PREFACE

This *Instructor's Manual* accompanies the fifth edition of the textbook *Physics for Scientists and Engineers* by Raymond Serway and Robert Beichner. It contains solutions for all of the chapter-end problems, with answers boxed; accounts of research in physics education and its implications for teaching, written by Jeffery Saul; and separate lists of answers to even-numbered problems. Duane Deardorff has written detailed solutions for some problems in each chapter, following the GOAL problem-solving strategy introduced in the textbook on its page 47. These GOAL problem solutions also appear in the *Student Solutions Manual and Study Guide*. Problems new to this edition have asterisks next to their solutions. This manual includes solutions to the chapter-end computer-based problems.

The first word is *Instructor's*. Please keep this manual out of the hands of students. Bear in mind:

- The publisher provides you with this manual for your convenience, free of charge.
- Many teachers at many colleges use the textbook. Some use problems from it in graded homework and in examinations.
- No student needs to see solutions to all of the problems. The textbook is rich with examples. The *Student Solutions Manual and Study Guide* contains detailed solutions to fifteen problems and several questions per chapter, those with their numbers boxed in the textbook. Of these, five per chapter are on the Saunders website.
- The useful life of this edition can continue only so long as the users maintain the integrity and security of the problem set and solutions.

We recognize that you may post answers and solutions to selected problems, but we ask that you take precautions to keep secure the manual as a whole.

In problem solutions, with the goals of communicating efficiently with you and of limiting the bulk of the manual, we have often omitted commentary, intermediate steps, and even initial steps that would make the solutions most clear to students. If you post solutions from this manual, try including your own explanations so that you communicate most effectively with your students. If you employ teaching assistants, they themselves may learn by making these impedance-matching additions.

Problems in this edition of the text are more varied than before, in subject matter and in what they ask the student to do. Your choice of the problems you assign strongly influences your students' perception of the course, what they learn, and how much they learn. Use of this manual may help you to make a thoughtful individual choice of problems to assign. Two sorts of problems deserve further explanation:

Each chapter contains a problem asking for estimates of data and an order-of-magnitude calculation. Solutions here look simple. Be prepared for students to have difficulty in deciding what quantities are relevant, in making estimates, and in believing that order-of-magnitude estimates have value. If you choose to include them in your course, we suggest examples, encouragement, working in pairs or groups, time to think, regularly repeated practice starting early in the course, and acceptance of different approaches.

Among the seventy problems for each textbook chapter are two pairs of adjacent problems stated in identical language, the first giving numerical data and asking for a numerical answer and the second asking for a symbolic solution. You can use either problem by itself. At any point in your course, for students who have learned to do numerical calculations but find difficulty with symbols, you can use both problems together. With your help the students will see that the same steps solve both. For students who rely too much on an equation-solving calculator, you can assign both problems. With your help the students will see the need to do their algebra themselves.

When a problem quotes data to three significant digits, we quote answers to three significant digits. The last digit is uncertain, often depending, for example, on the precision of the values assumed for physical constants. If the calculation involves a chain of steps, we carry forward many digits in intermediate results, even though we here write down only three. We "round off" only at the end of the calculation, never anywhere in the middle. The regularity of three significant digits, in nearly all textbook problems, can help students focus on physical concepts without distraction. We recognize that students may get the false impression that every physics problem should have values precise to three digits. You may assign your students to work more thoughtfully with laboratory measurements.

If you find errors, omissions, or inconsistencies, please notify us through:

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We will reply and will correct errors in future printings. We thank teachers who have helped to correct errors in solutions since the publication of the last edition: Ronald Bieniek, Des Penny, Steve Van Wyk, Peter Wehinger, John Gerty, and Jianming Qian. The student Robert Easton corrected the solution to problem 30-73.

Linda Miller and Carol Langer and Gloria Langer typed this manual and prepared diagrams and page layouts. We thank them for contributing greatly to the book's correctness, clarity, and usefulness. Various solutions in this manual were written originally by Raymond Serway, Louis Cadwell, John R. Gordon, Lawrence Hmurcik, Henry Leap, Steve Van Wyk, and Laurent Hodges; and by N. John DiNardo, Richard Cohen, Robert Forsythe, and Ronald Bieniek, who contributed new problems for this edition of the text. Richard McGrew carried out the solutions to problems 6-40 through 6-45, 6-71, 9-75, 13-72, 14-71, and 18-52. We thank Susan Dust Pashos, Senior Developmental Editor at Saunders College Publishing, who coordinated this project and provided resources for it. We thank Suzanne Hakanen and Peter McGahey, Ancillary Editors, and Myron Schneiderwent and Michael Tammaro, accuracy reviewers, who diligently worked on it with us.

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