with the application of thermodynamics to liquid-gaseous systems containing more than one component. Although the phase rule and the theory of dilute solutions (from the osmotic point of view) are discussed at some length, the greater part deals with the problems of phase equilibrium from the points of view and by the methods with which one associates the name of van der Waals himself. The book is divided into two main parts, first, the consideration of systems in the absence of external forces, chemical or capillary effects, and secondly, the behaviour of systems when exposed to such forces. The work requires no introduction to English readers. The fundamental nature of the subject itself, and the fact that it emanates from the greatest living authority upon this subject, ought to provide a sufficient reason for every physicist and physical chemist becoming acquainted with it.

(5) Planck's thermodynamics is already so well known to readers in every country that it is only necessary in this place to direct attention to the appearance of the (enlarged) French translation of the third German edition. It would be utterly futile to attempt any worthy review of this book in the space of a few lines. A very interesting feature of this edition is the incorporation by the French translator of the lecture on Nernst's theorem and the energy quanta hypothesis delivered by Prof. Planck in December, 1911, before the German Chemical Society, and also a list of the papers on thermodynamics published by Prof. Planck with cross-references to the paragraphs of the book in which the same subjects are treated. The work is divided into four parts: the first deals with fundamental experiments and definitions, the second and third with the first and second laws, whilst the concluding part takes up the application of those laws to special physical chemical cases. The last chapter of this part is devoted to the discussion of the absolute value of entropy (Nernst's theorem). As an illustration of the place which Planck's "Thermodynamics" occupies, it may be mentioned that a fourth German edition has already appeared this year. It is high time that the English translation was brought up to date.

W. C. McC. L.

OUR BOOKSHELF.

The Annual of the British School at Athens. No. xviii. Session 1911–1912. Pp. viii + 362 + 15 plates. (London: Macmillan and Co., Ltd., n.d.) Price 25*s.* net.

THE eighteenth volume of the Annual of the British School at Athens for the session 1911–12 is fully up to the level of this excellent series. The chief archæological article gives an account by Messrs. A. J. B. Wace and M. S. Thompson of the excavations at Halos, one of the smaller and less-known cities in Thessaly. A group of tombs at the foot of the acropolis was opened. Such cist graves formed of slabs are common in Thessaly, both in the fourth prehistoric period and in the Early Iron Age, to which the Halos tombs belong. Here there is no sign of cremation, simple inhumation being the only process. On the other hand, the excavation of a neighbouring tumulus proved that here corpses were burned. Thus in these two cemeteries we find two different methods of disposal of the dead. From an examination of the pottery and fibulæ it seems clear that the cremation tumulus is of a date later than that of the cist graves, and it may be referred to the middle of the so-called Geometric period, about the ninth century B.C. No exact parallel to this type of cremation burial has yet been found in Greece or elsewhere, and it differs from that of Halstatt and the rites described in the Homeric poems in some important particulars. The tumulus is clearly post-Homeric, and may be an Achæan burial in a degenerate or modified form.

Mr. M. N. Tod's paper on Greek numerical notation is of special importance. By a review of the epigraphical evidence he seeks to determine the numerical systems employed in the various Greek cities, and to state afresh some of the conclusions which we are entitled to draw from it. This paper is devoted only to the so-called "acrophonic" or "initial" class of numerical notation, the consideration of the other main type, in which the letters are used in their alphabetical order as numerical signs, being reserved for later treatment. The earliest example of this type appears to belong to the fifth century B.C., and the diversity of the systems employed in the various cities seems to be due to the modifications introduced into the pure numbers to make them capable of expressing money, weights, and measures. The detailed epigraphic evidence thus presented deserves the attentive study of students of the early history of mathematics.

The New Encyclopaedia. Edited by H. C. O'Neill. Pp. vii + 1626. (London and Edinburgh: T. C. and E. C. Jack, n.d.) Price 7*s.* 6*d.* net.

THIS encyclopædia is handy in shape and fairly light in weight, and considering the limits of size, it appears to be as complete and authoritative as can be expected. The expert in any branch of knowledge may note the omission of facts which he might think could have been included, but the general reader will find brief summaries on many topics. He will, therefore, find this volume useful, and will be able to continue his studies under the guidance of the bibliography which is appended to the more important articles. The information appears to be accurate and modern, but some of the less informative maps might have been omitted.

LETTERS TO THE EDITOR.

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

The Reflection of γ Rays from Crystals.

IN some recent investigations Prof. Rutherford and Mr. H. Richardson have analysed the γ radiations emitted by a number of radio-active products. They have shown, for example, that radium B emits three distinct types of γ radiation, which are absorbed exponentially by aluminium with absorption coefficients $\mu=230$, 40, and 0·51 (cm.)$^{-1}$ respectively. On the other hand, radium C appears to emit essentially only one type of γ radiation, the absorption coefficient of which is $\mu=0·115$ in aluminium.

Recently we have undertaken an examination of these types of radiation by the methods developed for X-rays by W. H. and W. L. Bragg, and by Moseley and Darwin, which consist in determining, either by the photographic or electric method, the intensity of the X-rays reflected from a crystal at different angles of incidence. In our experiments the source of γ radiation was a thin α-ray tube containing about 100 millicuries of emanation, the γ rays arising from the products of the emanation, radium B and radium C. A diverging cone of rays fell on a crystal of rock-salt, and the distribution of the reflected radiation was examined by the photographic method. The source and photographic plate were each about 10 cm. from the centre of the crystal. Suitable precautions were taken to reduce to a minimum the effect on the photographic plate of the primary and secondary β rays and penetrating γ rays. The source was first arranged so that the radiation made an average angle of about 9° with the face of the crystal.

It was calculated from the known data of the crystal that the radiation $\mu=40$ from the radium B, if homogeneous, should be strongly reflected at about this angle. A group of fine lines comprised between the angles 8° and 10° have been observed on the photographic plate in a number of experiments. Similar results have been observed with a crystal of potassium ferrocyanide, kindly loaned to us by Mr. Moseley. On examining the reflection for an angle of 2° another series of fine lines was obtained on the plate, probably resulting from the reflection of the more penetrating radiations from radium B and radium C.

The experiments indicate that the γ radiation for which $\mu=40$ is complex, and consists of several groups of rays of well-defined wave-length. Experiments are in progress to examine carefully the character of this reflected radiation, both by the photographic and electric method. It is hoped that in this way definite evidence will be obtained on the constitution and wave-length of each of the types of γ radiation which are emitted from radium B and radium C.

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The Piltdown Skull and Brain Cast.

Now that my friend Prof. Keith has explained (NATURE, October 16, pp. 197–99) so lucidly his reasons for making a big brain-case of the Piltdown fragments it is possible to define precisely the point at issue between us.

I should say at the outset that any anatomist, working with the plaster casts but without reference to the actual fragments from which they were moulded, might solve the extraordinarily difficult problem of reconstruction of the cranium in the way Prof. Keith has explained so plausibly. But the bones themselves present features which make such a solution altogether inadmissible. Anyone who examines the left parietal and temporal bones cannot fail to recognise that there is no room for any doubt as to the relative positions of these bones the one to the other, which is not that claimed for them by Prof. Keith.

The right parietal fragment and the occipital can be put into their proper positions and the symmetry of the two branches of the lambdoid suture be restored without producing "any marked asymmetry of another kind," such as troubled Prof. Keith, and without the necessity of making any such liberal additions to the capacity of the cranium as he demands (see his Fig. 2).

The "marked asymmetry of another kind" that he could overcome only by the adoption of the most drastic measures was created wholly by his refusal to admit the possibility that the middle line in the parietal region, as determined by Dr. Smith Woodward, was a close approximation to the truth.

The determination of the precise location of the middle line in the frontal and parietal regions is one of quite exceptional difficulty, but a number of facts and considerations make it certain that it is not where Prof. Keith would place it.

The crux of our difference, then, is the criteria which Prof. Keith uses for determining the middle line in the posterior parietal region. He writes (*op. cit.*, p. 198 *et seq.*):—"In the skulls of all the higher primates, the longitudinal sinus, near the hinder end of the adjacent margins of the right and left parietal bones, is marked by a narrow deep groove with distinct edges; on the margin of the upper angle of the Piltdown fragment the edge or margin of this groove can be clearly recognised."

It must be remembered that the area in question (the "upper angle" of the quotation) is immediately above the middle part of the lambdoid suture, which is preserved upon the larger parietal fragment. Prof. Keith does not seem to have realised this fact, for he represents the lambdoid suture (in his Fig. 2) as a large arch (A, B, A, B) crossing the middle line a short distance below the larger bone fragment. If a series of human and simian cranial casts be examined it will be found that, contrary to Prof. Keith's statement, in a considerable proportion of them there is no trace whatever (in the place just above the lambda corresponding to that preserved in the Piltdown specimen) of "the narrow deep groove with distinct edges" on which Prof. Keith relies as his guide for the determination of the middle line. This is especially the case in the casts of the more primitive human and the simian crania, as Profs. Boule and Anthony have pointed out in their discussion of the Chapelle-aux-Saints and La Quina brain-casts.

On these grounds Prof. Keith "moved the left parietal bone outwards or rather tilted [it] upwards and outwards until it assumes a more vertical position" (p. 199). But in order to do this he had to get rid of one of "the peculiar features of the original brain-cast—the sharp bending inwards or kinking of the temporal lobe of the brain" (p. 199). If Prof. Keith had not opened out the angle between the left temporal and parietal bones the aperture of the ear would have been made to look towards the neck, when he "tilted the left parietal upwards and outwards"! But the precise relationship of the left temporal and parietal bones is not a matter of argu-