

for guidance in the task which in his future career he may have to face, of collecting workmen in inaccessible districts, of housing them, and of looking after them generally.

The work contains 281 illustrations, some being drawings to scale and others reproductions of photographs, showing in a striking manner the operations of mining and quarrying. All are excellent, and, like the letterpress, are exceptionally well printed. A very full and accurate index greatly adds to the value of the book.

B. H. B.

SOME BOOKS ON QUATERNIONS.

Etude sur les Quantités mathématiques. Grandeurs dirigées, Quaternions. By Prof. Claro Cornelio Dassen, D. es Sc. Pp. vi+133. (Paris: A. Hermann, 1903.) Price 5 francs.

Introduction to Quaternions. By the late Profs. Philip Kelland, F.R.S., and P. G. Tait. Prepared by C. G. Knott, D.Sc. Pp. vii+208. (London: Macmillan and Co., Ltd., 1904.) Price 7s. 6d.

Bibliography of Quaternions and Allied Systems of Mathematics. Drawn up for the International Association for Promoting the Study of Quaternions, &c. By Alexander Macfarlane, D.Sc., LL.D., F.R.S.E., General Secretary of the Association. Pp. 86. (Dublin: University Press, 1904.)

It may perhaps be rather an exaggerated statement, but it is none the less to a great extent true, that mathematicians tend to divide themselves into two classes, quaternionists and non-quaternionists, and that these two classes frequently become involved in polemical controversies. But at the present time the notion of vector quantities is of frequent occurrence in physics, and it is important that everyone should have an opportunity of understanding the laws and nature of vector operations. It is not unfrequently stated that forces are vectors, because they are directed quantities, and *therefore* they are compounded by the parallelogram law. But the moment of inertia of a body about a line is also a directed quantity in the sense that its magnitude depends on the direction of the line, although moments of inertia, as every mathematician knows, are *not* compounded by the parallelogram law. Clearly dogmatic statements about vectors are dangerous for teaching purposes.

Dr. Dassen's book deals with a much wider field than the study of quaternions proper. The first part treats of "the concept of quantity," *i.e.* the fundamental laws of algebra. The second part is divided into three chapters, which treat of directed quantities in space of one, two and three dimensions respectively, so that it is only in this last chapter that the particular system of algebra associated with the name of Sir W. R. Hamilton is discussed.

Prof. Knott's edition of Kelland and Tait's book is a typical English text-book of a kind such as writers of other nationalities rarely produce. By this we imply that it is full of worked illustrative examples, and at the end of each chapter is a copious collection of examples for exercise. The first five chapters, extend-

NO. 1800, VOL. 69]

ing up to p. 89, would form an excellent course for a student whose time is short.

The chapter on dynamical applications is an important innovation which might well be extended in the interest of science students by the addition of more elementary examples. Chapter vi., dealing as it does with "cones and their sections," possesses little interest for the modern student. It would have been more useful thirty years ago, when it was the fashion not to teach the calculus until the student had learnt by heart a series of propositions for the parabola, a second series for the ellipse, and a third series (scarcely ever properly understood) for the hyperbola. Nowadays more suitable illustrations may be obtained from physical problems without wasting time over these elaborate discussions about conics. On the other hand, chapter vii., dealing with central *surfaces* of the second order, is less detailed in its treatment, and consequently likely to be more helpful.

Dr. Macfarlane is to be congratulated on the very complete list of papers which he has succeeded in drawing up for the association of which he is secretary. These papers, we notice, cover different systems of multiple algebras, discussions on the geometric representation of complex magnitude, and nearly every book, pamphlet or paper on mathematics or physics in which quaternions or allied systems of mathematics play any part whatever, such, for example, as Clerk Maxwell's "Matter and Motion" or Minchin's "Statics." The only improvement that can be suggested is a classification of the papers by which those merely containing references to quaternions should be separated from those which treat of a substantial portion of the general theory of algebras of vector quantities.

OUR BOOK SHELF.

A Manual of Zoology. By Richard Hertwig. Translated and edited by J. S. Kingsley. Pp. xi+704. (London: G. Bell and Sons, 1903.) Price 12s. 6d. net.

THE English student of zoology has now the choice of a large number of excellent text-books, varying in style, in thoroughness, in wealth of illustration, but sufficient for the purposes of his education up to the time when his more advanced studies require him to turn his attention to the writings of foreign authors in their original language. To add to the list, the translation of a foreign text-book requires some special justification. It must provide something, some special treatment of a subject or some philosophical speculation which has not been provided by those who, with a knowledge of the needs of our own students, have written text-books for their guidance. The great reputation of Prof. Hertwig would lead us to expect a text-book from his pen that would justify its translation into the language of any country where zoology is seriously studied, and in some respects we are not disappointed.

The book opens with a definition of general terms and a short history of the development of the science from the time of Aristotle to the present day, which are admirably concise and clear. The pages dealing with general morphology and physiology are also decidedly excellent, better, perhaps, than are the corresponding parts of any other modern text-book. In the portion dealing with special zoology, however,