The length of an arc of a circle is defined as the least upper bound of the set of real numbers representing the sums of the lengths of chords, after the existence of such a bound has been demonstrated. The concept of a path as the motion of a point travelling a directed distance along a circular arc is presented intuitively, and the values of the six trigonometric functions are specified by the coordinates of the terminal point of a standard path. Later it is shown that these functions may be expressed as functions of angles. The usual applications, including vector applications, are made.

The other elementary functions considered are the exponential and logarithmic functions. The laws of exponents are rigorously treated, and there is some logarithmic computation. Complex numbers and polar coordinates are discussed in appendices. Five-place common logarithm tables and four-place trigonometric tables are included.

The gifted, and interested, student should find this text stimulating and challenging as well as a source of considerable information not found in a conventional textbook on trigonometry. But the challenge may be too great for an unprepared instructor who could experience difficulty in motivating the author's treatment.

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Feynman as a Lecturer

The Feynman Lectures of Physics. Richard P. Feynman. Robert B. Leighton and Matthew Sands, Eds. Addison-Wesley, Reading, Mass., 1963. Unpaged. Illus. $8.75.

This book is based on the lectures given by Richard Feynman at California Institute of Technology during the academic year 1961 and 1962, and it covers the first year of a 2-year beginning physics course. The material consists essentially of the lectures as they were given by Feynman, the lectures being tape recorded, transcribed, and edited.

This is indeed a remarkable volume. On reading it, one is struck first by the extraordinarily extensive scope of the material contained therein, material which often takes one far afield from the conventional topics of the usual introductory course. As a result of this wealth of material, a certain conciseness is evident, but this lies primarily in the use of relatively few illustrative examples and not in any curtailment of the exposition of the basic physics. Reading this book is at times a breathtaking experience, and Feynman's style and special talent for exposition are evident throughout. Although the purpose of the course was to maintain the interest of the very enthusiastic and able students entering Caltech by presenting material taken from present-day physics, and this is done with boldness and depth, practically nothing in the older classical physics was neglected. In fact, the book appears encyclopedic in scope, and many topics related to other sciences and to engineering are dealt with in some detail.

Feynman states in his preface that he could see no " . . . reason to work the lectures in a definite order, in the sense that I would not be allowed to mention something until I was ready to discuss it in detail." The exercise of this degree of freedom, in my opinion, provided the book with one of its more attractive features. Feynman has shown clearly that it is not only possible but also rewarding to examine at some length the many rich implications of fundamental laws and ideas of physics before the maturity of the student allows an orderly derivation of such starting points. His elegant formulation of the law of electromagnetic radiation from an accelerated charge and its uses in a relatively detailed and extensive treatment of physical optics is a splendid example.

The reader must remember that the actual course consisted of section meetings and laboratory work as well as Feynman's lectures. One should really look at the problems (published separately in 1964 by Addison-Wesley) to appreciate what is expected of the students. Hence this book alone will not function well as a textbook, but as a reference for student and teacher alike, it is invaluable.

The general order of the material is as follows. After introductory chapters that describe physics in general and its relation to other sciences, the general subject of mechanics (including special relativity) is presented; this is followed by a relatively extensive discussion of electromagnetic radiation and physical optics. After a fairly brief introduction to quantum behavior, kinetic theory, and many of its applications, thermodynamics and wave motion are considered. The final chapter is devoted to symmetry and physical laws.

There are many items of special interest, but it would take far too long to describe them in any detail. The freshness of viewpoint, the accuracy of statement, the richness of the material, and the ingenuity of presentation—for example, the remarkable chapter entitled "Ratchet and pawl"—are striking. Reading this book will be a richly rewarding experience for all who desire to acquire a real understanding of what physics is all about as well as for students and teachers of physics.

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Mathematics

Lectures on General Algebra. A. G. Kurosh. Translated from the Russian edition (Moscow, 1960) by K. A. Hirsch. Chelsea, New York, 1963. 335 pp. Illus. $6.95.

Kurosh's book provides a coverage of the foundations of a good deal of what is treated nowadays under the title of modern or abstract algebra. The level of abstraction is, in general, that of Bourbaki's excellent works on algebra, though the terminology and notation frequently are rather different. In chapter 1, Kurosh deals with relations and sets; in chapter 2, he gives the basic properties of groups and rings and introduces the concepts of isomorphism and embedding; in chapter 3, he introduces the extremely general system of a universal algebra and also gives more results about groups, particularly groups with operators and free groups and rings. Chapter 4 is devoted to lattice theory with application to universal algebras and groups; chapter 5 gives an introduction to linear algebra from the general point of view of rings with operators and modules; chapter 6 introduces ordered and topological groups and rings and ends with a brief treatment of the Galois theory of fields.

As a text book, I feel that this volume would not be suitable for use in a first course in abstract algebra, except for a class of most unusual students, but it might well serve for a second course. Of course it is a superb reference book. Unfortunately, there are no exercises but there are occasional illus-