时代教育·国外高校优秀教材精选

Sears and Zemansky's

University Physics with Modern Physics

西尔斯当代大学物理

英文版 原书第12版

(美) 休 D.杨 (Hugh D.Young)
罗杰 A.弗里德曼 (Roger A. Freedman) 著

上册

机械工业出版社
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图书在版编目（CIP）数据

西尔斯当代大学物理：第12版：英文/（美）杨（Young, H. D.），（美）弗里德曼（Freedman, R. A.）著. —北京：机械工业出版社，2010.12

时代教育·国外高校优秀教材精选

ISBN 978-7-111-32675-5

Ⅰ.①西… Ⅱ.①杨…②弗… Ⅲ.①物理学-高等学校-教材-英文 Ⅳ.①O4

中国版本图书馆CIP数据核字（2010）第243926号

机械工业出版社（北京市百万庄大街22号 邮政编码100037）

策划编辑：李永联 责任编辑：李永联

封面设计：马精明 责任印制：乔 宇

北京机工印刷厂印刷（三河市南杨庄国丰装订厂装订）

2011年6月第1版第1次印刷

210mm×275mm·102印张·4插页·3277千字

标准书号：ISBN 978-7-111-32675-5

定价：169.00元（上、下册）

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引进国外优秀原版教材，在有条件的学校推动和开展英语授课或双语教学的同时，自然也引进了先进的教学思想和教学方法，这对提高我国自编教材的水平，加强学生的英语实际应用能力，使我国的高等教育尽快与国际接轨，必将起到积极的推动作用。

为了做好教材的引进工作，机械工业出版社特别成立了由著名专家组成的国外高校优秀教材审定委员会。这些专家对实施双语教学做了深入细致的调查研究，对引进原版教材提出了许多建设性意见，并慎重地对每一本将要引进的原版教材一审再审，精选再精选，确认教材本身的质量水平，以及权威性和先进性，以期所引进的原版教材能适应我国学生的外语水平和学习特点。在引进工作中，审定委员会还结合我国高校教学课程体系的设置和要求，对原版教材的教学思想和方法的先进性、科学性严格把关，同时尽量考虑原版教材的系统性和经济性。

这套教材出版后，我们将及时地将其推荐给各高校选用，并将根据各高校的双语教学计划，举办原版教材的教师培训。希望高校师生在使用教材后及时反馈意见和建议，使我们更好地为教学改革服务。

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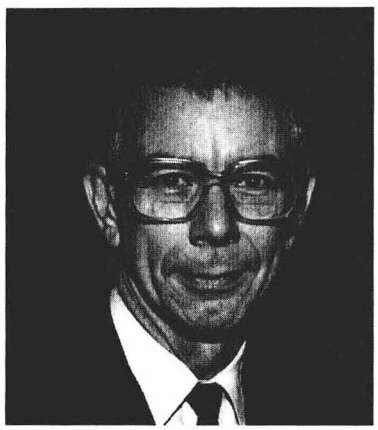
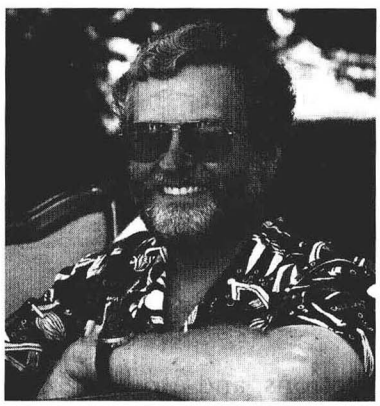
ABOUT THE AUTHORS



Hugh D. Young is Emeritus Professor of Physics at Carnegie Mellon University in Pittsburgh, PA. He attended Carnegie Mellon for both undergraduate and graduate study and earned his Ph.D. in fundamental particle theory under the direction of the late Richard Cutkosky. He joined the faculty of Carnegie Mellon in 1956 and has also spent two years as a Visiting Professor at the University of California at Berkeley.

Prof. Young's career has centered entirely around undergraduate education. He has written several undergraduate-level textbooks, and in 1973 he became a co-author with Francis Sears and Mark Zemansky for their well-known introductory texts. With their deaths, he assumed full responsibility for new editions of these books until joined by Prof. Freedman for *University Physics.*

Prof. Young is an enthusiastic skier, climber, and hiker. He also served for several years as Associate Organist at St. Paul's Cathedral in Pittsburgh, and has played numerous organ recitals in the Pittsburgh area. Prof. Young and his wife Alice usually travel extensively in the summer, especially in Europe and in the desert canyon country of southern Utah.



Roger A. Freedman is a Lecturer in Physics at the University of California, Santa Barbara. Dr. Freedman was an undergraduate at the University of California campuses in San Diego and Los Angeles, and did his doctoral research in nuclear theory at Stanford University under the direction of Professor J. Dirk Walecka. He came to UCSB in 1981 after three years teaching and doing research at the University of Washington.

At UCSB, Dr. Freedman has taught in both the Department of Physics and the College of Creative Studies, a branch of the university intended for highly gifted and motivated undergraduates. He has published research in nuclear physics, elementary particle physics, and laser physics. In recent years, he has helped to develop computer-based tools for learning introductory physics and astronomy.

When not in the classroom or slaving over a computer, Dr. Freedman can be found either flying (he holds a commercial pilot's license) or driving with his wife, Caroline, in their 1960 Nash Metropolitan convertible.

A. Lewis Ford is Professor of Physics at Texas A&M University. He received a B.A. from Rice University in 1968 and a Ph.D. in chemical physics from the University of Texas at Austin in 1972. After a one-year postdoc at Harvard University, he joined the Texas A&M physics faculty in 1973 and has been there ever since. Professor Ford's research area is theoretical atomic physics, with a specialization in atomic collisions. At Texas A&M he has taught a variety of undergraduate and graduate courses, but primarily introductory physics.

TO THE STUDENT

HOW TO SUCCEED IN PHYSICS BY REALLY TRYING

Mark Hollabaugh *Normandale Community College*

Physics encompasses the large and the small, the old and the new. From the atom to galaxies, from electrical circuitry to aerodynamics, physics is very much a part of the world around us. You probably are taking this introductory course in calculus-based physics because it is required for subsequent courses you plan to take in preparation for a career in science or engineering. Your professor wants you to learn physics and to enjoy the experience. He or she is very interested in helping you learn this fascinating subject. That is part of the reason your professor chose this textbook for your course. That is also the reason Drs. Young and Freedman asked me to write this introductory section. We want you to succeed!

The purpose of this section of *University Physics* is to give you some ideas that will assist your learning. Specific suggestions on how to use the textbook will follow a brief discussion of general study habits and strategies.

Preparation for This Course

If you had high school physics, you will probably learn concepts faster than those who have not because you will be familiar with the language of physics. If English is a second language for you, keep a glossary of new terms that you encounter and make sure you understand how they are used in physics. Likewise, if you are farther along in your mathematics courses, you will pick up the mathematical aspects of physics faster. Even if your mathematics is adequate, you may find a book such as Arnold D. Pickar's *Preparing for General Physics: Math Skill Drills and Other Useful Help (Calculus Version)* to be useful. Your professor may actually assign sections of this math review to assist your learning.

Learning to Learn

Each of us has a different learning style and a preferred means of learning. Understanding your own learning style will help you to focus on aspects of physics that may give you difficulty and to use those components of your course that will help you overcome the difficulty. Obviously you will want to spend more time on those aspects that give you the most trouble. If you learn by hearing, lectures will be very important. If you learn by explaining, then working with other students will be useful to you. If solving problems is difficult for you, spend more time learning how to solve problems. Also, it is important to understand and develop good study habits. Perhaps the most important thing you can do for yourself is to set aside adequate, regularly scheduled study time in a distraction-free environment.

Answer the following questions for yourself:

- Am I able to use fundamental mathematical concepts from algebra, geometry and trigonometry? (If not, plan a program of review with help from your professor.)
- In similar courses, what activity has given me the most trouble? (Spend more time on this.) What has been the easiest for me? (Do this first; it will help to build your confidence.)

- Do I understand the material better if I read the book before or after the lecture? (You may learn best by skimming the material, going to lecture, and then undertaking an in-depth reading.)
- Do I spend adequate time in studying physics? (A rule of thumb for a class like this is to devote, on the average, 2.5 hours out of class for each hour in class. For a course meeting 5 hours each week, that means you should spend about 10 to 15 hours per week studying physics.)
- Do I study physics every day? (Spread that 10 to 15 hours out over an entire week!) At what time of the day am I at my best for studying physics? (Pick a specific time of the day and stick to it.)
- Do I work in a quiet place where I can maintain my focus? (Distractions will break your routine and cause you to miss important points.)

Working with Others

Scientists or engineers seldom work in isolation from one another but rather work cooperatively. You will learn more physics and have more fun doing it if you work with other students. Some professors may formalize the use of cooperative learning or facilitate the formation of study groups. You may wish to form your own informal study group with members of your class who live in your neighborhood or dorm. If you have access to e-mail, use it to keep in touch with one another. Your study group is an excellent resource when reviewing for exams.

Lectures and Taking Notes

An important component of any college course is the lecture. In physics this is especially important because your professor will frequently do demonstrations of physical principles, run computer simulations, or show video clips. All of these are learning activities that will help you to understand the basic principles of physics. Don't miss lectures, and if for some reason you do, ask a friend or member of your study group to provide you with notes and let you know what happened.

Take your class notes in outline form, and fill in the details later. It can be very difficult to take word for word notes, so just write down key ideas. Your professor may use a diagram from the textbook. Leave a space in your notes and just add the diagram later. After class, edit your notes, filling in any gaps or omissions and noting things you need to study further. Make references to the textbook by page, equation number, or section number.

Make sure you ask questions in class, or see your professor during office hours. Remember the only "dumb" question is the one that is not asked. Your college may also have teaching assistants or peer tutors who are available to help you with difficulties you may have.

Examinations

Taking an examination is stressful. But if you feel adequately prepared and are well-rested, your stress will be lessened. Preparing for an exam is a continual process; it begins the moment the last exam is over. You should immediately go over the exam and understand any mistakes you made. If you worked a problem and made substantial errors, try this: Take a piece of paper and divide it down the middle with a line from top to bottom. In one column, write the proper solution to the problem. In the other column, write what you did and why, if you know, and why your solution was incorrect. If you are uncertain why you made your mistake, or how to avoid making it again, talk with your professor. Physics continually builds on fundamental ideas and it is important to correct any misunderstandings immediately. Warning: While cramming at the last minute may get you through the present exam, you will not adequately retain the concepts for use on the next exam.

TO THE INSTRUCTOR

PREFACE

This book is the product of more than half a century of leadership and innovation in physics education. When the first edition of University Physics by Francis W. Sears and Mark W. Zemansky was published in 1949, it was revolutionary among calculus-based physics textbooks in its emphasis on the fundamental principles of physics and how to apply them. The success of University Physics with generations of (several million) students and educators around the world is a testament to the merits of this approach, and to the many innovations it has introduced subsequently.

In preparing this new Twelfth Edition, we have further enhanced and developed *University Physics* to assimilate the best ideas from education research with enhanced problem-solving instruction, pioneering visual and conceptual pedagogy, the first systematically enhanced problems, and the most pedagogically proven and widely used online homework and tutorial system in the world.

New to This Edition

- **Problem solving.** The acclaimed, research-based **four-step problem-solving framework** (Identify, Set Up, Execute, and Evaluate) is now used throughout every Worked Example, chapter-specific Problem-Solving Strategy, and every Solution in the Instructor and Student Solutions Manuals. Worked Examples now incorporate black-and-white Pencil Sketches to focus students on this critical step—one that research shows students otherwise tend to skip when illustrated with highly rendered figures.

- **Instruction followed by practice.** A streamlined and systematic learning path of instruction followed by practice includes **Learning Goals** at the start of each chapter and **Visual Chapter Summaries** that consolidate each concept in words, math, and figures. Popular **Test Your Understanding** conceptual questions at the end of each section now use **multiple-choice and ranking formats** to allow students to instantly check their knowledge.

- **Instructional power of figures.** The instructional power of figures is enhanced using the research-proven technique of **"annotation"** (chalkboard-style commentary integrated into the figure to guide the student in interpreting the figure) and by **streamlined use of color and detail** (in mechanics, for example, color is used to focus the student on the object of interest while the rest of the image is in grayscale and without distracting detail).

- **Enhanced end-of-chapter problems.** Renowned for providing the most wide-ranging and best-tested problems available, the Twelfth Edition goes still further: It provides **the first library of physics problems systematically enhanced** based on student performance nationally. Using this analysis, more than 800 new problems make up the entire library of 3700.

- **MasteringPhysics™** (www.masteringphysics.com). Launched with the Eleventh Edition, MasteringPhysics is now the most widely adopted, educationally proven, and technically advanced online homework and tutorial system in the world. For the Twelfth Edition, MasteringPhysics provides a wealth of new content and technological enhancements. In addition to a library of more than 1200 tutorials and all the end-of-chapter problems, MasteringPhysics

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now also provides specific tutorials for every Problem-Solving Strategy and key Test Your Understanding questions from each chapter. Answer types include algebraic, numerical, and multiple-choice answers, as well as ranking, sorting, graph drawing, vector drawing, and ray tracing.

Key Features of *University Physics*

A Guide for the Student Many physics students experience difficulty simply because they don't know how to use their textbook. The section entitled "How to Succeed in Physics by Really Trying," which precedes this preface, is a "user's manual" to all the features of this book. This section, written by Professor Mark Hollabaugh (Normandale Community College), also gives a number of helpful study hints. *Every* student should read this section!

Chapter Organization The first section of each chapter is an *Introduction* that gives specific examples of the chapter's content and connects it with what has come before. There are also a *Chapter Opening Question* and a list of *Learning Goals* to make the reader think about the subject matter of the chapter ahead. (To find the answer to the question, look for the ? icon.) Most sections end with a *Test Your Understanding Question,* which can be conceptual or quantitative in nature. At the end of the last section of the chapter is a *Visual Chapter Summary* of the most important principles in the chapter, as well as a list of *Key Terms* with reference to the page number where each term is introduced. The answers to the Chapter Opening Question and Test Your Understanding Questions follow the Key Terms.

Questions and Problems At the end of each chapter is a collection of *Discussion Questions* that probe and extend the student's conceptual understanding. Following these are *Exercises,* which are single-concept problems keyed to specific sections of the text; *Problems,* usually requiring one or two nontrivial steps; and *Challenge Problems,* intended to challenge the strongest students. The problems include applications to such diverse fields as astrophysics, biology, and aerodynamics. Many problems have a conceptual part in which students must discuss and explain their results. The new questions, exercises, and problems for this edition were created and organized by Wayne Anderson (Sacramento City College), Laird Kramer (Florida International University), and Charlie Hibbard.

Problem-Solving Strategies and Worked Examples Throughout the book, *Problem-Solving Strategy* boxes provide students with specific tactics for solving particular types of problems. They address the needs of any students who have ever felt that they "understand the concepts but can't do the problems."

All Problem-Solving Strategy boxes follow the ISEE approach (Identify, Set Up, Execute, and Evaluate) to solving problems. This approach helps students see how to begin with a seemingly complex situation, identify the relevant physical concepts, decide what tools are needed to solve the problem, carry out the solution, and then evaluate whether the result makes sense.

Each Problem-Solving Strategy box is followed by one or more worked-out *Examples* that illustrate the strategy. Many other worked-out Examples are found in each chapter. Like the Problem-Solving Strategy boxes, all of the quantitative Examples use the ISEE approach. Several of the examples are purely qualitative and are labeled as *Conceptual Examples;* see, for instance, Conceptual Examples 6.5 (Comparing kinetic energies, p. 191), 8.1 (Momentum versus kinetic energy, p. 251) and 20.7 (A reversible adiabatic process, p. 693).

"Caution" paragraphs Two decades of physics education research have revealed a number of conceptual pitfalls that commonly plague beginning physics students. These include the ideas that force is required for motion, that electric current is "used up" as it goes around a circuit, and that the product of an

object's mass and its acceleration is itself a force. The "Caution" paragraphs alert students to these and other pitfalls, and explain why the wrong way to think about a certain situation (which may have occurred to the student first) is indeed wrong. (See, for example, pp. 118, 159, and 559.)

Notation and units Students often have a hard time keeping track of which quantities are vectors and which are not. We use boldface italic symbols with an arrow on top for vector quantities, such as $\vec{v}$, $\vec{a}$, and $\vec{F}$; unit vectors such as $\hat{\imath}$, have a caret on top. Boldface $+$, $-$, $\times$, and $=$ signs are used in vector equations to emphasize the distinction between vector and scalar mathematical operations.

SI units are used exclusively (English unit conversions are included where appropriate). The joule is used as the standard unit of energy of all forms, including heat.

Flexibility The book is adaptable to a wide variety of course outlines. There is plenty of material for a three-semester or a five-quarter course. Most instructors will find that there is too much material for a one-year course, but it is easy to tailor the book to a variety of one-year course plans by omitting certain chapters or sections. For example, any or all of the chapters on fluid mechanics, sound and hearing, electromagnetic waves, or relativity can be omitted without loss of continuity. In any case, no instructor should feel constrained to work straight through the entire book.

Instructor Supplements

The **Instructor Solutions Manuals,** prepared by A. Lewis Ford (Texas A&M University), contain complete and detailed solutions to all end-of-chapter problems. All solutions follow consistently the same Identify/Set Up/Execute/Evaluate problem-solving framework used in the textbook. The *Instructor Solutions Manual for Volume 1* (ISBN 0-321-49968-9) covers Chapters 1–20, and the *Instructor Solutions Manual for Volumes 2 and 3* (ISBN 0-321-49210-2) covers Chapters 21–44.

The cross-platform **Media Manager CD-ROM** (ISBN 0-321-49916-6) provides a comprehensive library of more than 220 applets from ActivPhysics OnLine™ as well as all line figures from the textbook in JPEG format. In addition, all the key equations, Problem-Solving Strategies, tables, and chapter summaries are provided in editable Word format. In-class weekly multiple-choice questions for use with various Classroom Response Systems (CRS) are also provided, based on the Test Your Understanding questions in the text. The CD-ROM also provides the Instructor Solutions Manual in convenient editable Word format and as PDFs.

MasteringPhysics™ (www.masteringphysics.com) is the most advanced, educationally effective, and widely used physics homework and tutorial system in the world. It provides instructors with a library of extensively pretested end-of-chapter problems and rich, Socratic tutorials that incorporate a wide variety of answer types, wrong-answer feedback, and adaptive help (comprising hints or simpler sub-problems upon request). MasteringPhysics™ allows instructors to quickly build wide-ranging homework assignments of just the right difficulty and duration and provides them with efficient tools to analyze class trends—or the work of any student—in unprecedented detail and to compare the results either with the national average or with the performance of previous classes.

Five Easy Lessons: Strategies for Successful Physics Teaching (ISBN 0-8053-8702-1) by Randall D. Knight (California Polytechnic State University, San Luis Obispo) is packed with creative ideas on how to enhance any physics course. It is an invaluable companion for both novice and veteran physics instructors.

The **Transparency Acetates** (ISBN 0-321-50034-2) contain more than 200 key figures from *University Physics,* Twelfth Edition, in full color.

The **Printed Test Bank** (ISBN 0-321-50035-0) provides more than 2000 multiple-choice questions.

The **Computerized Test Bank** (ISBN 0-321-50126-8) includes all of the questions from the Printed Test Bank on a cross-platform CD-ROM. More than half the questions have numerical values that can be randomly assigned for each student.

Student Supplements

The **Study Guide,** by James R. Gaines, William F. Palmer, and Laird Kramer, reinforces the text's emphasis on problem-solving strategies and student misconceptions. The *Study Guide for Volume 1* (ISBN 0-321-50033-4) covers Chapters 1–20, and the *Study Guide for Volumes 2 and 3* (ISBN 0-321-50037-7) covers Chapters 21–44.

The **Student Solutions Manual,** by A. Lewis Ford (Texas A&M University), contains detailed, step-by-step solutions to more than half of the odd-numbered end-of-chapter problems from the textbook. All solutions follow consistently the same Identify/Set Up/Execute/Evaluate problem-solving framework used in the textbook. The *Student Solutions Manual for Volume 1* (ISBN 0-321-50063-6) covers Chapters 1–20, and the *Student Solutions Manual for Volumes 2 and 3* (ISBN 0-321-50038-5) covers Chapters 21–44.

MasteringPhysics™ (www.masteringphysics.com) is the most advanced, widely used, and educationally proven physics tutorial system in the world. It is the result of eight years of detailed studies of how real students work physics problems, and of precisely where they need help. Studies show that students who use MasteringPhysics™ significantly improve their scores on final exams and conceptual tests such as the Force Concept Inventory. MasteringPhysics™ achieves this by providing students with instantaneous feedback specific to their wrong answers, simpler sub-problems upon request when they get stuck, and partial credit for their method. This individualized, 24/7 tutor system is recommended by nine out of ten students to their peers as the most effective and time-efficient way to study.

ActivPhysics OnLine™ (www.masteringphysics.com), now included in the self-study area of MasteringPhysics, provides the most comprehensive library of applets and applet-based tutorials available. ActivPhysics OnLine was created by the educational pioneer Alan Van Heuvelen of Rutgers. Throughout *University Physics,* Twelfth Edition, in-margin icons direct the student to specific applets in ActivPhysics OnLine in for additional interactive help.

ActivPhysics OnLine™ Workbooks, Volume 1 (0-8053-9060-X) and **Volume 2** (0-8053-9061-8) by Alan Van Heuvelen, Rutgers, and Paul d'Alessandris, Monroe Community College, provide a range of tutorials that use the critically acclaimed ActivPhysics OnLine applets to help students develop understanding and confidence. In particular, they focus on developing intuition, making predictions, testing assumptions experimentally, drawing effective diagrams, understanding key equations both qualitatively and quantitatively, and interpreting graphical information. These workbooks can be used for labs, homework, or self-study.

The **Addison-Wesley Tutor Center** (www.aw.com/tutorcenter) provides one-on-one tutoring via telephone, fax, e-mail, or interactive website. Qualified instructors answer questions and provide instruction with examples, problems, and other content from *University Physics,* Twelfth Edition, as well as help with MasteringPhysics™.

Acknowledgments

We would like to thank the hundreds of reviewers and colleagues who have offered valuable comments and suggestions over the life of this textbook. The continuing success of *University Physics* is due in large measure to their contributions.

Edward Adelson (Ohio State University), Ralph Alexander (University of Missouri at Rolla), J. G. Anderson, R. S. Anderson, Wayne Anderson (Sacramento City College), Alex Azima (Lansing Community College), Dilip Balamore (Nassau Community College), Harold Bale (University of North Dakota), Arun Bansil (Northeastern University), John Barach (Vanderbilt University), J. D. Barnett, H. H. Barschall, Albert Bartlett (University of Colorado), Paul Baum (CUNY, Queens College), Frederick Becchetti (University of Michigan), B. Bederson, David Bennum (University of Nevada, Reno), Lev I. Berger (San Diego State University), Robert Boeke (William Rainey Harper College), S. Borowitz, A. C. Braden, James Brooks (Boston University), Nicholas E. Brown (California Polytechnic State University, San Luis Obispo), Tony Buffa (California Polytechnic State University, San Luis Obispo), A. Capecelatro, Michael Cardamone (Pennsylvania State University), Duane Carmony (Purdue University), Troy Carter (UCLA), P. Catranides, John Cerne (SUNY at Buffalo), Roger Clapp (University of South Florida), William M. Cloud (Eastern Illinois University), Leonard Cohen (Drexel University), W. R. Coker (University of Texas, Austin), Malcolm D. Cole (University of Missouri at Rolla), H. Conrad, David Cook (Lawrence University), Gayl Cook (University of Colorado), Hans Courant (University of Minnesota), Bruce A. Craver (University of Dayton), Larry Curtis (University of Toledo), Jai Dahiya (Southeast Missouri State University), Steve Detweiler (University of Florida), George Dixon (Oklahoma State University), Donald S. Duncan, Boyd Edwards (West Virginia University), Robert Eisenstein (Carnegie Mellon University), Amy Emerson Missourn (Virginia Institute of Technology), William Faissler (Northeastern University), William Fasnacht (U.S. Naval Academy), Paul Feldker (St. Louis Community College), Carlos Figueroa (Cabrillo College), L. H. Fisher, Neil Fletcher (Florida State University), Robert Folk, Peter Fong (Emory University), A. Lewis Ford (Texas A&M University), D. Frantszog, James R. Gaines (Ohio State University), Solomon Gartenhaus (Purdue University), Ron Gautreau (New Jersey Institute of Technology), J. David Gavenda (University of Texas, Austin), Dennis Gay (University of North Florida), James Gerhart (University of Washington), N. S. Gingrich, J. L. Glathart, S. Goodwin, Rich Gottfried (Frederick Community College), Walter S. Gray (University of Michigan), Paul Gresser (University of Maryland), Benjamin Grinstein (UC San Diego), Howard Grotch (Pennsylvania State University), John Gruber (San Jose State University), Graham D. Gutsche (U.S. Naval Academy), Michael J. Harrison (Michigan State University), Harold Hart (Western Illinois University), Howard Hayden (University of Connecticut), Carl Helrich (Goshen College), Laurent Hodges (Iowa State University), C. D. Hodgman, Michael Hones (Villanova University), Keith Honey (West Virginia Institute of Technology), Gregory Hood (Tidewater Community College), John Hubisz (North Carolina State University), M. Iona, John Jaszczak (Michigan Technical University), Alvin Jenkins (North Carolina State University), Robert P. Johnson (UC Santa Cruz), Lorella Jones (University of Illinois), John Karchek (GMI Engineering & Management Institute), Thomas Keil (Worcester Polytechnic Institute), Robert Kraemer (Carnegie Mellon University), Jean P. Krisch (University of Michigan), Robert A. Kromhout, Andrew Kunz (Marquette University), Charles Lane (Berry College), Thomas N. Lawrence (Texas State University), Robert J. Lee, Alfred Leitner (Rensselaer Polytechnic University), Gerald P. Lietz (De Paul University), Gordon Lind (Utah State University), S. Livingston, Elihu Lubkin (University of Wisconsin, Milwaukee), Robert Luke (Boise State University), David Lynch (Iowa State University), Michael Lysak (San Bernardino Valley College), Jeffrey Mallow (Loyola University), Robert Mania (Kentucky State University), Robert Marchina (University of Memphis), David Markowitz (University of Connecticut), R. J. Maurer, Oren Maxwell (Florida International University), Joseph L. McCauley (University of Houston), T. K. McCubbin, Jr. (Pennsylvania State University), Charles McFarland (University of Missouri at Rolla), James Mcguire (Tulane University), Lawrence McIntyre (University of Arizona), Fredric Messing (Carnegie-Mellon University), Thomas Meyer (Texas A&M University), Andre Mirabelli (St. Peter's College, New Jersey), Herbert Muether (S.U.N.Y., Stony Brook), Jack Munsee (California State University, Long Beach), Lorenzo Narducci (Drexel University), Van E. Neie (Purdue University), David A. Nordling (U. S. Naval Academy), Benedict Oh (Pennsylvania State University), L. O. Olsen, Jim Pannell (DeVry Institute of Technology), W. F. Parks (University of Missouri), Robert Paulson (California State University, Chico), Jerry Peacher (University of Missouri at Rolla), Arnold Perlmutter (University of Miami), Lennart Peterson (University of Florida), R. J. Peterson (University of Colorado, Boulder), R. Pinkston, Ronald Poling (University of Minnesota), J. G. Potter, C. W. Price (Millersville University), Francis Prosser (University of Kansas), Shelden H. Radin, Michael Rapport (Anne Arundel Community College), R. Resnick, James A. Richards, Jr., John S. Risley (North Carolina State University), Francesc Roig (University of California, Santa Barbara), T. L. Rokoske, Richard Roth (Eastern Michigan University), Carl Rotter (University of West Virginia), S. Clark Rowland (Andrews University), Rajarshi Roy (Georgia Institute of Technology), Russell A. Roy (Santa Fe Community College), Dhiraj Sardar (University of Texas, San Antonio), Bruce Schumm (UC Santa Cruz), Melvin Schwartz (St. John's University), F. A. Scott, L. W. Seagondollar, Paul Shand (University of Northern Iowa), Stan Shepherd (Pennsylvania State University), Douglas Sherman (San Jose State), Bruce Sherwood (Carnegie Mellon University), Hugh Siefkin (Greenville College), Tomasz Skwarnicki (Syracuse University), C. P. Slichter, Charles W. Smith (University of Maine, Orono), Malcolm Smith (University of Lowell), Ross Spencer (Brigham Young University), Julien Sprott (University of Wisconsin), Victor Stanionis (Iona College), James Stith (American Institute of Physics), Chuck Stone (North Carolina A&T State University), Edward Strother (Florida Institute of Technology), Conley Stutz (Bradley University), Albert Stwertka (U.S. Merchant Marine Academy),

Martin Tiersten (CUNY, City College), David Toot (Alfred University), Somdev Tyagi (Drexel University), F. Verbrugge, Helmut Vogel (Carnegie Mellon University), Robert Webb (Texas A & M), Thomas Weber (Iowa State University), M. Russell Wehr, (Pennsylvania State University), Robert Weidman (Michigan Technical University), Dan Whalen (UC San Diego), Lester V. Whitney, Thomas Wiggins (Pennsylvania State University), David Willey (University of Pittsburgh, Johnstown), George Williams (University of Utah), John Williams (Auburn University), Stanley Williams (Iowa State University), Jack Willis, Suzanne Willis (Northern Illinois University), Robert Wilson (San Bernardino Valley College), L. Wolfenstein, James Wood (Palm Beach Junior College), Lowell Wood (University of Houston), R. E. Worley, D. H. Ziebell (Manatee Community College), George O. Zimmerman (Boston University)

In addition, we both have individual acknowledgments we would like to make.

I want to extend my heartfelt thanks to my colleagues at Carnegie Mellon, especially Professors Robert Kraemer, Bruce Sherwood, Ruth Chabay, Helmut Vogel, and Brian Quinn, for many stimulating discussions about physics pedagogy and for their support and encouragement during the writing of several successive editions of this book. I am equally indebted to the many generations of Carnegie Mellon students who have helped me learn what good teaching and good writing are, by showing me what works and what doesn't. It is always a joy and a privilege to express my gratitude to my wife Alice and our children Gretchen and Rebecca for their love, support, and emotional sustenance during the writing of several successive editions of this book. May all men and women be blessed with love such as theirs. — H. D. Y.

I would like to thank my past and present colleagues at UCSB, including Rob Geller, Carl Gwinn, Al Nash, Elisabeth Nicol, and Francesc Roig, for their wholehearted support and for many helpful discussions. I owe a special debt of gratitude to my early teachers Willa Ramsay, Peter Zimmerman, William Little, Alan Schwettman, and Dirk Walecka for showing me what clear and engaging physics teaching is all about, and to Stuart Johnson for inviting me to become a co-author of *University Physics* beginning with the 9th edition. I want to express special thanks to the editorial staff at Addison Wesley and their partners: to Adam Black for his editorial vision; to Margot Otway for her superb graphic sense and careful development of this edition; to Peter Murphy and Carol Reitz for their careful reading of the manuscript; to Wayne Anderson, Charlie Hibbard, Laird Kramer, and Larry Stookey for their work on the end-of-chapter problems; and to Laura Kenney, Chandrika Madhavan, Nancy Tabor, and Pat McCutcheon for keeping the editorial and production pipeline flowing. I want to thank my father for his continued love and support and for keeping a space open on his bookshelf for this book. Most of all, I want to express my gratitude and love to my wife Caroline, to whom I dedicate my contribution to this book. Hey, Caroline, the new edition's done at last — let's go flying! — R. A. F.

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October 2006

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