men to "play the game" fairly. The other sort binds the mind, limits thought, impels men never to question the rules. *When the rules that bind the mind are many and strait, men tend to regard lightly the rules that bind to conduct.* All this may seem far-fetched, but consider universal history. Is it not the fact that communities have been inefficient, stagnant, and turbulent in proportion as their minds have been bound?

I may be afflicted with racial prejudice, but to me it seems that the men of English speech owe their predominant position in the world to the fact that they more than others "play the game" scrupulously, and yet have been freest of all in their thoughts, and so, while obeying their existing rules, have most readily altered the rules both of conduct and of thought. We English may have only one sauce, but, fortunately, we have a hundred heresies. Modern English history tells of continuous evolution, but of only one revolution. Compare the histories of more orthodox countries. Men cannot get away from habit, and mental habits depend not so much on the things that are learned as on the way in which they are learned. Through imitation we get emotional convictions and closed habits of mind; through curiosity, intellectual convictions and open, reflective habits of mind. When a man is mentally "too old at forty" his mind has been artificially closed. It can no longer profit from experience.

He has become unintelligent. Consider the unlike results which would follow the teaching of science on the grounds of faith and of evidence. In the former case there would be stagnation, passionate and unending controversy, with deference to this authority and hatred of that; in the latter case, contempt for mere authority, efficiency, progress, cool discussion, and ultimate agreement. Always it is not so much the thing that is taught that matters, but the way in which it is taught, through imitation or through curiosity. Consider how inefficient were such nations as Russia and Turkey in the late war, and how they are smashed beyond repair. Had the peoples of the world been less prejudiced and more intelligent there would have been no war. The subject is immense, and desire for compression has made me didactic; but readers of NATURE may fill lacunæ, and perhaps forgive my manner.

Men learn, through imitation, unlike standards. Among us are people who regret the Dark Ages: as before them there were doubtless those who regretted the manly times of Saxon piracy, and before them those who grieved for painted savagery. But, obviously, if we desire intelligence, efficiency, a contented and prosperous population, and a progressive civilisation, we must teach our youth as much as possible through evidence. We cannot help imparting some things through imitation (*e.g.* our ideas of right and wrong), but our special aim should be to create through curiosity an open, reflective habit of mind. This is, of course, the way in which science has been created, and which its workers constantly advocate. But it is vain to express mere opinions. Many people who professedly, indeed sincerely, seek the same ends think it primarily essential to close the mind to evil by teaching especially the emotional convictions they may happen to hold, and to expend the rest of the pupil's time by causing him to learn through labour other things (*e.g.* languages) which are commonly acquired through imitation. A man may learn all the languages in the world and yet not part from a single prejudice.

Fortunately, the history of society furnishes crucial examples in abundance. For example, the modern world, like the Græco-Roman, but unlike every other, has been prolific in men great in thought or action. In these two worlds men have learned especially through curiosity. With very rare exceptions, only Christians (who more than others have abandoned mere imitation) have produced great men; and among Christians great men have been almost limited to the less orthodox (*i.e.* less imitative) sects, or to defaulters from the more orthodox. Consider Newton, Darwin, Napoleon and his contemporaries, Garibaldi, Bismarck, and the rest. The crime-rate of modern communities, ranging from civil war and rebellion, through brigandage and murder, to acts of petty violence, is immensely higher among the more orthodox, who, both peoples and individuals, usually occupy inferior positions and attribute their misfortunes to oppressors, native or foreign. But emigration to other lands leaves such people unchanged, as witness the alien population of Great Britain and the United States, with its emotionalism, tendency to corruption, and high crime-rate. Government by the orthodox is invariably corrupt or inefficient, or both, as in Russia, Turkey, and medieval England.

Efficient modern Governments, hoping to obtain peace, are often pathetically anxious to confer self-government on the orthodox. But you cannot make a silk purse out of a sow's ear. As object-lessons, compare Russia and Germany in defeat. The latter, wrecked by an emotional despot and his Byzantine Court, is cleverly reconstructing her prosperity. Russia was, and is, and will long continue, an autocracy or lapse into chaos. People with the degree of intelligence permitted by the Orthodox Church could not possibly evolve a free and orderly State. Consider all the nations of the world. Invariably you will find that the men whose rules limit thought are inferior to those whose rules, relatively speaking, limit only action. Many empires have perished in the past from internal decay or external pressure. In the former case the decay has always coincided with an increase of training through imitation; in the latter, rival nations have increased their training through curiosity. We may confer self-government on populations in India, Egypt, and nearer home; but very certainly these populations will then only reproduce societies like those which people similarly trained have produced elsewhere.

Science has endowed humanity with a vast command over Nature, but has been less successful in establishing the scientific spirit. Within the limits created by his prejudices, facts may be taught to the adult, but frames of mind, as a rule, only to the very young; and science has neglected to consider the education of the latter. It is one thing to discover the shape and age of the earth or the origin of species, and quite another thing to persuade men already biassed to accept the intellectual consequences. It is one thing to invent explosives and aeroplanes, and quite another thing to make men, already made creatures of emotion through imitation, tolerant, reflective, open-minded, rational, so that discovery shall not be used for evil. The world is seething with passionate hatreds, the offspring of prejudices, which are derived from imitation. Consider the moral and religious differences which are indelibly impressed on the minds of children, and are the root-causes of nearly all the trouble that ferments from Galway to Singapore. Knowledge, the child of Science, has outgrown her twin Wisdom, and in the hands of violent and intolerant men may easily bring our civilisation to ruin. Consider ancient Rome and how exactly her decline coincided with the rise of fanaticism. Compare, as revealed in their literatures, the minds of the fervid saints with those of the common-sense pagans. But at least we may try to guard our own land. We have a unique opportunity; for among the British, the least prejudiced of moderns, are many who would accept crucial evidence concerning the development of society if it were offered fearlessly and insistently, and only the followers of science can so offer it. The main difficulty lies in the beginning: it will be hard to move scientific men, especially biologists, to action. From the nature of their training they lack enthusiasm (which is an emotion), and therefore organisation, and therefore power. Compare Salvationists. The little finger of General Booth is thicker than the loins of the president of the Royal Society. But probably, were the movement in favour of a right method of mental training well started, the laity would supply the enthusiasm. However, all that is on the knees of the gods.

I now conclude my letters to NATURE. They may, perhaps, have achieved some small success in things about which I care little, but probably none at all in the things about which I care much. I think they have been misunderstood. I am not wildly concerned about biological terminology *per se*, or about chromosomes, or whether groups of naturalists limit their facts to those furnished by zoology and botany, or experiment, or biometry, and so forth, or whether they bring a wider range of evidence from other sciences and studies into court by means of crucial testing. If the public be uninterested or stupid, it matters not how biologists divert themselves. If it be interested and intelligent, it matters supremely; but in the latter case biologists will be compelled, by pressure from outside, especially from the followers of other sciences, to adopt the right methods, whatever they may be. But I am concerned with mind and education, and the moment one tries to reach bed-rock in such matters one finds oneself in biological quicksands. One is told that some characters are innate and some acquired, but not the distinction between the innate and the acquired. It is understood that things that are learned are acquired, but apparently no one has tried to ascertain how much is learned or how it is learned. Seemingly, all biologists are agreed that, in themselves, acquired characters are trifling things ; but while Lamarckians think them important through their cumulative effects, neo-Darwinians, conceiving them as transient, think them unworthy of study. Both parties mean one thing when they apply the word " inherit " to " innate " characters, and the exact opposite when they apply it to " acquirements."

Man is the educable animal, say some biologists. He is not educable, say (in effect) others who declare that in his mental make-up nature is four, perhaps nine, times more potent than nurture. One admires the precision of statement, but wonders what is meant. As I understand it, man's nature is such that he is particularly responsive to the nurture of mental use. It is as if a physicist had stated that the steam is four, perhaps nine, times more potent than the engine. And so on. Meanwhile, prejudice controls education and society flows towards the cataracts. I may be very ignorant as to facts and mistaken in my opinions, but in that case my demolition should be a holiday task to the trained and learned intellect. Failing demolition, I cannot help believing that biologists do not realise how very great their science is, or might be, and how vitally and immediately important their labours are, or should be. Incidentally, I have sought in these letters of mine to indicate the high importance, as it appears to me, of classifying characters, not as innate and acquired, but, as physiologists do, according to the stimuli which cause them to develop. So far as I am able to judge, unless scientific men ascertain precisely how mental characters are developed, and then vigorously apply their knowledge for the betterment of education, modern society will soon be on the rocks.

G. ARCHDALL REID.

9 Victoria Road South, Southsea, Hants.

Configurations of Molecules of Benzenoid Substances.

PROF. ROBINSON'S remarks (NATURE, April 15, p. 476) on Sir William Bragg's representation of the naphthalene molecule, as it occurs in crystals, lead me to invite attention to results obtained recently by Mr. G. H. Christie and myself. In a paper which will be published in the forthcoming number of the Journal of the Chemical Society, the resolution of *trans*-6 : 6′-dinitro-diphenic acid into optically active components is described. This, with the fact that an apparently homogeneous brucine salt has been obtained from the *cis*-form of the acid, indicates that in the separate molecules (as distinguished from their crystalline aggregates, to which Sir William Bragg's results apply) of these compounds the two benzene nuclei are not coplanar.

If this be so, it follows that the direction of the valency of each of the carbon atoms through which these nuclei are united is not, as represented in the usual formulæ for benzene, exerted in the plane of the benzene ring, and further, that this condition is a stable one rather than a phase of an oscillation of the type referred to by Prof. Robinson. It may be possible to determine to what extent, if at all, this stability involves a modification of the normal benzenoid properties associated with two benzene nuclei. Differences between diphenyl itself and benzene in respect of their molecular refraction, and behaviour on catalytic reduction and towards ozone, are already on record, so that it will also be pertinent to inquire whether the fixity of configuration is a general property of diphenyl derivatives, or is dependent on the nature of the substituents present, and connected, for example, with the observations of Baly and Collie (Trans. Chem. Soc., 1905, 1339) on the modification of the ultra-violet absorption of benzene by the introduction of a nitro group.

In any case, our result would appear to supply the first direct experimental proof that other configurations of the separate benzene molecule may exist than the plane (Kekulé) type. For the great majority of chemists, who also recognise the merits of the Kekulé formula, or some modification of it, this will involve the acceptance of some dynamic conception, such as, for example, has been advocated by Collie and by Bloch. It will be noted that one phase of Bloch's formula corresponds closely to that deduced by Sir William Bragg from his observations on the diamond and on naphthalene and its derivatives.

It should perhaps be pointed out that the above suggestions depend for their validity on the assumption that the relationship between the isomerides is stereochemical in the ordinary sense. There is always a possibility, which, however, will perhaps be generally considered remote, that the difference may be rather one of structure, in that the two compounds contain, for example, different types of nuclei.

J. KENNER.

The University, Sheffield, April 21, 1922.

The Speed of Light.

IN a discussion in NATURE last year (March 10, vol. 107, p. 42) Majorana's experiment was cited as direct proof that the velocity of light is independent of the motion of the source. In reality, however, there is a disadvantage in his method which seems to the writer very greatly to lessen the value of his results.

Majorana measured the wave-length of the green light from a moving mercury-vapour tube by means of a Michelson interferometer, and detected the change of wave-length that is required by the usual Doppler theory (*Phil. Mag.*, 37, p. 145, 1919). Now it is easily seen that the frequency of the waves arriving at the receiving apparatus will undergo the usual Doppler change whether the speed of propagation is altered (moderately) or not, and speed equals wave-length times frequency, hence Majorana concludes that the speed of the light from his tube was the same when the tube was moving as when it was at rest. But obviously he measured the wave-length only after the light had suffered one or two reflections or transmissions in stationary apparatus, and its velocity might easily have been altered by these processes. Any conclusion from his results must therefore rest, at best, upon very indirect reasoning.

We may freely admit that a satisfactory emission theory consistent with all the facts that are known to-day, including Majorana's result, would be difficult to construct. Yet it does seem regrettable that we have still no simple direct proof of the second postulate of Relativity.

U. 2.

Perhaps the simplest way to test the postulate directly would be to observe the Doppler effect with a concave reflecting grating so set as to form the image on the normal to the surface of the grating (cf. Tolman, *Phys. Rev.*, 35, p. 136, 1912); the retardation then occurs entirely before reflection, and it is the wave-length of incident light which is measured by the deviation. Any uncertainty as to the relative speed of the reflected rays can be removed by making the line of motion of the source pass through the centre of the grating, and then observing the effect of the motion upon the position of the central image when the grating is turned so as to bring this image into the position formerly occupied by the diffracted one. In these circumstances, for reasons of symmetry the speed of the incident waves along two rays equally inclined to the direction of motion must be the same; if it then turns out that the position of the central image is unaffected by the motion, it will follow that the speed must likewise be the same along the two corresponding reflected rays. This conclusion will hold also for the two diffracted rays which take these paths in the main experiment.

E. H. KENNARD.
Department of Physics, Cornell University.

On the N-Series in X-Ray Spectra.

WITH the new and very powerful X-ray-spectroscopic outfit constructed by Prof. M. Siegbahn (described in *Comptes rendus*, 1921, p. 1350) I have endeavoured to find a weaker group of lines in the X-ray region than the lines previously known as M-group. I have been able to find some lines which most probably must be referred to the N-series of the elements uranium and thorium. Hitherto, the measured wave-lengths for these lines lie for uranium between 8·6-12·0 A.U. and for thorium between 9·4-13·5 A.U.

From the theoretical and experimental work done by Coster and others, we are able to estimate the wave-lengths of the lines in the N-series. For the elements uranium and thorium we really find that some of these lines must have wave-lengths of about the measured value. For bismuth, however, and the elements in its neighbourhood, all the N-lines must have a wave-length of more than 13 A.U. so that in the present state of spectroscopy it will be very difficult to measure the wave-lengths for these elements.

I am continuing these researches.

V. DOLEJŠEK.
Physical Laboratory, The University,
Lund, March 31.

A Proposed Laboratory Test of the Theory of Relativity.

WITH the present interest so strong in devising experiments to test the theory of relativity, it may not be amiss to suggest the possibility of yet another method. According to recent hypotheses, it seems that the stars are the factories producing complex elements from simpler structures. Inside the stars, hydrogen atoms may unite to form helium, and with hydrogen and helium as intermediates, the more complicated atoms may be built. As pointed out by Harkins, Eddington, Perrin, and others, the synthesis of an atom of helium from four hydrogen atoms necessitates the loss of 0·774 per cent. of the mass of the hydrogen atoms. Since we cannot conceive of mass being annihilated, the only obvious solution is to say that mass is electromagnetic in origin and that, in the helium nucleus, the four protons are brought so near to the two electrons that their fields overlap and neutralise each other to some extent, accompanied by a loss of mass. According to the theory of relativity, 1 gram of matter is equivalent to 9×10^{20} ergs or $2 \cdot 1 \times 10^{13}$ calories. Both Harkins and Perrin have calculated the amount of heat that must be produced by the transformation of four gram atoms of hydrogen into one gram atom of helium. It has the enormous value of $0 \cdot 0078 \times 2 \cdot 1 \times 10^{13}$ or $1 \cdot 6 \times 10^{11}$ calories.

It may be possible for several helium nuclei to unite to form heavier nuclei, such as oxygen for example, without such a great evolution of heat. More accurate determinations of the atomic weights of the so-called "pure" elements would be necessary before we could say much concerning the energy relations in such sub-atomic reactions.

When the nuclei become so large that they are unstable, then the process of synthesis in the stars would stop. But there might be an over-shooting of the mark. With the enormous amount of energy free in the interior of the stars, some of this energy might be absorbed, according to the theorem of Le Chatelier, in the formation of nuclei which would be unstable in an environment not containing so much energy. Energy would be considered as one of the terms in a mass law equation, to use a well-known chemical analogy. The result would be the radioactive elements—uranium, thorium, etc.

Now let us calculate with the aid of the above equation, derived from the theory of relativity, the effect on the mass of a radioactive substance that would be caused by this addition of energy. Rutherford, in his book "Radioactive Substances and their Radiations," p. 582, states that 1 gram of radium in disintegrating to lead gives off $3 \cdot 7 \times 10^9$ calories. If 1 gram of mass $= 9 \times 10^{20}$ ergs $= 2 \cdot 1 \times 10^{13}$ calories, then 1 gram of radium in disintegrating to lead would give off 0·00017 gram and 1 gram atom of radium, 0·038 gram in the form of energy. If the atomic weight of RaG (radium-lead) is taken as 206 exactly, then the atomic weight of its parent, radium, may be calculated as follows:

1 gram atom of RaG	206·000	grams
5 gram atoms of He	20·000	,,
4 gram electrons	0·0005	,,
$3 \cdot 7 \times 10^9$ calories	0·038	,,
	226·038	,,

Therefore the atomic weight of radium should be 226·038. Calculations of this type for radioactive substances have been made by Harkins, but he does not state that they may be applied as a test of the theory of relativity.

This calculation involves six assumptions: (1) that the weight of one gram atom of RaG is 206·000, (2) that the atomic weight of He is 4·000, (3) that the weight of 4 gram electrons does not exceed 0·0005 by any great extent when incorporated in the nucleus of Ra, (4) that the amount of energy given off in the disintegration of Ra is substantially that calculated by Rutherford (a 20 per cent. decrease in the value given by him would not change the value for energy in grams in the second decimal place), (5) that the relativity equation connecting mass and energy holds, and (6) that the energy given off in radioactive disintegrations is derived from the atoms themselves and not photochemically from Perrin's hypothetical radiations of extremely short wave lengths. In trying to verify the results of such an equation, there are two more assumptions necessary: that the atomic weights of RaG and of Ra are determined for the pure substances, that there are no contaminating isotopes.

The lowest atomic weights of RaG that have been obtained are those of Richards and Hönigschmid, and are 206·08 and 206·05 respectively. These may be a little high due to admixture of other isotopes of lead. The best value for the atomic weight of radium is 225·97 by Hönigschmid, but the difficulties due to incomplete purification and small quantities of material worked with probably make this value less accurate. Nevertheless, if this figure for radium is accepted provisionally, one must conclude that either radium-lead (RaG) has an atomic weight less than the whole number 206, or that the energy is derived from outside sources as suggested by Perrin, or that the equation connecting mass and energy is not correct.

Now I will suggest a more exact method of testing experimentally the above calculation of the atomic weight of Ra. It is evident that the chemical determinations of the atomic weights of Ra and RaG cannot be made with sufficient accuracy due to difficulties inherent in such determinations and to the probable presence of isotopes in the samples used. When the method of positive ray analysis is extended so that it is accurate to 1 part in 10,000, then we would have a method of determining the masses of Ra, RaG, and He with sufficient accuracy. This refinement does not seem utterly impossible. Though the method is relatively in its infancy, yet Aston claims in the case of helium an accuracy of 2 or 3 parts in 1000. By the positive ray analysis all difficulty with contaminating isotopes in the case of RaG and Ra would vanish. The calculated atomic weight of Ra could be checked by data thus obtained, and the conclusions ought to show whether the relation of mass and energy based on the theory of relativity holds. In any case, the results would be valuable.

HAROLD S. KING.
Wolcott Gibbs Memorial Laboratory of Harvard University,
Cambridge, Mass., U.S.A., March 13.

Safeguarding of Industries Act, 1921.

FROM time to time complaints have been made in NATURE and received at the offices of this Union against the operation of the Safeguarding of Industries Act, 1921. It has been asserted that the Act greatly increases the running cost of laboratories, which are still, to some extent, dependent upon other countries for supplies of scientific apparatus, laboratory ware, and fine chemicals; and this increased cost has fallen upon research and teaching institutions at a time when the Government is restricting grants.

In consequence of the complaints received, this Union approached the British Medical Association, and a joint committee of the two organisations was formed, with the view of exploring the ground, and making representations in the proper quarters. If sufficient information is forthcoming, it is the intention of these two associations to arrange for a deputation to wait upon the Rt. Hon. H. A. L. Fisher, Minister of Education, following upon the suggestion made by Viscount Peel in the House of Lords on November 10 last. It is intended that this deputation should be representative of all scientific and educational bodies, and we are already assured of the support of some of them.

A letter has been addressed to the Deans of the Faculties of Science and Medicine of all British Universities and University Colleges, to Deans of Medical Schools, to Principals of Technical and Agricultural Colleges, and to the Institutes of Physics and Chemistry, and the various teachers' associations. This has asked for information under the five following headings:—

"1. The difficulties experienced by members of your" [University, society, etc.] "in obtaining British materials and laboratory ware of the requisite quality and quantity.

"2. The difficulties experienced in obtaining British scientific instruments.

"3. Detailed particulars of instances where difficulties and delays have been experienced through the action of the customs authorities, in obtaining consignments from abroad. (*N.B.*—It would be well to indicate here from which countries the greater bulk of the goods are obtained.)

"4. The increase in the running costs of laboratories which can be directly attributed to the operation of the Act.

"5. Details of cases where researches have been hindered or had to be definitely abandoned owing to the difficulties of obtaining materials from abroad or their excessive cost in this country."

A fair number of replies has been received, though in many cases the information given is not in sufficient detail. I should be glad, therefore, if all scientific workers, including those engaged in industry, would supply me with detailed information under these five headings at the first opportunity.

A. G. CHURCH,
General Secretary.
National Union of Scientific Workers,
25 Victoria Street, Westminster,
London, S.W.1.

Discovery of Gold in Devonshire.

I HAD occasion recently to conduct a party of my students from King's College, London, over the Devonian rocks in the neighbourhood of Torquay, Devon, and had the good fortune to discover an interesting occurrence of gold in the fault-rock of a small fault cutting the limestones near Hope's Nose. As it may prove of some interest, I take the opportunity of recording the find in the columns of NATURE.

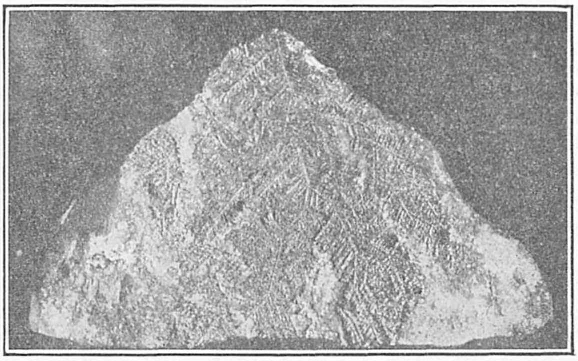

FIG. 1.—Dendritic gold in Devonian limestone. (×3.)

The fault-rock is a limestone-breccia cemented by crystalline calcite, through which the gold is distributed in a dendritic fashion, as indicated in the accompanying figure (Fig 1). It is premature to dogmatise on the possible commercial value of the gold, since time did not permit of a thorough examination of the locality, and a former find at Daddy's Hole proved too poor to work, but it is intended to proceed further with the matter in case it may prove worth exploitation.

W. T. GORDON.

Artificial Disintegration of the Elements.[1]

By SIR ERNEST RUTHERFORD, F.R.S.

SINCE the development of the atomic theory on an experimental foundation by Dalton, the progress of chemistry has been based on the central idea of the permanency and indivisibility of the atoms of the elements. The whole experience of chemistry for nearly a century had shown clearly that it was impossible to break up the atoms of the elements by the application of ordinary chemical and physical processes. This idea has had to be modified to some extent by the rapid growth of our knowledge during the last twenty years of the inner constitution of the atoms.

It is now generally accepted that the atoms of the different elements have all the same general type of structure. At the centre of the atom is a positively charged nucleus of minute dimensions which is responsible for most of the mass of the atom. This is surrounded by a distribution of electrons held in equilibrium by the forces from the nucleus. The electrons occupy rather than fill a region the diameter of which is of the order of 2×10^{-8} cm. The nuclear charge of the atoms follows a very simple rule first clearly brought to light by Moseley. The resultant nuclear charge of an atom is equal to its atomic or ordinal number, and varies from 1 "atom" of electricity in the case of hydrogen to 92 in the case of uranium. These ordinal numbers represent also the number of "planetary" electrons, as they have been called, which surround the nucleus of the atom. On this view of the atom, its ordinary physical and chemical properties, apart from its mass, are governed entirely by the nuclear charge, for this controls the number and arrangement of the external electrons on which these combining properties mainly depend. The mass of the atom is a property of the nucleus and exercises only a second order effect on the distribution of the electrons and so on the ordinary properties of the atom.

This point of view offers at once a simple explanation of isotopes, which consist of atoms of the same nuclear charge but of different nuclear masses. By the action of light and electrical discharges, we can readily remove one or more of the external planetary electrons from the atom, while by the action of X-rays and swift β-rays we may even eject one of the more strongly bound electrons of the system. In this way, we can effect, in a sense, a transformation of the atom, but it is merely a temporary one, and a new electron is soon captured from outside, and the atom is as before. The general evidence indicates that, even if a number of the planetary electrons were removed by suitable agencies, the stability of the nucleus would not be disturbed and the atom would in a short time regain its original structure. In order to effect a *permanent* change in the atom, it appears to be necessary to disrupt the nucleus itself. When once a charged unit of the nuclear structure is removed, the nuclear charge is altered permanently, and there is no evidence that this process is reversible under ordinary experimental conditions.

The discovery of the instability of the radioactive elements was the first severe shock to the idea of the permanency of all atoms. This radiating property is, however, confined mainly to the two heaviest elements, uranium and thorium, and their long series of descendants, and is shown only by two other elements, potassium and rubidium, and then only to a minor extent. Apart from these exceptions, the great majority of the atoms appear to be exceedingly stable structures, and to remain unaltered under ordinary conditions in this earth for periods of probably thousands of millions of years.

The property of radioactivity belongs to the nucleus, and is shown generally by the emission of a swift α-particle or helium nucleus and, occasionally, a swift electron or β-ray from the nucleus. The number and velocity of emission of these particles appear to be quite uninfluenced by the most powerful physical or chemical agencies, and to be an inherent property resulting from the instability of these very complex nuclei.

These results show clearly that the nuclei of heavy atoms contain both positively charged helium nuclei and negative electrons, and lead to the general view that the complex nuclei of all atoms are built up of hydrogen and helium nuclei and electrons. It is also generally supposed that a helium nucleus itself is a secondary unit composed of four hydrogen nuclei and two electrons. If this be the case, we may suppose the nuclei of all atoms to be composed ultimately of hydrogen nuclei, or "protons," as they have been termed, with the addition of negative electrons.

Radioactivity has thus not only provided us with the key of the structure of the elements, but has at the same time given us in the swift α- and β-particles a powerful method of probing the inner structure of the atom. By firing α-particles into the atoms of matter, we are able, by following the deflexions of the path of the α-particle, to find out the magnitude and law of the forces close to the nucleus and to form some idea of the dimensions of the latter. The general results suggest that the diameter of the nucleus of heavy atoms is of the order of 4×10^{-12} cm. or about 1/5000 of the diameter of the whole structure of the atom. The law of the inverse square of repulsion between electric charges is found to hold for a considerable region surrounding the nucleus. No doubt the size of the nuclei of light atoms is even smaller, and in the case of helium appears to be of the order of 5×10^{-13} cm. It is thus clear that the nuclei of atoms, although of very complex structure, are of exceedingly small dimensions.

It is probable that the forces which bind together the components of the nucleus are exceedingly powerful, and that consequently a large amount of energy will be required to disrupt its structure. The swift α-particle from radium or thorium, which is by far the most concentrated source of energy known to us, seems the agent most likely to succeed in an attack on the strongly-bound nucleus. The α-particle is expelled from radium with a velocity of about ten thousand miles per second, and thus has a speed twenty thousand

[1] A Lecture delivered before the Chemical Society on February 9.

times greater than that of a swift rifle bullet. Mass for mass, its energy of motion is four hundred million times greater than that of the bullet.

Whilst no doubt an α-particle fired directly at a heavy nucleus may penetrate its structure, its energy may at that stage be too small to cause a disruption. The attack on the lighter atoms is much more promising, for the repulsive forces are so much smaller that the α-particle may still retain much of its energy on entering the nuclear structure.

Before, however, considering experiments on this question, it is desirable to say a few words on the collision of α-particles with hydrogen nuclei, where no question arises of the disruption of the atom. When α-particles pass through hydrogen gas, there are occasional close collisions between the α-particles and the hydrogen nuclei, resulting in the appearance of high speed H-nuclei. These H-particles travel about four times the distance of the bombarding α-particle, and can be detected easily by the scintillations they produce on a zinc sulphide screen. From the ordinary principles of mechanics, the maximum speed given to an H-nucleus is 1·6 times that of the colliding α-particle, whilst the maximum energy communicated to it is 0·64 of the energy of the α-particle. It is found that the number of these swift H-atoms is far in excess of that to be expected if it be supposed that the α-particle and hydrogen nucleus behave as point charges for the very small distances involved in these violent collisions. In addition, the variation of the number with the velocity of the α-particle and the number shot off at different angles with the direction of the α-particle differ markedly from the results to be expected on the simple point theory.

It seems clear that not only has the α-particle a structure, but that the law of force at very short distances is entirely different from that of the inverse square. As a result of a careful investigation, Chadwick and Bieler concluded recently that the results of the collisions could be explained by supposing that the α-particle—to which the complexity is ascribed—behaves like a spheroid of axes 8×10^{-13} and 5×10^{-13} cm. Outside this surface, the law of the inverse square applies, but the forces increase so rapidly when the H-nucleus enters the spheroidal surface that it is rapidly turned back. This model of the helium nucleus is, no doubt, quite artificial, but it gives us some idea of its probable dimensions and the extent of the region in which new and powerful forces come into play.

We should consequently anticipate that, in a close collision of a swift α-particle with the nucleus of an atom more complex than that of hydrogen, the ordinary laws of force would break down when the distances separating the particle and nucleus became very small. It must be remembered that gigantic forces come into play in these nuclear collisions, and only very stable structures may be expected to survive the encounters.

The first observation which has to do with the main subject of my lecture was made some years ago. When the α-rays from a strong radioactive source pass through dry gases like oxygen or carbon dioxide, a small number of weak scintillations are observed on a screen beyond the range of the α-particles. These "natural" scintillations are believed to be due to atoms of hydrogen coming from the source, and probably result from a slight hydrogen contamination of the source during exposure to the radium emanation. If, however, dry air is substituted for oxygen or carbon dioxide, the number of scintillations is increased three or four times. This additional effect was found to be due to the presence of nitrogen, and was shown in a correspondingly greater degree by chemically prepared nitrogen. By suitable arrangements, it was found that the particles causing these scintillations were bent by a magnetic field to about the extent to be expected if they consisted of swift, charged H-atoms. It seemed probable from the beginning that these additional H-atoms, which appeared only in dry nitrogen and not in oxygen or carbon dioxide, must have their origin in a disintegration of the nitrogen nucleus by collision with a swift α-particle.

With the original counting arrangements, the scintillations were small in number, weak in intensity, and difficult to count with accuracy. Further progress has depended mainly on improvements in the counting microscope, with the object of increasing the intensity of the scintillations and the area of zinc sulphide screen under observation. By the use of wide-aperture objectives and special eyepiece lenses of low magnifying power, the counting of these scintillations has become much easier and more definite.

We shall now consider the methods adopted to investigate in more detail the effects observed in nitrogen and to test whether other elements behave in a similar way. The apparatus required is of the simplest character and consists merely of a brass tube, 3 cm. in diameter, provided with stopcocks by means of which dry gases may be circulated through it. At one end of the tube is a hole covered with a thin silver plate. The zinc sulphide screen is fixed 1·3 mm. away from the opening, leaving a slit in which absorbing screens of mica can be inserted. The radioactive source is fitted on the end of a rod so that its distances from the screen can be varied at will. In order to reduce the luminosity due to the β-rays from the source, the whole apparatus is placed in a strong magnetic field. It may be of interest to give a few details in illustration of the magnitude of the effects to be expected under different conditions. Suppose that the radioactive source, consisting of a brass disk coated on one side with an invisible layer of radium-*C* corresponding in γ-ray activity to 40 milligrams of radium, is placed 3·5 cm. from the screen and that a current of dry hydrogen is passed through the apparatus. Suppose the stopping power of the materials between the source and the zinc sulphide screen corresponds to 20 cm. of air, that is, it would suffice to stop an α-particle of range 20 cm. in air. The passage of the α-particles, which in this case have a range of 7 cm., through the hydrogen liberates a large number of high-speed H-atoms, which produce scintillations on the screen. Their number, seen through a special microscope which has a field of view of 40 sq. mm., is so great—thousands a minute—that it would be impossible to count them without reducing the activity of the source. As additional absorbing screens of mica are added, the numbers fall off rapidly, and for an absorption of, say, 30 cm. not a single H-scintillation can be observed per minute. A similar effect is shown if oxygen is substituted for hydrogen and a thin strip of paraffin wax or other hydrogen material is placed over the source. The number of H-scintillations observed for a given absorption depends only on the amount of hydrogen, and is quite independent of chemical combination. This is to be expected, for the forces required to set the H-nucleus in rapid motion are enormous compared with the weak forces involved in chemical combination. We thus conclude that, for α-particles of range 7 cm., no H-atoms from hydrogen in the free state or in chemical combination can be detected for an absorption greater than 30 cm. of air.

The oxygen which gives no scintillations is now replaced by dry air. At once we observe for an absorption of 30 cm. more than 100 scintillations per minute when for hydrogen we did not observe one. By adding mica screens we find that the scintillations cease for an absorption of 40 cm. It is clear that these particles, which come from nitrogen, have a greater range than free H-atoms bombarded by α-rays, so that the effect observed beyond 30 cm. cannot be ascribed to any hydrogen impurity in the nitrogen.

The air is now replaced by neutral oxygen, and thin foils of say copper, iron, silver, gold of stopping power corresponding to about 3 cm. of air are placed successively over the source. Not a single H-atom can be observed for an absorption of 30 cm. A piece of aluminium foil is substituted and at once the number of scintillations jumps to more than 100 per minute. Some of the scintillations are very bright, and we find that some of the particles are so swift that the absorption must be increased to 90 cm. before the scintillations vanish. It is clear that aluminium must give rise to a number of very long-range particles.

Thus if we examine the number of scintillations beyond the range of ordinary H-atoms, we are quite independent of any possible contamination of hydrogen in the material under examination. This is a great advantage, for we need not concern ourselves about the purity of the material as regards hydrogen. In this way, Dr. Chadwick and I have examined a large number of elements to test whether they emit particles of range more than 32 cm. When the element was not available, a compound of the element with an "inactive" element like oxygen was used. The material in the form of a fine powder is dusted on a thin gold foil, an adhesive film being used so that the average absorption of the material corresponded with 3-4 cm. of air, and was then exposed to the source of rays. With the exception of helium, neon and argon, all the elements up to atomic weight 40 have been tested. No element of atomic weight greater than phosphorus, 31, was found to give any effect, although it should be said that only a few of the elements of higher atomic weight have so far been examined.

A list of the elements examined in this way, from lithium to sulphur inclusive, is given in the following table. The second column gives the number of scintillations per minute per milligram activity of the source, namely, radium-*C*, for an absorption of 32 cm. of air. These numbers afford only a rough comparison of the effects given by different elements, for the conditions of the experiment, for example, the thickness and distribution of the film of material, varied from element to element. The fourth column gives the approximate range of the particles.

Element.	Material.	No. of particles per min. per mg. for the microscope used.	Maximum range of particles in cm. of air.
Lithium	Li_2O	—	—
Glucinum	GlO	—	—
Boron	B	0·15	*ca.* 45
Carbon	CO_2	—	—
Nitrogen	Air	0·7	40
Oxygen	O_2	—	—
Fluorine	CaF_2	0·4	over 40
Sodium	Na_2O	0·2	*ca.* 42
Magnesium	MgO	—	—
Aluminium	Al, Al_2O_3	1·1	90
Silicon	Si	—	—
Phosphorus	P (red)	0·7	*ca.* 65
Sulphur	S, SO_2	—	—

In addition to these, the following elements of higher atomic weight were examined: chlorine as $MgCl_2$; potassium as KCl; calcium as CaO; titanium as Ti_2O_3; manganese as MnO_2; iron, copper, tin, silver, and gold in the form of metal foils. In no case were any particles observed of range greater than 32 cm. of air. The question whether any of these elements give particles of range less than 32 cm. has not been examined.

It will be seen that the elements which give scintillations for an absorption of 32 cm. are boron, nitrogen, fluorine, sodium, aluminium, and phosphorus. The numbers for boron and sodium were distinctly less than for the other elements.

(*To be continued.*)

The Royal Academy.

THE representative of NATURE looking for points of scientific interest amongst the fourteen hundred or so annual exhibits at the Royal Academy may be excused if he sometimes feels depressed and is reminded of the proverbial searcher after a needle in a haystack, in so few of the pictures do objects having any direct connection with science appear. It has in past years been remarked that purely scientific work does not yet appeal to the Academy artist, and it is necessary to turn for points of interest to nature scenes such as may be found in pictures of sea, sky, snow, and country life.

In snow scenes J. Farquharson frequently has successful effects and "The Edge of the Forest" (239) this year is quite up to his standard. Another good snow effect, in this case associated with water, is contained in "A Yorkshire Bridge in Winter," by F. E. Horne (884). A successful landscape somewhat of the Leader type, the central feature of which is a group of pine trees, is shown by Frank Walton in 591. It is a pity that there is only this one example of his work in the exhibition. The title which A. J. Munnings has chosen for No. 111 does not lead one to expect a landscape, but the setting of the portraits which give the name to the picture is a wide expanse of country with distant blue hills in the background showing delightful lights and shades. The effect is spoilt rather than improved by the somewhat wooden sitters so obviously posing in the foreground.

Turning to agricultural scenes, the two ploughs seem out of place alongside the rick in "Farm Lands in Sussex" (459) while hay still lies in the field uncarted. Again in "Harrowing" (827) the crop seems to consist of heather, surely a somewhat unusual occupation.

In "A Summer Gale" (610) R. G. Brundrit has quite failed to convey the impression of a gale, ordinary cumulo-nimbus which might be associated with a shower being all that is indicated in the picture. The idea of a gale is introduced more effectively in Sir Arthur Cope's "An Evening in October" (750), though wind is not mentioned in this case. A very direct reference to the work of the Meteorological Office is made in "The South Cone" (250), though it is not indicated which of the two hundred gale warning stations round the British coasts is referred to. The warning seems to have been successful, judging from the flag at the masthead and the spray dashing against the shore, but the sea in the foreground, curiously enough, is scarcely rippled. The reference to a forecast in the title of 175, "A Hopeful Forecast," suggests further possibilities of reference to the work of the Meteorological Office, such as a forecaster studying the movements of Bjerknes' Polar Front, or plotting ships' observations received by wireless telegraphy from the Atlantic and deducing the probability of a week of fine weather. But any such expectations are destined to be disappointed, since what the picture reveals is a young lady with golf clubs tapping an old dial type of barometer, the hand of which is hard over in the "Set Fair" position.

Rain falling at a slant owing to the difference in velocity of upper and lower wind currents is a common sight, but Norman Wilkinson has shown the increase of wind aloft in a striking manner through the agency of falling rain in his picture of the King's yacht *Britannia* racing in a squall (395). The wind is blowing across the picture from left to right and making the yacht heel over until the mainsail is awash, while in a shower near by the rain slants backwards as it falls through air of diminishing velocity. One is almost tempted to commence calculating the rate of change of velocity with altitude.

An optical phenomenon figures prominently in "The Charcoal Burner's Hut" (632), where bright coloured rings surround the moon at a radius which is too small for a halo, while of unusual size for a corona; but such varied optical forms have been seen in the sky from time to time that it is unwise to dogmatise upon the unreality of this representation.

Adrian Stokes' "Sunset" (188) is suggestive of a sun pillar in the bright vertical extension above the sun, though it is improbable that a real sun pillar was the source of his inspiration. The moonlit scene in 80, "The Dead of the Night," is curious from the whiteness of the tower and wall in the moonlight and yet the absence of shadows where these would be expected under the trees.

Much interest naturally attaches to W. L. Wyllie's picture of the towing of the old *Victory* into her resting-place in dry dock. The execution of the water in Portsmouth Harbour is so good that the frame at the lower edge of the picture causes quite a shock, the eye being deceived by the reality of the representation. J. Olsson has a pleasant sea and island scene in the Scillies (42), which gains greatly over some former works by restraint in the use of brilliant colouring.

This year's exhibition is conspicuous for the number of portraits it contains, these forming a more than usually high proportion of the whole. It is gratifying to notice in a place of honour in one of the principal galleries, and adjacent to a painting of the Royal Wedding, a portrait of Sir Charles Parsons by Sir W. Orpen. Men of science are not numerously represented, and careful search was needed to disclose a tablet of Sir William Ramsay destined for Westminster Abbey and a silver medallion of Prof. James Thomson for Belfast University.

J. S. D.

Obituary.

SIR PATRICK MANSON, G.C.M.G., F.R.S.

THE death of Sir Patrick Manson, which occurred in London on April 9, has taken from the medical profession one of its most distinguished leaders. Born in 1844, and educated at his native University of Aberdeen, Manson decided to follow his calling in the Far East, and in 1866 went to Formosa, whence in 1871 he moved to China, where he continued during eighteen years. From the very beginning of his career Manson made the causation of disease his study. He was naturally interested in the elephantiasis so prevalent around him, but it was not until 1874, when he came home to marry a wife, that he learned fully of Lewis's discovery of a microscopic filaria (now known as *Microfilaria bancrofti*) in the blood of Indian sufferers from the chyluria often associated with that disease.

On his return to China he settled down to the study of "elephantoid" pathology, and began with a survey of the blood of a thousand Chinamen. Having satisfied himself that the microfilariæ found in the blood are the issue of parent filariæ locked up in the lymphatics of the host—a discovery in which, however, he was anticipated by Bancroft of Brisbane—and that they are embryos incapable of any further development in the blood, he saw that the series of events by which the microfilariæ living in the blood of one man became the adult filariæ living in the lymphatics of other men must take place in the outside world, and might possibly be initiated by some such free-ranging, blood-sucking insect as a mosquito. His selection of the mosquito was decided by his further discovery that the microfilariæ make their show in the cutaneous blood of their host only after sunset, when mosquitoes are active; in the daytime they flock to the host's lungs and central blood-vessels. In 1877, with the compliance of an infected Chinaman, he put his theory to the proof and found that it corresponded with fact: the microfilariæ were sucked into the stomach of his mosquitoes, and some of them migrated into the insects' tissues and there underwent definite changes of growth and development, and were thus set on their course, *via* the infected mosquito, for infecting other human beings.

It must be borne in mind that Manson was a busy medical practitioner working, far off and alone, as he could find time, and without particular appliances. It is not surprising, therefore, that he did not follow the exact course taken by infected mosquitoes in transferring their infection to man. He was content to have demonstrated the essential realities of a great original conception, and to have established the great pathogenetic discovery—so pregnant with further possibilities of knowledge, so abundant in its practical applications to human welfare—that a common blood-sucking insect is *the essential factor* in the maintenance and dissemination of a widely-diffused parasitic disease.

In 1894, when he had left China, Manson found his opportunity of applying this great principle to the problem of malarial infection. He had followed all the work that had been done on the parasites of malaria since their discovery by Laveran in 1880, and he had come to the conclusion that the secret lay in the motile filaments extruded from forms of the parasite now known to be male gametocytes. Other observers regarded these filaments as degenerations: Manson interpreted them in the light of his filaria observations. He argued that as the forms that produce them are so persistent and resistant, the filaments must have some vital meaning; that since they are not produced until the blood has been shed, their destiny lies in the outside world; and that since they cannot get out spontaneously, they possibly are extracted and nursed—like the microfilariæ—by mosquitoes. This is Manson's mosquito-malaria theory, that inspired and guided Ross in his wonderful discovery of the sexual cycle of the malaria parasite and final solution of the problem of malarial infection. The theory has sometimes been referred to as if it were one of the several ingenious speculations that have attributed the spread of malarial fevers to mosquitoes: quite otherwise; it stands apart as a closely-reasoned working hypothesis based on known facts in the history of the malaria parasite and legitimate inferences from the history of *Filaria bancrofti*. Ross, writing with all the combined authority of an historian and a malariologist, says of it (NATURE, vol. 61, 1900, p. 523): "Manson's theory was what I have called it—an *induction*—a chain of reasoning from which it was impossible to escape. . . . I have no hesitation in saying that it was Manson's theory, and no other, which actually solved the problem; and, to be frank, I am equally certain that but for Manson's theory the problem would have remained unsolved at the present day."

Manson had retired from China in 1890 and settled in London. In 1894 he joined the staff of the Seamen's Hospital, and in 1897 was appointed Medical Adviser to the Colonial Office. He was now able to realise his lifelong dream of a school in London where medical men going to the tropics could acquire all the necessary craftsmanship that he himself had yearned after in his early days in China. In this design he happily obtained the countenance of Joseph Chamberlain and the co-operation of the Seamen's Hospital Society, and in 1899 the London School of Tropical Medicine was established under him at the Albert Dock. Here, until his retirement from all active practice in 1913, he radiated rather than imparted wisdom and inspiration to many hundreds of his younger professional brethren; and here, under his sage and benign influence, there grew up a sort of Mansonian tradition that for useful work in the tropics a medical man, though always a clinician at heart and a sanitarian in his general outlook, must be a biologist in his attitude to pathology and ætiology.

Manson's place in the history of medicine can be estimated only when we consider how much of what for convenience we speak of as "tropical disease" is due to animal and animalcule parasites, and to what extent those parasites are fostered and diffused by blood-sucking arthropoda. Men before Manson had speculated on the pathogenetic possibilities—or even probabilities—of predaceous insects, but no man before him had followed—or gone near following—a specific pathogenic organism into a specific predaceous arthropod and discovered what happened to it there. "The light of humane minds," says Hobbes, "is perspicuous words, by exact definition snuffed and purged from ambiguity": it is Manson's pre-eminent distinction to have been the first to discover a connected series of facts and to have recorded them in exact definitions purged and snuffed from ambiguity—which is the acquisition of science. With Manson's high achievements as an original investigator and a teacher we have to consider also his extraordinary influence as a most prescient clinician—and a clinician who never forgot the comfort of his patients: in all this, as in his large humanity and his benevolent attitude to his fellow-workers, he worthily upheld the ideal of Hippocrates; and I have often thought that, as the Father of Tropical Medicine, his name may, perhaps, have the same lasting fragrance as that of his immortal archetype.

A. A.

SIR A. B. KEMPE, F.R.S.

SIR ALFRED BRAY KEMPE, whose death occurred on April 21, was born in 1849, and educated at St. Paul's School and at Cambridge, where he was twenty-second Wrangler. His first contribution to the science of mathematics was in 1876, when, in a paper on a general method of describing curves of the *n*th degree by link-work, he laid the foundation of the excellent discoveries he was destined to make in "linkages"—a subject in which he took a lifelong interest. In 1877 he gave his well-known lecture, "How to draw a straight line," in which he traced the history of the connection between the straight line and linkages from the partially successful attempts of Watt, Richard Roberts, and Tchebicheff, to the practical solution of the problem by Peaucellier in 1864. Together with Hart of Woolwich Academy and Sylvester he had added much to the knowledge of the subject, and these additions he described with models.

A paper on conjugate 4-piece linkages followed in 1878, and some smaller papers, but Kempe's principal contributions appeared in the years 1885–86. The "Memoir on the Theory of Mathematical Form" is a first-rate piece of work. Its avowed object is to separate the necessary matter of exact or mathematical thought from the accidental clothing—geometrical, algebraical, logical, etc.—in which it is usually presented for consideration, and to indicate wherein consists the infinite variety which that necessary matter exhibits. This long and thoughtful research shows that as a thinker Kempe perhaps resembled W. K. Clifford more than any one else has done in the world of science. This indeed was recognised by Spottiswoode, who, coming into possession of "Mathematical Fragments" which had been reproduced in facsimile from the papers left by Clifford, decided to send them to Kempe. He dealt with them, and finding inspiration in the graph theory which they contained he wrote a very valuable and suggestive paper upon the "Application of Clifford's graphs to ordinary binary quantics." Clifford had not at the time of his death succeeded in effecting this, and it required a man like Kempe who was well versed in the rapidly growing theory of invariants to accomplish it.

In 1894–96 Kempe was president of the London Mathematical Society. In his valedictory address he dealt in a thoughtful and learned manner with the question of defining the subject matter of mathematical science. He finally suggests the statement, "Mathematics is the science by which we investigate the characteristics of any subject matter of thought which are due to the conception that it consists of a number of differing and non-differing individuals and pluralities." Here we can trace the influence of his studies of mathematical form. He always tried to behold the objects of his thoughts in their lowest terms freed so far as possible from all extraneous matter, and it is greatly to be regretted that, shortly after vacating the chair, he became so busy with the duties thrown upon him by his acceptance of the position of chancellor to several dioceses that his direct contributions to science, from which much might have accrued, came to an end.

Indirectly, however, Kempe was for the remaining years of the greatest service to science. Those which he rendered to the Royal Society as treasurer have been described elsewhere. It must be added that from that position he was *ex officio* treasurer of the National Physical Laboratory from its foundation until April 1918, and he was able to do much for that great institution and for its director and executive committee. He never failed to attend particularly the finance committee, and was always fully informed as to the details of finance. His help and advice, often sought, was given ungrudgingly, and it may be said that it was owing largely to him that the funds necessary for maintaining and developing the laboratories were obtained. In the scientific life of the country he took a notable position. He was universally popular and respected.

P. A. M.

SIR WM. PHIPSON BEALE, BART., K.C.

SIR WILLIAM BEALE died at Dorking while on a visit to friends, on Thursday April 13, at the ripe age of eighty-two, in full possession of his faculties. His remains were cremated at Golders-green on April 19; a service in his memory was held in Lincoln's Inn Chapel on April 26. His qualities had endeared him to a wide circle of intimates, in scientific, legal and political society, by whom his loss will be deeply mourned.

Beale's early training was that of a chemist, the intention being that he should enter an ironworks at Rotherham in which his family was interested. He made a beginning in the laboratory of Mr. Hill, a well-known consulting chemist in Birmingham; he then studied in Heidelberg and Freiberg, finally in Paris. At Heidelberg he was brought into contact with a number of chemists who afterwards became well-known—Matthiesen, Mond, Roscoe, Russell and others.

After but a short stay in the ironworks, Beale turned his attention to the law as offering better prospects; he entered Lincoln's Inn in 1867. Throughout his life, however, he retained his scientific interests and long acted as honorary legal adviser to the Chemical Society. He was one of the most popular and active members of the now defunct B club, a club of chemists whose doings have been chronicled by Dr. A. Scott in one of his Presidential addresses to the Chemical Society. At Freiberg Beale became interested in mineralogy and crystallography. When, in later years, the subject was developed and he desired to modernise his knowledge, I was able to hand him over to William Pope, then active as demonstrator of crystallography in my department at the Central Technical College; they contracted a firm friendship. Later on Beale even wrote a treatise on the subject, in which he put forward an original graphic method of presenting the facts of crystal symmetry. He was many years Treasurer and finally President of the Mineralogical Society. He also took an active interest in the Royal Institution.

Beale entered Parliament, after several ineffective attempts at Birmingham, as Liberal member for South Ayrshire, in 1906, retaining his seat until he resigned in 1918. He enjoyed a high reputation in legal and political circles, on account of the breadth and accuracy of his knowledge and his wonderfully balanced sane judgment. Of late years he spent much of his time, always surrounded by friends, at his Scotch home, near Barrhill in Ayrshire, most beautifully placed on an open grouse moor in sight of the Galloway Cauldron, Merrick, the highest peak in South Scotland, being a prominent feature in the view. Geikie's "The Ancient Volcanoes of Great Britain" was not infrequently taken down from his shelves.

H. E. A.

SIR A. P. GOULD.

SIR ALFRED PEARCE GOULD, whose death at the age of seventy years we announced last week, had been a member of the honorary staff of the Middlesex Hospital since 1882, and was a consulting surgeon at the time of his death. He was a Fellow of the Royal College of Surgeons and a Master of Surgery at the University of London, of which he was Dean of the Faculty of Medicine 1912–16, and Vice-Chancellor 1916–17. His publications include the "Elements of Surgical Diagnosis," which went into five editions, and the Bradshaw Lecture on Cancer (1910). He was joint author of the "International Text-Book of Surgery." Though a surgeon of wide interests, Sir A. P. Gould devoted much work to the study of the clinical treatment of cancer, and was early in recognising the valuable adjuncts which X-rays and radium were to prove in the treatment of malignant disease. At the Middlesex Hospital he acted for a number of years as chairman of the Cancer Investigation Committee, and thus held a watching brief for any new remedial agent likely to prove of benefit in the treatment of cancer. He was an excellent teacher and did not spare himself in the many services which he was asked to undertake. He was at some time president of the clinical section of the Royal Society of Medicine, of the Medical Society of London, and of the Röntgen Society. Throughout the period of the war he acted as Officer-in-Charge of the Surgical Division of the 3rd London General Hospital at Wandsworth.

Current Topics and Events.

Dr. E. H. Griffiths, the General Treasurer of the British Association, informs us that Sir Charles Parsons has conveyed to the Trustees of the Association a gift of ten thousand pounds 5 per cent. War Loan Stock, which he has placed unreservedly at the disposal of the Council. This generous gift comes at a very opportune time, as the finances of the Association have suffered depletion during the past seven years, and there was a danger that the activities of an association which has rendered such notable services to science in the past might suffer restriction. It is interesting to note that the total sum granted in aid of research by the Association, since its foundation in 1831, exceeds 83,000*l*.

The Mount Everest Expedition, with the exception of Messrs. Finch and Crawford, who are delayed by the transport of the oxygen apparatus, arrived at Khampa Dzong on April 11. General Bruce's despatch to the *Times* describes the march from Phari Dzong. Considerable difficulty was experienced in obtaining a sufficiency of transport animals. The Tibetan authorities did their best, but owing to the earliness of the season many of the animals were in very poor condition. The expedition travelled in two divisions and found the march very trying. On the Dongka pass, where ridges of 17,000 ft. had to be crossed, low temperatures were experienced, but fortunately the blizzard experienced on the previous day had ceased. All members of the expedition are in good health, the trying experiences having affected neither the white men nor the hillmen.

The Bessemer Gold Medal of the Iron and Steel Institute for the year 1921 has been awarded to Mr. Charles Fremont, in recognition of his services in the advancement of the metallurgy of iron and steel and the technology of the testing materials. The following grants from the Andrew Carnegie Research Fund were made during the year by the council of the Institute: 100*l*. to Dr. L. Aitchison, Birmingham, for the investigation of the low apparent elastic limit in quenched and work-hardened steels, with particular reference to fatigue strength, proof stress, and constitution; 100*l*. to Prof. C. O. Bannister and Mr. A. E. Findley, Liverpool, for the investigation of the mechanical properties and heat treatment of very low carbon high chromium steels; 100*l*. to Mr. F. C. Langenberg, of Watertown Arsenal, United States, for research on impact testing; and 50*l*. to Mr. J. N. Greenwood, Sheffield, for research in optical data of steels and steel-making materials necessary for correcting temperature measurements of molten steel taken with an optical pyrometer.

The Third Hurter and Driffield Memorial lecture of the Royal Photographic Society is to be delivered at the Royal Society of Arts, at 8 o'clock, on Tuesday, May 9, by Prof. The. Svedberg, who will take as his subject "The Interpretation of Light Sensitivity in Photography."

At the annual general meeting of the Manchester Literary and Philosophical Society held on April 25, the following officers and members of council were elected:—*President*: Mr. T. A. Coward; *Vice-Presidents*: Sir Henry A. Miers, Mr. W. Henry Todd, Prof. Arthur Lapworth, and Mr. C. E. Stromeyer; *Hon. Secretaries*: Dr. H. F. Coward and Prof. T. H. Pear; *Hon. Treasurer*: Mr. R. H. Clayton; *Hon. Librarians*: Mr. C. L. Barnes and Dr. Wilfrid Robinson; *Hon. Curator*: Prof. W. W. Haldane Gee; *Members of Council*: Dr. W. M. Tattersall, Prof. F. E. Weiss, Mr. Francis Jones, Miss Laura Start, Prof. S. Chapman, Prof. W. L. Bragg, the Rev. A. L. Cortie, Mr. R. L. Taylor, and Mr. William Thomson.

A provisional programme has been issued of the annual general meeting of the Society of Chemical Industry to be held in Glasgow on July 4-11 next. On the first day of the meeting, formal business will be discussed and Dr. R. F. Ruttan will deliver his presidential address. During the morning of July 5, Prof. H. E. Armstrong will give the Messel Memorial lecture, while on the following day a novel feature will be introduced in the form of a demonstration of kinematograph films showing the manufacture of rubber, the production of sulphur, and the preparation of paper from wood. The Chemical Engineering Group of the Society will hold two sessions on July 6, at which papers on the design of ammoniacal liquor stills, tar and glycerine distillation, and the general problem of evaporation will be read. Visits to various works, among which are the Nobel Industries, Ltd., and several excursions, will occupy the remaining portions of the meeting.

At the fifth annual general meeting of the Society of Glass Technology held on April 26, Prof. W. E. S. Turner was elected president. In his presidential address entitled "The British Glass Industry: its

Development and Outlook," Prof. Turner gave an account of the growth of the British glass industry from the time of the Roman occupation onward. Speaking generally, there was a steady growth up to the year 1875, after which time the number of glass factories began to decrease and the imports of finished glassware increased. This steady decline was arrested on the outbreak of war in 1914, and during the last few months of 1914 and 1915 the industry was revived. New branches were created under the stress of war for the production of chemical glassware and for lampworking. They grew to such an extent that during the last twelve months of the war period more than two million pieces of chemical glassware were made at the furnace, and some 39 million lampblown articles and more than a million pounds of glass rod and tubing were manufactured. The output of electric lamp bulbs exceeded 43 millions, as compared with four million bulbs of pre-war years. Turning to the future, Prof. Turner acknowledged that the immediate outlook was not cheerful, but claimed that the industry was much more efficiently equipped than at any other time in its history.

WE have received a communication, dated March 23, from Mr. Y. Venkataramaiah, Calcutta, in which he states that the plastic sulphur separating in the action of concentrated nitric acid on a crystal of sodium thiosulphate, which is ordinarily yellow, becomes distinctly green if a little colloidal gold or platinum solution is added to the acid before the addition of the thiosulphate. Sometimes small blue spots are visible on the separated sulphur. Colloidal gold appears to be more effective than colloidal platinum. The sulphur dissolves in carbon disulphide forming a light greenish solution; when treated with absolute alcohol it becomes yellow. It dissolves in hot methyl salicylate, and nacreous sulphur separates on cooling.

IN a lecture delivered to the Société de Chemie Physique in February 1921, M. Edmond Bauer gave an excellent account of the present state of atomic physics, and the lecture has now been published by the society, in a pamphlet of about 50 pages entitled "La Théorie de Bohr, la Constitution de l'Atome et la Classification périodique des Éléments." It starts with the various atomic models, contrasting the rival merits of the static and the dynamic. There is then a description of the work on atomic numbers, both that originating with the X-ray work of Moseley, and that from Rutherford's theory and the work on the collisions of α-particles, and there follows a discussion of the periodic table. Next comes the photo-electric effect, and this is followed in due course by Bohr's theory. The lecture ends with a short reference to Born's work on the dynamics of crystals. It is remarkable how large a field the author has managed to cover in so small a space, and the whole is a very good sketch of the present condition of physical theory.

DR. P. D. STRACHAN, Serowe, Bechuanaland Protectorate, S. Africa, writes to us stating that in his experience it is necessary to tune the octaves of the upper register of the piano sharp in order that the notes may not sound dull and flat. Professional tuners apparently do the same, giving as their reason that it adds brilliancy to the tone. Dr. R. S. Clay informs us that tuners regularly make the upper eight or ten of a piano a trifle sharp, but there is a difference of a few vibrations only from the true frequency. He suggests that there may be a physiological explanation, or it may be due to the fact that the overtones of the upper notes of a piano are sharp and so produce a desire for corresponding sharpness in notes sounded with them. The effect would become marked with high notes, for the ratio of the restoring force due to the stiffness of the wire becomes progressively important as the length of the vibrating segment becomes shorter. In other instruments, such as the flute, in the use of which Dr. Strachan states he has had a similar experience, it is suggested that the effect may be due to variations in the pitch caused by changes in the method of blowing.

THE City Sale and Exchange, of 54 Lime Street, E.C.3, are issuing gratis and post free a catalogue of hand cameras that includes a very large number of items, and apparently every variety of pattern and price. It is gratifying to know that the prices have been very considerably reduced.

Our Astronomical Column.

TOTAL ECLIPSE OF THE SUN.—The Lick Observatory has arranged an expedition to Wallal, on the northwest coast of Western Australia, to view the total solar eclipse of September 21. The station offers uniquely favourable meteorological conditions combined with a duration of totality of 5 mins. 18 secs. Various spectroscopic observations will be undertaken, and special cameras are being constructed for investigating the Einstein displacements of the stars. The members of the expedition are Prof. and Mrs. Campbell with Drs. J. H. Moore and R. J. Trumpler (of the Lick Observatory), Prof. A. D. Ross (of the Western Australian Observatory), Dr. and Mrs. Adams (of the Wellington Observatory), and Mr. J. B. O. Hosking (of the Melbourne Observatory). The party will be the guests of the Australian Commonwealth Government during their visit. Wallal will also be occupied by a party organised by Prof. C. A. Chant of Toronto, while Australian expeditions will view the eclipse from Goodiwindi in Queensland and from the north-east corner of South Australia.

JUPITER AND HIS MARKINGS.—Mr. W. F. Denning writes that a number of interesting observations of features on Jupiter have been obtained recently by Mr. Frank Sargent at the University Observatory, Durham. The Red Spot Hollow was observed in transit across the central meridian on various dates and its longitude determined as follows: 1921, Dec. 12 = 260°·9, Dec. 22 = 259°·7, 1922, Feb. 21 = 257°·4, March 10 = 256°·0, March 31 = 256°·1, April 10 = 254°·2. These positions show a slowly decreasing longitude equivalent to a rotation period of 9 h. 55 m. 38·4 s. This is a decidedly lower rate than the spot exhibited about four years ago when the period was 9 h. 55 m. 34 s. The south tropical disturbance, which is now about 140° long, was central on April 6 in longitude 46° so that it follows the Red Spot Hollow by about 152°. Its rate of rotation during the present year has been about 9 h. 55 m. 32 s. or 6 seconds less than that of the Red Spot Hollow. In 1901 the difference of rotational velocity in the two objects amounted to 22s. but since that time the motions have been gradually approaching uniformity and may possibly in a few years become identical. Mr. Sargent has recently discovered a somewhat abnormal dark marking on the northern edge of the southern equatorial belt, and finds its rotation period to be 9 h. 51 m. 6 s. from 27 rotations performed from March 31 to April 11. He is continuing to follow this and other interesting features with his 10½-inch reflecting telescope.

OBSERVATIONS OF VENUS.—*Pop. Ast.* of March contains a study of this planet by Mr. Alfred Rordame. He has observed it regularly for 20 years with apertures between 4 and 16 inches. In 1921 he took several photographs during daylight with a 9-inch Alvan Clark refractor. Some of these are reproduced, and show some indubitable spots, which are confirmed on more than one negative. Naturally the chief interest concerns the rotation period. He notes that at first he accepted Schiaparelli's value, but now he has come to think that a value near 24 hours is correct. As illustrating the difficulty of the observations, he notes that on less than fifty occasions has he seen definite markings, and on six only has a positive movement of the spots been observed. Some drawings showing this are reproduced. One pair, taken on October 8-9, 1916, tend to confirm De Vico's period of 23 h. 21 m.; Mr. Rordame thinks that those spectroscopic determinations which were made in daylight are liable to error, owing to the blending of the sky spectrum with that of the planet. He considers that the planet is normally covered with dense clouds, the height of which is probably very great.

The same number of *Pop. Ast.* contains a note by Prof. St. John on a photograph of the red end of the spectrum of Venus; the dispersion was so great that the telluric lines would have been separated from those due to Venus's atmosphere by the Doppler effect. No companions, however, were visible to the telluric oxygen bands; it is concluded that oxygen is practically absent from the upper atmosphere of Venus.

SOLAR RESEARCHES.—The February number (vol. 34, No. 197) of the Publications of the Astronomical Society of the Pacific contains several communications on solar work. The first is a general article on the sun by Ferdinand Ellerman. "The Zeeman Effect on the Sun" is the title of the next article by Adrian van Maanen, written and translated from the Dutch journal *Physica*, the October (1921) number of which was dedicated to Dr. Zeeman in recognition of his discovery, 25 years ago, of the separation of spectral lines in a magnetic field. This article is of great interest, summing up the fine work done at Mount Wilson after Hale's important discovery of magnetic fields in sun-spots. Hale himself contributes a note on "Invisible Sun-spots," this term designating the invisible stage of spots which are usually visible during the greater part of their existence. By means of the apparatus which he describes, Hale indicates the importance of making a systematic search for local magnetic fields which may betray the presence of incipient or dying spots. Seth B. Nicholson gives a summary of Mount Wilson magnetic observations of sun-spots for November and December last, and describes the scheme of classification underlying the tables he produces. Systematic observations of the magnetic polarities of sun-spots have been made daily with the 150-foot tower telescope since 1915, and preparations are being made to publish all this valuable new work in detail. Spot groups are divided into three classes and designated unipolar, bipolar, and complex, and some interesting facts about their appearances are given.

PROPOSED 50-FOOT REFLECTOR.—A somewhat wild scheme is said to be contemplated by Prof. Todd and Mr. McAfee. This is the construction of a 50-foot reflector of 1200 feet focus, by utilising a mine-shaft of this depth at Chauaral, Chile, in the Andes, in the locality where Mars will pass exactly overhead at the opposition of 1924. The reflector will consist of rotating mercury, and there must be considerable incredulity about the possibility of keeping this sufficiently free from tremors and eddies to give tolerable definition. The plan ascribed to Prof. Todd is to use a flat, which throws the image into a cave at the side of the shaft, where the camera would be put. But clearly, with such high magnification, the shortest practicable exposure would give a blurred image on a stationary plate. A much better plan would seem to be to put a girder across the mouth of the shaft, carrying a plate-holder or eyepiece which could be moved by clockwork at the appropriate speed (about 1 inch per second). This is known as the Schaeberle method in eclipse photography, and has given satisfactory results. Prof. Todd is well known for bold and striking experiments, and all will wish him well, though without much expectation of success.

A CATALOGUE OF DOUBLE STARS.—A Greenwich volume has lately been published containing the measures of double stars made with the 28-inch refractor between 1893 and 1919. Earlier observations are given for many stars, and in an exhaustive series of notes, mainly by Mr. Jackson, the character of the motion is discussed and the deviations from published orbits indicated. There are also 25 new orbits, computed by him, many of which deviate considerably from earlier determinations. Hypothetical parallaxes are deduced for all stars for which orbit elements are available, and also for other stars which have been observed over an arc sufficiently long to indicate the amount of curvature. The assumed mass of each pair is twice the solar mass; this assumption gives a solar velocity of 19 km./sec., which is in close accord with the spectroscopic value. Comparison of the hypothetical parallaxes with the spectroscopic ones shows perfect accord, in the main, in the case of orbit-stars, but in the arc-stars the hypothetical parallaxes exceed the spectroscopic by 30 per cent.; this is not an excessive error for such small parallaxes (0·07″ to 0·02″). There is some indication of mass varying with spectral type, but this has not been used in obtaining the results.

Research Items.

PREHISTORIC COOKING-PLACES IN NORFOLK.—At the recent annual meeting of the Prehistoric Society of East Anglia, the president, Miss N. Layard, well known for her archæological investigations, particularly in the neighbourhood of Ipswich, delivered an address on prehistoric cooking-places in Norfolk. In the park at Buckenham Tofts, the discovery of what seems to have been a tribal cooking-place was due to rabbits scratching to the surface a number of cracked and fire-marked flints. The term usually applied to such articles is "pot-boilers," but more probably the heated stones were dropped into water-filled troughs made of the skins of large animals, either suspended from poles or used to line pits in the ground. Water and meat are easily boiled in these circumstances by keeping up the supply of heated stones, and the result, as shown by experiments made by the lecturer, was a mixture of charcoal, dirt, and ashes, with well-boiled but discoloured meat.

AN EARLY IRON-AGE VILLAGE NEAR DEVIZES.—In the report of the Marlborough College Natural History Society for 1921, Mrs. Cunnington describes an Early Iron-Age village discovered by chance on All Cannings Cross Farm, about 6 miles east of Devizes. The chief interest and importance of the site lies in the fact that the pottery as a whole seems to belong to the Hallstatt period, and to be throughout of the Hallstatt type. The site seems to have been occupied for a comparatively short and definite period, perhaps for some three centuries. Not a single fragment of anything Roman has been found, so that the occupation seems to have ended well before the Roman conquest, perhaps even some centuries earlier. A full report of the excavations will be found in the *Antiquaries Journal*, January 1922.

MISSIONARIES AS ANTHROPOLOGISTS.—Sir James Frazer in his introductory lecture of a course on the Belief in Immortality and the Worship of the Dead in Polynesia, published in *Science Progress* for April, discusses the general principles of anthropological inquiry, and notes that missionaries, men of education and character, who usually live for years among people of the lower culture, learn their language, and gain their confidence, have special opportunities for observing and recording the habits of savage races. He refers in particular to *Anthropos*, edited by an Austrian priest, Father W. Schmidt, and composed mainly of articles contributed by Catholic missionaries in many parts of the world. "It is much to be desired that the various missionary societies of England would combine to produce a journal of the same scope and the same scientific character. Perhaps, in view of our sectarian differences, that is too much to hope for. But in any case it is highly satisfactory to know that our Protestant missionaries are awakening more and more to the importance of anthropology in the training of missionaries and are taking active steps to remedy what till lately was a most serious defect in their mental equipment."

A HUMAN CRANIUM DREDGED FROM THE RIVER TRENT.—In the March issue of the *Journal of the Royal Anthropological Institute* (vol. li.) Prof. L. Gladstone describes a human cranium which was dredged from the bed of the river Trent, near Hatfield, in 1916. It differs considerably from the average type of skull found in recent and medieval burial-grounds in England, and from the average living types. The circumstances of its discovery indicate that it has affinities with the type of skull found in round barrows associated with bronze implements and pottery of the Beaker class. This race is believed to have made their appearance on our eastern and southern coasts about 2000 B.C., and these large-headed, brachycephalic invaders mingled with the indigenous small and narrow-headed Neolithic population and with subsequent invaders, including the Romans and those from the adjoining European shores. "As a result of inter-marriage of individuals belonging to these races, we find descendants from the original stocks who possess the characters of either one or the other of the ancestral races, in a more or less modified form, or intermediate types." The mid-European or Alpine stock and the broad-headed people of south-west Norway are modern representatives of the Bronze-Age race, modified by intermixture, change of environment and conditions of life, the eating of soft food affecting their jaw form and facial type.

SELF-FERTILISATION IN MOLLUSCA.—In NATURE of January 5, p. 12, Mr. G. C. Robson directed attention to some records of self-fertilisation in Gastropod mollusca and pointed out their importance. Stress was laid in the letter on the desirability of further investigation of this phenomenon. We have lately received an apparently unpublished communication from Mr. S. Manavala Ramanujam, of the Zoological Department, Madras Christian College, in which he describes what appears to be a structural adaptation for self-fertilisation in a family of Pulmonate Gastropoda. In the Vaginulidæ a connection is found between the vas deferens and the receptaculum seminis in the same animal. This connection (the "canalis receptaculo-deferentinus" of Keller) has been described by previous authors (Keller, Pelseneer), but, so far as can be ascertained, without comment. Mr. Ramanujam does not advance any objective evidence that self-fertilisation is effected through this canal, but he is probably right in suggesting that it is used to conduct the animal's own sperm to the receptaculum seminis, if it should fail to receive a supply from another individual. The existence of this connection perhaps indicates that self-fertilisation is of common occurrence in the family.

THE DIRECTION OF THE FIRST MOVEMENT IN AN EARTHQUAKE.—It has been known for some years that the first impulse in an earthquake may appear as a rarefaction at one station and as a condensation at another. Mr. S. Nakamura (*Journ. Meteor. Soc.*, Japan, February 1922) has studied recently several examples of such variations in Japan. In an earthquake at Miyosi (near Hiroshima) the disturbed area was divided into four quadrants by two slightly curved lines. In the south-east quadrant the direction of the first movement was inwards, and in the north-east and south-west quadrants outwards, the remaining quadrant being occupied mostly by the sea. In the Tokio earthquake of December 8, 1921, the distribution was somewhat similar, the curved bounding lines, however, being not quite at right angles; in two opposite regions (north-east and south-west) the movement was inwards, in the other two regions outwards. The great Chinese earthquake of December 16, 1920, seems also to belong to this type, the impulse being outwards in Formosa and inwards in Japan and at Zi-ka-wei. A second type was illustrated by an earthquake near Oomati (Shinano), in which the first movement was inwards on the south-eastern side of the epicentre and outwards on the north-western side. There appears also to be a third type, though not yet well established, in which the first movement is mainly inwards in all directions from the epicentre.

THE EARTH'S INTERIOR.—The planetesimal hypothesis of the aggregation of the earth is now so justly associated with the name of T. C. Chamberlin that his "Study of fundamental problems of Geology" (Carnegie Institution of Washington, 15th Ann. Rep., p. 412, 1921) has a very wide interest. Continuing his arguments as to the structure and behaviour of a contracting globe formed of solid mineral aggregates, he remarks on the effects of pressure in generating silicates of high density even within the limits of the earth's outer layers. Without actually predicting the occurrence of still denser compounds, formed of familiar types of crustal molecules, towards the earth's interior, he states that "there seems no need to assume the presence of an amount of metal, or other intrinsically heavy material, greater than is implied by the planetary evidence already cited."

TERTIARY FOSSILS OF BURMA.—Comparative diagnoses of Pleurotomidæ, and of Conidæ and Cancellariidæ from the Tertiary formations of Burma form two consecutive papers by E. Vredenburg in the Records of the Geological Survey of India, vol. 53, 1921, pp. 83-141, illustrated by four excellent photogravure plates by S. C. Mondel. These two papers are in continuation of a previous one on the Terebridæ, by the same author, that appeared in vol. 51, and consist mainly of descriptions of new species. One of these, *Mangilia* [sic] (*Clathurella*) *quinqueangularis*, it is claimed "does not resemble any previously described shell either fossil or recent." To the palæontologist this work will be invaluable, but the systematic conchologist will wish that the writings of later authors than Cossmann, whose big publication Vredenburg has evidently followed, had not been entirely ignored. Both Prof. Dall in America, and Iredale in this country, have advanced our knowledge of these groups since Cossmann dealt with them.

OIL SHALE AS A SOURCE OF GASOLINE.—The Journal of the Franklin Institute for March 1922 contains a paper by Prof. R. H. McKee on Gasoline from Oil Shale, in which he outlines the processes of extraction of petroleum from shale, and the possibilities of developing a successful industry in the United States. The text of the paper is not new; as usual, the Scotch Shale Industry is described as a "type," and modifications of method and practice are suggested for the treatment of American raw material. The significance of the paper lies not so much in the principles it seeks to enunciate, but in the warning it contains regarding the gradual decline in production of natural oil in America, and the corresponding need for activity in development of the oil-shale resources of that country. The importation of petroleum from Mexico into the United States, for example, increases annually, in order to help meet the demand both for motor spirit and for petroleum products; as Mexico is regarded by many (and evidently by the author) as a short-lived field, the position in America is likely to become critical within the next decade. Sooner or later a drastic scheme of conservation of the oil resources of the United States for national requirements must eventuate, and before this happens the oil-shale industry and the utilisation of other material as a source of fuel, must be well established in that country. It is well known that there are many technical difficulties arising in connection with the extraction of oil from shale, and that the methods employed in Scotland are not suited to all kinds of shale, especially some of the western American varieties. It is to the solution of these difficulties that American experts are now turning their attention, and research is being assiduously carried on in the Chemical Engineering Department of Columbia University, New York City, under the author's direction, with the view of studying the fundamental factors on which the industry must be based. Similar work is also in progress at the Colorado School of Mines, under the direction of Dr. V. C. Alderson, the well-known authority on oil shale.

AGRICULTURE IN INDIA.—The thirty-sixth issue of the Agricultural Statistics of India, for 1919–1920, sets forth most comprehensively the details relative to the position of agricultural affairs. The rainfall on the whole was normal or excessive, no deficit being reported for any area. Following on a marked depression in 1918–1919, the period under review shows a general recovery, though the high-water mark of 1916–1918 was not reached. The area sown was 255 million acres, of which 211 millions were under food crops and 44 millions under others. A considerable increase in the area sown occurred in the North-west and West and in Burma, which more than counterbalanced a drop in the Central Provinces and Bengal. There was less variation in the acreage of rice, cotton, and jute than in other crops, no less than 79 million acres being under rice. While the majority of crops are distributed more or less throughout the country, the larger part of sugar-cane and wheat is grown in the Punjab and United Provinces, tea in Assam, and practically the whole of the jute in Bengal. During the past ten years an increase of 18 millions in livestock has been recorded, due entirely to the larger number of bovine animals reared. In the appendix to the report a useful list of crops is given, with both vernacular and botanical names.

METEOROLOGY IN THE NETHERLAND INDIES.—A general summary of "The Climate of the Netherland Indies" is given by Dr. C. Braak—Verhandelingen, No. 8, vol. i., parts 1 and 2. A short English summary is given with each part. The most prominent feature of the climate is said to be its monotony or its uniformity from day to day, for the moving low-pressure systems common to the higher latitudes which make the weather variable are practically unknown. The most important weather changes are the variations of rainfall, and the monsoons cause a yearly variation in the climate which is rather small in the north but considerable in the south. It is stated that the Malay Archipelago is the most typical monsoon region of the world, the trade-wind systems being disturbed by the influence of the continents of Asia and Australia. Pilot balloon observations at Batavia show that the west monsoon from December to April reaches on an average to a height of 5000 m., whilst from May to October easterly winds blow at all levels up to 7 km. The monsoon wind on high mountain tops is stronger at night than during the day. Near the coast the land and sea breezes are said to have a strong influence. Monthly charts are given of the isobars and winds over the Archipelago which show a complete reversal of meteorological conditions during the year with the change of the monsoon.

Sheep-Breeding and Ancestry.[1]

IN the report referred to below, Prof. Ewart first briefly reviews the facts and beliefs about sheep, and, under nine concise statements, summarises our knowledge of the origin and development of present-day types. Much of the work upon which this summary is based is attributable directly to the extensive researches, extending over many years, which Prof. Ewart himself has conducted. In Figs. 1 and 2 the results of these researches are represented diagrammatically.

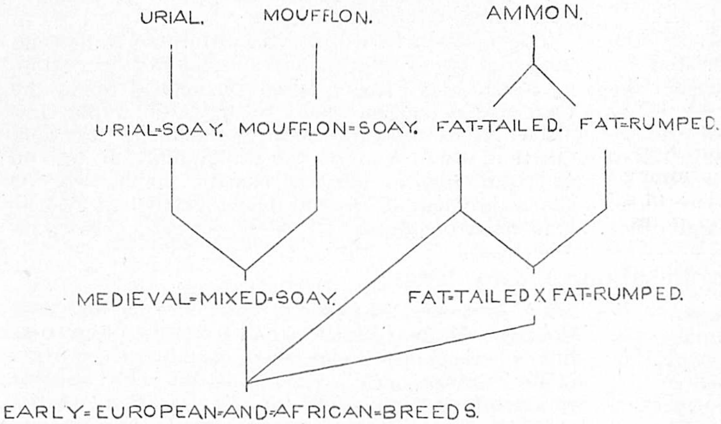

FIG. 1.

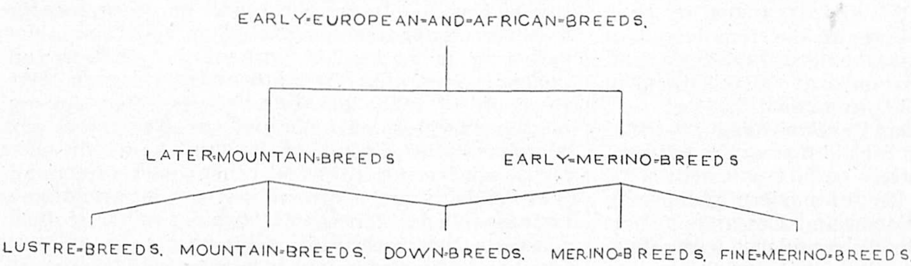

FIG. 2.

From Fig. 1 it will be gathered that the primitive sheep of Europe was of the Soay type, this type having a double ancestry in the Urial or horned sheep and the Moufflon or hornless sheep. Both these types are in evidence to-day in Soay flocks and both are still short-tailed. Nevertheless, both these types cross freely with long-tailed sheep. The modern sheep would seem to have obtained both its tail and its fattening characteristics through the fat-tailed and fat-rumped sheep of Asia. It is further conceivable that the Soay × Fat-tailed or Soay × Fat-rumped sheep followed two lines of migration across Europe—one to the north, coming eventually into the British Isles through the kingdom of Scandinavia, and the other along the shores of the Mediterranean, developing eventually into the Merino sheep of Spain, and in this form taking part in the formation of the British "Down" breeds. In Fig. 2 this latter suggestion is illustrated diagrammatically and the ancestry of present-day sheep indicated.

FIG. 3.

FIG. 4.

There is still a "drift" southwards of sheep from Scotland and a "drift" northwards of sheep from the south of England. It may be that these two drifts are a relic of the drifts of the Nordic and Mediterranean races across the British Isles; but such a theory would need many more facts than are at present available to support it. There is, however, direct support for Prof. Ewart's suggestion respecting our present-day sheep having a fat-tailed ancestor. In Fig. 4 is illustrated the normal head and ears of the Suffolk Down type of sheep. In Fig. 3 is given a photograph of a lamb discovered among a number of this year's Suffolk lambs; and in Fig. 5 an illustration of a sheep with the fat-tailed head. The similarity is very striking. Further, the suggestion that at the base of English Down breed is the Merino is illustrated in Fig. 4, a Suffolk Down lamb with "crinkled skin"—this crinkled skin being very characteristic of sheep of the Merino type. In further support

FIG. 5.—Head of a 21-days'-old extracted Fat-tail ram lamb. From the *Scottish Journal of Agriculture*. By permission of the Board of Agriculture for Scotland.

[1] Report on Sheep-breeding Experiments. By Prof. J. Cossar Ewart. British Research Association for the Woollen and Worsted Industries, Torridon, Headingley, Leeds.

of the fat-tailed ancestry of present-day sheep, Prof. Ewart noted some time ago a Border-Leicester sheep with the tip of the tail turned up following the lines of the tail of the fat-tailed sheep. Thus it would appear that the nine brief statements with which the report starts are of quite extraordinary interest, and in addition may usefully be kept in mind when studying present-day types of sheep.

Mendelian principles—particularly involving the reshuffling of "characters"—are then insisted on and the value of crosses beyond the first cross emphasised. This is really essential, as so many breeders fail to realise the importance of the F_2 cross. Australian sheep-breeders, however, say "three generations to obtain the cross and thirty to fix it"!

The report is then divided into two sections: (1) experiments with Highland blackface and other modern breeds; and (2) experiments with primitive breeds. It is pleasing to note the assistance accorded by the Duke of Richmond and Gordon and his agent, Mr. R. A. Dawson, Mr. R. Macmillan, Captain J. Stirling, Mr. Dyson Perrin, Sir John Ramsden, Sir Malcolm Macgregor, Mr. Gordon, and the veteran of experimental sheep-breeders, Mr. J. Elwes of Colesborne, Cheltenham.

The Scottish Board of Agriculture is also taking a deep and broad interest in experiments here partially recorded. Ten photographs of typical sheep and their crosses add materially to the value of the report.

The report concludes with references to the experiments in progress under the direction of Prof. White in Wales and to the experiments on British wool characteristics at present being carried out at the University of Leeds.

A. F. B.

The Organisation of Knowledge.

CURIOUS reflections on the present state of scientific knowledge are suggested by the extraordinarily interesting address of Dr. F. L. Hoffman to the social and economic science section of the American Association, at the Toronto meeting last December, on "The Organisation of Knowledge," published in *Science* of March 10 and 17. Dr. Hoffman has been for thirty years a very practical organiser of knowledge in connection with his management of the Prudential Insurance Company of America. He has been reading Prof. Whitehead's "The Organisation of Thought," and it seems to have impressed him with a sense of the remoteness of mathematical principles, mathematical methods, and mathematical research from any organisation of science which is serviceable in practical life.

The problem Dr. Hoffman deals with is a profound one, and carries us back to the old distinction between truths of reason and matters of fact which in some form has been the problem of modern philosophy since it first arose with Bacon and Descartes. It is interesting to look back on the confidence with which some of the leaders of philosophic thought in the nineteenth century supposed they had solved it. The confidence appears first in Comte and afterwards in Spencer, who devoted a great part of his intellectual energy to an attempt to give it practical effect. It rested on the idea of a division of labour. It was to be the business of scientific workers to observe and collect facts, guided of course by certain rules of classification and arrangement, but it was to be the special business of philosophers to systematise and generalise. An amusing illustration is a story related to the present writer many years ago by the late Dr. Williamson, professor of chemistry in University College. Herbert Spencer had written to him to ask him whether certain specified chemical experiments could be relied on as correct. In his reply he added to the information asked for his own interpretation, only to receive by return a sharp rebuke pointing out to him that his business was to observe and report facts; it was for the philosopher to theorise concerning them. It is perhaps needless to add that the narrator saw no humour in the story.

The fact gatherer, Dr. Hoffman tells us, should be the fact user. It is the reason he gives for this, however, that deserves particular attention. Fact gathering is impossible without imagination, and imagination is what the mathematician is ever trying to get rid of. The ideal of science is forecasting, and in the business of insurance we have the most complete development of it. In the organisation of knowledge for insurance the whole principle is that all facts are regarded in their interrelation or interdependence for useful purposes. Dr. Hoffman contrasts this with Prof. Whitehead's appeal for a first-hand knowledge which has "never been scared by facts." Progress and discovery depend upon a disciplined imagination, and Dr. Hoffman quotes Karl Pearson, "the man with no imagination may collect facts, he cannot make great discoveries." What we want to forecast are the sort of things mathematics is helpless before, things like the international war, or the influenza epidemic.

Dr. Hoffman concludes his address by outlining the general scheme of his own organisation of the library and information service of his business office.

The Centenary of Naval Engineering.

UNDER this title an interesting paper was read at a meeting of the Newcomen Society on March 30 by Engineer-Commander Edgar C. Smith. Among other matters treated was the development of paddle-wheel vessels, and a notable feature is presented by two tables giving particulars of steam vessels added to H.M. Navy during the period 1820-1850.

During the first twenty years all Navy boilers were of the flue type and were box-shaped. Leakage was very frequent; Dinnen remarks on the numerous "weeps" of which no notice was taken. These boilers were suitable for low pressures only, and it was forty years before the working pressure increased from 3·5 to 20 lb. per sq. in.

Great care was necessary for working these early boilers with salt water. Ships at sea put out the fires every third or fourth day and emptied the boiler. Afterwards, blowing down every two hours became the rule. If the blow-down cocks jammed, the water could be blown through the hand pump, or, according to Murray, "a usual plan is to knock out a rivet from the bottom of the boiler." Feed heating came into use early, an annular tank being placed round the funnel.

The first vessel in the Navy to have a surface condenser was the *Megaera*. She had the five-fold combination of an air-pump, a circulating pump, a surface condenser, an evaporator, and a steam saver. This vessel was wrecked in 1843. The oscillating engine was invented by Murdock, improved by Manby, taken up by Maudslay, and its final success was due to Penn. Since all warships had to retain their sailing qualities, special attention had to be paid to devices for preventing interference from the paddle-wheels whilst the vessel was under sail.

We are indebted to the *Engineer* for the foregoing details, and trust that the author will complete his work by another paper dealing with the development of screw propulsion.

British Research Chemicals.

WE have received a pamphlet entitled "British Research Chemicals produced by Members of the Association," issued by the Association of British Chemical Manufacturers. This is a revised edition of the association's earlier pamphlet, and now contains inorganic as well as organic chemicals. In the list of inorganic chemicals, however, there are many which cannot fairly be called research chemicals, and can be obtained from almost any dealer. These include alum, ammonium chloride, barium chloride, bismuth subnitrate, and the like. It is evident that the Association had research chemicals in mind in drawing up the list, since such substances as ferrous ammonium sulphate are omitted. This inclusion of common chemicals swells the bulk of the list without adding to its value.

Although the preface states that there are certain chemicals on the list a permanent supply of which cannot be guaranteed unless there is sufficient demand (these might have been indicated in some way), it is evident that considerable progress has been made since the issue of the first edition, and the manufacturers are to be congratulated heartily on their efforts to supply from home sources materials which were obtained formerly from abroad. The list is far from complete; the present writer sought in vain for four not very rare substances he requires for research and used to obtain from Germany. With such an excellent beginning, however, the by no means small difficulties of research workers at the present time should rapidly be alleviated.

We notice that the manufacture of new chemicals may be undertaken by one or other of the firms "according to demand." We wish to point out, however, that this will scarcely meet the case satisfactorily. There are some materials which could formerly be obtained from German firms for which the demand must have been extremely small. If the research worker is to be told that the materials he requires cannot be made in this country because there do not happen to be a hundred other people working on the same subject, he will not derive much comfort from the statement. We offer these criticisms in the hope that they may be of assistance, and not in any way as detracting from the praise which is due to the firms for what they have already accomplished.

University and Educational Intelligence.

LEEDS.—At a meeting of the Court of the University of Leeds, held on April 26, it was decided to confer the following honorary degrees among others: *D.Sc.*, Sir Dugald Clerk; Sir Frank Dyson, Astronomer-Royal; Sir Richard Gregory; Sir Charles Sherrington, President of the Royal Society, Waynflete Professor of Physiology in the University of Oxford; and Sir Harold Stiles, President of the Association of Surgeons of Great Britain and Ireland, Professor of Clinical Surgery in the University of Edinburgh. *M.Sc.*, Mr. R. W. Haydon, until recently Lecturer in Agriculture in the University.

A CONFERENCE of representatives of the Universities of the United Kingdom will be held on May 13 in the Botanical Theatre, University College, London. The subjects and the openers of the discussions are as follows: the urgent need for the provision of enlarged opportunities for advanced study and research (Dr. J. C. Irvine); the increase of residential accommodation for undergraduate and other students (Sir Michael E. Sadler); specialisation in certain subjects of study by certain universities (Dr. L. R. Farnell); and the organisation of adult education as an integral part of the work of the universities (Sir. Henry A. Miers).

THE Melbourne correspondent of the *Times* announces that the Universities of Melbourne, Sydney, and Adelaide have agreed to invite Prof. Einstein, when he visits Java, to continue afterwards to Australia and visit the principal cities. Sydney and Melbourne will contribute 80*l.* each towards his expenses, and Adelaide 60*l.*

IT is announced in the *Chemist and Druggist* that under the will of the late Mr. Henry Musgrave sums amounting to 57,000*l.* have been bequeathed to Queen's University, Belfast. The Senate requested the Academic Council to make the consequential regulations for awarding "The Musgrave Research Studentship."

IN a new magazine, *The Beacon*, for April, Mr. E. H. Dance writes on "The Channels of Education: a Suggestion for Remuneration Economy." He admits that economy is as necessary in education as in other national activities, and he remarks that the Scripture lesson is the most unfruitful in the whole curriculum; he also states that the advantages of commandeering a large proportion of the time allotted to it and transferring it to geography would be incalculable. It is suggested that economics might largely take the place of Latin. Science teaching in its present form he condemns because its matter is of little real utility, "even when the canon of utility is educational . . . in spite of recent developments, education continues to lay undue emphasis on deductive reasoning." Science teaching, as now carried out, might, he thinks, be replaced by a more suitable medium: "that medium lies ready to hand in the modern treatment of history. History may be described as the laboratory of politics." "The inculcation of a general æsthetic sense is perhaps the most obvious need of modern education." Some of us may find it difficult to accept the writer's conclusions, but the article is well written and suggestive.

IN the course of his presidential address, delivered on April 20 at the annual general meeting of the Institution of Mining and Metallurgy, Mr. S. J. Speak referred to the part which the Institution has played in the development of technical education. Speaking of the Imperial College of Science and Technology, London, and particularly of the Royal School of Mines, he said that the Institution had aimed always at securing recognition for the College as "the technological centre of the Empire." The work of the College was, however, hampered seriously by lack of the power to grant degrees, and for this reason it is advocated that the status of the College should be raised to that of an Imperial University of Science and Technology. Opposition to this suggestion comes mainly from two sources: first, from the University of London, which naturally desires to absorb vigorous local institutions into itself and fails to see that facilities for obtaining London degrees do not meet the case. The second source of opposition is found in those educated on the classical side of existing universities, and to them a University of Science and Technology is unthinkable. Mr. Speak protested against this as suggesting that the study of the "humanities" is a higher form of education than the study of science.

Calendar of Industrial Pioneers.

May 4, 1879. **William Froude died.**—" The greatest of experimenters and investigators in hydrodynamics," Froude began his researches on the motion of ships among waves in 1856. They were made at the request of I. K. Brunel, who was then engaged with the building of the *Great Eastern*. Froude had been employed under Brunel on the Great Western Railway. His work led to the construction by the Admiralty of the experimental tank at Torquay, the first of its kind ever built. He carried out experiments on the effects of bilge keels and on the resistance and propulsion of ships, and he is also known as the inventor of a dynamometer.

May 4, 1886. **James Muspratt died.**—After an adventurous youth, a part of which was spent in the Navy, Muspratt settled in Liverpool and began the manufacture of soda according to the Leblanc process. Six years later he was joined by Gamble and new works were erected at St. Helens. Afterwards he had works at Widnes and Flint. He has been called the father of the alkali trade in Lancashire. He was a great friend of Liebig.

May 4, 1908. **Gustav Friedrich Herman Wedding died.**—A distinguished writer on metallurgy, Wedding studied at the Mining Academies of Berlin and Freiburg and ultimately became professor of metallurgy at the Technical High School at Charlottenburg. His works were regarded as of exceptional value and in 1896 he was awarded the Bessemer Medal of the Iron and Steel Institute.

May 5, 1909. **Bindon Blood Stoney died.**—For many years chief engineer to the Dublin port authority, Stoney attracted attention by his use of huge concrete monoliths of 350 tons weight. He made an elaborate study of stresses in girders, contributed many papers to the scientific societies, and in 1871 was president of the Institution of Civil Engineers of Ireland.

May 6, 1897. **Jedediah Strutt died.**—A Derbyshire farmer, Strutt in 1758 and 1759, with his brother-in-law, took out successful patents in connection with stocking machines. He also suggested improvements in the spinning frame of Arkwright.

May 7, 1890. **James Nasmyth died.**—An eminent mechanical engineer and inventor, Nasmyth in 1829 became the personal assistant of Henry Maudslay, and four years later set up in Manchester as a maker of machine tools. To him we owe the steam hammer, the steam pile driver, the nut making machine, a hydraulic punching machine, and the coiled spiral wire flexible shaft now so largely used.

May 8, 1916. **John Edson Sweet died.**—The recipient of the John Fritz medal for his " achievements in machine design, and pioneer work in applying sound engineering principles to the construction and development of the high-speed steam engine," Sweet was at one time professor of mechanical engineering in Cornell University. To him was due the initial step leading to the founding of the American Society of Mechanical Engineers, of which he became the third president.

May 9, 1914. **Paul Hérault died.**—Born in 1862, Hérault studied at the Paris School of Mines and at the age of twenty-four brought out his electrolytic process for the production of aluminium, a discovery made independently in America by C. M. Hall (1863–1914).

May 10, 1864. **Alphone René le Mire de Normandy died.**—A pioneer in the modern practice of distilling fresh water from salt water, Normandy brought out his invention in 1851. A native of France, he became a practical chemist and settled in England in 1843.

E. C. S.

Societies and Academies.

LONDON.

Geological Society, April 12.—Prof. A. C. Seward, president.—F. W. **Edwards**: Oligocene mosquitoes in the British Museum, with a summary of our present knowledge concerning fossil Culicidae. All the specimens are from the Oligocene of the Isle of Wight. The genera appear to be inseparable from those of the present day, and some of the species suggest a fauna similar to that of Ethiopian and Oriental regions. No peculiar forms occur. The genus Anopheles has not been found, probably because of its comparative rarity. Three species from the Oligocene of the Isle of Wight, described by Prof. Cockerell, are referred to the genus Aedes; and two new species, one of Culex and one of Tæniorhynchus, are described. No fossil that can be positively referred to the Culicidæ is yet known from the Mesozoic.—A. C. **Seward**: On a collection of Carboniferous plants from Peru. The plants described were collected by Mr. J. A. Douglas in 1911 from coal-bearing strata on the south side of the Peninsula of Paracas, a few miles south of Pisco on the coast of Peru. They are mostly fragmentary; whether they are of an Upper or a Lower horizon is not certain. Hitherto no fossiliferous Palæozoic rocks have been recorded from the Peruvian coast.—Miss M. E. J. **Chandler**: The geological history of the genus Stratiotes: an account of the evolutionary changes which have occurred within the genus during the Tertiary and Quaternary eras. Stratiotes, a monotypic genus of European and West Asian water-plants, can be traced back to the Eocene. The recent seed was described and an account given of the modifications which have occurred in the genus since the Eocene period. Of nine species described, *S. aloides* alone is still living. Seven appear to be direct ancestors of the recent plant, while two perhaps represent a branch-line of evolution. The fossil species occur in great abundance, are widespread geographically, and each seems to have a limited range in time. They may therefore serve to correlate isolated freshwater deposits in Europe.

Royal Meteorological Society, April 19.—Dr. C. Chree, president, in the chair.—W. T. **Russell**: The relationship between rainfall and temperature as shown by the correlation coefficient. The temperature of any two successive months over a series of years is correlated to the extent of approximately $+0 \cdot 3$. Since the mean monthly temperatures for the twelve calendar months follow very closely a sine curve, the coefficient of correlation should be unity. Rainfall in alternate months shows some high correlation coefficients, *e.g.* the coefficient between the rainfall in June and August in London is $+0 \cdot 55$. There is a negative correlation of $0 \cdot 5$ between rainfall and temperature in the same month in summer—evidence of the effect of solar radiation—while positive coefficients are found for the winter months. The change is attributed to the influence of the ocean in maintaining a temperature in excess of that due to latitude and season.—R. A. **Fisher** and Winifred A. **Mackenzie**: The correlation of weekly rainfall. The weekly rainfall for the past forty years at York, Aberdeen, and Rothamsted has been examined with a view of exploring the main features of weather localisation. Probably simple laws connect these quantities over considerable areas, which will give an idea of the accuracy of meteorological estimates based on a limited number of stations. A well-marked annual periodicity in the rainfall correlations rises relatively slowly in the autumn, and the autumn values commonly remain for about three months close to the mean value for the year.—S. **Chapman** and Miss E. **Falshaw**: The lunar atmospheric tide at Aberdeen, 1869–1919. Methods similar to those formerly employed for the Greenwich records were used. The phases of the tide at the two stations agree as well as can be expected considering that Aberdeen is more disturbed, and the amplitude appears to be slightly greater at Aberdeen than at Greenwich.

PARIS.

Academy of Sciences, April 3.—M. Emile Bertin in the chair.—The president announced the death of Prof. Ph. A. Guye, correspondent of the Academy for the section of chemistry.—A. **Lacroix**: A syenite containing corundum and sillimanite formed by endomorphism of granite.—M. **Hamy**: The determination of the diameter of stars by the interference method. The telescope objective is covered by a screen carrying two narrow slits, and if the latter are sufficiently near, Young's fringes are seen. When the distance between the slits increases, the fringes diminish in clearness and vanish at a distance which is a function of the diameter of the star. The formulæ for the determination of the star diameter are given, and the numerical constants worked out.—C. **Moureu** and A. **Lepape**: The estimation of krypton and xenon in absolute value by spectrophotometry. A simplification of the method described in 1911. Standard mixtures of pure krypton and xenon in argon have been prepared and the pressure determined, in the Plücker tube, at which the intensity of a given krypton (or xenon) line is equal to that of a fixed argon line. These pressures and proportions are given in two tables.—F. **Mesnil** and M. **Caullery**: The maxillary apparatus of *Histriobdella homari*; the affinities of the Histriobdellæ with the Eunicians.—M. René Baire was elected correspondent for the section of geometry in the place of the late M. Nœther.—N. E. **Nörlund**: The interpolation formula of Stirling.—B. **Gambier**: Isothermal surfaces with spherical isothermal representation.—J. **Le Roux**: The curvature of space.—S. **Millot**: Calculating balances. A plate oscillating on two knife edges and having various scales ruled on it perpendicular to the axis of oscillation can be used as a generalised calculating machine. A practical example of its use in a complicated calculation is given.—G. **Rémoundos**: Plane deformations and the problem of the thrust of earth.—M. **Frontard**: Law of the dangerous height of clay cuttings.—A. **Perot**: The measurement of pressure in the atmosphere of the sun. The method is based on the variation with pressure of the ratio of the wave lengths of two lines of the spectrum, the coefficients of variation with pressure of which are different. The present data are based on five iron lines and give a mean pressure of 34 cm. of mercury, or just under half an atmosphere.—J. **Mascart**: Observations of the partial eclipse of the sun of March 28, 1922, made at the Lyons Observatory (Saint-Genis-Laval). Observations of the times of contacts by six observers are given, and these differ appreciably from the calculated times given in the *Connaissance des Temps*.—E. **Esclangon**: Observations of the eclipse of the sun of March 28, 1922, made at the Observatory of Strasbourg.—T. **Moreux**: Observations of the eclipse of the sun of March 28, 1922. Observations made at Bourges under unfavourable conditions.—G. **Bruhat** and A. **Delaygue**: Determination of the upper point of inversion of the specific heat of the saturated vapour of benzine.—M. **de Broglie**: The corpuscular spectra of the elements. A continuation of previous researches carried out with larger apparatus. Reproductions are given of the spectra obtained with silver, tin, gold, and uranium.—C. **Gutton**: The simultaneous maintenance of an oscillating circuit and harmonic circuits.—P. **Job**: The hydrolysis of the roseocobaltic salts.—A. **Wahl**, G. **Normand**, and G. **Vermeylen**: The monochlortoluenes. Pure ortho- and para-monochlortoluenes were prepared and the melting point curve for mixtures of the two constructed. This curve can be used in the analysis of mixtures. In the chlorination of toluene, a new catalytic effect of lead chloride is noted, which has a bearing on the industrial preparation of benzyl chloride.—Mlle. G. **Cousin**: Tectonic observations of the secondary strata of the southern border of the Vosges.—L. **Dangeard** and Y. **Milon**: Contribution to the study of the Tertiary basin to the south of Rennes. Discovery of beds containing fishes and plants in the black clays at the summit of the Chattian.—P. **Bugnon**: The hypocotyl of the Mercurialis.—H. **Jumelle**: A great palm tree from the centre of Madagascar.—A. **Policard** and Juliana **Tritchkovitch**: The mechanism intervening in the fixation of fats by the cortico-suprarenal gland.—P. **Lecompte du Noüy**: The superficial equilibrium of the serum and of some colloidal solutions. A description of a new apparatus for studying the continuous variation of the surface tension of a liquid. With this it has been shown that, at constant temperature, the surface tension of solutions of sodium oleate, glycocholate and taurocholate, of saponin and of blood serum diminishes spontaneously with time, rapidly during the first ten minutes then more slowly, the results being expressed by an exponential curve.—E. **Roubaud**: The winter hibernation in the larvæ and nymphs of the flies.—E. **Grynfeltt**: The perforating fibres of the bone of mammals.—P. **Bouin**: The parallel conjugation of the chromosomes and the mechanism of the chromatic reduction.—H. **Bierry**, F. **Rathery**, and F. **Bordet**: Experimental azotemia and hyperproteidoglycemia.—E. **Burnet**: A type of arthritis frequently observed in guinea-pigs infected with *Micrococcus melitensis*.

CAPE TOWN.

Royal Society of South Africa, March 15.—Dr. J. D. F. Gilchrist, president, in the chair.—B. de C. **Marchand** and B. J. **Smit**: The soils of the Hartebeestpoort irrigation area (Pretoria and Rustenburg districts).—H. E. **Penrose**: The trend of radio-development. The various methods adopted for wireless transmission were described and compared with the three electrode thermionic valve method. The possibilities of transmitting a beam of wireless waves in any given direction and direction finding were also discussed.—W. S. H. **Cleghorne**: A study in charcoal: being a research on charcoals made from exotic woods grown in the Union of South Africa. Charcoals were classified by the following methods: (*a*) proximate analysis; (*b*) measurement of the fuel consumption per brake horse-power on suction gas engine trial at constant given load for six hours' run; (*c*) analysis of the gas from the gas producer while the engine was on the trial; (*d*) measurement of the weight of a given volume of charcoal. Charcoal from *Acacia saligna*, the common Port Jackson Wattle of the Cape Flats, gave excellent results.—F. G. **Cawston**: Some notes on the differentiation of closely-allied Schistosomes. Fresh-water snails are infested occasionally with the cercariæ of more than one species of trematode. There are conditions under which schistosomes may develop in other than their common intermediary host. A determination of the number of pairs of mucin glands is one of the best means of determining the species to which a cercaria belongs.

Official Publications Received.

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 11, No. 4: Studies in Gujurat Cottons. By Maganlal L. Patel. Part 1. Pp. ii+75-127+8 plates. 2 rupees; 2*s.* 6*d.* Botanical Series, Vol. 11, No. 6: The Influence of Atmospheric Conditions upon the Germination of Indian Barley. By W. Youngman. Pp. 145-151. 9 annas; 1*s.* (Calcutta: Thacker, Spink & Co.; London: W. Thacker & Co.)

Union of South Africa. Report of the South African Museum for the Year ended 31st December 1921. Pp. ii+12. (Cape Town: Cape Times, Ltd.)

Société française de Physique. Procès-Verbaux et Résumé des communications faites pendant l'année 1921. Pp. 112. (Paris: Gauthier-Villars et Cie.)

Third Annual Report of the Governors of the Imperial Mineral Resources Bureau. Pp. 72. (London: The Bureau, 2 Queen Anne's Gate Buildings.)

Università degli Studi di Perugia. Annali della Facoltà di Medicina e Chirurgia (Organo Ufficiale dell' Accademia Medico-Chirurgica di Perugia). Vol. 26, Serie V. Pp. 302. (Perugia: G. Guerra.)

Papers and Proceedings of the Royal Society of Tasmania for the Year 1921. Pp. iv+222+30 plates. (Hobart: Tasmanian Museum.) 10*s.*

Transactions and Proceedings of the Royal Society of South Australia. Edited by Prof. W. Howchin. Vol. 45. Pp. vii+316+22 plates. (Adelaide: Royal Society of South Australia.) 9*s.*

Diary of Societies.

FRIDAY, MAY 5.

IRON AND STEEL INSTITUTE (at Institution of Civil Engineers), at 10.30 A.M.—D. Selby-Bigge: Recent Developments in Power Production.—A. Westgren and G. Phragmen: X-ray Studies on the Crystal Structure of Steel.—N. T. Belaiew: The Inner Structure of the Pearlite Grain.—J. H. Whiteley: Formation of Globular Pearlite.—A. F. Hallimond: Delayed Crystallisation in the Carbon Steels: the Formation of Pearlite, Troostite, and Martensite.—K. Honda: The Constitutional Diagram of the Iron-Carbon System, based on Recent Investigations.—K. Honda and T. Kikuta: The Stepped A1 Transformation in Carbon Steel during Rapid Cooling.—N. Yamada: The Heat of Transformation of Austenite to Martensite, and of Martensite to Pearlite.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 3.—Annual General Meeting and Special Clinical Meeting.

ROYAL SOCIETY OF ARTS (Dominions and Colonies and Indian Sections), at 4.30.—Prof. W. H. Eccles: Imperial Wireless Communication.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Museum Specimens illustrating Umbilical and Diaphragmatic Hernia.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 7.—R. P. Howgrave-Graham: Electrically Oscillatory Discharges.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Failures.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—E. N. Ching: Casting under Steam Pressure.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. M. Grabham: Biological Studies in Madeira

SATURDAY, MAY 6.

ASSOCIATION OF ENGINEERS-IN-CHIEF (at St. Bride's Institute), at 7.30.—Discussion on Uniflow *v.* Multiple-Expansion Steam Engines.

MONDAY, MAY 8.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. Shattock: Demonstration of Museum Specimens illustrating Tuberculosis.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.30.—Annual General Meeting.

ROYAL SOCIETY OF ARTS, at 8.—F. F. Renwick: Modern Aspects of Photography (2) (Cobb Lectures).

SURVEYORS' INSTITUTION, at 8.—R. Cobb: Agricultural Valuations.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall, 135 New Bond Street, W.1), at 8.30.—R. Bryce: The Klagenfurt Plebiscite.

MEDICAL SOCIETY OF LONDON, at 9.—H. J. Waring: Annual Oration.

TUESDAY, MAY 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Arthur Keith: Anthropological Problems of the British Empire. Series II. Racial Problems of Africa (3).

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—E. H. Cunningham Craig: The Oil Shale of Esthonia.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 5.30.—Annual General Meeting.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—E. Cuzner: A Short Account of some Varieties of Marine Zoology.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (at Royal Society of Arts), at 8.—Prof. The. Svedberg: The Interpretation of Light Sensitivity in Photography (Hunter and Driffield Memorial Lecture).

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Capt. M. W. Hilton Simpson: Some Ethnographical Researches among the Berbers of Algeria.

WEDNESDAY, MAY 10.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. H. Burrows: The Results and Treatment of Gunshot Wounds of the Blood Vessels (1) (Hunterian Lectures).

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. E. J. Garwood and Miss E. Goodyear; The Lower Carboniferous Succession in the Settle District and along the Line of the Craven Faults.—E. J. Wayland and Dr. A. Morley Davies: The Miocene of Ceylon.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-section of Proctology), at 5.30.—Annual General Meeting.

ROYAL SOCIETY OF ARTS, at 8.—Major P. A. MacMahon: The Design of Repeating Patterns for Decorative Work.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—J. Watt: Automobile Calculations: Practical Methods for the Designer.

THURSDAY, MAY 11.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. F. Keeble: Plant Sensitiveness. I. To Light.

ROYAL SOCIETY, at 4.—Election of Fellows, 4.30.—*Probable Papers.*—Lord Rayleigh: A Photographic Spectrum of the Aurora of May 13-15, 1921, and Laboratory Studies in connection with it.—Lord Rayleigh: A Study of the Presence or Absence of Nitrogen Bands in the Auroral Spectrum.—Dr. C. Chree: The 27-day Period (Interval) in Terrestrial Magnetism.—M. Barker: The Use of very small Pitot-tubes for measuring Wind Velocity.—E. T. Paris: Doubly-resonated Hot-wire Microphones.—Prof. J. C. McLennan and D. S. Ainslie: The Structure of the Line of Wavelength $\lambda=6708$ Å.U. of the Isotopes of Lithium.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. H. Burrows: The Results and Treatment of Gunshot Wounds of the Blood Vessels (2) (Hunterian Lectures).

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. G. H. Hardy: The Elements of the Analytic Theory of Numbers (Lecture).—L. J. Mordell: The Integral Solutions of the Equation $y^2=ax^3+bx^2+cx+d$.—W. P. Milne: Sextactic Cones and Tritangent Planes of the same System of a Quadri-cubic Curve.—A. C. Dixon: An Integral Equation.—E. L. Ince: On Harmonic Equations and in particular the Equations associated with Parabolic and Circular Boundary Problems.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—Discussion on Motorcar Head-lights.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Annual General Meeting.—Dr. E. Bramwell: Some Features of Myopathy.

FRIDAY, MAY 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Annual General Meeting.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. H. H. Dale: The Search for Specific Remedies.

SATURDAY, MAY 13.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. O. W. Richardson: The Disappearing Gap between the X-ray and Ultra-violet Spectra. I. Grating Results.

PUBLIC LECTURES.

(*A number in brackets indicates the number of a lecture in a series.*)

FRIDAY, MAY 5.

UNIVERSITY COLLEGE, at 5.—Prof. T. Borenius: The Re-discovery of the Primitives (Admission by Invitation only);—at 5.30.—Prof. W. R. Shepherd: The Expansion of European Civilisation (1).

KING'S COLLEGE, at 5.30.—Dr. J. Hjort: Biological Aspects of Oceanography (4).—R. F. Young: The University of Prague.

TUESDAY, MAY 9.

UNIVERSITY COLLEGE, at 5.—Sir Arthur Shipley: Insects and Disease (2).

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Principle and Method of Hegel (2). The Dialectic.

GRESHAM COLLEGE, at 6.—A. R. Hinks: Astronomy (1) (Gresham Lectures).

WEDNESDAY, MAY 10.

UNIVERSITY COLLEGE, at 5.15.—Dr. D. H. Scott: The Early History of the Land Flora (3).

GRESHAM COLLEGE, at 6.—A. R. Hinks: Astronomy (2) (Gresham Lectures).

THURSDAY, MAY 11.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Prof. G. Elliot Smith: The Anatomy of Anxiety.

ROYAL SOCIETY OF ARTS, at 5.15.—Sir Lawrence Weaver: Rural Re-Settlement and its Relation to Public Health (2) (Chadwick Lectures).

UNIVERSITY COLLEGE, at 5.15.—Sir Joseph J. Thomson: Atoms, Molecules, and Chemistry (2);—at 5.30.—H. E. Goad: Nature in Giosue Carducci's Poems.

BIRKBECK COLLEGE, at 5.30.—Prof. J. C. Schoute: Whorled Phyllotaxis.

GRESHAM COLLEGE, at 6.—A. R. Hinks: Astronomy (3) (Gresham Lectures).

FRIDAY, MAY 12.

LONDON SCHOOL OF ECONOMICS, at 5.—Dr. P. Giles: Modern Views of Indo-European Origins (1).

UNIVERSITY COLLEGE, at 5.15.—A. E. M. van der Meersch: Simplified Solutions for B.M. and S.F. Values for Rolling Loads (1);—at 5.30.—Prof. W. R. Shepherd: The Expansion of European Civilisation (2).

BIRKBECK COLLEGE, at 6.—Dr. E. J. Russell: Recent Work with regard to the Influence of Soil Conditions on Agriculture (1).

GRESHAM COLLEGE, at 6.—A. R. Hinks: Astronomy (4) (Gresham Lectures).