

silver, and should be worked up to produce all of these. This being so, it does not follow that the roasting of the ore for acid should necessarily be carried on at the same place as the smelting of the roasted material for the metals. Moreover, it is just the fact that this ore is a potential source of acid which renders it necessary for the bulk of the concentrates to be shipped from Australia, where the market for acid is limited, to a country like Great Britain, with nine times the population of Australia, and highly developed industries which can absorb the acid.

Stated broadly, if Great Britain is going to produce all the zinc needed for home consumption, the output of "primary" spelter will have to be increased at least fivefold. At present neither electrolytic zinc nor electro-thermally distilled zinc can compete commercially in this country with that obtained by distillation with coal in externally fired retorts heated by gas. Unquestionably the most difficult part of the problem is the training and organisation of the labour required for this process. Difficult though this is, it should be undertaken without delay, for America has shown that it can be done, and done rapidly when necessary. The establishment in this country of a zinc-smelting industry on a scale commensurate with its needs is most urgently required. There is no reason, if there is a proper application of organising ability, technical knowledge, perseverance, and resourcefulness—such as is now being exhibited on the British battle-front—why success should not be achieved. It would be an industrial victory of the first magnitude, and it would remove a peril in which this country was placed by the outbreak of war, which has been all too imperfectly realised, and should never be allowed to recur.

No reference has been made in this article to the possibility of assistance to be given by the British Government. As already mentioned, the Australian Government has dealt with the situation created there, and the Prime Minister, Mr. Hughes, is credited with having a very definite policy as to the future of the zinc mining and smelting industry, a policy in which Australia and Great Britain are immediately concerned. Whether and to what extent the statements relative to this which have appeared in the Press are trustworthy and authentic it is impossible to say. Some of them have been so inherently improbable that it is wisest to suspend judgment until the matter has been settled and an authoritative announcement made. There is every reason why there should be as little delay as possible in reaching a decision and acting upon it.

H. C. H. CARPENTER.

PROF. PIERRE DUHEM.

THE precise formulation of the fundamental principles of mathematical physics may be said to be the outstanding feature of the work of Pierre Maurice Marie Duhem, whose sudden death at Cabrespine (Aude) on September 14 was announced in NATURE of September 21.

NO. 2451, VOL. 98]

Born at Paris on June 10, 1861, Duhem in due course graduated in science, and for many years past held the chair of theoretical physics in the University of Bordeaux.

Although for a considerable time a corresponding member of the Academy of Sciences, it was not until 1913 that the distinction of full membership was conferred on him.

Unlike most physicists, who take as their starting-point the equations of reversible dynamics, Duhem commenced with thermodynamics, and his treatise on the Thermodynamic Potential, published in 1886, will always remain a classical work of reference on the subject. At that time the work of Willard Gibbs (1876–8) was beginning to attract attention to the potentialities of thermodynamics in relation to chemical theory, and Duhem became an early exponent of the new methods. In 1893 he published his "Introduction à la Mécanique chimique," which was followed in 1897–9 by a much more comprehensive work in four volumes, entitled "Traité élémentaire de mécanique chimique fondée sur la Thermodynamique."

A large portion of this work is in a high degree original. We may instance the detailed studies of ternary and other mixtures and the use of trilinear co-ordinates in this connection as one of the interesting features of the work, but perhaps the most remarkable sections are those dealing with false equilibria and explosions, in which the author abandons the limitations of "classical mechanics" and invokes the assistance of a retardation analogous to friction in explanation of the observed phenomena. About the same time also appeared his "Cours de physique mathématique," dealing with hydrodynamics, elasticity, and acoustics.

The more technical applications of Duhem's work on physical chemistry form the basis of his "Thermodynamique et Chimie," which appeared a little later, and has been translated into English. In 1911 Duhem endeavoured to unite thermodynamics and mechanics in a comprehensive treatise on energetics covering statics, dynamics, hydrodynamics, elasticity, and physical chemistry. In a series of smaller contributions, entitled "Recherches sur l'Hydrodynamique," Duhem gave a detailed discussion of certain aspects of the study of fluid motions.

If the properties of matter occupied so large a place in Duhem's work, electricity was by no means overlooked. A volume of 228 pages, published in 1902 (Paris: A. Hermann), is devoted to a critical and historic study of Maxwell's electric theories. About the same time appeared the volumes in commemoration of the twenty-fifth anniversary of the doctorate of H. A. Lorentz (1900), and the sixtieth birthday of Boltzmann (1904). To the former Duhem contributed a paper on Helmholtz's electrodynamic theories and the electromagnetic theory of light, while to the latter he presented in June, 1903, an important contribution on the problem of electric stability.

Historical studies would likewise appear to

have had considerable attraction for Duhem. On the origins of statics he published two volumes, but the crowning work of Duhem's later years would appear to be a work of ten volumes on the history of astronomy up to Copernicus, of which so far only four have appeared.

The writer of this notice visited Duhem at Bordeaux in 1901. He was a shortish man with a very pleasing manner, in which could be observed that element of preciseness which characterises his writings. It will readily be understood that a vast laboratory fitted with costly and complicated apparatus was not needed by a mathematical physicist like Duhem, and it was interesting to compare the simple equipments at Bordeaux with the rather less simple, but more dusty, pieces of apparatus used by another mathematical physicist, Ludwig Boltzmann, at the dingy buildings in the Türkenstrasse at Vienna. But if Duhem did not indulge in superfluous luxuries, he made the best use possible of all the essential apparatus, and on the occasion of the visit he demonstrated the then newly discovered properties of radio-active substances with the same care and attention to detail that are so noticeable in his theories.

If Duhem did not concentrate his main efforts on the discovery of new phenomena or the measurement and re-measurement of physical constants, he has at least played an equally important part in the advancement of our knowledge by evolving order out of chaos, and uniting isolated portions of mathematical physics in the form of a connected and logical theory.

G. H. BRYAN.

NOTES.

A MEETING to consider the steps to be taken to raise a memorial to the late Sir William Ramsay will be held at University College, London, on Tuesday, October 31, at 4.30 p.m. Invitations will be sent out on or about October 20. It will, however, greatly help in making the arrangements if all persons wishing to be present, including in particular scientific friends and former students of Sir William Ramsay, will send a postcard to the secretary, University College, London, intimating their desire. Those who thus apply will not be asked to reply to the invitation when issued. Further particulars of the arrangements for the meeting will be issued in a few days. After the meeting the director of the University College Chemical Laboratories, Prof. J. Norman Collie, will deliver a memorial lecture on "The Scientific Work of Sir William Ramsay," at 5.30 p.m.

THE annual Huxley Memorial Lecture of the Royal Anthropological Institute will be delivered on Tuesday, November 14, by Sir J. G. Frazer; the title of the lecture is "Ancient Stories of a Great Flood."

MR. H. G. NAGEL and Mr. A. D. Hall have been appointed members of the Government committee which is considering the question of the teaching of science.

WE learn through the *Electrical Review* that it has been decided, owing to the war, not to hold the Hobart meeting of the Australasian Association for the Ad-

vancement of Science, which had been arranged for January, 1917.

THE meetings of the London Mathematical Society will be held during the session 1916-17 in the rooms of the Royal Astronomical Society, Burlington House, W. They will not always be on the second Thursday of each month, as hitherto, but on dates and days announced by the council in the list just issued.

THE twenty-fourth "James Forrest" lecture of the Institution of Civil Engineers will be delivered on Tuesday, October 24, at 5.30 p.m., by Sir John Purser Griffith. The subject will be "The Development of Appliances for Handling Raw Materials and Merchandise at Ports and other Large Centres of Traffic."

THE death is recorded in the *Revue Scientifique* of Dr. Valentin J. J. Magnan, a leading French authority on mental disorders. Dr. Magnan was elected a member of the Paris Académie de Médecine in 1893, and became president in 1915. He was the author of "Leçons cliniques sur les Maladies mentales."

THE death is announced in action on September 28 of Capt. E. J. Smith, Duke of Wellington's Regiment. Before joining the forces, at the outbreak of war, he was senior science master at Sexey's School, Blackford, Cheddar. While in Gallipoli he was shot through the shoulder when in command of the snipers of his battalion. Later he commanded the Brigade Bombing School at Suvla Bay.

THE Hippurite from the chalk near Faversham, noticed in our last issue, has now been placed, with some other illustrative specimens, on exhibition in the Gallery of Fossil Reptiles at the Natural History Museum, since the galleries containing fossil invertebrates are closed to the public.

REPORTS from the Swedish expedition to Spitsbergen, noticed in NATURE for July 27 (p. 448), show that valuable work has been done, especially in the detailed mapping of the district. Besides conducting the investigations previously mentioned, the expedition has made several excavations in the old moraines on the shore, resulting in the discovery of deep-seated ice, many thousands of years old. How thick a covering of rock such fossil ice can support is a question worth solving. At any rate, deep borings have proved that it does not continue under the floor of the harbour. A Norwegian expedition to Spitsbergen, which has been investigating the Svalbard Company's coalfield, reports that it is of colossal size, containing, according to calculation, as many as 880 million tons. Norway's yearly consumption of coal is 2.8 million tons.

REPLYING, in the House of Commons, to a question by Mr. Ashley, M.P., on October 12, Mr. McKinnon Wood said:—"The direct savings resulting from closing the national museums and picture galleries to the public are estimated at approximately 50,000l. per annum, in addition to which a large economy results from freeing staffs, and in several cases accommodation, for purposes of immediate national importance at the present time." The sum named is that which was put forward by the Government when the proposal was first mooted, and, relatively small though it be, it is satisfactory to learn that this regrettable step has actually resulted in such direct addition to the National Exchequer. It must not, however, be forgotten that the museums in question had already forgone their purchase grants and had in other directions greatly reduced their expenditure, while continuing to perform, as exemplified in our last issue, important national services. It would be interesting to compare the actual expenditure on museum work at the present