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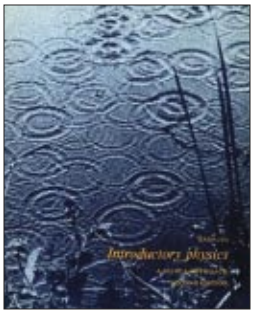
Introductory Physics: A Model Approach, 2nd ed., by Robert Karplus, edited by Fernand Brunschwig of Empire State College and published by Captains Engineering Services Inc. (2003), 510 pp. Available online for $39.95 at Bank Street Bookstore, http://www.bankstreetbooks.com.



Robert Karplus, a Berkeley physicist and science educator, originally wrote *Introductory Physics* in 1969 for nonscience students. The book acquired a strong reputation among physics teachers; it was infused with Karplus' lively, down-to-earth style, his joy of discovery, and his intimate knowledge of Piaget.

The book went out of print before a second, revised edition could be written, but now Fernand Brunschwig has brought it back to life in an inexpensive, eminently usable paperback that successfully preserves the spirit of the original. Brunschwig has intelligently edited the text, eliminating errors, smoothing off certain rough edges, and bringing the book more up-to-date. The graceful line drawings and the clean, readable page layout have been retained, as has the striking cover with Karplus' photograph of circular waves on a pond. Before further critiquing the second edition, we must recall the unique features of the original. As Karplus pointed out in his preface: Newtonian mechanics, traditionally at the beginning of most physics courses, requires strong abstract reasoning power, which often "acts as a deterrent to non-science students' full appreciation of physics. Therefore, I have placed Newtonian physics at the end of the text." In doing this Karplus was following the example of the Physical Science Study Committee (PSSC) in the initial versions of their ground-breaking high school textbook.

Karplus had a very deep understanding of the way beginning students think about physics, and he had many years of experience with preparing curricula for elementary schools. As a result, the first quarter of his book (Part I, or Chapters 1–4) is unique and represents, to this reviewer at least, an approach that is extraordinarily promising.

Chapters 3 and 4 (in which Karplus develops the concepts of interaction, systems, and energy) are particularly valuable. These three concepts, along with the idea of a "scientific model" (Chap. 1) are explained at a relatively understandable, "intermediate" level of abstraction. Karplus uses all of these concepts as a foundation for the study, in Part II (Chaps. 5-8), of waves, light, sound, the Bohr atom, and wave mechanics; and, in Part III (Chaps. 9-12), of energy, temperature, and heat. In Chapter 11, he shifts back to the Newtonian framework, introducing force and work, and then closing the circle to the previously introduced concept of energy. Chapter 12 (the final chapter in Part III) focuses on electrical circuits and energy transfer. Finally, Part IV addresses Newtonian mechanics head on: kinematics, Newton's laws, gravity, periodic motion, and kinetic theory.

As we know from relativity and electromagnetic theory, the concepts of velocity, acceleration, and force have limited usefulness in trying to understand modern physics. In contrast, as Karplus demonstrates convincingly in Chapter 8, by building directly on the concepts from Part I (models, systems, interaction, energy, and momentum) plus familiarity with wave phenomena, one can develop the fundamentals of atomic physics and quantum mechanics in a coherent and honest way that beginners can understand.

Overall, Brunschwig has done an excellent job in maintaining the style and improving the clarity of the text. There are some notable omissions; for example, Karplus uses a good, concrete operational definition (in terms of electrolysis) to define the Faraday as a unit of charge, but there is no mention of the Coulomb. Karplus almost always explains his reasoning clearly; I was able to find just one place (Chap. 16, p. 451) where he resorted to an "it is possible to show"

argument (to establish the proportionality between average molecular kinetic energy and temperature of a gas).

Karplus originally provided a variety of suggestions for hands-on exercises, some of which Brunschwig substantially improved, but the book would benefit from additional specific ideas for experiments. The text has a substantial number of end-of-chapter problems; many of them are interesting and imaginative, and there is a good variety. The answers to the odd problems are at the back of the book. The book also includes examples of many fully worked-out problems and calculations, as well as an appendix on the mathematics used in the text (powers of ten, graphs, basic geometry, and the definitions of the sine, cosine, and tangent functions), but there is no student study guide with solutions to the end-of-chapter problems.

The second edition also includes the following specific changes from the 1969 edition:

- In Chapter 11, a substantially clarified explanation of work and how to calculate it.
- A new section in Chapter 4 focusing on efficiency in energy transfer.
- A note in Chapter 3 on the current evidence for global warming, as an example of interaction.
- A slightly expanded and much clarified comparison of the ray and wave models of light.
- An improvement in the readability of the sections in Chapter 7 on sound and music, as well as a recalculation of the tables illustrating the relationships of wavelength and frequency in a 12-tone scale.

The format of this textbook is somewhat old-fashioned: just simple black-and-white line drawings, photographs, and text. No color, no high-tech graphics; also, no study guide, no website, no PowerPoint slides, and no CD-ROM. But this can be a strength as well as a weakness. There are some (including myself) who feel that the color, graphics, and peripherals are often overdone, thus increasing the price while decreasing the understandability. If you are among them, here's an alternative.

This is a clear, exceptionally well-written textbook with verve, the ability to connect with beginners, and an innovative conceptual structure. Given all that has been learned about physics teaching in the last 35 years, especially the many insights from physics education research (PER), Karplus' approach seems especially on-target. In summary, the second edition of *Introductory Physics: A Model Approach* by Robert Karplus is a genuinely outstanding text for non-science students, as well as a font of stimulation and wisdom for teachers.

Reviewed by:

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Kahn has a strong interest in physics education, and in addition to publications in research he has written two books published by John Wiley and Sons: Mathematical Methods for Scientists and Engineers: Linear and Nonlinear Systems *and, together with Yair Zarmi,* Nonlinear Dynamics: Exploration Through Normal Forms.

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MicroReviews by the Book Review Editor

• ***Physics, the Human Adventure: From Copernicus to Einstein and Beyond,*** by Gerald Holton and Stephen G. Brush, published by Rutgers University Press (2001), xv+582 pp., paperback $39.00. Effectively, an extensively revised third edition of *Introduction to Concepts and Theories in Physical Science*, which has served for over a half century as an excellent introduction to the history of physics for humanities students and should also serve well enhancing the background of K-12 teachers of all disciplines.

• ***Oppenheimer: Portrait of an Enigma,*** by Jeremy Bernstein, published by Ivan R. Dee, Chicago (2004), xi+225 pp., hardback $25.00. If your eyes glazed over and your mind went dull attempting to read 1000 pages of the small print of *In the Matter of J. Robert Oppenheimer*, you will welcome and enjoy this portrait of Oppenheimer and perhaps come to a better understanding of the "trial" (hearing).

• ***Five Easy Lessons: Strategies for Successful Physics Teaching,*** by Randall D. Knight, published by Addison-Wesley (2002), viii+330 pp., paperback $18.38 (available from AAPT, www.aapt.org/store) and ***Teaching Physics with the Physics Suite,*** by Edward F. Redish, published by John Wiley & Sons Inc. (2003), xi+216 pp., paperback with CD $26.95. These two books complement each other in their efforts to make physics teachers more effective and to keep students more actively engaged in the classroom while providing insight into the successes of physics education research.