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Review

Author(s): X. Y. Z.

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The author promises, however, to follow up his present work with two other volumes, the greater part of which would be occupied in remedying this seeming defect, the subjects to be dealt with being ordinary algebra, the algebra of quantities, algebraic geometry, and vector analysis. The appearance of these additional volumes will be looked forward to with much interest, as they can scarcely fail to be of considerable service in the advancement of science. It will also then be apparent to what extent the theory of determinoids is likely to contribute towards such advancement. So far as one can at present see, there is safety in hazarding the conjecture that the extent will be limited as compared with that of its fellow-subject Matrices, or its prototype Determinants.

THOMAS MUIR.

**Problem Papers. Supplementary to Algebra for Secondary Schools.** By C. DAVISON. 8d. 1913. (Cambridge University Press.)

This pamphlet contains 160 selected questions in Algebra, with answers, from papers set, presumably by the author, for the Intermediate Board, Ireland.

The questions cover the ordinary range of algebra up to progressions and theory of quadratics. They are clearly put and in good style, and the collection forms a useful and inexpensive supplement to the contents of the standard text-books.

C. S. J.

**The School Algebra** (Matriculation Edition). By A. G. CRACKNELL, M.A., B.Sc. Pp. 420+lxv. Price 4s. 6d. (Clive & Co.)

As a school text-book, this volume has much to recommend it, the examples and test-papers being carefully chosen and very full. The idea fundamental in the advice "whenever the student finds any difficulty in expressing the work algebraically, he is advised to invent for himself a corresponding question in arithmetic with some simple numbers" is the main-spring of the book.

Regarded as an exposition of Algebra the volume is scarcely so happy. To begin with, the author considers one of the main difficulties in teaching Elementary Algebra to be the multiplicity of the rules. Surely this is the fault of the text-books, not of Algebra. One almost suspects that the author does not realize what Algebra is. He defines Algebra as a "kind of advanced arithmetic in which numbers may be represented by letters." Can this definition be accepted?

The theory of so-called Arithmetical Fractions (Art. 16) is Algebra; for the symbol  $\frac{2}{3}$  is quite as "imaginary," as an abstract number, as  $\sqrt{-1}$ .

The author rightly assumes the Commutative Law for Multiplication and Division in Arithmetic and its extension to fractional forms, but incorrectly assumes, in Art. 68, that it is true for fractions in general. The only correct method is to *define* multiplication and division in general for fractions in such a way that the laws already assumed (or proved quite easily) for fractional forms are not contradicted. The definition of the new meaning of the  $-$  sign as a *reversal* is far too sweeping: it is not logically necessary that, if  $+(-5)$  is defined as reverse of  $-5$ , that it should follow that  $A \times (-5) = -(A \times 5)$ , so that Arts. 44, 45 hardly prove what they profess to do. The author states: "No satisfactory proof can be given of the law of signs for multiplication when the signs indicate positive and negative quantities—at any rate no proof which will really apply to all possible cases." The meaning of this is not quite clear, but if it refers to the proof of the rule  $(\pm a) \times (-b) = \mp ab$ , it is incorrect. There is no proof at all for this "rule": in fact it is not a rule, it is the *definition* of a negative multiplier.

As this is a volume for matriculation students, the whole treatment of negative quantities and zero in Chapter XIV. is unfortunate; for it is getting quite usual for little bits of theory such as "Prove (illustrate or explain) that  $2 - (-3) = 5$ ," to appear in matriculation papers. This cannot be proved, although the author apparently professes to do so in general. It can only be *defined* as the meaning to be attached to subtracting a negative so that the laws of Arithmetic are not contradicted, or *illustrated*, by reference to a thermometer, debit and credit, etc. It is also unfortunate that the author perpetuates the cause of much muddle amongst beginners in Calculus by suggesting that "0" or "zero" ever stands for anything else but "absolute nothingness." The same remark applies to the use of the word quantity for number and calling infinity a quantity. It cannot be too strongly impressed that  $(x^2 - a^2)/(x - a)$  is meaningless when  $x$  is absolutely equal to  $a$ , though a meaning can be found for all other values of  $x$  no matter how small  $x - a$  is.

The chapter on Fractions contains "proofs" of the Laws "as in Arithmetic": these, depending on the idea of dividing the unit, are unsound as laws of abstract number. They apply only to "fractions in measurement," concrete quantities.

There are one or two little slips, such as in the definition of "term," Art. 27. The terms of  $2a + b - 3cd$  are  $(2a)$ ,  $(b)$  and  $(-3cd)$ , and not  $2a$ ,  $b$ ,  $3cd$  as stated.

It is not stated that the multiplicand can be distributed as well as the multiplier, and yet in Ex. 12, Art. 37, we have both operations performed. It is not *necessary* to take out inner brackets first; it is in general convenient, but a boy in the sixth form would probably remove them all simultaneously. The note at the foot of page 73 should be deleted: whatever  $a$  is (including infinities)  $3a + 5a - 8a = 0$ .

The treatment of Graphs is one of the best features of the book: the chapter on the use of formulae is also an innovation deserving all commendation; ratio and proportion receive adequate treatment; but surds suffer from a lack of preparation as to approximate values. X. Y. Z.

**A School Arithmetic.** By A. CLEMENT JONES, M.A., Ph.D., and P. H. WYKES, M.A. Pp. 440+xxxii Answers. Price 4s. 6d. (Arnold.)

This is a very useful text-book, especially noteworthy for the excellence of its revision exercises and miscellaneous exercises and problems. Everything is beautifully explained, and the authors have not hesitated to use literal symbols to generalize the rules. The development of fractions on the idea of subdividing the unit, although I do not care for it, is perhaps not so unsound in an Arithmetic as it would be in an Algebra, especially as the authors are careful not to profess to prove the rules, but only to justify them. Still I should like to see the rules proved for fractional forms and then extended. I am sure it could be done in an Arithmetic quite simply without wearying or frightening the beginner, and yet perfectly strictly. It is a treat to see Interest, etc., considered as simply variations of the one great principle of proportion, coupled with a satisfactory account of the Unitary Method. Approximate Methods for Decimals and Logarithms are well done. There is also a large section on Mensuration, which should make the work interesting. A very good book.

**A General Course of Pure Mathematics.** By Prof. A. L. BOWLEY, Sc.D. Pp. 268. Price 7s. 6d. net. 1913. (Clarendon Press.)

Perhaps the only adverse criticism that can be made against this excellent volume is that one is not clear as to the section of the public for which it is intended. It is admittedly not for the mathematical specialist; for the engineering student, it is, more's the pity, liable to be considered too rigorous, preference being given to one or other of the advanced treatises labelled "Advanced Practical Mathematics"; and, apparently, in England these two classes alone are worth consideration!

The volume starts from an assumed knowledge of "Matriculation Mathematics" and extends to and slightly beyond "Scholarship Mathematics." The proofs are beautifully clear and rigorous, and worked out on up-to-date lines. The opening article on the rule of signs is worth the attention of many an author of elementary mathematical text-books. We also find on p. 3 a cross-reference to the possibility of finding a value for an incommensurable index, e.g. a logarithm, without which the proofs of the laws for logarithms are worthless; the idea is assisted by obtaining  $\log_{10} 2$ ,  $\log_{10} 3$  from the calculation of  $2^x$ ,  $3^x$  in a highly suggestive manner. Variation is illustrated graphically in such a way as is likely to convince even a dull student. Limits are carefully treated, the definition being given accurately, though in a slightly unusual form, the essential point that  $|f(x) - l|$  becomes and *remains* less than  $\epsilon$  being excellently brought out. The author's definition is, however, in my opinion, inferior to that derived from an endless sequence, as given by Hobson, and the whole matter might be improved by a preliminary, graphical, and arithmetical treatment of "large" and "small" numbers. The usual present-day symbol  $\lim$  would look better than the author's sign for limit. The proof of the Logarithmic Series does not seem so satisfactory as some of the other proofs; the author is rearranging a double series without having given any preliminary work on the permissibility of this. Complexes are treated from the standpoint of an operator, and worked to a logical conclusion; but my experience has been that no student except the mathematical specialist ever gets a grasp of an