THURSDAY, AUGUST 9, 1917.

CHARTS AND PROJECTIONS.

Charts: Their Use and Meaning. By Dr. G. Herbert Fowler. Pp. iv + 47 + charts viii. (London: J. D. Potter, 1916.) Price 4*s*.

DR. FOWLER states in his preface that whilst the use and meaning of maps have often been described, no book appears to have been written describing charts, but anyone who can read a map can readily read a chart also, for charts are merely maps of harbours and coast and ocean areas. At any rate, it scarcely appears necessary to describe parallels of latitude and meridians of longitude, or to give a long description in chap. iii. of conventional signs which are graphically depicted on a sheet published by the Admiralty, namely, Sheet X. ii., price 2*s*.

Charts published by the Admiralty are designed for navigational purposes, and may generally be classed under three headings: (1) charts for ocean voyages out of sight of land; (2) charts for navigating along a coast; and (3) charts or plans for entering harbours or taking vessels through narrow channels. The general charts are mostly on the Mercatorial projection, whilst the plans of harbours, etc., are on the gnomonic projection.

The idea of the Mercatorial projection is that if the earth be enclosed in a cylinder of a diameter equal to the earth's diameter, and all lines from the earth's centre be produced until they reach the cylinder, this will give a representation of the earth where all the parallels of latitude are equal in area, but their distance from the equator will be equal to the tangent, and the scale on that parallel equal to the secant of the latitude. This has certain advantages for navigational purposes, as all the meridians are parallel and the route taken by a vessel is shown as a straight line; but the disadvantage is that the route thus shown is not the shortest distance that can be followed by a vessel in sailing across the ocean; and although in the days of sailing vessels, when the progress was slow, this was not of much consequence, in these days, when vessels may steam 500 miles or more in the day, special lines have to be drawn to show the route to be followed, and the course by compass has to be constantly changed.

Although it is impossible to show on a flat surface a large area of a sphere or spheroid with perfect accuracy, a considerable area may be so shown by the gnomonic projection. The idea of the gnomonic projection is to place a flat board or surface against the sphere touching at its centre the central spot of the area to be shown, the board being at right-angles to a line drawn from the centre of the sphere to this central spot, *i.e.* tangential to the sphere's surface. Now on a sheet of paper 8 ft. square, which is as large as can be conveniently used for plotting charts, if a scale of 1 in. to the nautical mile be adopted, an area of 7000 square miles can be shown, when the error of the longest distance that can be measured on the chart would not exceed 2/100 of an inch—that is, about 100 ft. This error is practically of no consequence for navigational purposes.

On the gnomonic projection, if the chart be graduated, all the meridians are inclined and the parallels are curved, and it may be considered as a correct representation. The Mercatorial projection is greatly distorted.

Dr. Fowler gives representations of some charts, and in the preface to his book recommends the reader to study first his last chapter on the use of instruments, and it is certainly true that without a knowledge of mathematical instruments it is useless to study this work; but to readers unacquainted with the use of mathematical instruments it is better to study some good work which treats of the subject, such as that compiled by Mr. J. F. Heather, rather than the account given by Dr. Fowler.

Dr. Fowler's explanation of the reason why, owing to the flattening of the earth at the poles, the miles of latitude increase in length from the equator to the pole is not because a sector of 10° with a large radius is greater than a sector of the same number of degrees with a small radius—this is true whether the globe is a sphere or spheroid—the real reason being that with a spheroid the radii which enclose a sector are of unequal length, the one nearest the pole being shorter than the one nearest the equator. Thus if the radius nearest the pole be, say, 5 miles shorter than the one nearest the equator and the length of the arc 60 minutes, we have practically a right-angle triangle with a base of 60 miles and a perpendicular of 5 miles to find the hypotenuse.

The representations of the Admiralty charts given by Dr. Fowler require to be cut out of the book and spread separately on a drawing board, or flat table, before they can be utilised. Chart i. is not on the Mercatorial projection, as stated on p. 6, but on a gnomonic projection, though the difference on a chart of the scale of 4 in. to the nautical mile between the two projections is inappreciable for such a small area.

Dr. Fowler gives directions as to how to graduate chart iv., on which there is neither scale nor position, but states on pp. 7 and 8, though not very clearly, that the natural scale of the chart is 1/12,100 and the position of the Longships lighthouse lat. 50° 4′ 4·1″ N., long. 5° 44′ 43·9″ W. By the natural scale he shows that by referring to Carrington's tables he finds the chart scale to be almost exactly 6 in. to the nautical mile, and then draws a line 6 in. long and divides it into tenths, etc., and having done this gets a longitude scale by a graphic method instead of taking out the scale of longitude from Carrington's tables, whence he got his latitude scale. He does not appear to be aware of the great value of the sector in dividing lines or taking off proportional distances from it. The directions on p. 8 would be much shorter if the sector was understood and used.

It would greatly facilitate the work of a student if a reference were given in the margin to the chart, which should be consulted in all cases where directions are given for plotting courses or bearings, etc.

On chart vi. the isobar between 28·78 and 29·09 should be 28·94, and not 28·24.

Dr. Fowler omits to notice the great advantage of the "knot." It combines a measure of a time with a measure of distance—one knot signifying one nautical mile per hour, ten knots ten nautical miles per hour.

MENTAL ASPECT OF SOUND.

The Psychology of Sound. By Dr. H. J. Watt. Pp. vii+241. (Cambridge: At the University Press, 1917.) Price 10*s.* 6*d.* net.

THIS volume is written by a psychologist of repute, who is a lecturer on psychology in the University of Glasgow. It is one of the most important presentations of the sense of hearing since the time of Helmholtz. It is true that Dr. Watt discusses hearing more from the psychological than from the physiological point of view; he is less interested in the physiological mechanism than in the mental experiences associated with hearing. Still, the author is familiar with physiological theories regarding hearing and the cochlea. In the eighth chapter he gives an excellent critical account of all the physiological theories from Helmholtz onwards, and discards them more or less in favour of a theory of his own, which he thinks reconciles psychological and physiological data better than any other.

His theory, briefly stated, is that the basilar membrane does not act as a resonance apparatus, but when a sound wave enters the cochlea from the stapes there are variations of pressure at points of the basilar membrane—positive and negative pressures—positive when the pressure is increased by the stapes, negative when the pressure is diminished and backward; and the negative pressure "dissipates itself in all directions." It is not easy to understand the illustrative diagram on p. 164. There remains the doubt whether an accurate analysis can be made of motions in a space of such small dimensions as the *scala intermedia*. Nor is it easy to see what is gained over the resonance theory by the resolution of motions into positive and negative pressures.

Limits of space forbid giving a detailed account of many of the author's views. Pitch is primarily a variation of *quality*, or it includes that within it. Physiologists have used the term "quality" with a different meaning, and they prefer a "quantitative classification" of pitch. Pitch, in our view, depends on the number of pressures on the auditory mechanism, or the duration of each pressure, and this fits in with a theory of resonance. Again, the word "mass," as applied to tones, is liable to lead to confusion. "Bi-tonal mass" is a term difficult to understand; the meaning of tone or blending of tones is clearer if we think of the fusion of two or more waves to form one. There is an important chapter on the analysis of tonal sequences, and interesting explanations are given of experiences on this subject. The author discusses melody and the formation of scales. "Intensity is not, as is often supposed, the direct basis of auditory localisations, but only the indirect basis. It is required to provide a means whereby the predominance of one order over others may be attained." There must be a predominant order. This is difficult to understand. Surely it is easier to regard intensity as the result of greater or less stimulation? The author gives an admirable summary of his conclusions. His most important point is that the cochlea has few of the characters of an analytic apparatus, and thus much of the resonance theory is discounted.

This is undoubtedly a book on psychology, but it will indirectly be of much service to the physiologist. The physiologist has to explain how the ear works, and he confines himself to the mechanism. The psychologist adds to this, mainly by introspective methods, an attempt to explain the experiences associated with hearing, and the feelings that arise from these. Psychology and physiology are distinct departments of science, and each must be investigated by its own methods. The danger is to allow one province to encroach on the other. One has to remember also that when we listen to a tone, or a combination of tones, as in music, we have to do not only with the cochlea, but with neural processes in the brain and elsewhere. The psychologist may be able to frame theories that will explain these experiences, but neither he nor the physiologist can tell us much of the neural phenomena. We do not accuse Dr. Watt of mysticism. He is too learned a psychologist to fall into this error. An extensive bibliography, enumerating no fewer than 159 separate works, shows how he has drunk deeply at the well-springs of both psychology and physiology. Not a little in this book will awaken reflection. There is an excellent index.

J. G. M.

OUR BOOKSHELF.

Cotton Spinning. By W. Scott Taggart. Vol. iii. Fourth edition. Pp. xxviii+462. (London: Macmillan and Co., Ltd., 1916.) Price 10*s.* net.

MR. SCOTT TAGGART'S treatise has become a standard book of reference on cotton spinning, and deservedly so; the illustrations are excellent, the descriptions of the various pieces of mechanism are clear and adequate, and the scheme of the work is based upon the regular sequence of the movements dealt with.

Vol. iii. is devoted to mule and ring spinning, to winding, doubling, reeling, gassing, bundling, mill planning, and humidity. It also contains a chapter on "Useful Information." In most cases attention has been given to the relative importance of the several sections into which the treatise is divided, but more care might, with

advantage, have been given to this aspect of the subject. For example, four times as much space is devoted to reeling, and nearly as much to bundling, as to gassing. This is not commensurate with the relative importance of the operations.

It is when the author turns his attention from machinery to the material to be treated and after its treatment that lack of clearness, loose statements, over-statements, and errors are found. The matter on p. 17 relating to the diameter of yarns may be cited as an example of these defects. Mr. Taggart's book, as a whole, is so good that it is unfortunate that those parts which deal with cotton and its behaviour during and after spinning have not been revised.

How to Know the Ferns. By S. L. Bastin. Pp. viii+136. (London: Methuen and Co., Ltd., 1917.) Price 1*s.* 6*d.* net.

THIS book contains descriptions of the British ferns and their allies, prefaced by an account of ferns in general and an outline of their classification. The chapter on life-histories is well up to date, as is also that on fossil ferns, a group usually ignored in books of this kind. The species are described without unnecessary technicalities and on a uniform plan; first comes an explanation of the name, then a general account of the structure of the plant, followed by an indication of its habitat and, in most cases, hints on its cultivation. These descriptions, written in narrative form, give a good account of the general appearance and distinctive characters of the various species, but their use would have been greatly increased by adding a short key to genera to the synopsis of families on pp. 8–12. The last two chapters deal with collecting, preserving, and cultivating ferns.

Amongst the fern-allies there is a description of *Azolla caroliniana,* an American water plant, which has been naturalised and has spread with great rapidity during recent years in this country, but no reference is made to *A. filiculoides,* which is also naturalised in Britain.

There are thirty-three illustrations taken from photographs, which have not been reproduced very successfully. This book is a trustworthy and up-to-date addition to the many popular accounts of British ferns. C. H. W.

Chemistry in the Service of Man. By Prof. Alex. Findlay. Second edition. Pp. xvi+272. (London: Longmans, Green, and Co., 1917.) Price 6*s.* net.

WE are glad that Prof. Findlay's enlightening account of the facts and ideas of chemical science of to-day has reached a public large enough to require a second edition within about a year of its original publication. The work was described in our issue of August 31, 1916, as "a distinct and valuable addition to the popular literature of science"; and the encomium then passed upon it has been fully justified. A new chapter has been added on "Fermentation and Enzyme Action," but otherwise the volume remains unchanged. Not many works on chemistry can be followed with interest by lay readers, but this is one of the first rank, and it should long continue to perform the useful service of stimulating attention to chemical science for its own sake as well as for the value of its achievements to man.

CHEMISTRY AND THE WAR.

A RECENT issue of *Science* (June 15) contains an address by Prof. J. R. Withrow, delivered at the Columbus meeting of the Ohio Academy of Science, on "The Relation of War to Chemistry in America," which has certain features of interest for us at the present juncture. To begin with, it is a scathing indictment of the mentality of a people that can condone and even applaud the damnable conduct of their armies and Government at home and in the hapless countries for a time at their mercy. The nation seems to have become the willing, or at least the easily manipulated, pawn in the hands of unscrupulous statesmen.

We have not forgotten that it was a chemist—Ostwald—in the early days of the war, when he was acting as a spokesman for Germany to men of science throughout the world, who was quoted, when Germany was in the flush of her initial victories over Belgium, as saying the world had outgrown the idea of freedom for little or weak peoples.

The *Kultur* that can lead men of great mental endowments and catholicity of thought into such a mental position stands self-condemned. It affronts every instinct of charity and fair-dealing and stinks in the nostrils of right-minded men.

The greater part of the address, however, is concerned with a question of more immediate practical importance to chemists, namely, the influence of the war upon the progress and development of their special branch of science. Of course, it need scarcely be said that this world-wide cataclysm, affecting directly the most powerful and most highly developed of nations, has profoundly modified the course and trend of chemical progress. But it would be untrue to affirm that it has stagnated or declined as a consequence of war.

"Since," says Prof. Withrow, "war requires brains, science is of course utilised, and since the demand is inexorable, science must produce, and when science and engineering are producing, they grow."

It is stated that it requires three men in the shops to maintain one man in the Army and seven men for one in the Navy.

It is evident therefore that it is the applied portions of science that are most used, and hence that grow most under war's influence. It is common experience, however, that the stretching into new domains and the striving for new goals by applied science enrich the feeding-ground of unapplied science, and uncover fertile fields for the patient and quiet research which follows.

But there can be no doubt that, whatever the future may have in store for us, in the meantime progress in pure chemistry all the world over has been greatly retarded, and in proof of this Prof. Withrow points to the serious and progressive decline in the number of *Chemical*

Abstracts published by the American Chemical Society since the beginning of the war. It is claimed for this publication that, as the organ of a society of some 9000 members, it has for years covered the field of chemistry more thoroughly than any foreign journal of the kind. It reviews some 600 journals from all parts of the world, and is therefore a sure index of the world's chemical activity. The effect of the war on current chemical literature is plainly evident from the following figures:—

Total number of abstracts published (patents included).

In 1913	25,971
In 1914	24,338
In 1915	18,449
In 1916	15,784

Certain foreign chemical journals have ceased to be published since the war started, although the number is not large. Most of the French and German journals are published less frequently than in normal times, two or more numbers being contained within one cover. No important English, Italian, or Russian chemical journal has ceased publication. Eight German, thirty-one French, and seven Belgian periodicals more or less connected with applied chemistry no longer appear. Owing to the increased cost of paper, wages, etc., the cost of production of such as continue to be printed has greatly increased. In America, however, to judge from the cost of *Chemical Abstracts*, the increase has not exceeded 10 per cent. But this was before the entrance of the United States into the war.

As regards applied chemistry war has had two mutually antagonistic effects—one retarding, the other developing and benefiting. In the outset the war struck at all the main factors of success in chemical industry, and many branches in the United States, such as petroleum refining, turpentine and other wood products, were hard hit. Important markets were suddenly lost, and the importation of certain essential products ceased. Capital was, of course, at once discouraged, and stagnation inevitably set in. That the great German combines foresaw this result was evident from the manner in which, prior to the outbreak, they organised American branches of their colour works, eliminating American employees to conceal the market and its peculiarities, and placing all their business in the hands of "American citizens" of German name. Then when the U.S. Bureau of Foreign and Domestic Commerce attempted last September to publish the amounts of each dye consumed in that country, they vigorously protested that their rights as American citizens were being infringed by encouraging competition. The uncovering of this octopus to public gaze should be set down to the war's credit. It has long been a familiar animal to many industrial chemists.

The tentacles of the "familiar animal" stretch, as is well known, even to this side of the Atlantic, and have struck deep into our industries. We may hope, in spite of Chancellor Michaelis, it is in a fair way to be exorcised.

Much of Prof. Withrow's address is concerned with the efforts which America has made, and is making, to free herself from the toils of the octopus, and he utters words of warning against the feverish and unintelligent haste with which she has thrown herself into the struggle. He gives a number of instances in which inexperienced capital has been led to squander millions of dollars on the unsuccessful plants and futile schemes of ignorant or unscrupulous chemical engineers. It is a "hustling" time in a country of "hustle"—with, as we are told, "disastrous results to capital and grave loss of confidence in chemical research." At the same time there has been much real progress. "The evils mentioned are largely growing pains." The progress in industrial chemistry and chemical engineering in America during the last three years has been wonderful.

"All this progress," says Prof. Withrow, "is in spite of the war. War," he holds, "could force us to do nothing we did not possess capacity for before. . . . Industrial chemical tendencies during the war have been governed by unusual demands for chemicals from abroad in addition to war drains, healthy home requirements, new demands from industries formerly supplied from abroad or forced to use new material by scarcity or high prices, together with speculation, raising prices to unusual levels. This resulted in expansion of existing plants, rapid installation of new ones, hasty perfecting of new processes already slowly maturing, and the seizing of opportunities to profit by high prices through erection of small plants for the production of special chemical materials and through the development of processes hitherto existing as possibilities only in the minds of chemists."

As was to be expected, this extraordinary activity has reacted upon the developments of chemical engineering and upon the manufacture of chemical appliances and manufacturing plant, and it is asserted that the progress in these departments has been as great during the past three years as has been accomplished in many previous decades.

It is gratifying to learn that this country is fully awake to the necessity of studying the after-war conditions of our chemical industries, as shown by Dr. Addison's reply to a deputation of the Association of British Chemical Manufacturers which recently waited upon him, in which the Minister of Reconstruction suggested the formation of an advisory committee which should co-operate with him in considering the problems which had been created by the large number of new factors arising out of the war. He thought that if we did not succeed in placing some British industries on a much firmer and more scientific foundation than they were before the war, it would be very discreditable to us all as a nation. This is undoubtedly a step in the right direction. But Heaven helps those who help themselves. However benevolent may be the intentions of a Government department, success will only be assured by the intelligent initiative and firm co-operation of the manufacturers themselves. To attempt to shape their policy at the bidding of a bureaucracy would almost certainly end in disaster.

T. E. THORPE.

SCIENCE AND INDUSTRY.[1]

THIS is the first of a series of papers which the Department of Scientific and Industrial Research proposes to publish, and it is a report of remarkable value and interest at the present time. It describes the progress made in the United States, chiefly in recent years, in the creation of institutions concerned in industrial research, and is illustrated by eighty-five excellent photographs of buildings and the interior of laboratories.

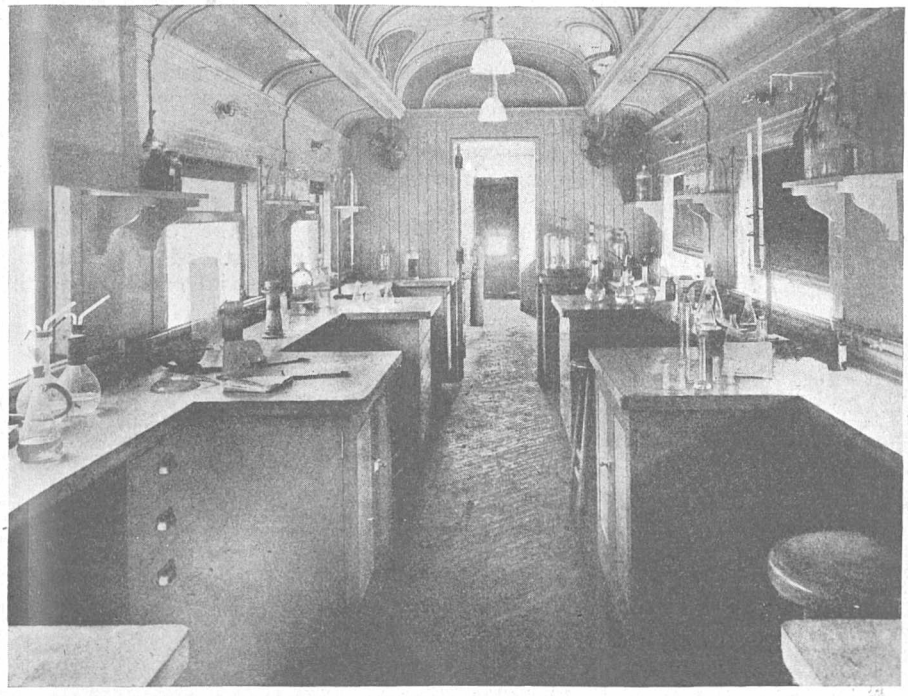

FIG. 1.—Laboratory car, Pennsylvania Railroad Company.

It is pointed out that in this country the chief facilities for research are in the technical schools and universities, though the railways, steelworks, and some other industries have realised the need of laboratories and have provided them. But the staffs of colleges and universities, though well suited to carry on research in pure science, are not as a rule in touch with industry, and the amount of research required for industrial progress is beyond their resources. Hence it may be conceded that "the research facilities created to such an extent during the past two years are as yet quite disproportionate to the magnitude of British industry." This is true without the limitation to two years.

What is most striking about the condition of research in the United States is the large amount of money devoted to it. There are a number of manufacturing corporations the annual expenditure of which on research ranges from 10,000*l.* to 100,000*l.*, and there is a tendency for each large industrial firm to establish its own research laboratory.

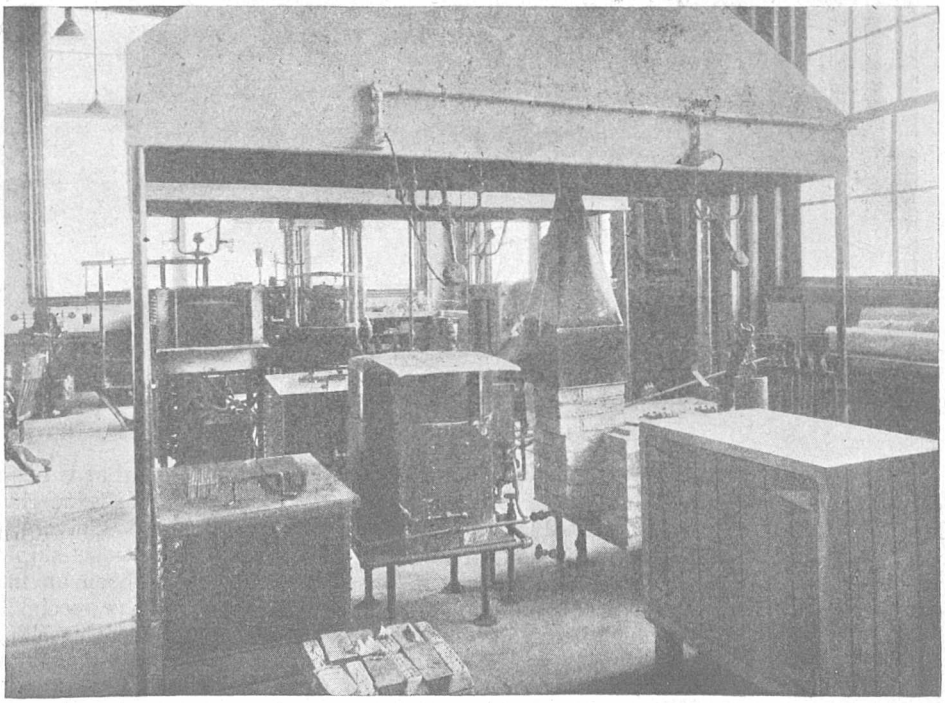

FIG. 2.—Heat treatment laboratory, Pennsylvania Railroad Company.

Thus the Eastman Kodak Company established a laboratory which cost 30,000*l.*, and though its annual cost is about the same, this is only 0·7 per cent. of the annual profits. The

[1] "Industrial Research in the United States of America." By A. P. M. Fleming. (Published for the Department of Scientific and Industrial Research by H.M. Stationery Office.) Price 1*s.* net.

General Electric Company expends annually on research 80,000*l.* to 100,000*l.*, and has a laboratory staff numbering 150. The Pennsylvania Railroad Company erected laboratories at a cost of 60,000*l.* for buildings and equipment, and a locomotive testing plant at a cost of 40,000*l.* The annual maintenance cost is about 100,000*l.* The laboratory cost is only about 0·6 per cent. of the value of the materials tested. Besides these private institutions there is the Bureau of Standards, on which the Federal Government spent 270,000*l.* for buildings and equipment, and to which it gives a subvention of 120,000*l.* a year. The Carnegie Institution of Washington, for encouraging investigation, research, and discovery, has an endowment of 4,500,000*l.*

York. This is controlled by the bond-holders of the Association of Edison Illuminating Companies. It has a floor area of 30,000 sq. ft. and a staff numbering 125. Its primary object is lamp testing, and about twenty million are tested annually. But it has also provision for chemical and fuel testing and photomicrographic work.

With regard to the universities and colleges Mr. Fleming says:—"A careful consideration of the conditions in the six States having the greatest manufacturing output fails to show, other than in isolated instances, very close co-ordination between university research and the manufacturing interests." But although in the report the work of universities is, we think, rather less adequately described than that of industrial companies, still

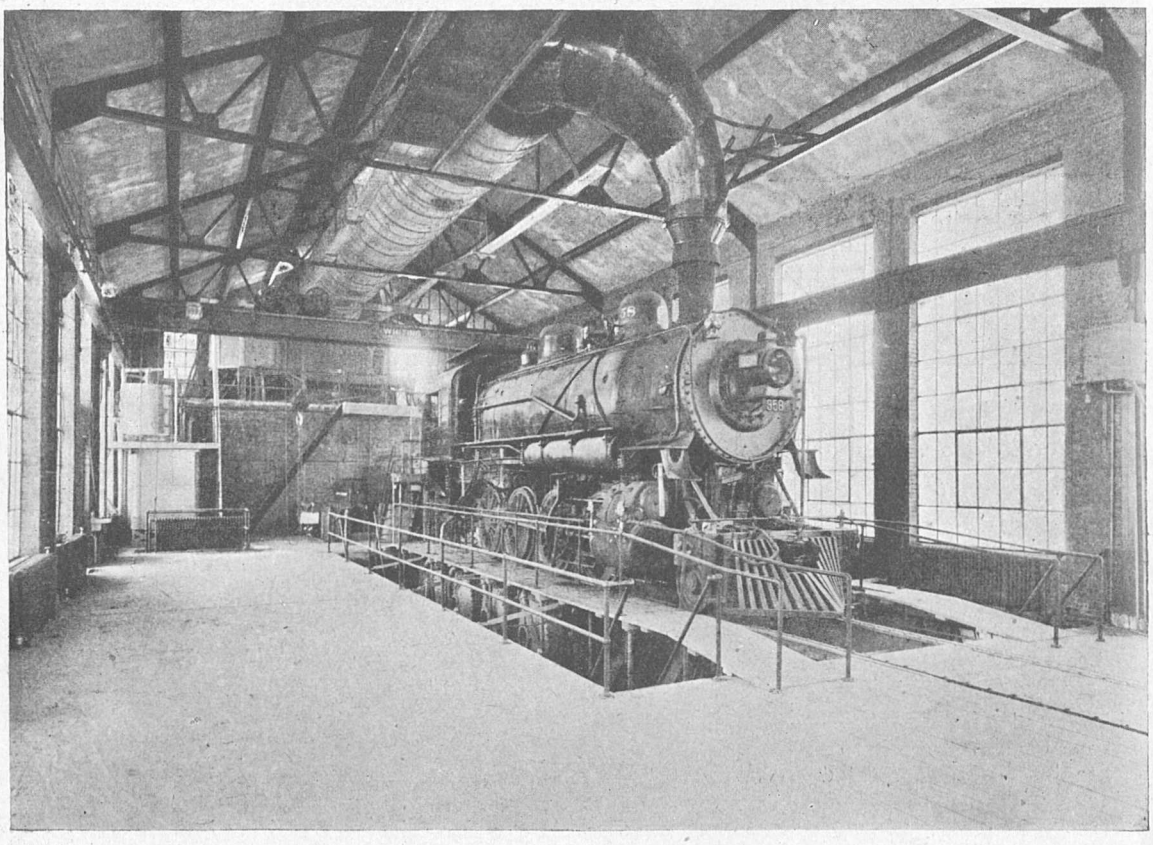

FIG. 3.—Locomotive testing laboratory, University of Illinois.

With regard to the very extensive laboratories of the General Electric Company at Schenectady, N.Y., it is stated that it is "generally acknowledged that the research laboratory has been an unquestionable financial success, not only because it has solved regularly the industrial problems of the large organisation with which it is connected, but also because it has produced discoveries which the company can turn to advantage. . . . Further, the research department is able to pronounce authoritatively, for the benefit of capitalists, on the probabilities of success of new projects involving considerations of a scientific character."

An example of commercial research laboratories is the Electrical Testing Laboratory at New

there is evidence that it has been of great service, especially to the engineering industry. For instance, Michigan University has at Ann Arbor a tank for testing ship resistance, and its researches have been an important factor in the development of the special freight boats used on the great lakes. The Illinois University has a laboratory for investigations on a full-size locomotive engine.

A very interesting development in the United States is the creation of research fellowships by industries requiring special investigations. Thus, at the Worcester Polytechnic, Mass., four men are selected annually from the graduate class to pursue research work for an engineering firm.

During two years, half the time is devoted to research and half to preparation for a professional degree. At the end of the period these students enter the research department of the firm.

The Mellon Institute of Industrial Research, attached to the University of Pittsburg, was erected by Mellon Brothers, bankers, to provide manufacturers with the use of a well-equipped laboratory and trained staff at less cost than the establishment of a works laboratory. Any manufacturer requiring a subject investigated can endow a fellowship for one or more years, paying from 100*l.* to 400*l.* and also the cost of any special apparatus. The building cost 50,000*l.*, and the equipment 16,000*l.* A staff of seven men of high attainments supervises the researches. The director of the institute selects the fellows, usually men with a doctor's degree. Seventy-five fellows have been appointed in five years. The total amount spent in salaries and maintenance is 30,000*l.* a year.

A National Research Council has recently been appointed by the Academy of Sciences, at the request of President Wilson, to co-ordinate the scientific research work of the country.

The report, of which this is a very brief account, is extremely comprehensive, and should be read by all interested in the industrial progress of this country. The author draws some general conclusions, and suggests the establishment of an Imperial Industrial Research Laboratory, say, in the Midlands, controlled by a board largely composed of manufacturers.

RAINFALL AND GUNFIRE.

M. ANGOT, the eminent director of the French Meteorological Service, has made a valuable and authoritative contribution, published in the Journal of the French Academy of Agriculture for May, to the literature of a well-worn controversy. The alleged connection between rainfall and gunfire, in favour of which so many champions sprang up during the wet periods of 1914–16, has recently lost favour as a subject for argument, owing, no doubt, to the coincidence of the spring drought of 1917 with the Allied offensive on the Western front; but so short is the public memory, especially for negative evidence, that the incidence of 3 in. of rain during a recent summer afternoon in North-West London has proved sufficient to disinter the bone of contention. The mental attitude of the public towards a theory of this nature is of great psychological interest: there is little doubt that, should we experience this summer a repetition of the weather of July, 1888, when snow fell in London, followed by a recurrence of that of August, 1911, when the thermometer touched 100° F. at Greenwich, both phenomena would generally be attributed to the war.

Accordingly M. Angot's paper reaches us at an opportune moment. After dealing briefly with the historical aspect of the question, and alluding to the work of M. Le Maout—who, not content with having established a connection between the bombardments of the Crimean War and the rainfall of India, the United States, Nicaragua, and Barbados, went on to ascribe the diurnal variation of the barometer to the striking of public clocks and the ringing of church-bells—M. Angot proceeds to consider the physical changes which could be effected by the discharge of artillery, and could at the same time be held responsible for the causation, increase, or acceleration of rainfall.

The first proposition is that a succession of violent explosions might result in the displacement of masses of cold air at certain heights, which, coming under the influence of the upper winds and encountering layers of warmer, saturated air, could give rise to precipitation which would not otherwise have occurred: in this connection the author points out that in order to obtain a rainfall of so small an order as 1 mm. (0·04 in.), even if one were to take two equal masses of saturated air, the one at a temperature of 0° C., the other at 20° C. (an extreme case, of course), it would be necessary to effect a rapid and thorough intermingling of the two throughout a layer of air 6850 metres in thickness. In M. Angot's opinion, the mixing of layers of air may be the cause of cloud-formation or of slight drizzle at the earth's surface, but can never be responsible for considerable precipitation.

In the case of the second proposition—that water-vapour resulting from chemical reaction of the explosives might take effect—it is asserted that in order to produce the same amount of rainfall (1 mm.) as in the previous proposition the employment of no fewer than 21,750 tons of melinite per square mile would be necessitated—that, indeed, only on the supposition that all the hydrogen in the explosive became water-vapour which condensed immediately in its entirety and, so to speak, on the spot.

In the third and last instance, the possibility of electrical action being brought into play is considered in some detail. We know that supersaturated air (*i.e.* air which contains more water-vapour than it normally should be able to hold for the existing temperature) is a physical possibility, in the absence of dust-particles or other matter which may form nuclei for condensation. The necessary medium may be supplied by the action of ozone, of ultra-violet rays, by any cause, in fact, which can set up ionisation of the atmosphere; under this last category may be classed the detonation of high explosives, inasmuch as highly ionised gases result therefrom. The lower regions of the atmosphere, however, which alone are the seat of explosive activity on a large scale, always harbour large numbers of both ions and dust-particles, and cannot, therefore, be subject to supersaturation; while it has yet to be shown that the addition of quantities of ions or of dust-particles to a stratum of atmosphere nearly, but not quite, saturated can bring about premature condensation. Assuming for the moment the possibility of such a hypothesis, we must consider that no outpouring of ions or dust-particles can do more than accelerate a precipitation which would be necessitated sooner or later

by the progressive cooling of the air, since the mass of water that results from the cooling of, say, a kilogram of saturated air from 15° C. to 0° C. is constant (rather more than 5 gr.), whether or not supersaturation may have existed at the inception of the temperature-reduction.

Having thus pronounced upon the theories which have been advanced to account for the alleged connection, M. Angot goes on to consider whether in reality anything has occurred that needs accounting for—whether the rainfall since the outbreak of hostilities has been less inclined to observe the rules by which we endeavour to forecast its occurrence than before. Careful comparison between the daily weather-maps and the observed rainfall figures has convinced him that it is not. He points out, very rightly, that we have been passing through a series of wet years since 1909—a period that balances the run of dry years 1898–1904 (1903 and 1911 were both exceptions to their groups and may be said to balance one another)—and that excess of rain in 1915 and 1916 might reasonably have been expected; that 1909 was wetter (in France) than 1915, 1910 than 1916; furthermore, that during December, 1915, an unprecedentedly wet month, relative calm prevailed over the whole front, and that in the second ten-day period of the very wet February of 1916 considerably more rain fell (40 mm. as against 28 mm.) than in the last ten-day period, which witnessed the development of the giant German bid for Verdun. Similar conclusions will be reached if frequency of rain instead of amount be considered: 1910 had more rain-days than 1916; 1912 and 1913 both more than 1915, when the number in France was eleven below the average. The author has found nothing exceptional in the local distribution of rainfall: proximity to the firing-zone has not resulted in relatively greater totals or frequencies, while the great spring offensive of 1917 failed to interrupt the long spell of brilliant weather which accompanied it.

An examination was made some months ago at the British Meteorological Office into the local distribution of rainfall over England during the first twenty-two months of the war, the results of which afford corroborative evidence for M. Angot's last-mentioned point. It was found that the greatest excess of rain over the normal figure was one of 59 per cent. on the South Yorkshire coast; that three areas in Lincolnshire and on the Norfolk and Suffolk coasts respectively had rather more than 40 per cent. excess; but that round the North Foreland there was a slight deficit. No trace whatever of a distribution having reference to a centre over northern France was discoverable.

M. Angot concludes with the reflection that it may be with rainfall and gunfire as it is with weather changes and the phases of the moon, that "sous la suggestion d'une croyance instinctive on est conduit involontairement à ne remarquer que les coïncidences favorables et à s'affermir ainsi de plus en plus dans cette croyance." For those, indeed, who are cognisant of the relationship between the weather and modern warfare it is not difficult to see the possibility of the connection, but it is a connection in which the amount of gunfire varies inversely as the amount of rain that is falling rather than one which makes the rainfall in any way dependent upon the gunfire.

E. L. HAWKE.

NOTES.

M. PAUL OTLET, who is director of the International Institute of Bibliography at Brussels, has published a long and interesting memoir in the May–June number of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* on the question of the establishment, in Paris, of a Central Information and Records Office for Industry. There are already in existence a certain number of enterprises of the kind, such as the *Mois Scientifique et Industriel* in France, the *Engineering Index* in England, and the *Repertorium der technischen Wissenschaften* in Germany, but their scope is limited. According to M. Otlet, the scheme should assume an international character, and its functions should be the collection, classification, and dissemination of all information available, both French and foreign, which will tend to facilitate and develop industry. A mere catalogue of works on particular subjects is not alone sufficient; a bibliography should be included in the scheme, so as to afford more detailed information on any desired subject. Books of all kinds, pamphlets, catalogues, descriptions of processes, journals, standard reference books of all countries, plans of machinery and plant, where available, a complete set of patent specifications, prospectuses of educational establishments, etc.—all would be collected and classified in accordance with a plan definitely laid down beforehand. Extensive card or similar indexes would be compiled for reference, and a complete catalogue on the decimal system, together with a bibliography, would be published at definite intervals. All these works would be available for free consultation by interested parties. Authors and publishers would be invited to co-operate in order to ensure the success of the enterprise. Existing publications, *e.g.* the International Catalogue of Scientific Literature, would be used as the nucleus of the work. It is to what the author calls the science of "documentation" that the Germans owe to a great extent the place they have attained in the industrial and military world, although they have often employed unscrupulous means to reach their end. He suggests that every industrial concern should have its own information and records department, which should be planned on the same lines as the national establishment, with which it should keep in touch. In connection with the question of patents, it was suggested at the Conference of Allies held at Paris last year that an international patent office be formed after the war, to save the time and expense now required for taking out patents in various countries. An undertaking of this nature would greatly increase the necessity for a more elaborate—practically an international—Record and Information Office to enable all questions of priority and infringement to be dealt with efficiently. Every phase of an important subject is reviewed in this memoir of thirty pages.

WITH a view to the just apportionment of pensions due to soldiers for injuries received in the present war, the French Government has established at Paris, at the instigation of Dr. Camus, a well-known military surgeon, a special centre for determining scientifically the extent of incapacitation. This establishment will serve both as a research laboratory and for the additional treatment of those who have already undergone the usual hospital treatment. Here special

measurements are carried out with instruments designed by Dr. Camus, these measurements having reference to (1) the anatomical condition, and (2) the physiological function of the injured part. The special instruments include those for measuring the movements of the joints, a special dynamo-ergograph for studying small movements, a device for recording vaso-motor disturbances, and an apparatus for recording trembling. The methods of this laboratory permit of replacing the long descriptions of specialists by documents of a more complete and scientific nature, *i.e.* photographs, numerical tables, curves, etc., which can only be interpreted in one sense. The insurance companies are interesting themselves in this new method of determining bodily efficiency, and hope to employ it in all cases of disputes arising out of compensation awards for accidents. The writer of the article in *La Nature* for July 28 (from which this note is derived) hopes that this system of evaluation will prevent exaggerated claims and make for equity of treatment as regards the pension to be paid to the partially disabled.

IT is stated in the *Scientific American* that Dr. G. Müller has been appointed director of the astrophysical observatory at Potsdam, in succession to the late Prof. K. Schwarzschild.

THE Baly medal of the Royal College of Physicians of London has been awarded to Prof. W. M. Bayliss, and the Bisset-Hawkins memorial medal to Sir A. Newsholme.

THE Edward Longstreth medals of the Franklin Institute have been awarded to Prof. A. E. Kennelly and Messrs. F. H. Achard and A. S. Dana, for their joint paper on "Experimental Researches on the Skin Effect in Steel Rails."

ACCORDING to a telegram from Wellington, New Zealand, a violent earthquake has occurred in the southern portion of North Island, causing great damage. The Wairarapa district suffered most. The earthquake is described as the worst since the upheaval in the 'fifties.

WE learn from *Physis* that Dr. G. R. Wieland, of Yale University, U.S.A., has spent the last season in collecting fossil plants in the Argentine Republic. He has paid special attention to the Rhætic formations of Mendoza and the Lias of Neuquen.

THE Rockefeller Foundation, with the co-operation of the Philippine Government, is sending a hospital ship to the Moros and allied tribes of the Sulu Archipelago. It is intended that the ship shall cruise for five years among the many islands in the southern Philippine group, the Rockefeller Foundation having learned that many of the Moros are suffering from skin diseases, malaria, hookworm, dysentery, and other diseases.

A SPECIAL series of preparations has just been placed on exhibition at the Horniman Museum, Forest Hill, S.E., to illustrate the stages in the life-histories of numerous insects which damage the food plants grown in gardens and allotments. Specimens and models showing the damage done are also exhibited, and means of combating the pests indicated. Visitors to the museum may obtain there copies of the leaflets of the Board of Agriculture dealing with the insects shown.

EXCEPTIONALLY heavy rains occurred over the east and south-east of England during the closing days of July and on the opening days of August. For the four days from July 30 to August 2 inclusive the rains were heavier in many parts of London than for any similar period for the last twenty-five years. At South Kensington, the recording station of the Meteorological Office, the measurement for the four days was 3·28 in., which is 70 per cent. of the average London fall for July and August combined. According to the weather reports from the health resorts the rainfall at Southend was 3·44 in., which is 89 per cent. of the average fall for July and August, and at Margate 3·48 in., being 84 per cent. of the average for the two months. At Hastings the rainfall measured 3·16 in., at Eastbourne 2·60 in., and at Bournemouth 2·00 in. In the northern and western parts of England the rainfall was slight, and in the midlands it was by no means heavy. The subsequent rains in the south-east of England have been frequent, but not heavy. During the period of the heavy rains the temperature was very low for the time of year, and on several days the midday temperature remained below 60°. The disturbances which occasioned the rains in England also caused very wet weather in Flanders and other parts of north-western Europe.

IN *Science Progress* for July Prof. Flinders Petrie contributes a valuable paper on "History in Tools." He points out that while there are many books on offence and defence, arms and armour, there is none that traces the history of our mechanical aids. Thousands of writers have described the sculptures of the Parthenon, but not one has described the means used in performing that work. It is a mystery to us how fluted columns with an entasis could be produced, true to a hundredth of an inch, in the diameters between the deep groovings. He goes on to describe the evolution of tools from the age of Stone to that of Iron, and he sums up the discussion in the following words:—"Thus the spread of forms throughout the ancient world illustrates the movements of trade and of warfare, while the isolation of various types at the same time shows how efficient and self-supporting the ancient civilisations were in most requirements. The history of tools has yet to be studied by a far more complete collection of material, above all of specimens exactly dated from scientific excavations. It will certainly be, in the future, an important aid in tracing the growth and decay of civilisations, the natural history of man."

THE report of the Somerset Archæological Society is, in spite of difficulties caused by the war, which have impeded the excavations at Glastonbury, a record of steady progress. The great work of the year is the completion of the report of excavation of the Lake Village at Glastonbury, on which Dr. A. Bulleid and Mr. St. George Gray are to be congratulated. The society has wisely organised an advisory committee on church restorations in the county, which will, it may be hoped, secure the protection of ancient ecclesiastical buildings, and prevent any proposed restorations which threaten to destroy their archæological value.

IN the July *Quarterly Review* there is a clearly written and shrewd article on the problem of degeneracy by Dr. A. F. Tredgold. He defines degeneracy as "a retrograde condition of the individual resulting from a pathological variation of the germ-cell," and suggests that the word "decadency" might be used to denote the somatic modification arising from a defective environment. Any usage which will keep two distinct conditions from being confused with one another will be a gain in thought and action. To prevent hereditary retrogressive variations being continued and diffused is the problem of restrictive or negative eugenics, but can we not discover how they arise? (1) Some investigators—*e.g.* Dr. C. B. Davenport—believe that feeble-mindedness means a perpetua-

tion of a distantly ancestral or Simian condition. But feeble-mindedness as we know it does not look like a stage in an evolution that went on! Mosckoff is more explicit. He traces all degeneracy and much else to the persistently assertive influence of a Pithecanthropus strain, which unfortunately got mixed up long ago with that of "white diluvial man," who seems to have been a sort of Apollo. (2) Another so-called theory is that retrogressive variations are fresh "spontaneous" sports, bad shots on the part of the changeful germ-plasm. But there are few who are inclined to rest satisfied with the word "spontaneous," which is only a confession of ignorance. (3) So the third view is that retrogressive variations arise as variations conditioned by a disturbing, depressing, or deteriorating immediate environment, such as toxic conditions of the parent, which may induce senescence or enfeeblement in the germ-cells. The author might have referred with effect to the striking experiments of Werber, which show how toxic agents, like butyric acid and acetone, produce no end of monstrosities in the developing fish-embryo. Perhaps, as Werber suggests, parental metabolic toxæmia higher up in the scale may account for degeneracy in the offspring. Dr. Tredgold directs attention to the fact that the chief expression of degeneracy occurs in the most elaborate, and phylogenetically the most recent, part of the organism—namely, the higher parts of the brain. From his own experience, he notes that all the offspring of two markedly degenerate persons are always defective, and that those resulting from the union of a pronounced degenerate with a healthy individual tend to be, not some normal and some abnormal, but all abnormal.

In the *Revue Scientifique* for July 14–21 M. André Godard directs attention to the important services rendered by birds to agriculture. The depredations of insects on cultivated crops, both at home and abroad, he points out, are so serious that it is well that we should realise their extent and the good that is done by truly insectivorous species of wild birds. The opinions of many authorities are quoted, and figures given in support of their various statements, which show that enormous numbers of insects, insect larvæ, and eggs are annually destroyed by birds, which, if permitted to live, would make profitable cultivation impossible. M. Godard is of opinion that although many species may appear to be injurious, they are really beneficial when the nature and quantity of their food are carefully considered. He seems to regard the situation as one in which we must be content to put up with a small amount of damage by birds or absolute disaster due to injurious insects. Whilst fully agreeing with all the author claims for the truly insectivorous species, we must differ from him in regarding the damage done as small, and bearing in mind that the truly injurious species are comparatively few in number, we think that agriculture will best benefit by the elicitation of a thorough and detailed knowledge of their feeding habits and the nature of their food throughout the whole of the year, and the enactment of wise measures for the destruction of such species as are known to be too plentiful. We believe that in France, as in Great Britain, many of the insectivorous species of wild birds have suffered owing to the unrestricted increase of the commoner and injurious species, and the situation is one that will not improve by neglect or by the shutting of one's eyes to the actual facts.

The *Scottish Naturalist* for July–August is entirely devoted to the report on Scottish ornithology in 1916 by the Misses Leonora Rintoul and Evelyn Baxter. This in every way maintains the high standard of their reports of former years. One of the most striking of the many good things they record concerns the herring-gull, nesting on the cliffs at North Uist and the Skerries. After building their nests, which they seem to have done in normal numbers, very few of them laid eggs, and fewer still hatched out young, not more than a dozen being brought off where there used to be scores. So far no explanation of this state of affairs is forthcoming, though it was believed, in the case of the North Uist birds, that this failure was due to the plague of rats which infests the cliffs there, but it is clear, they remark, that this explanation fails. The presence of rats in such conspicuous numbers on cliffs facing the sea is in itself a noteworthy fact, and should be kept under observation. "One of our correspondents," they write, "records about twenty pairs of red-necked phalaropes." But the precise breeding-place of this bird is rightly withheld. Another note concerns the spotted flycatcher, eight or nine of which were watched catching flies over a big pool in the Malzie Burn, Corsemalzie, where one of them was seen to alight several times on the still water.

Mr. N. Hollister, superintendent of the National Zoological Park, Washington, in the Proceedings of the United States National Museum, vol. liii. (June), records some valuable notes on the effects of environment and habit on captive lions, which will be read with interest, not only by those desirous of obtaining data of this kind, but also by such as are responsible for the selection of specimens for museums. The author shows clearly enough that captivity produces very marked changes, both in the coloration and length of the pelage and in the skeleton, particularly in the skull, where the regions affected are chiefly the areas of origin for the muscles concerned with the seizing of the prey and with certain of the masticatory muscles. Further, the brain capacity in captive lions is much less than in wild specimens.

The April issue of the *Agricultural Journal of India* (vol. xii., part ii.) contains two notes from different sources on materials said to be now used in Germany as substitutes for jute, and their probable significance as future competitors with Indian jute. Waste paper and cellulose are dismissed as unlikely to be more than war-time substitutes, but a more serious view is taken of the possibilities of the two plants, *Epilobium hirsutum* (hairy willow herb) and Typha (reedmace), which are said to be now utilised for fibre by the Germans. The opinion is expressed that the former is unlikely, for some time at any rate, to prove a serious competitor, owing to the necessity for prolonged cultural improvement of the plant before good fibre-producing strains can be evolved. Typha fibre, according to a quotation from the *Chicago Daily News* of October 1, 1916, would appear to be a more formidable competitor. It is claimed in Germany that this material, "if it meets with expectations," will make Germany independent of the importation of cotton, jute, and wool, and the further assertion is made that Germany so early as next year will make enough of the material to equal all the supplies usually imported, largely from America and Egypt. Capital for the exploitation and manufacture of this material has been subscribed by "the greatest spinners, merchants, and bankers of Germany," and attention is being directed first to the development of the coarser grades of material.

The June issue of *Tropical Life* contains a review by Mr. H. C. Brill, of the Bureau of Science, Manila, of the outlook for the alcohol industry in the Philippines and the tropics generally. Three of the cheapest sources of alcohol occur in the tropical countries, namely, sugar-cane molasses, "tuba" from the nipa palm, and possibly from the coconut palm, and starch from the starch plants, such as cassava and arrowroot.

The two former sources are already utilised to a considerable extent, the second largely predominating. In 1914 the islands produced about 12,000,000 proof litres of alcohol, of which more than 95 per cent. was made from the sap (tuba) of the nipa and of the coco palms. The molasses fermentation industry has suffered much from faulty methods, but considerable improvement is being effected through the activities of the Bureau of Science. The nipa palm offers a cheap source for the production of alcohol, each fruiting stalk yielding normally 30 to 50 litres of sap during a season, equivalent to an output per hectare of fully 30,000 litres of juice with an average sugar-content of 15 per cent. The utilisation of starch plants still awaits development. It is estimated that an average acre of cassava would yield more than three times as much starch as an average acre of maize, whilst, in addition, the cassava contains 4 to 6 per cent. of fermentable sugars. Arrowroot yields 18 to 22 per cent. of starch, and is no more difficult to handle than potatoes. It is predicted that when these sources are developed the tropical countries will secure a practical monopoly of the alcohol industry.

THE thickness of a covering of peat is often cited as giving some clue to the age of the surface on which it grew. Mr. S. R. Capps's recent remarks ("The Chisana-White River District, Alaska," Bull. 630, United States Geological Survey, p. 72) are thus of general interest. He points out that a seedling spruce sends out its first radial roots on the mossy soil, and, in a high latitude, follows these by others at higher levels, as the moss thickens and the food-supply from below is cut off through the rising of the level of ground frost. Hence, under such conditions, "the vertical distance between the lowest horizontal roots of a living tree and the surface of the ground represents the thickness of the peaty accumulation during the lifetime of the tree." Mr. F. V. Coville has informed Mr. Capps that trees of very slow growth may fail during unfavourable years to form distinct annual rings, and that the estimate of the age of the peat-layer by the age of the trees must take this into consideration.

MR. W. G. FOYE, in a paper on "The Lau Islands of the Fiji Group" (*Amer. Journ. Sci.*, vol. xliii., p. 343, 1917), concludes that there is here positive evidence of subsidence, and very good evidence of the development of atolls and barrier reefs during such subsidence. He regards, however, a general depression of the Pacific area as unlikely, owing to the irregular occurrence of uplifted and subsided blocks.

MR. J. COGGIN BROWN continues his description of "The Geology of the Province of Yünnan in Western China" in the Records of the Geological Survey of India, vol. xlvii., p. 205. The Silurian fossils collected have been determined by Mr. F. R. Cowper Reed, of Cambridge. The paper, with its foundation of hard travel, and its geographical observations interspersed with details of stratigraphy, reminds one of those of the pioneers of the last century, and the illustrations show what fine adventure awaits the surveyor on the borderlands of the British Empire.

THE Riviera or Ligurian earthquake of February 23, 1887, was one of the first earthquakes instrumentally recorded beyond the limits of the disturbed area. In the early estimates of the velocity there was considerable discordance, and a new estimate has therefore been made by Messrs. Agamennone and Cavasino (*Rend. della R. Acad. dei Lincei*, vol. xxvi., 1917, pp. 167–71). Taking the position of the epicentre as about 20 km. south of P. Maurizio, and using the twenty-eight best estimates in which the initial epoch is given, they find the mean velocity to be 2·54 km. per second, and the time at the epicentre 6h. 21m. 9s. a.m.

PROF. OMORI'S fifth memoir on the recent eruptions of the Asama-yama (Bull. Imp. Earthq. Inv. Com., vol. vii., No. 2, pp. 217–326) contains a list of the earthquakes and earth-tremors registered at Yuno-taira during the six warmer months (May to October) of each year from 1913 to 1916. This seismological station is situated on the west-south-west slope of the volcano, at a distance of 2·3 km. from the centre of the crater. As in his earlier memoirs, Prof. Omori divides the volcanic earthquakes into two types—the A-type, not directly accompanied by outbursts, and the B-type, caused by eruptions. The former consist of quick vibrations and are usually of very short duration, the latter of slow gentle movements and of comparatively long duration. The tables show, as Prof. Omori remarks, that the former earthquakes have increased in frequency from 34 in 1913 to 229 in 1916, while the latter have declined from 7126 in 1913 (all but 25 corresponding to very small outbursts) to none in 1915 and 2 in 1916. Since May 5, 1914, there has been no strong outburst of the Asama-yama.

A NEW acid sodium phosphate is described by Dr. J. H. Smith in a recent number of the Journal of the Society of Chemical Industry (vol. xxxvi., No. 8). The formula attributed to it is $Na_4P_6O_{17}$, or $6Na_2O,9P_2O_5$. It is notable as having a very energetic corrosive action upon glass, porcelain, nickel, and even platinum and silica. The author describes also a method for the titration of mixed phosphates by employing two indicators, methyl-orange and phenolphthalein, at 55° C., and shows that by this means it is possible to determine readily the proportions of the three sodium salts of orthophosphoric acid when present together in a mixture.

SOME lines of possible research, with a view to the better utilisation of by-products from the coking of coal, are outlined by Mr. G. E. Foxwell in a recent number of the Journal of the Society of Chemical Industry (vol. xxxvi., No. 10). Recovery of sulphur from the pyrites of the coal, so that, together with the ammonia given off in coking, it could be obtained as ammonium sulphate is one of the problems to which a solution is required. Where the chlorine content of the coal is sufficiently high, it also may be recovered with the ammonia in the form of ammonium chloride, and in a few cases this is, in fact, already done. Improved methods for the recovery of naphthalene and benzol are required, as also for the utilisation of the surplus gas from the coke ovens. This gas, the author calculates, is equivalent to more than a million tons of coal per annum, and in a great number of cases is got rid of by being allowed to burn away. It might possibly be used as a source of certain chemicals—*e.g.* chlorinated hydrocarbons—or utilised in gas-engines to generate electricity for distribution, or the gas itself might be distributed in mains to neighbouring towns.

IN the issue of *La Nature* for July 14, M. Le Chatelier gives a brief survey of the progress of high temperature measurements. He points out the main causes of error that are likely to arise in using the thermo-electric type of instrument, though, as he remarks, troubles have been largely eliminated by the use of improved types of galvanometer of the moving coil pattern. Great care is required in the graduation of the instruments, and frequent regraduation is necessary. One of the great advantages of the thermo-electric pyrometer is that it lends itself readily

to photographic recording. A spot of light from a slit or hole is allowed to fall on to the mirror of a mirror-galvanometer, whence it is reflected on to a sensitised plate. This method is frequently used nowadays in investigating the critical points of steel. The writer mentions the recording apparatus thought out by M. Saladin, which permits of tracing all kinds of curves on a photographic plate by using two mirrors both capable of rotation about a vertical axis and operated by two galvanometers. A fixed mirror, inclined 45° to the horizontal, is placed between the two moving mirrors. The ray of light reflected by the first mirror is thus given a horizontal movement, which becomes vertical after reflection by the fixed mirror at 45°. It is then reflected on to the second mirror, which imparts to it a second and final horizontal displacement. Finally, the combination of these two perpendicular movements traces a curve on a stationary photographic plate. It is thus possible to plot directly curves of electric resistance, of dilatation, and of E.M.F. in terms of temperature.

In view of the importance of internal waterways and of the many questions which revolve round the development of the hydraulic resources of their country, the National Association of Navigation Congresses in Italy has inaugurated the publication of a small periodical of eight pages, known as *Navigazione Interna*, to deal with matters of interest in that connection as they arise. The first issue, for May, 1917, lies before us and contains an account of the work of the Hydrotechnical Institute at Stra, associated with the University of Padua and the Hydrographic Department at Venice, describing in particular the experimental tank 200 metres (656 ft.) long, with a bottom width of 3·70 metres (12 ft.), a top width of 10·75 metres (35¼ ft.), and a mean depth of 3·50 metres (11½ ft.). The tank is constructed in cement concrete, with light metal reinforcement, and is fitted with a moving platform and the appropriate mechanical equipment. The institute undertakes experimental work in connection with all hydraulic problems, including those in regard to the resistance offered to the movement of solid bodies in water. Another interesting article in the journal deals with a Swiss project of a navigational connection between Lake Maggiore and the River Po. We welcome the advent of this latest recruit to the service of hydrological science.

Evidence of the difficulty of destroying reinforced-concrete buildings is given in an article on concrete in war in the *Times Engineering Supplement* for July 27. Steel cupolas have been blown to fragments by high-explosive shells, while similar structures in reinforced concrete have survived the ordeal with comparatively little injury. Many of the reinforced concrete buildings plentifully scattered over Northern France have been used by the Germans as well as by ourselves, and have shown remarkable capacity for withstanding artillery fire. One case quoted is of an elevated reservoir measuring about 80 ft. long, 40 ft. wide, and 12 ft. deep, supported on a framework of thin columns more than 40 ft. high, with horizontal bracings. The flat roof at a height of 55 ft. was used by the Germans as a ready-made observation post. This reservoir, built in June, 1911, of Hennebique ferro-concrete, was destroyed so far as possible when the Germans evacuated the town in March last, having successfully withstood our bombardment, which destroyed all surrounding buildings. The columns were broken by explosives, allowing the reservoir proper to fall to the ground, where it remained intact save for a few cracks and holes cut in the corners, where explosives had been inserted with the object of trying to damage the walls.

OUR ASTRONOMICAL COLUMN.

Discovery of a New Star.—According to the *Times* of August 6, the discovery of a new star by Mr. Ritchey on July 19 has been announced by Prof. Pickering. The star is very faint, being of the 14th magnitude, but it may be of special interest because of its situation in the nebula N.G.C. 6946. This is a large faint nebula in Cygnus, its position being R.A. 20h. 33m. 17s., decl. +59° 51′.

Stellar Motions and Absolute Magnitudes.—The relationship of stellar motions to absolute magnitudes has been further investigated, as regards 1300 stars of types F, G, K, and M, by W. S. Adams and G. Strömberg (*Astrophysical Journal*, vol. xlv., p. 293). Parallaxes determined by the spectroscopic method were available for about 700 of the stars used, and these were supplemented by others derived with the aid of a new formula connecting mean parallax with proper motion. From the parallaxes and apparent magnitudes, the absolute magnitudes are easily calculated, being defined as apparent magnitudes reduced to the distance corresponding to a parallax of 0·1″. The stars being divided into groups defined by certain limits of parallax, it is first shown that among stars at the same distance from the sun there is an increase of radial velocity with decrease in absolute brightness, and that there is little evidence of any variation in radial velocity depending upon distance from the sun. For the spectral types considered, the increase in velocity is 1·5 km. for a decrease in brightness of one magnitude. It is shown that this effect cannot be ascribed either to distance from the sun, to the law of frequency-distribution of the velocities, or to the effect of stream motion. The same conclusion is reached with regard to the cross linear motions of the stars, and it appears to hold in the mean for apparent as well as for absolute brightness. The stars of types K and M have mean velocities about 1·0 to 1·5 km. higher than the F and G stars of the same absolute magnitude.

Union Observatory, Johannesburg.—Circular No. 37 of the Union Observatory includes measures of ninety-eight double stars and the results recently obtained by the blink microscope in connection with proper motions and new variable stars. On twenty-three pairs of plates taken at the Melbourne Observatory, at intervals averaging about twenty years, 104 proper motions were found and measured, twenty-three of the stars having a centennial proper motion of 20″ or more; fifty-six of these stars have a motion nearly parallel to the galactic plane and towards the solar ant-apex. Proper motions amounting to only 0·04″ or 0·06″ a year were easily and certainly determined. A disagreement with the results from astrographic measurements in the case of three pairs of plates taken at the Cape Observatory has led to an interesting correspondence with Prof. Kapteyn. The general impression obtained by Mr. Innes from his work with the blink microscope is that practically all stars, nebulæ, and clusters in any one region are at the same distance from us, and that with very few exceptions they are all relatively fixed. In Circular No. 38 Mr. Innes announces an important undertaking in the form of a photographic map of the southern sky, from the Franklin-Adams star plates. Each chart will be ruled with hour circles and parallels, and will cover a little more than 30 square degrees, the scale being 36 mm. to 1°. The region to be covered will require 556 charts. An excellent specimen chart accompanies the circular, and others will be issued as opportunity offers.

THE EXAMINATIONS FOR CLASS I. OF THE CIVIL SERVICE.

IN November last a Treasury committee was appointed to consider and report upon the scheme of examination for Class I. of the Civil Service. The committee consisted of Mr. Stanley Leathes, C.B., First Civil Service Commissioner (chairman); Sir Alfred Ewing, K.C.B., Vice-Chancellor of the University of Edinburgh; Sir Henry Alexander Miers, Vice-Chancellor of the University of Manchester; Mr. H. A. L. Fisher, Vice-Chancellor of the University of Sheffield; Prof. W. G. S. Adams, Gladstone professor of political theory and institutions in the University of Oxford; and Mr. D. B. Mair, M.A., director of examinations to the Civil Service Commissioners, to be secretary to the committee.

Mr. Fisher resigned his membership of the committee on his appointment as President of the Board of Education, and Dr. W. H. Hadow, principal of Armstrong College, Newcastle, and Vice-Chancellor of Durham University, was appointed in his stead.

The committee was instructed "to consider and report upon the existing scheme of examination for Class I. of the Home Civil Service;

"To submit for the consideration of the Lords Commissioners of his Majesty's Treasury a revised scheme such as they may judge to be best adapted for the selection of the type of officer required for that class of the Civil Service, and at the same time most advantageous to the higher education of this country;

"And in framing such a scheme, to take into account, so far as possible, the various other purposes which the scheme in question has hitherto served, and to consult the India Office, the Foreign Office, and the Colonial Office as to their requirements, in so far as they differ from those of the Home Civil Service."

The report of the committee, dated June 20, 1917, has now been published (Cd. 8657), and the outstanding points of the new scheme proposed for the examinations of the future are printed below. We hope next week to deal with the report as a whole.

SCHEME PROPOSED BY THE COMMITTEE.

This scheme should be established on a basis of equality of studies; that is, of the chief studies which are pursued by students at the university up to the conclusion of an honours course. We propose to place on an equal footing the main schools of: Classical languages, history, and literature; modern languages, with history and literature; history; mathematics; and the natural sciences. The classical subjects will be valued at 800 marks; history and mathematics at the same; candidates in natural science taking one main subject up to the higher level and two subsidiary subjects on the lower level can obtain the same totals; while two modern languages studied as comprehensively as the classics will be worth the same. It is possible, however, that for some time candidates able to take full advantage of this last opportunity may be few. We propose that the candidate coming from any one of these schools shall be encouraged—it might almost be said constrained by the force of competition—to offer one or two other additional subjects estimated by us as the equivalent of one-fourth part of his whole main subject. This addition, valued at 200 marks, may be made up in many ways, and we do not propose to limit in any way the free choice of candidates. There is also a great range of university studies—political, legal, economic, and philosophical—which have not been as yet, so far as we know, consolidated into one honours school, though the courses offered by the London School of Economics may cover the most part of them. We have greatly increased the individual and collective weight of these studies, but we do not consider it desirable that candidates for the Civil Service should study exclusively either politics, law, economics, or philosophy; however, for students whose chief interest lies in two or more of these subjects we offer a varied field of selection which is fully equivalent to that appertaining to any of the schools mentioned above.

While grouping subjects as above, and expecting that on the whole the main choice of candidates will be in one or other of the groups, we retain for subjects of university study the old freedom of selection. Whatever limits we imposed upon the choice of candidates, we should still be confronted by the difficulty of equating disparate subjects; *e.g.* language including literature and history, mathematics, history, natural sciences. That difficulty has to be solved as best it may by the Civil Service Commissioners and their permanent and occasional staff. It will be no greater under our proposed scheme than it is under the existing scheme. Moreover, we think it would be difficult to make up a list of subjects under our proposed scheme which would not secure a useful university education, either narrower or wider.

But we do not consider it necessary to confine our tests to the results of university study alone. The young men who will be examined by the Civil Service Commissioners will have spent not only three or four years at the university, but ten or more years at school; and the best of them will have had abundant leisure in which to educate themselves and pick up knowledge and accomplishments useful to them in the work of life. Much that they have learnt at school they will quite rightly have forgotten, but that knowledge should have served its purpose; and we do not propose to examine our candidates in school subjects. But we consider that a sound and systematic education should show certain results at university-leaving age; and that candidates who, while devoting themselves to their individual studies, have nevertheless retained an alert and acquisitive mind and have kept their eyes open to the most important facts in the world around them, should have seized and retained a certain amount of knowledge—scientific, economic, and political. We consider it also highly desirable that all Civil Servants should have a good working knowledge—that is, a reading and translating knowledge—of at least one modern foreign language, preferably two.

On this basis we have constructed a separate section that all candidates must take. We consider that all well-educated young men should be able to use the English language skilfully and accurately and to grasp its meaning readily and correctly. This accomplishment is specially valuable for Civil Servants, but any form of education that has not developed it has failed in a principal part of its purpose. We therefore propose in the first place that all candidates should write an essay. To construct an essay and work out therein a line of thought with suitable words, logical order, and just proportions is a severe criterion of ability. But it is found by experience that an excellent candidate may on any one occasion fail to do justice to his powers. We therefore propose that candidates should have in other papers opportunities of manifesting like powers of arrangement and effective expression One of these papers should be a test in English (Section A, subject 2), the nature of which may best be understood by reference to the specimen paper supplied.

Further, we propose a paper in modern subjects, social, political, and economic. A specimen paper is supplied. It may be found that many—perhaps most—young men of our country are unduly ignorant of such matters. But the existence of this test should encourage many to turn their attention to these subjects and accumulate in their leisure much useful information It should be noted throughout this Sec-

tion A that no candidate will be disqualified for failure in any part, or in the whole of the section, though, since we allow 500 marks for the written part of the section, there is much advantage to be gained or lost thereby in the whole competition.

We have received from the Government Committee on Science in the Educational System of Great Britain the following resolution:—

"The committee has had under its consideration certain proposals for remodelling the Competitive Examination for admission to Class I. of the Civil Service at home and in India or in the Colonies. It is unanimous in thinking that it is indispensable that a course in science extending over several years shall have formed a serious part of every candidate's previous education. It is, however, not prepared to trespass on the province of the committee which is dealing in detail with this examination. It feels strongly that if the men with high scientific qualifications who will undoubtedly be needed in the Service to a greater or less extent are to be secured at a comparatively early age by this examination, then candidates offering science only (without mathematics) should in future be placed on complete equality with other candidates, and that this is not the case at present. But it recognises that there may be advantages in obtaining also by other methods scientific advisers for the Service at a greater age and with practical professional education."

With the trend of this resolution we find ourselves in general agreement; and we desire to make it clear that by placing science, as we have endeavoured to do, on a complete equality with other subjects of a university course, we do not expect to make it possible for certain departments to dispense with scientific advisers selected in maturer age and possessed of practical experience and of knowledge of a kind that may have to be obtained elsewhere than at a university. And in some departments specialists in one or another branch of science will doubtless be selected by tests of a less general kind than that with which we are concerned. The young men selected under our scheme partly for their knowledge of natural science, unless they happen to be employed in a scientific branch of the department in which they are working, may have no opportunity of exercising their scientific acquirements and their knowledge may pass out of date. They should, however, not lose a just estimate of scientific knowledge, and they should know when and where it may with advantage be sought.

We must, however, make one reservation to the terms of this resolution. The "indispensable" requirement of a school course in science must apply rather to the future than to the present. We cannot now correct the defective education of the past or rule out from our competition for some years to come all those useful candidates who may not satisfy this demand of the Science Committee. Perhaps later it may be possible to require of all candidates some form of school certificate which may be evidence of suitable training in this and some other subjects not tested by the examination.

However, we think we may even now go so far as this. We can give a substantial advantage in the competition to those candidates who by whatever means have obtained and retained a sound knowledge of some of the principles, methods, and applications of science, and are able to give a lucid and intelligent account of their knowledge. [Specimen questions are supplied.] It is hoped that the inclusion of this subject in the scheme will encourage all candidates to make themselves acquainted with the general principles of science. This paper will also be a test of orderly, effective, and exact expression.

Finally, we propose to allot 100 marks for a translation paper from some modern foreign language. We intend this paper to be a serious test of capacity to understand and translate accurately passages from the foreign language. We do not propose to limit the scope; verse may be set as well as prose; but nothing that is antiquated should appear; the candidate should be able to master any passage that is likely to occur in books of ordinary difficulty written in the living tongue; passages dealing with history and politics may be set, but not any technical matter. This should be not only a test of specific knowledge, but also a test of capacity to use the English language with skill and accuracy. The languages mentioned in our list are those which appeared to us most likely among European languages to afford information useful to students or to Civil Servants, or to both. We include Latin as an option for those candidates who take two modern languages because Latin is commonly imposed at school upon those pupils who take modern languages, and we do not wish to lay any unnecessary burden on the modern language candidates. In any case, for candidates who have mastered two languages, classical or modern, there should be no hardship and much advantage in acquiring a third.

Since it is of high importance that Civil Servants should have ready use of two modern languages, we include among our recommendations that any candidate who wishes to offer a second modern language on the same terms as in Section A should be permitted to do so beyond the limit of the subjects prescribed in Section A and those permitted in Section B. To acquire a modern language for reading and translation purposes should not be a difficult task for any well-educated man; it can be done in leisure time with a little assistance. But some adequate motive is needed to induce the effort; an effort which should be made by students of history, natural science, politics, economics, and, indeed, of almost all the subjects in our schedule, but, in fact, is not always made. We trust that in course of time all our candidates will be prepared to offer two modern languages up to a useful standard, but we do not at present propose to make two compulsory. We hold out an advantage to those who offer two, but success will be possible with only one, and in some cases perhaps without any.

VIVA VOCE EXAMINATION.—The Royal Commission expressed a cautious inclination towards a *viva voce* examination, but made no definite recommendation. The Consultative Committee in its report says that there should be a *viva voce* examination. On this point, as on almost every point of our report, we are unanimous. We believe that qualities may be shown in a *viva voce* examination which cannot be tested by a written examination, and that those qualities should be useful to public servants. It is sometimes urged that a candidate—otherwise well qualified—may be prevented by nervousness from doing himself justice *viva voce*. We are not sure that such lack of nervous control is not in itself a serious defect, nor that the presence of mind and nervous equipoise which enable a candidate to marshal all his resources in such conditions is not a valuable quality. Further, there are undoubtedly some candidates who can never do themselves justice in written examinations, just as there are others who, under the excitement of written competition, do better than on ordinary occasions. We do not consider that it is desirable to forgo the *viva voce* test for the advantage of a few weak vessels. We consider that the *viva voce* can be made a test of the candidate's alertness, intelligence, and intellectual outlook, and as such is better than any other. The *viva voce* examination has been proved by experience to redress in certain cases the results of written examination. The examination should, of course, be skilfully conducted by carefully selected examiners accustomed

to handle young men and to put them at their ease. We consider that the *viva voce* examination should not be in matters of academic study, but in matters of general interest, on which every young man should have something to say. We think that the marks assigned under this heading should be a valuable corrective to the results of the written papers, and should not infrequently help a useful man to success or save the State from a bad bargain.

LIMITS OF AGE.—We propose no change in the limits of age, which are at present not less than twenty-two nor more than twenty-four on August 1 in the year in which the competition is held. Under existing practice the examination begins on August 1 or on August 2 if the 1st is a Sunday. We consider this time of year convenient for university candidates.

SCHEME OF EXAMINATION PROPOSED BY THE COMMITTEE.

SECTION A.

To be taken by all Candidates.

	Marks
1. Essay	100
2. English	100
3. Questions on contemporary subjects, social, economic, and political ...	100
4. Questions on general principles, methods, and applications of science	100
5. Translation from one of the following languages not taken in Section B, viz. French, German, Spanish, Italian, Portuguese, Dutch, Norwegian, Swedish, Danish, Russian; Latin being also an option for those who take two modern languages in B	100
6. A *viva voce* examination...	300
Total for Section A	800

This section is intended to test the candidates' knowledge of the English language and their capacity for its skilful use, their accurate command of knowledge which they should have acquired in the course of a systematic education and self-education, and should have retained to assist them in their future work, and their equipment in one foreign language at least for working purposes. The languages selected are those most likely to afford information useful to public servants. As circumstances change others should be added at the discretion of the Civil Service Commissioners.

The *viva voce* should be a test, by means of questions and conversation on matters of general interest, of the candidate's alertness, intelligence, and intellectual outlook, his personal qualities of mind and mental equipment.

It is not intended that any candidate should be disqualified for failure in any of the parts of this section or in the section as a whole, but that the section should count substantially in the competition.

SECTION B.

Optional Subjects.

Candidates to be allowed to take up subjects in this section up to a total of 1000 marks.

Languages with History and Literature.

	Marks
7. Latin, translation, and prose or verse composition	200
8. Roman history and Latin literature ...	200
9. Greek, translation, and prose or verse composition	200
10. Greek history and literature	200
11. French, translation, free composition, set composition, and conversation ...	200
12. French history and literature	200
13. German, translation, free composition, set composition, and conversation ...	200
14. German history and literature	200
15. Spanish[1] or Italian,[1] translation, free composition, set composition, and conversation	200
16. Spanish[1] or Italian[1] history and literature	200
17. Russian,[1] translation, free composition, set composition, and conversation ...	200
18. Russian[1] history and literature ...	200

The history and literature subject associated with each of these languages (7–18) can only be taken by candidates who also offer themselves for examination in the relevant language in Section B.

	Marks
19. English literature, 1350–1700	200
20. English literature, 1660–1914	200

History.

21. English history to 1660, social, economic, political, constitutional ...	200
22. British history, 1660–1914, social, economic, political, constitutional ...	200
23. European history, 1494–1763	200
24. European history, 1763–1914	200

Economics, Politics, Law, and Philosophy.

25. General economics	200
26. Economic history	100
27. Public economics, including public finance	100
28. Political theory	100
29. Political organisation	100
30. The Constitutional Law of the United Kingdom and of the British Empire, and the law of English local government	100
31. English private law	200
32. Roman law	100
33. Public international law and international relations	100
34. Moral philosophy	100
35. Metaphysical philosophy	100
36. Logic	100
37. Psychology	100

Mathematics and Science.

38. Mathematics, lower	400
39. Mathematics, higher	400
40. Astronomy	200
41. Statistics	100
42. Chemistry, lower	200
43. Chemistry, higher	200
44. Physics, lower	200
45. Physics, higher	200
46. Botany, lower	200
47. Botany, higher	200
48. Geology, lower	200
49. Geology, higher	200
50. Physiology, lower	200
51. Physiology, higher	200
52. Zoology, lower	200
53. Zoology, higher	200
54. Engineering	400
55. Geography	200
56. Physical anthropology, prehistoric archæology, and technology	100
57. Social anthropology	100
58. Agriculture	200
59. Experimental psychology	100

[1] Papers on these languages should only be prepared on evidence presented one year in advance and satisfactory to the Civil Service Commissioners that at least one candidate will present himself who is likely to be fit for examination on a standard equivalent to those in French and German.

A candidate desiring to offer any of the subjects 42–54 or 59 must produce evidence satisfactory to the Commissioners of laboratory training in an institution of university rank. For (40) astronomy, (41) statistics, (55) geography, (56) physical anthropology, etc., and (58) agriculture, other equivalent training will be required. There will be no laboratory test as a part of the examination.

Extra Numerum.

Candidates may take, in addition to the above, one of the translation papers of Section A in a language not already taken by them in that section, not more than one of the Scandinavian languages, nor more than one of the three, Spanish, Italian, Portuguese, being offered by the same candidate; for this 100 marks will be awarded, not included in the 800 of Section A or the 1000 of Section B.

RADIO-ACTIVE HALOS.[1]

II.

WE shall now see that the thorium halo follows faithfully the same laws of development as the uranium halo, whatever we may assume as to the nature of these laws.

By plotting the seven α-ray curves of ionisation which must contribute to the formation of a halo in the medium surrounding a particle containing the parent element thorium, and then, as before, adding up the ordinates, we get for the total ionisation responsible for the thorium halo the next curve (Fig. 6).

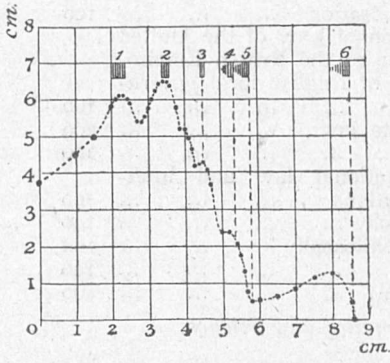

FIG. 6.—Integral curve for thorium halo.

Note that the single conspicuous maximum displayed by the corresponding curve for the uranium halo is now replaced by two maxima, the one which is nearer the centre being a little the lower. Beyond these two maxima the curve descends steeply with two excrescences before the minimum of ionisation is reached. Then the curve reascends to the low maximum due to ThC_1.

Now, the first beginning of the thorium halo shows two rings, and the radial dimensions of these rings are in good agreement with the positions of the two maxima of the curve. The inner ring has not been found alone. Next we find the space within and around these rings growing darker, accompanied by the early appearance of the outer ring due to ThC_1, just as in the case of the uranium halo we observe the early appearance of the ring due to RaC_1. The next stage, so far certainly observed, shows the loss of the internal features, the resulting halo exhibiting much the same appearance as the uranium halo in the final stage of development.

Above the ionisation curve for the thorium halo I have marked the several features of the halo. The agreement of the observed with the theoretical features is even closer than in the case of the uranium halo.

When we consider the successive steps in the genesis of the radio-active halo, which I have now laid before you, we can only come to the conclusion that some cause exists which tends to accentuate the effects going on in the outer regions of the halo. Could we assign a cause for the strengthening of the outer effects of ionisation, or, what comes to the same thing, for the weakening of the inner effects, every feature of the halo becomes explained by the curve of integral ionisation—that is, by the curve which simply sums the effects of the several Bragg curves. We would then find an explanation of the appearance of successive rings and of the appearance of the effects of the extreme or limiting ray at such an early stage of development.

If we assume that the process which results in the formation of a halo under the influence of the α ray is essentially similar in nature to that which is responsible for the photographic image under the stimulus of light, the desired explanation of the weakening of the inner features is forthcoming. For the phenomenon of reversal or of solarisation, well known to photographers, would assuredly lead to the weakening of the inner parts of the image. The repetition of stimuli at or near the same spot is necessarily more marked in the inner than in the outer parts of the halo, and the ionisation accumulating in the region traversed by the external limiting α rays is to a large extent exempt from the effects of repetition.

Now there are features in common between the halo image and the photographic image. Both are brought about by ionisation in a sensitive medium. There is so much indirect evidence for this view that we can scarcely doubt its truth. The salts of iron in many forms have been found to be photographically sensitive. In the photochemistry of chlorophyll they appear to play a fundamental part in Nature. Again, we may interpret the fact that the halo may be obliterated by heat, as proof of instability. Finally, the photographic plate is affected by the α ray in a manner not readily distinguished from that due to light.

Halos have been found which show all the appearance of reversal. In them we find the penumbra replaced by a band which is darker than the region lying within. Normal halos in its neighbourhood, by contrast, well show the peculiar change which affects the reversed halo. It is the negative of a halo. What is this appearance due to, if not to reversal? The effect must arise from very intense ionisation. The reversal has cleared the inner pupil more or less, but the repetition of stimuli has not been sufficient to affect the penumbra in the same manner. If these views are correct we may claim to know something of the nature of the phenomena which lead to the building up of the halo. We may regard the radio-active nucleus as emitting, for countless ages, radiations which slowly act, according to the laws affecting the latent photographic image, upon the surrounding medium. We must suppose the electric charge upon the α ray to affect the stability of the sensitive mineral, ionising the constituent atomic systems, and, finally, producing stresses and, possibly, displacements, which are revealed in the increased colour absorption.

Hitherto I have more especially dwelt upon the points of agreement between the observed and the theoretical halo. I venture to think that the agreement sets beyond any doubt not only the radio-active origin, but also the general mode of development of halos. I shall now refer to some details in which the observed halo is not in perfect agreement with the curve of ionisation.

In the case of the thorium halo the measured dimensions of the halo are in very perfect accord with the ionisation curve. The agreement seems generally as perfect as we could expect. There is, however, a very small appearance of misfit in the location of the first ring. The estimates I have made of the radius of

[1] Discourse delivered at the Royal Institution on Friday, May 11, by Prof. J. Joly, F.R.S. Continued from p. 458.

this first ring have consistently shown a small deficit. Small as it is, we should not ignore it. For there is some reason to suspect that our knowledge of the range of the α ray of thorium itself, which is largely responsible for the position of the first maximum upon the curve, is incomplete. The facts appear to show that the accepted range of the ray from thorium is too large. The evidence for this is both interesting and important.

Rutherford long ago pointed out that there appeared to exist a connection between the range of an α ray and the duration of life of the element from which it originates. The speed of the α particle seemed to be greater the shorter the period of transformation. Geiger and Nutall re-investigated the accepted ranges of the α rays of the radio-active elements, and established Rutherford's inference. Plotting the logarithms of the range and of the period of transformation against each other, they ascertained that for each family of elements there is a straight line along which the points found for the several α rays lie, and—in nearly every case—lie with astonishing accuracy. There is only one notable discrepancy. That exception is in the case of the range of the α ray from thorium itself. It is a few per cent. too great according to the observations. It is also, admittedly, the most difficult to measure with accuracy.

Translated into the distances obtaining in the halo, the few per cent. are almost beyond the limits of accuracy which may be fairly claimed. But the evidence for the slight misfit is based on many observations and may be significant.

In the case of the uranium halo there is also a discrepancy between the curve and the observations as regards the position of the first ring; but the magnitude of the discrepancy is more considerable than the misfit referred to above in the case of the thorium halo. And here we have no reason to throw the blame on any error in the accepted value of the ranges of the rays of U_1 and U_2. The curve of ionisation due to the α rays of these chemically inseparable elements has been investigated by Geiger and Nutall. The results obtained are explained on the assumption that U_1 has a range of 2·5 cm. and U_2 a range of 2·9 cm. in air. And these determinations accurately fit the logarithmic curve. The position of the maximum on the halo-ionisation curve is mainly determined by these results.

Careful measurements of the first ring of the uranium halo reveal this small but definite discordance between the radius of the ring and the position of the maximum of the curve. It will be seen that the section of the ring—the feature numbered 1 in Fig. 3—does not lie accurately above the centre of the maximum. The ring has a radius which is distinctly too great. That the ring essentially corresponds with the first great maximum of the curve seems beyond doubt. We find no other record of this maximum. There seems no apparent escape from the conclusion that the ring which is so largely due to the rays from U_1 and U_2 has been formed by rays of greater range than the average range of the rays now emitted by these elements.

The granite in which this halo-ring has been measured is very ancient, certainly not younger than the Devonian period. Similar rings, but not so sharp and easily measured, have been found in the Carboniferous granite of Cornwall. In younger granites I have not succeeded in finding them. It would be important to measure this ring in the younger granites, supposing they have been formed in these rocks. Such measurements would make quite clear whether or not the abnormal dimension of this first ring is really due to the former existence of a longer average range of the rays responsible. If the misfit of the first ring proves to be inexplicable in any deficiency of our knowledge of the ranges of the uranium isotopes, and especially if we are able to get evidence that it is confined to the more ancient rocks, then it will be difficult to escape the direct conclusion that, however brought about, there was a former greater range of the α ray of the parent element of the uranium family.

There is a certain temptation to accept such a conclusion, for there is a strange contradiction in the evidence advanced for the duration of geological time. The conclusion that the halo reveals a former greater range for the α ray from U_1 carries with it the former more rapid decay of that element. All the difficulties and contradictions respecting the age vanish if this indeed occurred. It will only require a few words to state the present position of the matter.

From measurements of the rates of denudative processes at the earth's surface, and of the quantities accumulated, the evidence is, with wonderful consistency, in favour of a period of about 100 millions of years having elapsed since those processes came into existence. By making certain assumptions some 150 millions of years might be claimed, and even, not inconceivably, somewhat more. What other evidence have we? The only major limit which astronomy appears to give us would be in favour of an age even less than 100 millions of years. I refer to the duration of solar heat. It is quite certain that the earth was bathed in abundant sunshine even in Cambrian times; but solar heat of the present intensity cannot be accounted for on any known source of supply for 100 millions of years. From lunar theory we do not seem able to get a major limit. We must remember that we are not discussing the age of the earth as an astronomical unit. The geological age is the period of denudation only. Well, then, a generation ago very brilliant work was done by Kelvin on the period since the solidification of the surface rocks. But the thermal data involved became invalidated in the light of Strutt's discovery that heat-producing radio-active elements exist all over the earth's crust.

But if radio-active science in this way has closed one avenue of approach to the age problem, it has opened up another. Rutherford pointed out that the accumulation of radio-active products of decay in ancient rocks and minerals should afford a measure of the age in much the same manner as, from the amount of sand which has fallen through, we compute time by the hour-glass. In this connection Strutt's work on the amount of helium accumulated in materials of various geological ages will ever be memorable. The amount of accumulated lead, however, possesses, in some respects, less liability to error. The measurement of the ratio of the quantity of lead to the quantity of parent radio-active element in the case of uranium has occupied the attention of several investigators. The conclusion as regards the accumulation of lead in uranium-bearing minerals seems to be—although not without conflicting evidence—that the earth's geological age is not less than some 1500 millions of years.

Now, while we must admit the possibility of considerable variations in the rate of denudation over the past, yet the statement that the rivers are now pouring some ten times as much dissolved matter into, and transmitting some ten times as much sediment to, the ocean as they did in past times is, I think, quite inadmissible. All efforts to explain so extraordinary an increase—whether we suppose it to be temporary or permanent—have so far failed.

But the uranium series of radio-active elements is

not the only one available in the application of Rutherford's method of computing the age. There is quite as good evidence that the thorium series ends in an isotope of lead as there is for the same conclusion respecting the uranium series.

Now, in dealing with the atomic weight of the lead found in Ceylon thorite, Prof. Soddy recently carried out, on a large scale, a very careful chemical analysis of this mineral, and determined the quantity of lead present. When we calculate, on the basis of his results, the age of the mineral, we get about 140 millions of years. The rocks to which this determination applies are very ancient—certainly pre-Cambrian. The result is, therefore, in good agreement with the conclusion derived from denudation. Is this a mere coincidence?

Before this recent result it was known that the indications of thorium-derived lead were opposed to those of uranium-derived lead, and those who upheld the longer age urged that the lead derived from thorium must be unstable, and must turn into something else over geological time. But the view that thorium lead is not permanent is one beset with difficulties.

From this we see that the uranium and the thorium families of elements give, at the present time, contradictory evidence respecting the age of the earth. The latter apparently agrees in a remarkable manner with the indications of the surface changes of the globe; the former does not. And now the measurements of the uranium halo admit of the interpretation that they indicate the failure of uranium-derived lead as a true indicator of geological time. For if the range of U_1 was, indeed, in remote times longer than it now is, then we must suppose that its rate of decay was at that period faster than it is to-day. Or we may suppose that, however derived, in remote times relatively short-lived uranium isotopes existed which have died out during geological time. I am far from contending that this view is free from difficulties. On the other hand, our ignorance of the mode of origin of radio-activity and of its possibilities is very considerable.

If we have to admit that the evidence of the halo on the age problem is not yet complete, we can refer to a still more important matter upon which the testimony of the halo admits of no uncertainty. Until the radio-active origin of halos was ascertained it was impossible to pronounce on how far, in remote periods of earth-history, radio-activity might have affected the chemical elements. Thus it would have been a quite allowable speculation to suppose many of the elements to have been derived as end-products of radio-active families the activity of which has only comparatively recently become extinct. The halo enables a very general answer to be given to such speculations. A substance such as brown mica—and this is one of the most widely diffused of rock minerals—is sensitive to α radiation, and integrates its effects with the same certainty as the photosensitive plate integrates the effects of light. A mineral containing a minute trace of a radio-active substance beams, throughout the ages of geological time, upon the medium in which it is contained. If the medium is sensitive the accumulated effects in general persist for our inspection, and in the halo we are, in consequence, able to identify the presence of quantities of radio-active substances of almost inconceivable minuteness. Imagine that stellar magnitude which would be recorded upon a photographic plate exposed uninterruptedly for scores of millions of years!

We see from this that the *unaffected* plate of mica is evidence for the absence of even the feeblest α radiation from surrounding or included elements, just as the blank photosensitive plate is proof of the absence of luminous influence. No definite halo-producing effects have been observed other than those which may be referred to the known radio-active elements.

Thus we find that the study of the conditions which call the halo into existence affords a criterion for determining the absence of any general elemental evolution during the period of geological time. When geological time began any earlier evolutionary process must have already come to an end, with the sole exceptions of the known families of radio-active substances. This result, which is *a priori* by no means evident, is of importance to our views on the physical history of the earth. Only from the minute hieroglyphics we have been considering could such information have been derived.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Rhodes trustees have decided to make a grant of 1000*l.* towards the fund which is being raised for the endowment of a permanent professorship of forestry in the University, and the trustees of the University Endowment Fund are allowing the payment of 250*l.* per annum, which they have hitherto made towards the payment of an assistant professor, to be carried this year to the professorship of forestry fund.

A CHAIR of zoology has been established in the University of Manitoba, Winnipeg, and applications for the filling of it are invited.

THE following bequests have been made to American educational institutions by Col. O. H. Payne:—200,000*l.* each to Yale University and the New York Public Library; 100,000*l.* each to the Cornell University Medical College and Phillips Academy, Andover, Mass.; 40,000*l.* each to Hamilton College, Clinton, N.Y., and the University of Virginia.

THE Ellen Richards research prize, value 200*l.*, is offered by the Naples Table Association for Promoting Laboratory Research by Women for the best thesis written by an American woman embodying new observations and new conclusions based on independent laboratory research in biology (including psychology), chemistry, or physics. The competing essays must be received before February 25 next. Application forms are obtainable from Mrs. A. W. Mead, 823 Wayland Avenue, Providence, R.I., U.S.A.

LORD HALDANE presided at a meeting of University Extension students at Oxford on August 6, and delivered an address in which he urged that in education, as in most other things, unless we have a devolution of powers to those who are able and willing to do the work in the various localities, we shall not make very much progress. He suggested the inauguration of from seven to ten educational provinces in Great Britain. The general object should be to break down the gulf between elementary and post-elementary education. They should be unified into one great organic whole of national education, and the universities should exert a permeating influence in every province—no province without a university at one extreme, and representatives of the local education authority at the other. The best men in the locality should be co-opted on the provincial councils, and the teachers, secondary and elementary, should also have an important place on them. The Board of Education should give as much latitude as possible to the provincial authorities. If we can get rid of the network of rigid regulations, we shall have got a great deal done.

ONE of the most important changes which the war has brought about in our educational institutions has been the rapid conversion of the engineering laboratories of our universities, colleges, and schools into training centres for munition-makers or into munition works. The number of those trained who are now doing work of national importance must be very large. According to a report of the Education Committee of the London County Council the institutions under its control train 3000 per annum, while the output of gauges from the institutions employed in their manufacture exceeds 30,000 per annum. Between one and two hundred woodwork instructors in the employ of the council have become proficient in metalwork, and the remarkable results which have been obtained by sending men and women without any previous experience of metalworking through a five or six weeks' training have taught the committee the desirability of devoting much more attention to instruction in workshop processes and production in educational institutions after the war. Hitherto such training has been left to the factories, but recent experience has shown that it ought to form a more intimate part of the work of the technical schools. It is of importance to ascertain to what extent the experience of authorities in other parts of the country agrees with that of London.

WE have received from Delhi a copy of the report of a conference held in January last of the directors of public instruction for the various provinces of India (see NATURE, March 8, p. 38). The conference was opened by the Viceroy, Lord Chelmsford, who, in the course of his inaugural address, urged the directors in their work of developing technical education in India not to overlook the claims of agricultural and commercial education. He said the great advance made by scientific agriculture during the last half century justifies us in pressing forward with a policy of agricultural education in India, and though the directors would not claim to speak as experts on the agricultural side, their educational experience qualifies them to give useful hints with regard to an advance along this road. Again, on the commercial side of education, he expressed surprise to find how little has been done in spite of India's large and growing commerce. Compared with a technical institution, a commercial school is a relatively cheap institution, and one would think that there was a great opening in the big towns of India for good commercial schools. In technical training in its narrower sense he said sight must not be lost of workshop practice in outside works. Laboratory training, however good, is no real substitute for the discipline of the workshop. The directors discussed, among other subjects, the teaching of science in the secondary schools of India. It appears that in the higher classes of Madras schools elementary science is obligatory. In Bombay science is compulsory in Government high schools, and the University demands a study of science from matriculation candidates, though it conducts no examination in science at this stage. In the provinces which come under the Calcutta matriculation the position of science teaching is not satisfactory. In Bengal there is practically no science teaching whatever in schools for Indian pupils. One of the optional subjects for the matriculation examination is elementary mechanics, but very few candidates offer this subject. Geography is also an optional subject for matriculation. Otherwise, no provision whatever is made in the Calcutta University matriculation for the teaching of science. Looking to the peculiar difficulties which underlie the educational problem in Bengal, it was thought practical science should be made obligatory and be included in the school-leaving certificate.

THE Association of Headmasters, which, it will be remembered, is concerned with secondary education, has adopted and circulated an "educational policy" which may be taken to embody the considered opinion of the headmasters of the secondary schools in this country as to what are desirable educational changes to meet the conditions which will follow the declaration of peace. Their policy insists, among other points, that elementary education should be considered as a preliminary or preparatory stage. It is not yet possible to require that no one shall be allowed to leave school in order to earn money before the age of eighteen; but it is possible to provide that no child's education shall wholly cease on its leaving the elementary school, and that up to the age of eighteen education shall never be wholly subordinated to the ability to earn wages. There must be a considerable increase (1) in the number of secondary schools—*i.e.* schools which provide some form of whole-time general education as distinct from technical training up to the age of eighteen, and (2) in facilities for part-time education. The chief needs in respect of secondary education enumerated by the policy are:—(*a*) More extensive and more varied provision for children capable of profiting by a definite course of education up to the age of eighteen. (*b*) The encouragement and assistance of a much larger number of children to take full advantage of such provision. This involves the lengthening of school life by means of (1) the provision of adequate scholarships and maintenance allowances; (2) the requirement that all pupils who enter a secondary school shall continue in attendance at some such school until the age of sixteen. (*c*) As in the case of elementary schools, the expenditure of much more money in attracting competent persons into the teaching profession. With reference to the curriculum it is stated that one of the most serious dangers to secondary education lies in the overcrowding of the time-table through the conflicting demands of an ever-increasing number of subjects. In framing curricula the first consideration should be to guard against this overcrowding, and to ensure that sufficient time is available for the adequate treatment of the subjects which are taught. No boy should be allowed to specialise until he has attained a satisfactory standard of general education. This standard should be that which a boy of ordinary ability may be expected to reach at the age of sixteen. The subjects of a general education should include as a rule Scripture, English, history, geography, mathematics, science, and ordinarily two languages other than the pupil's own—in most cases these should be French and Latin.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 9.—M. Ed. Perrier in the chair.—L. **Maquenne** and E. **Demoussy**: The influence of mineral matter on the germination of peas. Peas have been germinated in sand moistened with distilled water containing varying known amounts of metallic salts and the length of the roots measured after six days' germination. Twelve metals were used in these experiments, details being given of the results obtained with each one. Calcium would appear to be the only element which, in the absence of any other, is capable of producing normal germination, and the amounts required are extraordinarily small. The growth of the stem will be the object of further researches.—E. **Ariès**: The sign of the specific heat of saturated vapour in the neighbourhood of the critical state.—A. **Thybaut**: Tautochrone curves.—G. L. le **Cocq**: All known systems of hyperstatic suspension bridges are

derivatives of isostatic suspension bridges, and the latter are only particular cases of one single and unique system which includes all.—M. **Siegbahn**: High-frequency spectra. Some of the work recently published by MM. R. Ledoux-Lebard and A. Dauvillier has been anticipated by the author and E. Friman (*Phil. Mag.*, July, 1916).—P. **Chevenard**: The mechanism of the tempering of carbon steels. The results of the experiments described completely confirm the conclusions recently published by MM. Portevin and Garvin.—A. **Portevin**: The manganese steels. The steels were submitted to very slow cooling, seventy-five hours in cooling from 1300° to 100° C. The results, given in detail, differ considerably from the effect of a normal annealing (three to five hours from 1000° C.). —E. **Urbain**: A method of determining molecular weights. The method is based on determinations of the boiling point of a mixture of the liquid the molecular weight of which is to be measured with a non-miscible liquid, such as water, and the composition of the distillate. Examples are given of the measurement of the molecular weights by this method of benzene, carbon tetrachloride, and limonene.—Mlle. Y. **Dehorne**: The presence of the genus Stromatoporella in the Senonian in the neighbourhood of Martigues (Bouches-du-Rhône).—L. **Bordas**: The egg deposition of *Rhynchites conicus* and the anatomy of its larva. This parasite has caused great damage to apple, pear, cherry, and peach trees in Rennes and its neighbourhood.—A. **Compton**: Cerebrospinal meningitis and meteorology

July 16.—M. Camille Jordan in the chair.—A. **Lacroix**: The felspathic ortho-amphibolites and ortho-pyroxenites of Madagascar.—G. **Bigourdan**: A gardener-astronomer of the seventeenth century, Elzéar Féronce: Calignon de Peyrins and the reciprocation of the pendulum.—G. **Gouy**: Interferences with large differences of path.—G. A. **Boulenger**: The evolution of the poison apparatus of snakes. Remarks on a recent communication of Mme. Marie Phisalix.—J. **Priwaloff**: The convergence of conjugated trigonometrical series. —E. **Vessiot**: The canonical equations and developments in series of celestial mechanics.—M. **Amsler**: The development in a continued fraction of a quadratic irrational.—V. M. **Hegly**: Flow over a weir in a free sheet with lateral contraction.—MM. **Luizet** and **Guillaume**: Occultations observed during the total eclipse of the moon of July 4, 1917, at the Lyons Observatory.—St. **Procopiu**: Induction apparatus for detecting projectiles in wounds. A modification of the Hughes induction balance in which a galvanometer replaces the telephone. The deviations of the galvanometer vary with the distance of the projectile from the surface.—A. **Colani**: Study of the system water, uranyl oxalate, sodium oxalate.—A. **Pictet**, O. **Kaiser**, and A. **Labouchère**: The alcohols and bases of vacuum tar. Six alcohols and six bases were isolated. The alcohol of lowest boiling point was proved to be *p*-methyl-*cyclo*hexanol (hexahydro-*p*-cresol). The other alcohols were not identified, but belong to the hydroaromatic series. It is probable that these alcohols exist in the coal, since the benzene extract contains these alcohols in practically the same proportions as the vacuum tar. —Em. **Saillard**: The action of acids on the rotatory power of saccharose and invert-sugar in the presence of soluble salts.—F. X. **Skupienski**: Sexuality in the Myxomycetes group of fungi.—Mme. M. **Phisalix**: The subjective value of the evolution of the poison apparatus of snakes and the physiological action of the poisons in systematic classification.—MM. **Denier** and **Vernet**: The bacteriological study of the natural coagulation of the latex of *Hevea brasiliensis*.—A. **Policard** and B. **Desplas**: The histological mechanism of granulation of wounds in man.

BOOKS RECEIVED.

Scientific Treatise on Smoke Abatement. By H. Hamilton. Pp. xiii+155. (Manchester: Sherratt and Hughes.) 5*s.* net.

History of the Spanish Conquest of Yucatan and of the Itzas. By P. A. Means. Pp. xv+206+plates. (Cambridge, Mass.: The Peabody Museum.)

Notes on the Order of my Categories and Alphabet. By R. E. Dennett. Pp. 18. (Lagos: Government Printer.)

The African Table of Periodic Law. By R. E. Dennett. Pp. 12. (Lagos: Government Printer.)

Studies in Psychology. Contributed by Colleagues and Former Students of E. Bradford Titchener. Pp. 337. (Worcester, Mass.: L. N. Wilson.)

Results of Atmospheric-Electric Observations made Aboard the *Galilee* (1907–8) and the *Carnegie* (1909–16). By L. A. Bauer and W. F. G. Swann. (Washington: Carnegie Institution.)

The Magnetic Work of the *Galilee*. By L. A. Bauer, W. J. Peters, and J. A. Fleming. (Washington: Carnegie Institution.)

The Magnetic Work of the *Carnegie* (1909–16). By L. A. Bauer, W. J. Peters, J. P. Ault, and J. A. Fleming. Some Discussions of the Ocean Magnetic Work (1905–16). By L. A. Bauer and W. J. Peters. (Washington: Carnegie Institution.)

A Class-Book of Organic Chemistry. By Prof. J. B. Cohen. Pp. viii+344. (London: Macmillan and Co., Ltd.) 4*s.* 6*d.*

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