

Building on a firm foundation

Physics from the Ground Up

By H. Y. Carr, R. T. Weidner

706 pp. McGraw-Hill, New York, 1971.
\$12.50

Reviewed by Walter Eppenstein

Neither the title nor the preface of this book indicate that this is a physics text for engineers, for poets or any other specific group; it is written for students who want to study "the workings of the physical universe." A knowledge of elementary algebra and trigonometry is assumed. There are specially marked sections making use of calculus; they can, however, be omitted without a loss of continuity.

Throughout the book the approach to an understanding of physics is "From the Ground Up." The simplest cases are discussed first, usually starting with the behavior of ordinary objects. More complicated situations then lead to generalizations. Pedagogically this is probably a better approach in many cases than to derive the most general situation first and discuss special cases later on. An example of this approach is the discussion of the Compton effect. The change of wavelength of the scattered photon for a one-dimensional head-on collision is derived first, with nonrelativistic equations. This is followed by the appropriate equations for the more general two-dimensional case. In a worked-out example, the Compton effect is eventually treated relativistically. Although the problem is presented "from the ground up" by treating it nonrelativistically first, in this particular example it may actually complicate the picture because of the necessary assumption that the change in wavelength of the photon is small compared to its wavelength, an assumption that has to be made in the "simple" nonrelativistic calculation but does not enter into the actual analysis with relativistic relations. "From the Ground Up," therefore, is an excellent idea as long as we are very careful about all possible implications.

The principle "From the Ground Up" really works well in the relativity chapters, where the example of moving trains is used to illustrate reference frames,



Electron diffraction from a thin film, which is partly polycrystalline and partly a single crystal. The photo, by Sigrid Herd of IBM Corporation is included in *Physics from the Ground Up*.

time dilation, length contraction, simultaneity and velocity transformations without ever mentioning Lorentz transformations and the associated mathematics.

The text contains a large number of very good worked-out examples, which are set off from the main body by a shaded background. From the student's point of view, this may well be one of the strong features of the book. The footnotes, queries and comments in the wide margin add considerably to an understanding of the topics discussed. There is a good set of problems at the end of each chapter with the answers to most odd-numbered problems given

at the end of the book.

Most topics usually found in an introductory physics text are treated, with the exception of fluids. The space devoted to each topic and the order of presentation is somewhat different than in conventional courses to better fit into the following five main areas: the classical conservation laws (34% of the book is devoted to this topic), gravitational, electric and magnetic interactions (20%); light and waves (13%); relativity (9%) and quantum theory, atoms, nuclei and elementary particles (24%). Solid-state physics is not mentioned in the text. The coverage is not encyclopedic, but concentrates

today and the day before

Physics in the Twentieth Century:

Selected Essays

by Victor F. Weisskopf

foreword by Hans A. Bethe

This selection of essays covers a wide range of subjects connected with the physical sciences and their relation to human affairs. They are broadly conceived and directed to a generally interested audience rather than to specialists in particular areas. Some are written for the initiated, some are broad synopses of a branch of physics and are directed to the scientifically interested layman. Some deal with more philosophic questions such as Niels Bohr's ideas on complementarity, and others deal with the problems of science, ethics, and society.

Hans Bethe writes as follows in his foreword:

"His summary articles on special topics are lucid, and are 'popular scientific writing' at its best. The subject is made clear to physicists in other branches of physics, and to the educated public, by simplifying it, but without ever making a compromise with fundamental accuracy, as many popular writers on science do when they get enamored with their own imagery and forget the subject that they really want to explain."

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Problems of Atomic Dynamics

by Max Born

\$2.95 (paperback)

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edited by Bernard T. Feld and Gertrud Weiss Szilard

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by Eugene P. Wigner

\$3.95 (paperback)

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in Honor of Alfred Landé

edited by Wolfgang Yourgrau and

Alwyn van der Merwe

\$17.50

The Character of Physical Law

by Richard Feynman

\$6.95 (\$2.45 paperback)

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on the main features of these five themes. The authors did not hesitate to omit ideas that are unnecessary for an understanding of these themes, such as fluids and Gauss's law. Topics mentioned only in the problem sets at the end of chapters include simple harmonic motion and capacitance. Over 25% of the material in the text is marked as an "extra," an interesting extension of the main theme but not essential to the continuing story. One should therefore be able to cover the book comfortably in a one-year introductory physics course. Comparing the coverage of topics with other texts, such as the three volumes of Richard T. Weidner (co-author of the text reviewed) and Robert L. Sells, one finds that a higher percentage of space is devoted to classical conservation laws, primarily at the expense of fluids, thermodynamics and optics.

The authors have tried to develop the five main themes by precise arguments and have, on occasion, used an historical approach. An example is the introduction of kinetic energy after a discussion of conservation of momentum. The *retrieval principle* (relative speed of separation equals relative speed of approach) is discussed in some detail; although it may not be very fundamental, it certainly simplifies the mathematics of elastic collision problems. The ideas of Huygens and Leibniz leading to *vis viva* are then applied to

introduce kinetic energy.

Some of the terminology used in this text is different but usually introduced for very good reasons. Gravitational mass, for instance, is initially referred to as "gravitational charge," a "magnetic charge" is also discussed. An *emf* is called *electromotance* with a footnote that the historically sanctioned but misleading term *electromotive force* is often used instead of *electromotance*.

The diagrams and illustrations are very well done, and the computer-produced electron-density pictures illustrating probability densities for various states certainly add to an understanding of quantum systems. The use of an extra color throughout the book is appealing.

I feel that the text *Physics From the Ground Up* is a valuable addition to the existing market of noncalculus introductory physics books primarily because of its somewhat different approach in discussing relatively few principles in some detail and also because of the overall quality of content as well as printing.

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The reviewer has lectured in introductory physics courses at Rensselaer Polytechnic Institute for many years and has been a participant in a number of national curriculum development projects dealing with physics for nonscience majors.

Introduction to Mechanical Properties of Materials

By M. M. Eisenstadt

444 pp. MacMillan, New York, 1971. \$14.95

Entrance into the Material Science research area at the University of Maryland is announced by a large poster hanging in the corridor. Upon leaving, one is confronted by the inscription on the back of the poster, the work of irreverent students, no doubt, announcing return to the realm of "Immaterial Science."

Since many institutions have instituted various materials-sciences programs, a well written introductory text would appear to be welcome. Melvin M. Eisenstadt, assistant professor of mechanical engineering at the University of California in Santa Barbara, has written such a text. Though most properties discussed are of general interest, by considering metals, ceramics and polymers, Eisenstadt is able to supply basic ideas in comparing similarities and differences of these materials. For example, in the chapter on molecular bonding, two sections are devoted to polymerization in addition to more commonly considered bonding mechanisms. In the third chapter, a

large section on structure is devoted to chain molecules, and the chapter on plastic behavior of solids discusses work hardening of metals, dislocation motion in ceramics and permanent deformation of polymers. This comparative approach also is evident in the later chapters.

The book is aimed at the sophomore or junior with little special preparation beyond calculus. Though this makes several of the derivations somewhat forced, the overall emphasis on conceptual model building makes the well organized material readily accessible. Eisenstadt succeeds admirably in his stated aim to pursue two goals in considering mechanical phenomena in materials. On the one hand, he presents physical, microscopic models. They serve as guides to macroscopic equations and thus lead to an understanding of why materials behave as they do. On the other hand, he considers quantitative measurements to give the engineer a feeling for the order of magnitude associated with changes in mechanical phenomena. An unusually large number of well selected figures and tables (almost one per page) help to illustrate ideas and support the text.