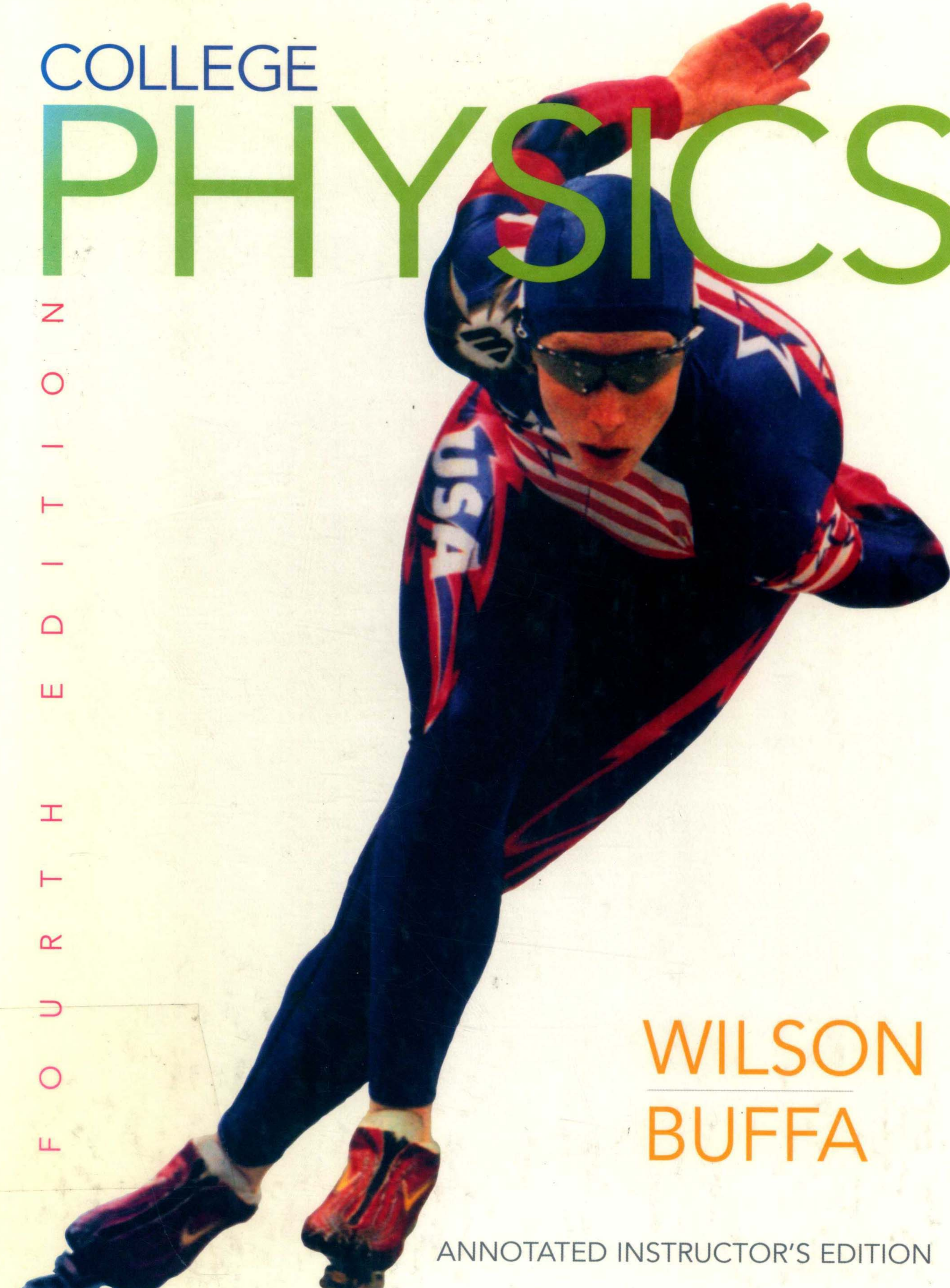
COLLEGE PHYSICS

FOURTH EDITION



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ANNOTATED INSTRUCTOR'S EDITION

Annotated Instructor's Edition

College Physics

Fourth Edition

Jerry D. Wilson

Lander University

Anthony J. Buffa

California Polytechnic State University
San Luis Obispo

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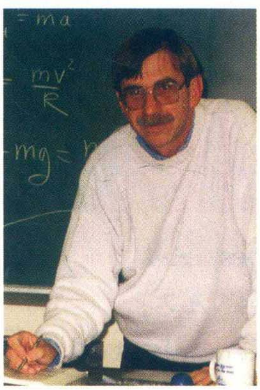
About the Authors

Jerry D. Wilson Jerry Wilson, a native of Ohio, is now Emeritus Professor of Physics and former Chair of the Division of Biological and Physical Sciences at Lander University in Greenwood, South Carolina. He received his B.S. degree from Ohio University, M.S. degree from Union College, and in 1970, a Ph.D. from Ohio University. He earned his M.S. degree while employed as a Materials Behavior Physicist by the General Electric Co.

As a doctoral graduate student, Professor Wilson held the faculty rank of Instructor and began teaching physical science courses. During this time, he co-authored a physical science text that is now in its eighth edition. In conjunction with his teaching career, Professor Wilson continued his writing and has authored or co-authored six titles. Having retired from full-time teaching, he continues to write, including *The Curiosity Corner*, a weekly column for local newspapers, which now can also be found on the Internet.

With several competitive books available, one may wonder why another algebra-based physics text was written. Having taught introductory physics many times, I was well aware of the needs of students and the difficulties they have in mastering the subject. I decided to write a text that presents the basic physics principles in a clear and concise manner, with illustrative examples that help resolve the major difficulty in learning physics: problem solving. Also, I wanted to write a text that is relevant so as to show students how physics applies in their everyday world—how things work and why things happen. Once the basics are learned, these follow naturally.

—*Jerry Wilson*



Anthony J. Buffa Anthony Buffa received his B.S. degree in physics from Rensselaer Polytechnic Institute and both his M.S. and Ph.D. degrees in physics from the University of Illinois, Urbana–Champaign. In 1970, Professor Buffa joined the faculty at California Polytechnic State University, San Luis Obispo, where he is currently Professor of Physics, and has been a research associate with the Department of Physics Radioanalytical Facility since 1980.

Professor Buffa's main interest continues to be teaching. He has taught courses at Cal Poly ranging from introductory physical science to quantum mechanics, has developed and revised many laboratory experiments, and has taught elementary physics to local teachers in an NSF-sponsored workshop. Combining physics with his interests in art and architecture, Dr. Buffa develops his own artwork and sketches, which he uses to increase his effectiveness in teaching physics.

I try to teach my students the crucial role physics plays in understanding all aspects of the world around them—whether it be technology, biology, astronomy, or any other field. In that regard, I emphasize conceptual understanding before number crunching. To this end, I rely heavily on visual methods. I hope the artwork and other pedagogical features in this book assist you in achieving your own teaching goals for your students.

—*Tony Buffa*

Preface

We continue to believe that there are two goals any introductory physics course must accomplish, regardless of the approach, emphasis, or pedagogical techniques: (1) to impart an understanding of the basic physics principles and (2) to enable students to solve a variety of reasonable problems in topics presented in the text material.

These goals are linked. An understanding of physical principles is of limited use if it does not enable students to solve problems. Physics is a problem-solving science—and in the real world, students will be evaluated on their ability to produce correct answers on final exams or on the MCAT. Yet learning to solve problems by rote is not the same thing as learning physics. Knowing and doing—insight and skill—must go hand in hand.

Any deficiency in meeting the first goal is likely to be obvious. Test scores quickly get the attention of both test takers and test graders. Low grades demoralize instructors while discouraging students who, understandably, conclude that physics is "too hard" for any but the phenomenally gifted. Deficiencies in meeting the second goal tend to be more subtle. Research in physics education has shown that a surprising number of students who learn to solve typical problems well enough to pass examinations do so without ever arriving at a real understanding of the most elementary physical concepts. Such students often get high marks on exams, yet when asked to answer simple, qualitative questions designed to test their grasp of basic principles, they betray a surprising lack of insight. Simply put, they can solve quantitative problems and get the right answer, but they do not know why it is right.

Achieving Our Goals—Features of the Fourth Edition

Most of the specific features of *College Physics* can be understood in light of these goals.

Conceptual Basis. We believe that giving students a secure grasp of physical principles will almost invariably enhance their problem-solving abilities. Central to this belief is an approach to the development of problem-solving skills that stresses the understanding of basic concepts, rather than the mechanical and rote use of formulas, as the essential foundation. Throughout the writing of *College Physics*, we have organized discussions and incorporated pedagogical tools to ensure that conceptual insight drives the development of practical skills.

Concise Coverage. To maintain a sharp focus on essential concepts, a book should emphasize the basics and minimize superfluous material. Topics of marginal interest have been avoided, as have those that present formal or mathematical difficulties for students. Similarly, we have not wasted space deriving relationships when they shed no additional light on the principle involved. It is usually more important for students in a course such as this to understand what a relationship means and how it can be used rather than the mathematical or analytical techniques employed to derive it.

Applications. *College Physics* has always been known for the strong mix of applications related to technology, science, architecture, medicine, and everyday life in its Insight boxes and text narrative. While the Fourth Edition continues to have a wider range of applications than do most texts, we have also increased the number of biological applications in recognition of the high percentage of pre-med and allied health majors who take this course. Some examples are the new Insight boxes Human Body Temperature, Electric Potential and Nerve Signal Transmission, and Magnetism in Nature. Overall, one-third of our Insight boxes are new. The Fourth Edition also contains many new applications within the text narrative and has an increased emphasis on real-world and applied topics in the worked Examples and end-of-chapter Exercises. A list of the most important applications with page references is found on p. xiii.

Insight

Human Body Temperature

We commonly take "normal" human body temperature to be 98.6°F (or 37.0°C). The source of this value is a study of human temperature readings done in 1868—more than 130 years ago! A more recent study, done in 1992, notes that the 1868 study used thermometers that were not as accurate as modern electronic thermometers. The new study has some interesting results.

The "normal" human body temperature from oral measurements varies with individuals over a range of about 96°F to 101°F, with an average temperature of 98.2°F. After strenuous exercise, the oral temperature can rise as high as 103°F. When the body is exposed to cold, oral temperatures can fall below 96°F. A rapid drop in temperature of 2 to 3 F° produces uncontrollable shivering. There is not only a contraction of the skeletal muscles, but also of the tiny muscles attached to the hair follicles. The result is "goose bumps."

Your body temperature is typically lower in the morning, after you have slept and your digestive processes are at a low point. "Normal" body temperature generally rises during the day to a peak and then recedes. The study also indicated that women have a slightly higher average temperature than men do (98.4°F versus 98.1°F).

What about the extremes? A fever temperature is typically between 102°F and 104°F. A body temperature above 106°F is extremely dangerous. The enzymes for certain chemical reactions in the body begin to be inactivated, and a total breakdown of body chemistry can result.

On the cold side, decreasing body temperature results in memory lapse and slurred speech, muscular rigidity, erratic heartbeats, loss of consciousness, and, below 78°F, death due to heart failure. However, mild hypothermia (lower-than-normal body temperature) can be beneficial. A decrease in body temperature slows down the body's chemical reactions, and cells use less oxygen than they normally do. This fact is applied in some surgeries (Fig. 1). A patient's body temperature may be lowered significantly to avoid damage to the heart, which must be stopped during such procedures, and to the brain.

FIGURE 1 Lower than normal During some surgeries, the patient's body temperature is lowered to slow down the body's chemical reactions and to reduce the need for blood to supply oxygen to the tissues.

Visualization: "Learn by Drawing." Visualization is one of the most important problem-solving tools in physics. In many cases, if students can make a sketch of a problem, they can solve it. "Learn by Drawing" features offer students specific help on making certain types of sketches and graphs that will provide key insights into a variety of physical situations. The Fourth Edition has three new Learn by Drawing features, on the following topics: Cartesian coordinates and one-dimensional motion, oscillation in a parabolic potential well, and the independence of potential difference on reference point.

LEARN BY DRAWING

Graphical Relationship between Electric Field Lines and Equipotentials

Since it takes no work to move a charge along an equipotential, equipotential surfaces and electric field lines must be perpendicular to one another. Also, the electric field at any location points in the direction in which the potential decreases most rapidly and has a magnitude equal to the change in potential per meter. We can use these facts to construct equipotentials for a given pattern of electric field lines. The reverse is also true: Given the equipotentials, we can construct the electric field lines. If we know the potential value (in volts) associated with each equipotential, we can estimate the strength and direction of the field.

A couple of examples should provide graphical insight into the close connection between equipotentials and fields. Consider Fig. 1, in which you are given the electric field lines and want to determine the shape of the equipotentials. Pick any point, such as A, and begin moving at right angles to the electric field (mapped by the field lines) at that point. Keep moving, always maintaining this same perpendicular orientation to the field lines. Between lines you may have to approximate, but plan ahead to the next field line so that you can cross it at a right angle. To find another equipotential, start at another point, such as B, and proceed the same way. Sketch as many equipotentials as you need to map the area of interest. Figure 1 shows the result of sketching four such equipotentials, from A (at the highest potential value—can you tell why?) to D (at the lowest potential).

Suppose that you are given the equipotentials instead of the field lines (Fig. 2). The electric field lines point in the direction of decreasing V and are perpendicular to the equipotential surfaces. Thus, to map the field, start at any point and move in such a way that your path intersects each equipotential surface at a right angle. The resulting field line starting at point A in Fig. 2 is shown. Starting at points B, C, and D gives rise to additional field lines that suggest the complete electric field pattern; you need only add the arrows in the direction of decreasing potential.

Suppose that you want to estimate the magnitude of **E** at some point P, knowing the values of the equipotentials 1.0 cm on either side of it (Fig. 3). From this information you can easily tell that the field points in the direction from A to B (why?). Its approximate magnitude is

$$|\mathbf{E}| = \frac{\Delta V}{\Delta x} = \frac{(1000\ \mathrm{V} - 950\ \mathrm{V})}{2.0 \times 10^{-2}\ \mathrm{m}}$$

$$= 2.5 \times 10^{3}\ \mathrm{V/m}$$

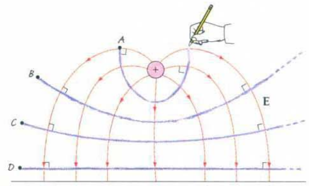


FIGURE 1 Sketching equipotentials from electric field lines Given the electric field pattern, pick a point in the region of interest and move so that your path is always perpendicular to the next field line. Keep your path as smooth as possible, since kinks and loops in the equipotentials are not allowed. (Why?) To map a higher potential value, move opposite the direction of the electric field and repeat the process. Here $V_A > V_B$ and so on.

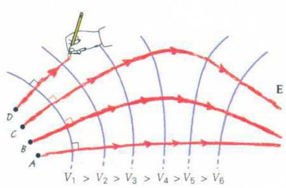


FIGURE 2 Mapping the electric field from equipotentials Start at a convenient point and trace a line that crosses each equipotential at a right angle. Repeat the process as often as needed to reveal the field pattern, adding arrows to indicate the direction of the field lines from high to low potential.

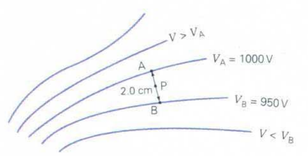


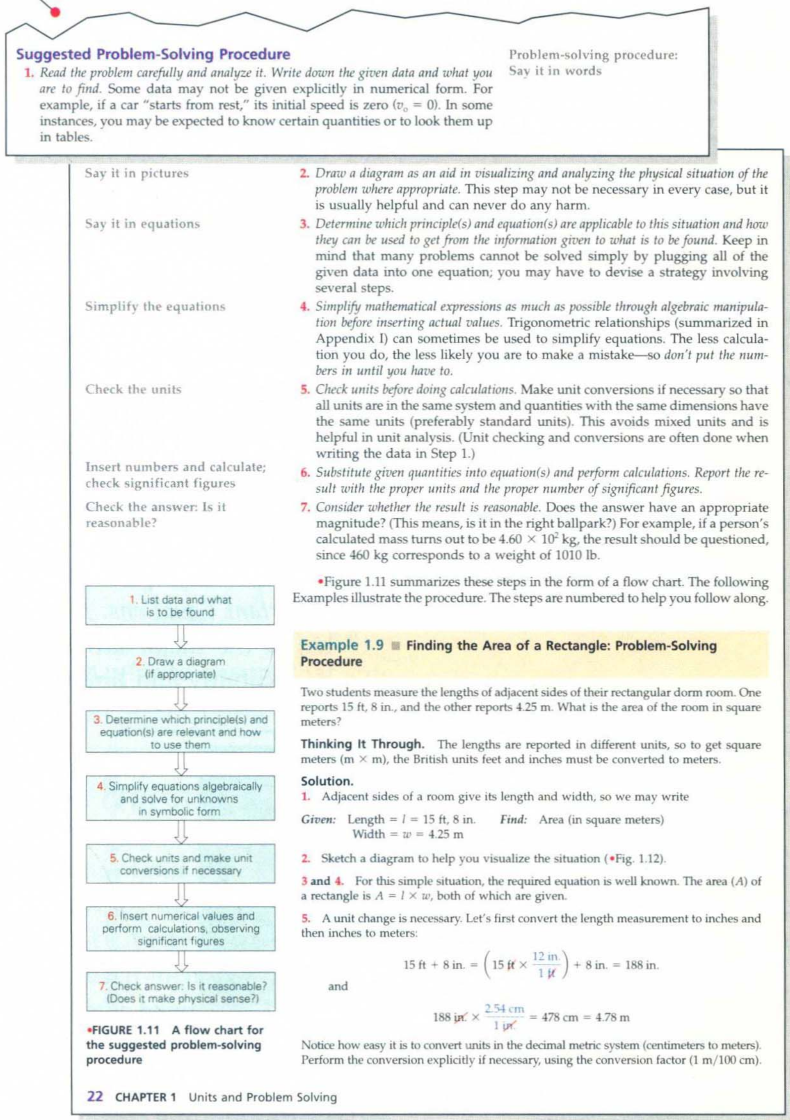
FIGURE 3 Estimating the magnitude of the electric field The magnitude of the potential change per meter at any point gives the strength of the electric field at that point.

Demonstrations. Photo sequences of 16 physics demonstrations bring physical principles to life, helping students understand that the information and equations on the page describe real-world phenomena.

Integrated Learning Objectives. Specific learning objectives, located at the beginning of each chapter section, help students structure their reading and facilitate review.

Suggested Problem-Solving Procedure. An extensive section (Section 1.7) provides a framework for thinking about problem solving. This section includes:

- An overview of problem-solving strategies;
- A seven-step procedure that is general enough to apply to most problems in physics but is easily used in specific situations;
- Three Examples that illustrate the problem-solving process, showing how the general procedure is applied in practice.



Suggested Problem-Solving Procedure

Problem-solving procedure: Say it in words

1. *Read the problem carefully and analyze it. Write down the given data and what you are to find.* Some data may not be given explicitly in numerical form. For example, if a car "starts from rest," its initial speed is zero ($v_o = 0$). In some instances, you may be expected to know certain quantities or to look them up in tables.

Say it in pictures

2. *Draw a diagram as an aid in visualizing and analyzing the physical situation of the problem where appropriate.* This step may not be necessary in every case, but it is usually helpful and can never do any harm.

Say it in equations

3. *Determine which principle(s) and equation(s) are applicable to this situation and how they can be used to get from the information given to what is to be found.* Keep in mind that many problems cannot be solved simply by plugging all of the given data into one equation; you may have to devise a strategy involving several steps.

Simplify the equations

4. *Simplify mathematical expressions as much as possible through algebraic manipulation before inserting actual values.* Trigonometric relationships (summarized in Appendix I) can sometimes be used to simplify equations. The less calculation you do, the less likely you are to make a mistake—so *don't put the numbers in until you have to.*

Check the units

5. *Check units before doing calculations.* Make unit conversions if necessary so that all units are in the same system and quantities with the same dimensions have the same units (preferably standard units). This avoids mixed units and is helpful in unit analysis. (Unit checking and conversions are often done when writing the data in Step 1.)

Insert numbers and calculate; check significant figures

6. *Substitute given quantities into equation(s) and perform calculations. Report the result with the proper units and the proper number of significant figures.*

Check the answer: Is it reasonable?

7. *Consider whether the result is reasonable.* Does the answer have an appropriate magnitude? (This means, is it in the right ballpark?) For example, if a person's calculated mass turns out to be 4.60×10^2 kg, the result should be questioned, since 460 kg corresponds to a weight of 1010 lb.

•Figure 1.11 summarizes these steps in the form of a flow chart. The following Examples illustrate the procedure. The steps are numbered to help you follow along.

1. List data and what is to be found
2. Draw a diagram (if appropriate)
3. Determine which principle(s) and equation(s) are relevant and how to use them
4. Simplify equations algebraically and solve for unknowns in symbolic form
5. Check units and make unit conversions if necessary
6. Insert numerical values and perform calculations, observing significant figures
7. Check answer: Is it reasonable? (Does it make physical sense?)

•FIGURE 1.11 A flow chart for the suggested problem-solving procedure

Example 1.9 ■ Finding the Area of a Rectangle: Problem-Solving Procedure

Two students measure the lengths of adjacent sides of their rectangular dorm room. One reports 15 ft, 8 in., and the other reports 4.25 m. What is the area of the room in square meters?

Thinking It Through. The lengths are reported in different units, so to get square meters (m × m), the British units feet and inches must be converted to meters.

Solution.

1. Adjacent sides of a room give its length and width, so we may write

Given: Length = l = 15 ft, 8 in. *Find:* Area (in square meters)
Width = w = 4.25 m

2. Sketch a diagram to help you visualize the situation (•Fig. 1.12).

3 and 4. For this simple situation, the required equation is well known. The area (A) of a rectangle is $A = l \times w$, both of which are given.

5. A unit change is necessary. Let's first convert the length measurement to inches and then inches to meters:

$$15\text{ ft} + 8\text{ in.} = \left(15\text{ ft} \times \frac{12\text{ in.}}{1\text{ ft}}\right) + 8\text{ in.} = 188\text{ in.}$$

and

$$188\text{ in.} \times \frac{2.54\text{ cm}}{1\text{ in.}} = 478\text{ cm} = 4.78\text{ m}$$

Notice how easy it is to convert units in the decimal metric system (centimeters to meters). Perform the conversion explicitly if necessary, using the conversion factor (1 m/100 cm).

22 CHAPTER 1 Units and Problem Solving

Problem-Solving Strategies and Hints. The initial treatment of problem solving is followed up throughout *College Physics* with an abundance of suggestions, tips, cautions, shortcuts, and useful techiques for solving specific kinds of problems. These strategies and hints help students apply general principles to specific contexts as well as avoid common pitfalls and misunderstandings.

Conceptual Examples. *College Physics* was among the first physics text to include examples that are conceptual in nature in addition to quantitative ones. Our Conceptual Examples ask students to think about a physical situation and choose the correct prediction on the basis of an understanding of relevant principles. The discussion that follows (Reasoning and Answer) explains clearly how the correct answer can be identified as well as why the other answers are wrong.

More Explanation in Examples. Too many solutions to worked examples in other texts rely on formulas such as "From Eq. 6.7 we have. . . ." We have tried to make the solutions to in-text Examples as clear, patient, and detailed as possible. The aim is not merely to show students which equations to use but to explain the strategy being employed and the role of each step in the overall plan. Students are encouraged to learn the "why" of each step along with the "how." This technique will make it easier for students to apply the demonstrated techniques to other problems that are not identical in structure.

Thinking It Through. New to the Fourth Edition, every worked Example now includes a "Thinking It Through" section after the problem statement and before the Solution to focus students on the critical thinking and analysis they should do before beginning to use equations.

Example 4.5 ■ A Braking Car: Finding a Force From Motional Effects

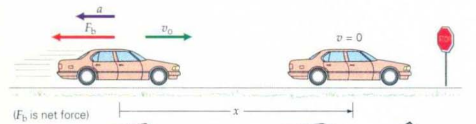
A car traveling at 72.0 km/h along a straight, level road is brought uniformly to a stop in a distance of 40.0 m. If the car weighs 8.80×10^3 N, what is the braking force?

Thinking It Through. It is noted that the car's velocity changes, so there is an acceleration. Given a distance, we might surmise that first the acceleration is found by using a kinematic equation, and then the acceleration is used to compute the force.

Solution. In bringing the car to a stop, the braking force caused an acceleration (actually a deceleration), as illustrated in •Fig. 4.13. Listing what is given and what we must find, we have

Given: $v_o = 72.0$ km/h $= 20.0$ m/s
$v = 0$
$x = 40.0$ m
$w = 8.80 \times 10^3$ N

Find: F_b (braking force)



•**FIGURE 4.13 Finding force from motional effects** See Example 4.5.

Follow-up Exercises. Follow-up Exercises at the end of each Conceptual Example and each regular worked Example further reinforce the importance of conceptual understanding and offer additional practice. (Answers to Follow-up Exercises are given at the back of the book.)

Chapter Review. Each Chapter Review is made up of three parts:

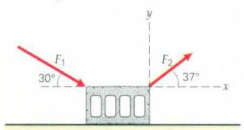
1. *Important Terms:* A listing, with page references, of the key terms introduced in the chapter that students should be able to define and explain.
2. *Important Concepts:* A summary of the key principles of each chapter.
3. *Important Equations:* A listing, cross-referenced to the equations in the chapter, of the major laws and mathematical relationships introduced. Specific applicability and limiting conditions are clearly stated for each expression.

10. If your professor's car is traveling west with a constant velocity of 55 mi/h west on a straight highway, what is the net force acting on it?

11. ■ Which has more inertia, 20 cm^3 of water or 10 cm^3 aluminum, and how many times more? (See Table 9.2.)

12. ■■ You are told that an object has zero acceleration. Two forces on the object are $\mathbf{F}_1 = 3.6$ N at 74° below the $+x$ axis and $\mathbf{F}_2 = 3.6$ N at 34° above the $-x$ axis. Is there a third force on the object? If yes, what is it? Can you tell whether the object is at rest or in motion?

13. ■■ A 5.0-kilogram block at rest on a frictionless surface is acted on by forces $F_1 = 5.5$ N and $F_2 = 3.5$ N, as illustrated in •Fig. 4.30. What additional horizontal force will keep the block at rest?



•**FIGURE 4.30 Two applied forces** See Exercises 13 and 86.

14. ■■■ A 1.5-kilogram object moves up the y axis with a constant speed. When it reaches the origin, the forces $\mathbf{F}_1 = 5.0$ N at 37° above the $+x$ axis, $\mathbf{F}_2 = 2.5$ N in the $+x$ direction, $\mathbf{F}_3 = 3.5$ N at 45° below the $-x$ axis, and $\mathbf{F}_4 = 1.5$ N in the $-y$ direction are applied to it. (a) Will the object continue to move along the y axis? (b) If not, what simultaneously applied force will keep it moving along the y axis with a constant speed?

4.3 Newton's Second Law of Motion

15. The newton unit of force is equivalent to (a) kg·m/s, (b) kg·m/s^2, (c) kg·m^2/s, (d) none of these.

16. In general, this chapter considered forces that were applied to objects of constant mass. What would be the situation if mass were added to or lost from a system while a force was being applied to the system? Give examples of situations in which this might happen.

17. Good football wide receivers usually have "soft" hands for catching balls (•Fig. 4.31). How would you interpret this description on the basis of Newton's second law?

18. ■ A 3.0-newton net force is applied to a 1.5-kilogram mass. What is its acceleration?

19. ■ What is the mass of an object that accelerates at 3.0 m/s^2 under the influence of a 5.0-newton net force?

20. ■ A worker pushes on a crate, which experiences a net force of 75 N. If the crate also experiences an acceleration of 0.50 m/s^2, what is its weight?

•**FIGURE 4.31 Soft hands** See Exercise 17.

21. ■ An ocean tanker has a gross mass of 7.0×10^7 kg. What constant net force would give the tanker an acceleration of 0.10 m/s^2?

22. ■ A 6.0-kilogram object is brought to the Moon, where the acceleration due to gravity is only one-sixth of that on the Earth. What is the mass of the object on the Moon? (a) 1.0 kg (b) 6.0 kg (c) 59 kg (d) 9.8 kg

23. ■ What is the mass of a person weighing 740 N?

24. ■ What is the net force acting on a 1.0-kilogram object in free fall?

25. ■ What is the weight of an 8.0-kilogram mass in newtons? How about in pounds?

26. ■■ What is the weight of a 150-pound person in newtons? What is his mass in kilograms?

27. ■■ (a) Is the product label shown in •Fig. 4.32 correct on the Earth? (b) Is it correct on the Moon, where the acceleration due to gravity is only about one-sixth of that on Earth? If not, what should the label be on the Moon?

•**FIGURE 4.32 Correct label?** See Exercise 27.

Exercises. Each chapter ends with a wealth of Exercises, organized by chapter section and ranked by general level of difficulty. In addition, the Exercises offer the following special features to help students refine both their conceptual understanding and their problem-solving skills:

- ***Integration of Conceptual and Quantitative Exercises.*** To help break down the artificial and ultimately counterproductive barrier between conceptual questions and quantitative problems, we do not distinguish between these categories in the end-of-chapter Exercises. Instead, each section begins with a series of multiple-choice and short-answer questions that provide content review, test conceptual understanding, and ask students to reason from principles. The aim is to show students that the same kind of conceptual insight is required regardless of whether the desired answer involves words, equations, or numbers. The conceptual or "thought" questions are marked by a bold **TQ** in the *Annotated Instructor's Edition* of the text for easy reference when assigning questions. Unlike most other texts, *College Physics* offers short answers to all odd-numbered conceptual questions (as well as to all odd-numbered quantitative problems) in the back of the text so that students can check their understanding. About 35% of all Thought Questions and Exercises in the Fourth Edition are new.

- ***Interactive Exercises.*** New to the Fourth Edition, many of the end-of-chapter Exercises are keyed to simulations on Prentice Hall's multimedia study guide, the *Interactive Journey through Physics*. Exercises that have a corresponding simulation are indicated with a CD-ROM icon. The *College Physics Media Pack* (ISBN 0-13-085346-1), a specially discounted package consisting of the text and *Interactive Journey through Physics* CD-ROM, includes a cross-reference/location guide to allow you to match Exercise numbers to corresponding simulations.

- ***Paired and Trio Exercises.*** Most numbered sections include at least one set of paired Exercises and, new to the Fourth Edition, one set of trio Exercises, that deal with similar situations. The first problem in a pair or trio is solved in the Study Guide; the second problem, exploring a similar situation, has only an answer at the back of the book, thereby encouraging students to work out the problem on their own. The third problem in a trio is answered in the *Student Study Guide and Solutions Manual*.

- ***Additional Exercises.*** Each chapter includes a supplemental section of Additional Exercises drawn from all sections of the chapter to ensure that students can synthesize concepts.

The Absolutely Zero Tolerance for Errors Club (The AZTECs). This team approach to accuracy checking worked quite well in the third edition, so we did it again. Bo Lou of Ferris State University, the author of our *Instructor's Solutions Manual*, headed the AZTEC team and was supported by the text authors and two additional accuracy checkers, Bill McCorkle of West Liberty State University and Dave Curott of the University of North Alabama. Each member of the team individually and independently worked all end-of-chapter Exercises. The results were then collected, and any discrepancies were resolved by a "team" discussion. All data in the chapters, as well as the answers at the back of the book, were checked and rechecked in first and second page proofs. In addition, two other physics teachers—J. Erik Hendrickson and K. W. Nicholson—read all first pages in detail, checking for errors in the chapter narrative and text art. Although it is probably not humanly possible to produce a physics text with absolutely no errors, that was our goal; we worked very hard to make the book as error-free as we could.

New Multimedia Explorations of Physics

New to the Fourth Edition are a state-of-the art Website and a CD-ROM media package.

Companion Website. Our Website (at http://www.prenhall.com/wilson), with contributions from leaders in physics education research, provides students with a variety of interactive explorations of each chapter's topics, easily accommodating differences in learning styles. Student tools include Warm-Ups, Puzzles, and "What Is Physics Good For?" applications by Gregor Novak and Andy Gavrin (Indiana University–Purdue University, Indianapolis); award-winning Java-based Physlet problems by Wolfgang Christian (Davidson College); algorithmically generated numerical Practice Problems, multiple-choice Practice Questions, on-line Destinations, and Net Search key words by Carl Adler (East Carolina University); Ranking Task Exercises edited by Tom O'Kuma (Lee College), David Maloney (Indiana University–Purdue University, Fort Wayne) and Curtis Hieggelke (Joliet Junior College); downloadable PDF files for a Mechanics Problem-Solving Workbook by Dan Smith (South Carolina State University); and MCAT Questions by Glen Terrell (University of Texas at Arlington) and from ARCO's MCAT Supercourse. Using the Preferences module at the opening of the site or the tool in the "Results reporter" part of each module, students can, at a professor's request, have the results of their work on the Companion Website e-mailed to the professor or teaching assistant. Instructor tools include on-line grading capabilities and a Syllabus Manager. See pp. xxviii–xxiv for further information about the modules in this site.

Media Pack for College Physics, Fourth Edition (0-13-085346-1). *College Physics, Fourth Edition* can be purchased in a specially discounted package called the Media Pack, which includes the student text, the dual-platform *Interactive Journey through Physics* (*IJTP*) CD-ROM by Cindy Schwarz (Vassar College) and Logal, Inc., *Science on the Internet: A Student's Guide, 1999* by Andrew Stull, and a cross-reference/location guide to correlate Exercises in the text marked with a CD-ROM icon and corresponding simulations on the *IJTP* CD-ROM. This CD-ROM is a multimedia study guide for physics, with simulations, animations, videos, hyperlinked topic reviews, MCAT review questions and problems (including Ranking Task Exercises, context-rich problems, and video problems) for mechanics, thermodynamics, electricity and magnetism, and light and optics. It also includes a built-in scientific calculator with a library of key physics constants, a glossary, and pertinent tables and equations. See pp. xxx–xxxi for a complete description of the types of materials on the *IJTP* CD-ROM.

Additional Supplements

The pedagogical value of *College Physics* is enhanced by a variety of supplements developed to address the needs of both students and instructors.

For the Instructor

Annotated Instructor's Edition (0-13-084167-6). The margins of the *Annotated Instructor's Edition* (*AIE*) contain an abundance of suggestions for classroom demonstrations and activities, along with teaching tips (points to emphasize, discussion suggestions, and common misunderstandings to avoid). In addition, the *AIE* contains:

- Icons that identify each illustration reproduced as a transparency in the *Transparency Pack.*
- Answers to end-of-chapter Exercises (following each Exercise).
- References to applicable video demonstrations from the *Physics You Can See* videotape.

Instructor's Solutions Manual (0-13-084168-4). Prepared by Bo Lou of Ferris State University, the *Instructor's Solutions Manual* supplies answers with complete, worked-out solutions to all end-of-chapter Exercises. Each solution has been checked for accuracy by a minimum of five instructors. This manual is also available electronically on both Windows and Macintosh platforms.

Test Item File (0-13-084160-9). Fully revised by Dave Curott of the University of North Alabama, the *Test Item File* now offers more than 2300 questions—approximately 30% of them new to this edition—and includes several new conceptual questions per chapter. The questions are now organized and referenced by type and by section.

Prentice Hall Custom Test (Windows: 0-13-084171-4; Macintosh: 0-13-084172-2). Based on the powerful testing technology developed by Engineering Software Associates, Inc. (ESA), the *Prentice Hall Custom Test* allows instructors to create and tailor exams to their own needs. With the On-line Testing Program, exams can also be administered on-line and data can then be automatically transferred for evaluation. A comprehensive desk reference guide is included, along with on-line assistance.

Transparency Pack (0-13-084175-7). The *Transparency Pack* contains more than 300 full-color acetates of text illustrations useful for class lectures. It is available upon adoption of the text.

Physics You Can See Video Demonstrations (0-205-12393-7). Each segment, 2–5 minutes long, demonstrates a classical physics experiment. Eleven segments are included, such as "Coin & Feather" (acceleration due to gravity), "Monkey & Gun" (rate of vertical free fall), "Swivel Hips" (force pairs), and "Collapse a Can" (atmospheric pressure).

Presentation Manager CD-ROM (0-13-084174-9). This new CD-ROM contains all the text art and videos from the *Physics You Can See* videotape as well as additional lab and demonstration videos and animations from the *Interactive Journey through Physics* CD-ROM, which is also available from Prentice Hall (see below).

Just-in-Time Teaching: Blending Active Learning with Web Technology (0-13-085034-9). Just-in-Time Teaching (JiTT) is an exciting new teaching and learning methodology designed to engage students. Using feedback from pre-class Web assignments, instructors can adjust classroom lessons so that students receive rapid response to the specific questions and problems they are having—instead of more generic lectures that may or may not address topics with which students actually need help. Many teachers have found that this process makes students become active and interested learners. In this resource book for educators, authors Gregor Novak (Indiana University–Purdue University, Indianapolis), Evelyn Patterson (United States Air Force Academy), Andrew Gavrin (Indiana University–Purdue University, Indianapolis), and Wolfgang Christian (Davidson College) more fully explain what Just-in-Time Teaching is, its underlying goals and philosophies, and how to implement it. They also provide an extensive section of tested resource materials that can be used in introductory physics courses with the JiTT approach.

For the Student

Student Study Guide and Solutions Manual (0-13-084365-2). Significantly revised by Bo Lou of Ferris State University, the *Student Study Guide and Solutions Manual* presents chapter-by chapter reviews, chapter summaries, key terms, additional worked problems, and solutions to selected problems.

The New York Times "Themes of the Times" Program. This innovative program, made possible through an exclusive partnership between Prentice Hall and *The New York Times*, brings current and relevant applications into the classroom. Through this program, adopters of *College Physics, Fourth Edition* are eligible to receive our free, unique "mini-newspapers," which bring together a collection of the latest and best physics articles from the highly respected pages of *The New York Times*. They are updated annually and are free to qualified adopters up to the quantity of texts purchased. Contact your local representative for ordering.

MCAT Physics Study Guide (0-13-627951-1). This study resource by Joseph Boone of California Polytechnic State University–San Luis Obispo references all of the physics topics on the MCAT to the appropriate sections in the text. Since most MCAT questions require more thought and reasoning than simply plugging numbers into an equation, this study guide is designed to refresh students' memory about the topics they've covered in class. Additional review, practice problems, and review questions are included.

Science on the Internet: A Student's Guide, 1999 (0-13-021308-X). This guide helps students gain a greater understanding of the Internet and the ways in which they can access information on the Web relating to their study of physics.

Other Related Multimedia Materials

Interactive Physics II Player Workbook (Windows: 0-13-667312-0; Macintosh: 0-13-477670-4). Written by Cindy Schwarz of Vassar College, this highly interactive workbook/software package contains simulation projects of varying difficulty. Each includes a physics review, simulation details, hints, an explanation of results, math help, and a self-test.

Interactive Journey through Physics CD-ROM (0-13-254103-3). This highly interactive CD-ROM can be used as a stand-alone supplement for any introductory physics course or as a general reference tool. Through simulation, animation, video, and interactive problem solving, students can visualize difficult physics concepts in ways not available through the traditional lecture, lab, and text. The innovative concept checks and extension exercises within the simulations facilitate the reinforcement of important physical concepts. The content of this CD-ROM is organized according to the main topics in physics—mechanics, electricity and magnetism, thermodynamics, and light and optics. The numerous analysis tools are easily navigated through a user-friendly interface. See the previous description under Media Pack and pp. xxx–xxxi for more detail about the *IJTP CD-ROM*, and see ordering information for the discounted price when purchased with *College Physics, Fourth Edition,* in the Media Pack.

Acknowledgments

We would like to acknowledge the generous assistance we received from many people during the preparation of the Fourth Edition. First, our sincere thanks go to Bo Lou of Ferris State University for his vital contributions and meticulous, conscientious help with checking problem solutions and answers, preparing the *Instructor's Solutions Manual* as well as the answer keys for the back of the book, and preparing a major revision of the *Student Study Guide and Solutions Manual*. We are similarly grateful to Dave Curott of the University of North Alabama for preparing the *Test Item File* as well as for his participation as an accuracy checker for all solutions to end-of-chapter Exercises.

Indeed, all the members of AZTEC—Bo Lou, Dave Curott, and Bill McCorkle (West Liberty State University)—as well as the reviewers of first and second page proofs—Xiaochun He (Georgia State University), J. Erik Hendrickson (University of Wisconsin–Eau Claire), K. W. Nicholson (Central Alabama Community College), Peter Shull (Oklahoma State University), and Lorin Vant-Hull (University of Houston)—deserve more than a special thanks for their tireless, timely, and extremely thorough review of all materials in the book for scientific accuracy.

Dozens of other colleagues, listed next helped us with reviews of the Third Edition to help us plan the Fourth Edition as well as with reviews of manuscript as it was developed. We are indebted to them, as their thoughtful and constructive suggestions benefited the book greatly.

At Prentice Hall, the editorial staff continued to be particularly helpful. We are especially grateful to Karen Karlin, Senior Development Editor, for everything—her cheerful competence, experienced hand, insight, creativity, extreme attention to detail, and even her queries, all of which have helped make this book one of the most carefully crafted introductory physics texts available. Pat McCutcheon, Project Manager for the book, and Lisa Kinne, Assistant Managing Editor, kept the whole complex endeavor moving forward, while designers Joseph Sengotta and Rosemarie Votta made sure the ultimate physical presentation would be both visually engaging and clean and easy to use. We also thank Danny Hoyt, Senior Marketing Manager, for his cheerful enthusiasm; Wendy Rivers for her work on the supplements; Alison Reeves, Executive Editor, and Gillian Buonanno, Editorial Assistant, for their help in coordinating all of these facets; and Paul Corey, Editor in Chief, for his support and encouragement.

In addition, I (Tony Buffa) once again extend my thanks to my coauthor, Jerry Wilson, for his helpfulness and professional approach to the work at hand during this revision. As always, several colleagues of mine at Cal Poly gave unselfishly of their time for fruitful discussions. Among them are Professors Joseph Boone, Ronald Brown, Theodore Foster, and Richard Frankel. My family—my wife, Connie, and daughters, Jeanne and Julie—was a continuous source of support and inspiration that helped me through the hectic parts of the schedule. I also acknowledge my recently deceased mother, Florence, for her help and advice over the years.

Finally, both of us would like to urge anyone using the book—student or instructor—to pass on to us any suggestions that you have for its improvement. We look forward to hearing from you.

—Jerry D. Wilson
—Anthony J. Buffa

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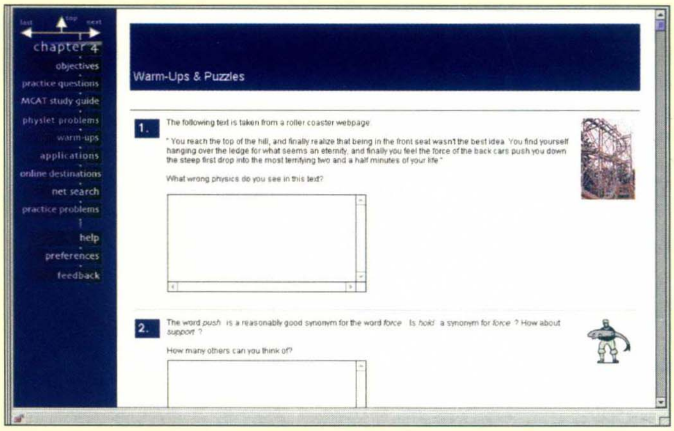
This exciting text-specific interactive Website for introductory physics provides students and instructors with a wealth of innovative on-line materials for use with *College Physics, Fourth Edition*.

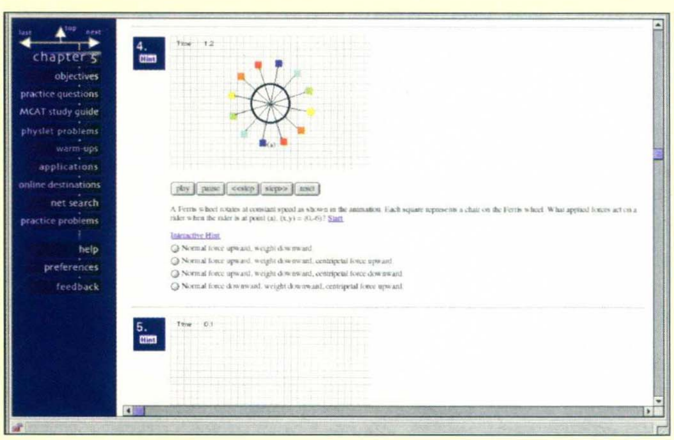


Warm-Ups & Puzzles by Gregor Novak and Andrew Gavrin (Indiana University–Purdue University, Indianapolis)

Warm-Up and Puzzle questions are real-world short-answer questions based on important concepts in the text chapters. Both types of questions get students' attention, often refer to current events, and are good discussion starters. The **Warm-Ups** are designed to help introduce a topic, whereas the **Puzzles** are more complex and often require the integration of more than one concept. Thus, professors can assign Warm-Up questions after students have read a chapter but before the class lecture on that topic, and Puzzle questions as follow-up assignments submitted after class.

Applications by Gregor Novak and Andrew Gavrin (Indiana University–Purdue University, Indianapolis)

The **Applications** modules answer the question "What is physics good for?" by connecting physics concepts to real-world phenomena and new developments in science and technology. These illustrated essays include embedded Web links to related sites, one for each chapter. Each essay is followed by short-answer/essay questions, which professors can assign for extra credit.



Physlet Problems by Wolfgang Christian (Davidson College)

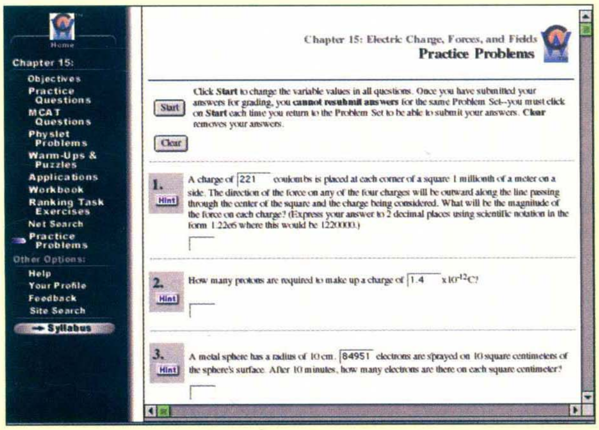
Physlet Problems are multimedia-focused problems based on Wolfgang Christian's award-winning Java applets for physics, called *Physlets*. With these problems, students use multimedia elements to help solve a problem by observing, applying appropriate physics concepts, and making measurements of parameters they deem important. No numbers are given, so students are required to consider a problem qualitatively instead of plugging in formulas.

Practice Questions by Carl Adler (East Carolina University)

Twenty-five to 30 multiple-choice **Practice Questions** are available for review and drill with each chapter.

Practice Problems by Carl Adler (East Carolina University)

Ten algorithmically generated numerical **Practice Problems** per chapter allow students to get multiple iterations of each problem set for practice.



Mechanics Problem-Solving Workbook by Dan Smith (South Carolina State University)

The **Mechanics Problem-Solving Workbook** is a self-contained workbook designed for student self-study and is available from the Wilson/Buffa Website in downloadable PDF files. It helps students explore issues of central importance in mechanics by beginning with conceptual solutions to problems and then building slowly to final results. Each topic has between 4 and 10 problems that students work out in successive stages, beginning with a conceptual description of the problem and ending with algebraic analyses. Students must complete each stage before proceeding to the next stage, thereby ensuring that they understand the physics before using the algebra.

Ranking Task Exercises edited by Tom O'Kuma (Lee College), David Maloney (Indiana University–Purdue University, Fort Wayne), and Curtis Hieggelke (Joliet Junior College)

Available for most text chapters as PDF files downloadable from the Wilson/Buffa Website, **Ranking Tasks** are conceptual exercises that require students to rank a number of situations or variations of a situation. Engaging in this process of making comparative judgments helps students reason about physical situations and often gives them new insights into relationships among various concepts and principles.

MCAT Study Guide by Glen Terrell (University of Texas at Arlington) and ARCO's MCAT Supercourse

For all relevant chapters, the MCAT Study Guide module provides students with an average of 25 multiple-choice questions on topics and concepts covered on the MCAT exam. As with all multiple-choice modules, the computer automatically grades and scores student responses and provides cross-references to corresponding text sections.

Destinations

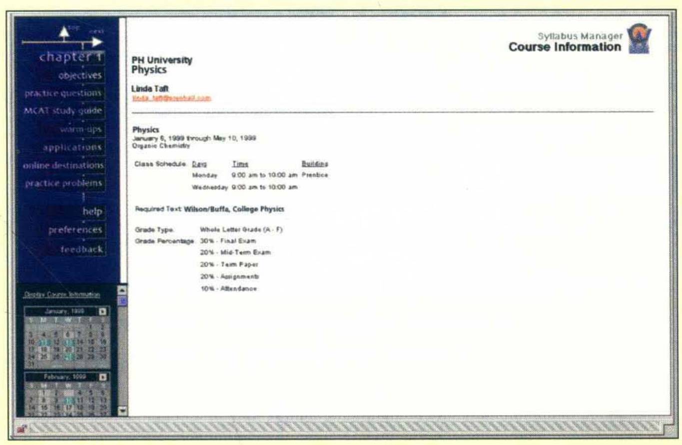
Destinations are links to relevant Websites for each chapter, either about the physics topic in the chapter or about related applications.

Net Search

The **Net Search** feature automatically configures key words according to the key word search conventions of the top three Internet search engines.

Syllabus Manager

Wilson/Buffa's **Syllabus Manager** provides instructors with an easy, step-by-step process for creating and revising a class syllabus with direct links to the text's Companion Website and other on-line content. Through this on-line syllabus, instructors can add assignments and send announcements to the class with the click of a button. The completed syllabus is hosted on Prentice Hall's servers, allowing the syllabus to be updated from any computer with Internet access.



On-line Grading

Scoring for all objective questions and problems, as well as responses to essay questions, can be e-mailed back to the instructor.