

all the preceding propositions. Mathematics consists of all such mathematical sciences." The appended note treats from a historical point of view the three stages of rhetorical, syn-copated, and symbolic algebraic notation.

The book is strongly commended to teachers and prospective teachers and will be very useful to those giving teachers' courses. While a few discussions, such as that of the first three known infinite cardinal numbers, may not be appreciated by those whose knowledge of mathematics is limited, yet practically no use is made of the technique of higher mathematics. The ability for abstract thinking required of the reader is considerable, but the careful reading of such a book cannot fail to have a broadening effect particularly upon those teaching elementary mathematics and in daily contact with immature minds. There is a need for scholarly contributions to mathematical literature in English sufficiently elementary in character to be useful and inspiring to progressive secondary teachers, and we believe the book under review to be just such a contribution.

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*Leçons de Cristallographie.* Par G. FRIEDEL. Paris, Hermann, 1911. 8vo. vi + 310 pp. 10 fr.

Two things have been kept in mind by the author in writing this book. One is the purely utilitarian view of furnishing some knowledge of the subject to students of the mining college. The other is the purely cultural view of the subject. The latter might seem a little strange, considering the title. But from a mathematical standpoint, there is a distinct cultural value in the study of geometrical properties in crystallographic form. This becomes evident when we remember the thirty-two types of crystals and the related finite groups. We can assert from experience, having tried the experiment for several years, with freshman classes, that such a study is fully worth the time put upon it, even worth more than some other branches of elementary mathematics. After the class has drawn all the types of crystals, and manufactured one or more apiece, considering in each case the symmetry involved, the rotations possible, the way each face is produced from the original one, they are in a position to know something of group theory, at least in a very concrete form. A half-semester is ample time to cover the ground. The interest shown in

mathematics from this simple study is gratifying, the improvement in geometrical imagination is valuable, and the idea of the mathematical study of essential structure is one that will go a long way in placing the correct estimate on the necessity of mathematics in a liberal education. If such a course is given by a mathematician rather than a mineralogist, and its bearing on the various problems in mathematics that it opens up is fully brought out, there are few subjects more stimulating to the student.

The text is based upon the "law of Bravais"—that crystal-line structure is a finitely periodic reticulation. This law includes the law of rational indices. The first part is devoted to the study of the individual crystal, the second to the complex crystalline structures. There are two sections in the first part, the first of them being on the geometry of the crystal, the second on the physics of the crystal. In the latter the properties are classified as those due to discontinuous vectors, those due to continuous vectors. The treatment as a whole is clear and well put. The text is elementary.

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*Nouvelles Tables Trigonométriques Fondamentales.* By H. ANDOYER. Paris, A. Hermann. 4to. xxxii + 602 pp.

It is not easy to arouse much enthusiasm over a table of logarithms. Most of those who use aids to calculation are apt to regard them as tools necessary to the workshop, which are taken up and laid down with absolute indifference and with absolute confidence in their complete accuracy. Perhaps the latter is justified as far as the ordinary four-, five- and seven-place tables are concerned, and if this new issue were one of the many reprints that appear almost annually it would scarcely call for notice in the pages of the BULLETIN.

But there are features of M. Andoyer's work which merit special mention. The main portion of the work consists of the logarithms of the sines, cosines, tangents and cotangents to *fourteen* places at intervals of ten seconds of arc for the whole quadrant. An additional table gives the logarithms of  $\sin \alpha/\alpha$ ,  $\tan \alpha/\alpha$  for the same interval and for the first three degrees. Four further tables used in the calculations are printed: a page of logarithms to eighteen places of certain numbers; a page of formulas for the expansions of  $\log \cos \frac{1}{2}\pi x - \log (1 - x^2)$  in powers of  $x^2$  as far as  $x^{40}$ , and similar