

Textbooks for the nonscientist: Two approaches

Introductory Physics: A Model Approach

By **Robert Karplus**

498 pp. W. A. Benjamin, New York, 1969. \$11.75

An Introduction to the Meaning and Structure of Physics

By **Leon N. Cooper**

747 pp. Harper and Row, New York, 1968. \$13.95.

Reviewed by **THOMAS VON FOERSTER**

Teaching physics to students who plan never to use it in a professional capacity is a less well defined endeavor than is the teaching of future physicists. One generally finds it easy to decide what physicists-to-be must learn, and, with only rare exceptions, it is not difficult to decide how to teach it.

It is, however, very difficult to decide what people in other professions should know about physics. There are none of the boundary conditions imposed by future courses in related fields, and the long-range importance comes anywhere during the following 30 or 50 years. Lacking any objective criteria for the "usefulness" of his course, the teacher of physics for laymen is forced to rely on the more subjective criteria of importance, elegance and relevance. He is therefore likely to find none of the existing texts completely satisfactory and may be tempted to fill the gap with another text. Anyone who is on publishers' mailing lists for brochures on introductory texts can testify to the strength of that temptation.

These two books clearly demonstrate the widely divergent tastes among authors of physics texts for nonscientists. To classify their approaches one can put Robert Karplus's book into a group vaguely defined by the Physical Science Study Committee texts and Elisha Huggins's *Physics I*; Leon Cooper's book fits into a group containing Gerald Holton's classic text and Edwin Kemble's *Physical Science: Structure and Development*.

Karplus's *Introductory Physics: A Model Approach* is, indeed, just what the title indicates. As PSSC, Hug-

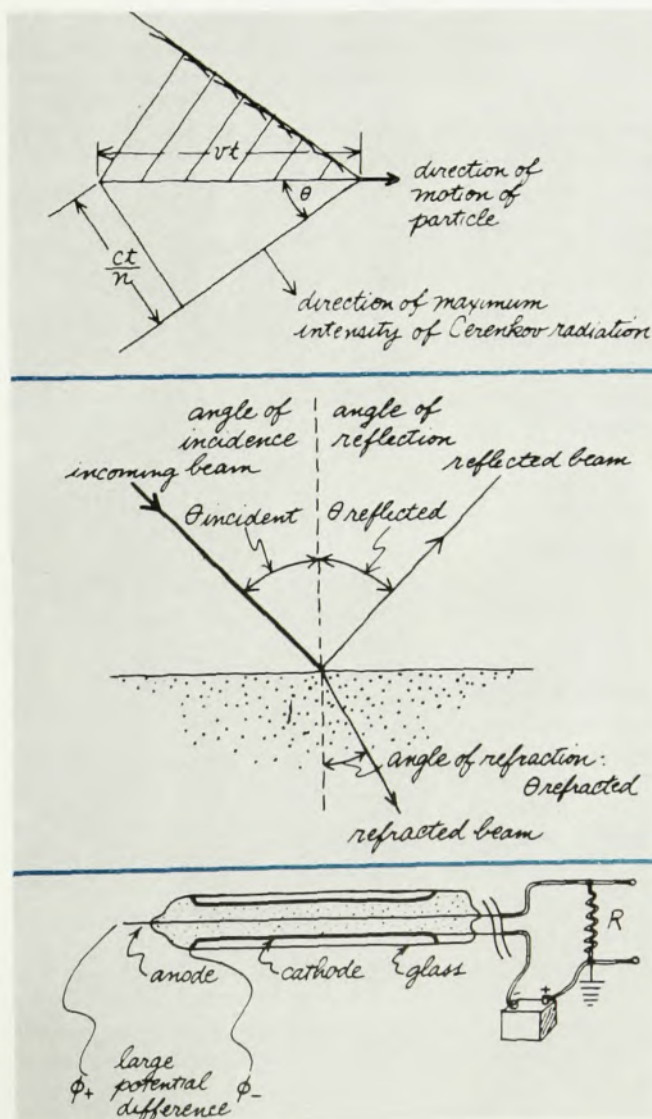
gins, A. V. Baez and many others have done, Karplus has decided to arrange the topics in such a way that Newtonian dynamics comes as late as possible. The obvious advantage is that the interesting topics can be treated before the students are totally numbed by the traditional, deadly exposition of mechanics. Thus, after a general prologue, the contents are roughly:

kinematics, a general discussion of systems, interactions and energy transfer; waves, sound and light; atomic physics, from Dalton through Bohr to Heisenberg and a bit of

fission and fusion; heat (calorics, not thermodynamics) and energy; electricity (currents, not electrodynamics); dynamics, with much on oscillation and a bit on celestial mechanics, and kinetic theory.

It is recommended for a one-semester course, and obviously needs some padding for a full-year course.

In looking at the contents, I am rather puzzled that once Newton has been moved to the end, to make way for more interesting material, that the decision is not taken to any logical conclusion. Thus all of physics since



COOPER'S FREE-HAND LINE DRAWINGS.

Top to bottom: the bow wave in Cerenkov radiation; incident, reflected and refracted light rays, and a Geiger-Mueller counter.

1926 occupies only a little more than ten pages; there is no mention of any of the fascinating experimental or theoretical topics of current research. Instead, geometrical optics (the topic that drives almost as many students from physics as does mechanics) occupies 17 pages, and almost two whole chapters are devoted to heat. The choice of emphasis is, of course, not an arbitrary one: It is necessary for Karplus's approach, given the limitations imposed by a one-semester course. Furthermore, the general approach appears to be very up to date, with many examples drawn from current events. Unfortunately such a book becomes dated very quickly. How long will there be undergraduates who can relate to Luis Alvarez's conclusions from the films of President Kennedy's assassination?

Cooper's *Introduction to the Meaning and Structure of Physics* takes a completely different approach. Starting from Aristotle (with one of the few treatments that does not make him a total dunderhead), he continues in an essentially historical order—with, of course, concessions to logical continuity when historical developments cross. The topics covered are:

kinematics and dynamics, including celestial mechanics, developed through Laplace; light, through Young; electrodynamics, from Gilbert to Hertz; thermodynamics, and a bit of kinetic theory and statistical mechanics; relativity, mentioning the general theory; atomic physics, through the Schrödinger equation, with qualitative application to the hydrogen atom and the solid state; the Dirac equation; and elementary-particle physics, with rudimentary Feynman diagrams and even with quarks.

All this makes for a very full year's work. Although no derivatives or integrals are mentioned, the differential equations of electromagnetism and of quantum mechanics are discussed thoroughly, albeit qualitatively. It is, unfortunately, very difficult to reduce this vast quantity of material, for, as all of physics, it all hangs together tightly and intricately. Omitting sections can get one into difficulty later; the only solution seems to be to have students read all the material, but to have them study only some of it carefully, for all of it would be too much.

Cooper appears to prefer having students stand, perhaps in awe, before the "cathedral-like" structure of

physics. His book provides the equivalent of a catalogue raisonné with comments, glosses and explanations of a created structure. Cooper writes a consistent, excellent prose style, with none of the condescension that some physicists, including Karplus, display in texts of this kind. The whole format is consistent with that style. Even the diagrams are unusual for a physics text: They are freehand line drawings of a simplicity and clarity that all of us would like to see in our own endeavors at the blackboard.

Karplus, by contrast, tries to make students feel at home in the structure of physics. His book provides a sort of *House and Garden* view of the more manageable portions. His explanations of technical matters are always models of clarity; I am sure his wide range of teaching experience—from elementary school to college—has contributed a great deal to this clarity. His prose style is somewhat inconsistent; one gets the impression that the text alternately addresses school children and college students. This ambiguous attitude is perhaps best represented by a picture of Vitruvian man, redrawn from Leonardo in the style of "Dick and Jane," with a fig leaf added.

For teaching, Karplus's text has many advantages over Cooper's. At the end of each chapter Karplus provides a summary, an excellent and very thorough bibliography and a long list of good homework problems. Mathematical symbols and physical quantities are also listed at the ends of chapters, and Karplus has taken care not to use any symbol for more than one quantity, for example P is pressure, $\mathfrak{p}$ is momentum and M is mass. Cooper does not interrupt the flow of his text with problems, but puts them at the end after the appendixes; his values for constants and conversion factors are scattered throughout the text, and there is no adequate listing in any one place.

In discussing philosophy, the authors' differences are perhaps most obvious. Cooper's historical approach permits him to examine the philosophical problems from many different viewpoints, and to show how current views have evolved. Karplus is apparently addressing an audience that is much less interested in philosophy than Cooper's and thus limits himself to fairly straightforward expositions of simple operationalism and its consequences.

Cooper's book is clearly an excellent text for a freshman or sophomore "physics-for-poets" course. Karplus's text appears better suited for a fairly technical high-school level course—as a competitor for PSSC, for instance.

* * *

Thomas Von Foerster is assistant professor of physics at Harvard University. He is currently helping to teach a "physics-for-poets" course, for which Cooper's book is one of the texts.

The Stanford Two-Mile Accelerator

R. B. Neal, ed.

1169 pp. W. A. Benjamin, New York, 1968. \$35.00

During the past two decades a deplorable tendency has arisen among accelerator physicists and engineers. Instead of publishing the results of their work in reputable journals, they have, more and more, written internal laboratory reports, which are often hastily composed and capriciously circulated.

The Stanford linear-accelerator group has been caught in this trend, but it has fought a noble rearguard action. In the 1955 linear-accelerator issue of the *Review of Scientific Instruments*, they presented a careful and detailed account of the Mark 3 accelerator. Then they proceeded to the tremendous task of setting up the Stanford Linear Accelerator Center (SLAC) and of building the two-mile accelerator. Now, once again, they have presented us with a comprehensive and well organized account of this splendidly successful project, this time in book form.

Although 90 authors contributed to this work, the hand of Richard Neal, the editor, is visible everywhere. The vast amount of available material has been carefully organized, providing internal consistency and avoiding unnecessary duplication. This is, in short, a very valuable addition to the literature on particle accelerators and a credit to the SLAC organization. Throughout it conveys the impression of enormous competence that has continually emanated from the SLAC organization.

SLAC began its history in a meeting of a few Stanford scientists held on 10 April 1956. The study group was gradually increased, and was supported by voluntary studies by two architect-engineering firms. Within a