Review

learnt if not from Hamilton. The one serious blemish on the book is the multitude of trivial misprints, but if the work meets with the reception it deserves abroad as well as at home, the author will have an early opportunity of correcting these in a second edition.

### Some Famous Problems of the Theory of Numbers and in particular Waring's Problem. By G. H. HARDY. Pp. 35. 1s. 6d. 1920. (Clarendon Press.)

### An Introduction to Combinatory Analysis. By P. A. MACMAHON. Pp. viii + 71. 7s. 6d. 1920. (Camb. Univ. Press.)

The pure mathematician is often challenged to give to the layman some idea of what he tries to do and how he sets to work, to say why he wishes to answer the questions that he asks, and to justify the devotion of his intellect to studies which do not affect the material welfare of his fellows. The last of these demands is met by Prof. Hardy in a few inimitable sentences that deserve to become classical, but it is the first that the greater part of his inaugural lecture, here in print, was designed to satisfy ; in Major MacMahon's booklet, akin to the lecture, because it can be read without previous training in higher mathematics, methods as well as problems are described in detail.

Readers of the *Gazette* need not be told that Prof. Hardy's account of the problems of which he talks is perfect ; even an Oxford audience must have˙ understood most of what he said, and we have an uneasy feeling that his lucidity may have proved his undoing. How can his new University respect a Professor who, far from dealing with matters at the limit of human intelligence, announces that one of his deepest desires will be satisfied when he learns exactly how many fourth powers are required for the expression of an arbitrary large whole number ? For, of course, it is not the goal but the game that attracts, and when players of ping-pong and old-maid can realise the pleasure that Prof. Hardy finds in tennis and vint, those who have not attacked the problems for themselves will be able to appreciate both the excitement of the investigations of which glimpses are given here and the skill which their pursuit requires.

As a summary of the facts relative to Waring's problem known when it was delivered, Prof. Hardy's lecture is of great interest, and to the reader familiar with Cauchy's theorem and with the idea of a generating function he has succeeded in explaining the nature of his researches so far as to convey an idea of their fascination. On the other hand, while Major MacMahon is doubtless right in claiming that to read his " Introduction " no mathematical equipment is necessary—the novice will have his self-confidence put to a severe test by the misprints in the scheme on p. 12—and while there could not be a better account than this for the mathematician who requires to learn the principles of combinatory analysis, it is to be feared that the normal effect of the book on the outsider will be to deepen his wonder that people should take interest in such things ; for the work, well written as it is, has to be read with attention, and the reader who is not constitutionally attracted by the questions discussed will hardly be convinced that the trouble taken would not have brought greater return if expended elsewhere. It is only fair to add that in presenting his subject in an elementary form Major MacMahon's object was not to illustrate to the sceptic the beauties of mathematics, but to discover to the mathematician valuable points of view that are easily overlooked in an elaborate treatment, and that this purpose has been most admirably achieved.

### The Absolute Relations of Time and Space. By A. A. ROBB. Pp. x + 80. 1921. 5s. (Camb. Univ. Press.)

Dr. Robb's work on space and time has been the subject of vigorous discussion for several years, and this synopsis in which we can appreciate his definitions and postulates without the diversion of skipping his proofs is very welcome. Two positive achievements are beyond dispute. The description of ' conical order ' is a great boon to such physicists and philosophers as find it hard to understand that a universal ' now ' is neither logically nor psychologically indispensable. And the enumeration of the various species of three-