The problems are arranged under the type of differential equation involved, and consist for the most part of the conventional initial and boundary value problems connected with vibrating strings, bars and membranes, heat conduction and diffusion, electrostatics, elasticity and the like. The index helps the reader to find examples in any of these branches. The solutions are in general concise and clear; occasionally the student may find them somewhat cryptic, as in the few examples of the integral equation method of formulating the Dirichlet and Neumann problems in potential theory; the authors are not to blame for this, for it must be pointed out that the present collection of examples is intended as a companion volume to Tikhonov and Samarski's *Equations of Mathematical Physics*, also available in English Translation (Pergamon Press, 1963, £6), and there is no doubt that the value to the student of the work under review would be enormously increased by a simultaneous study of both volumes.

Prodigious industry must have gone to the compilation of this work, and the student will have a correspondingly Herculean task if he is to master it. He is wisely advised by the authors to attempt only a few problems from each section, and he may take comfort from the reflection that the English edition has been shortened as compared with the original by the omission of " a number of the more uninteresting problems ".

The book will undoubtedly be of great value to anyone following a systematic course on " mathematical methods "; but not many students are likely to be able to afford to buy it as well as the main work which it is designed to supplement.

The translation reads well, and the paper and printing are excellent; only half a dozen minor misprints have been noticed. R. SCHLAPP

HAYES, CHARLES A., JR., *Concepts of Real Analysis* (John Wiley and Sons Ltd., 1964), vii+190 pp., 49s.

This book is intended to give an understanding of the real number system, and the fundamental limit processes associated with it, to students who have completed a course in elementary calculus. It was developed from a summer course for schoolmasters who have to teach calculus and need to understand what lies behind it.

The first of the seven chapters gives a leisurely introduction to set theory, just the notation, unions and intersections, ordered pairs, the definition of a function in terms of ordered pairs, inverse functions and the axiom of choice. In the second chapter, on number systems, no attempt is made to construct the real numbers, but their basic properties are listed in the form of axioms. The well-ordering principle, the Archimedean property, a discussion of integers and rationals, and the upper bound axiom are included in this chapter. It is followed by one on finite and infinite sets, in which the rationals are shown to be countable; cluster points and cardinal numbers are introduced, but the latter are defined only for finite sets.

In the early chapters the level of the presentation is well chosen, though I began to feel in Chapter 3 that too much space was being given to proving things which most readers would readily accept, for example, that a finite set has a largest member. I felt also that the proof of the Bolzano-Weierstrass theorem could have been presented more simply if the author had not insisted on using set notation.

Chapter 4 is on sequences, and in Chapter 5 many of the previous notions are extended in a rather painstaking way, to the system consisting of the real numbers together with $+\infty$ and $-\infty$. By this time the author's obsession for set notation is making the treatment unnecessarily heavy. He devotes half a page to explaining the term *subsequence*, and a further nine lines to the proof that a subsequence of a subsequence of a given sequence A is a subsequence of A. He never hesitates to replace a standard abbreviation by a more complicated expression in set notation; thus the upper limit of a sequence $\{A_n\}$ is defined effectively as $\lim_{n\to\infty}\left(\sup_{m \geqq n} A_m\right)$, but in fact the set

$$\mathscr{A}_p = \{x \mid \text{there exists } n \text{ such that } p \leqq n \in P \text{ and } x = A_n\}$$

is introduced.

Chapter 6, on definition by induction, will appeal to those who feel uncomfortable about this method of definition, but I feel that Chapter 7, on functions of a continuous real variable, including uniform continuity and uniform convergence, could be improved by suppression of some repetitive details in its first half. Also, an interval is defined in set notation, of course, and a lemma is given to prove its endpoints unique; it seems to me that this kind of thing raises more doubts in the mind of the average student than it resolves.

This, then, is rather an unconventional book. It gives a treatment of analysis, stopping short of infinite series and differentiation, which is rigidly tied to set theory. It will appeal to some and rouse antagonism in others; that there are valuable things in Chapters 1, 2, 3 and 6, everyone will admit. The text seems to be virtually free from errors and misprints, and the layout and printing are very good. P. HEYWOOD

FREYD, PETER, *Abelian Categories. An Introduction to the Theory of Functors* (Harper and Row, 1964), xi+164 pp., $7.00.

MITCHELL, BARRY, *Theory of Categories* (Academic Press, 1965), xi+273 pp., $13.75.

These two books will make it possible for any mathematician to achieve some familiarity with the motivations and foundations of the theory of categories, a subject that has been forcing itself upon our attention increasingly in recent years.

Freyd, with the laudable aim of keeping his book short, follows what he calls a " geodesic " path towards his main theorem, that every small abelian category can be embedded as an exact full subcategory of a category of modules. This rather specialised goal does not, however, seriously distort the treatment of the theory: all the important notions are introduced and treated briefly, and the exercises (of which there are many) give a hint of alternative paths of development.

The book has certain eccentricities of style, which might irritate some readers, but it seemed to me as I read that on the whole the eccentricities contributed to the quite outstanding readability of the book—and the appendix was a rare entertainment!

Mitchell's book is vastly more comprehensive than Freyd's. Several topics, such as extensions and sheaves, are treated extensively by Mitchell and only mentioned by Freyd, and the results on global dimension in Chapter IX are not to be found at all in Freyd's book. A careful attempt (which I hope will be successful) is made in the early chapters to rationalise and standardise the terminology of the subject, and the exposition throughout is clear. A useful commentary on the text is provided by the exercises, which give motivation to the definitions and illustrations of the theorems.

Because of its more ambitious syllabus, the book is harder to read than Freyd's, and the beginner would probably find Freyd less discouraging. Mitchell's book, is, however, much the more useful as a reference, and should certainly be acquired by university and departmental libraries. J. M. HOWIE

RUTHERFORD, D. E., *Classical Mechanics* (University Mathematical Texts, Oliver & Boyd Ltd., Edinburgh, 1964), viii+206 pp., 10s. 6d.

Professor Rutherford's services to mathematics and mathematical education are universally recognised, and the appearance of the third edition of this well-known book, originally published in 1951, is a testimony to its value to successive generations of students. The new edition is substantially a reprint of the second edition with only minor additions. R. SCHLAPP