chosen as to give the smallest possible number of changes. *A little reflection shows that this will always be the case,*" etc. The sentence we have italicised contains the fault referred to. The present reviewer learnt the theory of equations mainly from Todhunter's treatise; the immortal Isaac, in his old-fashioned, unemotional way, does not appeal to his readers powers of reflection, but does his best to show that in his diagram, and any such, the last row of signs must have at least one more variation than the first. We doubt whether anybody could write, in a reasonable space, a better explanation than Todhunter's; nevertheless, it took us a good deal of reflection to appreciate it. A still more striking instance is in the discussion of Sturm's theorem (p. 219). Here we read: "*It will be seen,*" etc., followed by a statement of the theorem for a particular case. We learnt Sturm's theorem in the first instance from De Morgan's article in the "Penny Cyclopædia." The great Augustus does not say: "It will be seen . . ." (Did he ever say so, in this kind of way?)

One more example, of a rather different kind. Pp. xi–xiv contain a list of formulæ, etc., which the reader is supposed to know, and are given for reference. Under "Binomial Theorem" we have: "*Key number of term.* The number of factors in the numerator of any term, the number whose factorial occurs in the denominator, the exponent of x, and the number subtracted from m to form the exponent of a are always the same number, viz. $n-1$." Doubtless this would be lucid to the late Henry James, but it is not so to us, and we do not believe that it would be so to an average English student, except after a good deal of previous explanation.

Of actual mistakes we have found very few. P. 20 (top) the reasoning is so vague that a student might fairly argue that the proper formula is $n!-r!$ instead of $n!\div r!$; p. 23, in England, if the probability of an event is 3/7, we say that the odds are 4 to 3 against it, but "odds" may have a different meaning in the States; p. 56, "a variable can have only one limit" is wrong as it stands; p. 79 (bottom) gives a very cryptic rigmarole for differentiating u^c; p. 108, *for* "a number" *read* "a fixed number," otherwise the whole argument breaks down; p. 115, the expansion of $(2-3x+4x^3)/(1-3x+2x^2)$ should be done by synthetic division, not by undetermined coefficients; p. 149, the notes about Napier's logarithms are incorrect (in particular, Napier's logarithms are not "natural" logarithms); p. 169, "i represents the positive square root of -1" is meaningless, especially the "positive."

(2) Prof. Atma Ram's book ought to be extremely useful to those who can use a collection of solved examples in the proper way. It is a sort of abbreviated "Walton" fairly brought up to date, the range being from elementary dynamics and kinematics to central forces, including planetary motion. So far as we have been able to test them, the solutions are all correct, sufficiently detailed, and often very elegant. The English is thoroughly idiomatic, and Prof. Ram is his own printer and publisher. Paper and typography are as good as many Indian Government samples; we wish that the quality could be improved all round.

G. B. M.

BIOLOGY OF WATER SUPPLIES.

The Biology of Waterworks. By R. Kirkpatrick. (British Museum (Natural History) Economic Series, No. 7.) Pp. 58. (London: Printed by order of the Trustees of the British Museum, 1917.) Price 1s.

SINCE men of science became more intimately associated with engineers in the management of waterworks, questions of animal and plant life in water supplies have been brought more into the foreground, and it is with the object of directing attention to the importance of these questions that the trustees of the British Museum have placed an exhibition in the South Kensington Museum and have published this pamphlet as a guide thereto.

The first section, dealing with the animals associated with water supplies, opens with an account of some experiments made in 1886 on the pipe-fauna of Hamburg, then supplied with unfiltered water from the Elbe. Examples of as many as fifty genera, representing most of the main groups of the animal kingdom, were obtained, and the author gives an interesting account of the life-history of some of the more important, showing how when once established they can rapidly spread to the whole of the system, and in some cases—for example, sponges and molluscs—cause grave restrictions to the flow of water in the pipes.

Under the second heading of "Plants in Waterworks" the author deals chiefly with algæ and bacteria. The former class, when present in excessive amounts, may cause serious choking of filter-beds, and sometimes give rise to unpleasant tastes and odours, but otherwise are an important factor in efficient filtration.

Ordinary bacteria, including those which cause water-borne disease, are not dealt with, but a very full account is given of the dreaded crenothrix or iron bacteria. Several water supplies, both in this country and abroad, notably Cheltenham, Liverpool, Berlin, and Rotterdam, have suffered from this pest, and the author describes in some detail the history of these visitations, which have had the effect not only of almost entirely choking the pipes, but of imparting to the water a deep red colour and an unpleasant odour.

In the last section the question of biology in relation to water purification is dealt with. The theory and practice of slow sand filtration, depending as they do on the formation of a biological film on the surface of the sand, are fully described, and the section concludes with a brief summary of the pioneer work of Dr. Houston on storage.

The pamphlet is profusely illustrated with diagrams and photographs, and is a most useful, interesting, and readable work.