

# Preface

*Physics* is intended for a two-semester college course in introductory physics using algebra and trigonometry. Our main goals in writing this book are

- to present the basic concepts of physics that students need to know for later courses and future careers,
- to emphasize that physics is a tool for understanding the real world, and
- to teach transferable problem-solving skills that students can use throughout their lives.

*Physics* is based on the second edition of the authors' *College Physics*, with Chapters 2–4 reorganized to present kinematics before forces and Newton's laws of motion.

## ORGANIZATION OF CHAPTERS 2 THROUGH 4

In spite of the more traditional organization, Chapters 2–4 retain much of the flavor of the approach in *College Physics*. In particular,

- We use correct vector notation, diagrams, terminology, and methods from the very beginning. Even in Chapter 2—which treats one-dimensional kinematics—displacements, velocities, and accelerations are always treated as vector quantities. For example, we carefully distinguish components from magnitudes by writing “ $v_x = -5$  m/s” and never “ $v = -5$  m/s,” even if the object moves only along the  $x$ -axis.
- Before plunging into kinematics, Chapter 2 begins with a brief *conceptual* introduction to Newton's laws to give students a rough idea *why* we are interested in these quantities and how they fit into a bigger picture of Newtonian mechanics. Laying such a conceptual foundation is a recurring theme in the book.

## COMPREHENSIVE COVERAGE

Students should be able to get the whole story from the book. The text works well in our self-paced course, where students must rely on it as their primary learning resource. Nonetheless, completeness and clarity are equally advantageous when the book is used in a more traditional classroom setting. *Physics* frees the instructor from having to try to “cover” everything. The instructor can then tailor class time to more important student needs—reinforcing difficult concepts, working through example problems, engaging the students in cooperative learning activities, describing applications, or presenting demonstrations.

## INTEGRATING CONCEPTUAL PHYSICS INTO A QUANTITATIVE COURSE

Some students approach introductory physics with the idea that physics is just the memorization of a long list of equations and the ability to plug numbers into those equations. We want to help students see that a relatively small number of basic physics concepts are applied to a wide variety of situations. Physics education research has shown that students do not automatically acquire conceptual understanding; the concepts must be explained and the students given a chance to grapple with them. Our presentation, based on years of teaching this course, blends conceptual understanding with analytical skills. The **Conceptual Examples** and **Conceptual Practice Problems** in the text and a variety of **Conceptual** and **Multiple-Choice Questions** at the end of each chapter give students a chance to check and to enhance their conceptual understanding.

● “*Conceptual ideas are important, ideas must be motivated, physics should be integrated, a coherent problem-solving approach should be developed. I'm not sure other books are as explicit in these goals, or achieve them as well as Giambattista, Richardson, and Richardson.*”

Dr. Michael G. Strauss,  
University of Oklahoma

## INTRODUCING CONCEPTS INTUITIVELY

We introduce key concepts and quantities in an informal way by establishing why the quantity is needed, why it is useful, and why it needs a precise definition. Then we make a transition from the informal, intuitive idea to a formal definition and name. Concepts motivated in this way are easier for students to grasp and remember than are concepts introduced by seemingly arbitrary, formal definitions. We give particular attention to laying the groundwork for a concept when its name is a common English word such as *velocity* or *work*.

For example, in Chapter 8, the idea of rotational inertia emerges in a natural way from the concept of rotational kinetic energy. Students can understand that a rotating rigid body has kinetic energy due to the motion of its particles. We discuss why it is useful to be able to write this kinetic energy in terms of a single quantity common to all the particles (the angular speed), rather than as a sum involving particles with many

“I think chapter 8 is particularly well-written. Rotational motion, magnetism, and ac circuits spring to mind as the most notoriously difficult subjects to teach in this course. The authors have chosen a number of excellent biomechanical examples in chapter 8 and this chapter’s presentation alone might persuade some lecturers to switch texts.”

Dr. Nelson E. Bickers,  
University of Southern  
California

different speeds. When students understand why rotational inertia is defined the way it is, they are better prepared to move on to the concepts of torque and angular momentum.

We avoid presenting definitions or formulas without any motivation. When an equation is not derived in the text, we at least describe where the equation comes from or give a plausibility argument. For example, Section 9.9 introduces Poiseuille’s law with two identical pipes in series to show why the volume flow rate must be proportional to the pressure drop per unit length. Then we discuss why  $\Delta V/\Delta t$  is proportional to the fourth power of the radius (rather than to  $r^2$ , as it would be for an ideal fluid).

## WRITTEN IN CLEAR AND FRIENDLY STYLE

We have kept the writing down-to-earth and conversational in tone—the kind of language an experienced teacher uses when sitting at a table working one-on-one with a student. We hope students will find the book pleasant to read, informative, and accurate without seeming threatening, and filled with analogies that make abstract concepts easier to grasp. We want students to feel confident that they can learn by studying the textbook.

While learning correct physics terminology is essential, we avoid all *unnecessary* jargon—terminology that just gets in the way of the student’s understanding. For example, we never use the term *centripetal force*, since its use sometimes leads students to add a spurious “centripetal force” to their free-body diagrams. Likewise, we use *radial component of acceleration* because it is less likely to introduce or reinforce misconceptions than *centripetal acceleration*.

## ACCURACY ASSURANCE

The authors and the publisher acknowledge the fact that inaccuracies can be a source of frustration for both the instructor and students. Therefore, throughout the writing and production of this edition, we have worked diligently to eliminate errors and inaccuracies. Ten professors performed independent accuracy checks of textual examples, practice problems, and solutions and worked the new and revised end-of-chapter questions and problems. Bill Fellers of Fellers Math & Science also conducted an independent accuracy check and worked all end-of-chapter questions and problems in the final draft of the manuscript. He then coordinated the resolution of discrepancies between accuracy checks, ensuring the accuracy of the text, the end-of-book answers, and the solutions manuals. Corrections were then made to the manuscript before it was typeset.

The page proofs of the text were proofread against the manuscript to ensure the correction of any errors introduced when the manuscript was typeset. The textual examples, practice problems and solutions, end-of-chapter questions and problems, and problem answers were accuracy checked by Fellers Math & Science

again at the page proof stage after the manuscript was typeset. This last round of corrections was then cross-checked against the solutions manuals.

## PROVIDING STUDENTS WITH THE TOOLS THEY NEED

### Problem-Solving Approach



Problem-solving skills are central to an introductory physics course. We illustrate these skills in the example problems. Lists of problem-solving strategies are sometimes useful; we provide such strategies when appropriate. However, the most elusive skills—perhaps the most important ones—are subtle points that defy being put into a neat list. To develop real problem-solving expertise, students must learn how to think critically and analytically. Problem solving is a multidimensional, complex process; an algorithmic approach is not adequate to instill real problem-solving skills.


**Strategy** We begin each example with a discussion—in language that the students can understand—of the *strategy* to be used in solving the problem. The strategy illustrates the kind of analytical thinking students must do when attacking a problem: How do I decide what approach to use? What laws of physics apply to the problem and which of them are *useful* in this solution? What clues are given in the statement of the question? What information is implied rather than stated outright? If there are several valid approaches, how do I determine which is the most efficient? What assumptions can I make? What kind of sketch or graph might help me solve the problem? Is a simplification or approximation called for? If so, how can I tell if the simplification is valid? Can I make a preliminary estimate of the answer? Only after considering these questions can the student effectively solve the problem.

**Solution** Next comes the detailed *solution* to the problem. Explanations are intermingled with equations and step-by-step calculations to help the student understand the approach used to solve the problem. We want the student to be able to follow the mathematics without wondering, “Where did that come from?”


**Discussion** The numerical or algebraic answer is not the end of the problem; our examples end with a *discussion*. Students must learn how to determine whether their answer is consistent and reasonable by checking the order of magnitude of the answer, comparing the answer to a preliminary estimate, verifying the units, and doing an independent calculation when more than one approach is feasible. When there are several different approaches, the discussion looks at the advantages and disadvantages of each approach. We also discuss the implications of the answer—what can we learn from it? We look at special cases and look at “what if” scenarios. The discussion sometimes generalizes the problem-solving techniques used in the solution.

**Practice Problem** After each Example, a Practice Problem gives students a chance to gain experience using the same physics principles and problem-solving tools. By comparing their answers to those provided at the end of each chapter, they can gauge their understanding and decide whether to move on to the next section.


Our many years of experience in teaching the college physics course in a one-on-one setting has enabled us to anticipate where we can expect students to have difficulty. In addition to the consistent problem-solving approach, we offer several other means of assistance to the student throughout the text. A boxed problem-solving strategy gives detailed information on solving a particular type of problem, while an icon  for problem-solving tips draws attention to techniques that can be used in a variety of contexts. A hint in a worked example or end-of-chapter problem provides a clue on what approach to use or what simplification to make. A warning icon  emphasizes an explanation that clarifies a possible point of confusion or a common student misconception.

 “The major strength of this text is its approach, which makes students think out the problems, rather than always relying on a formula to get an answer. The way the authors encourage students to investigate whether the answer makes sense, and compare the magnitude of the answer with common sense is good also.”


Dr. Jose D’Arruda,  
University of North Carolina,  
Pembroke

 “I understood the math, mostly because it was worked out step-by-step, which I like.”


Student, Bradley University

 “The math was really clear. I was impressed with how easy the math and steps involved were to understand.”

Student, Bradley University

 “The ‘Strategy & Discussion’ in each example were extremely helpful in understanding the ideas.”

Student, Houston  
Community College

 “The warning signs about many of the misconceptions, traps, and common mistakes is a very helpful and novel idea. Those of us who have taught undergraduate students in service courses have spent considerable time on these. It is good to see them in a book.”

Dr. H. R. Chandrasekhar,  
University of Missouri,  
Columbia

An important problem-solving skill that many students lack is the ability to extract information from a graph or to sketch a graph without plotting individual data points. Graphs often help students visualize physical relationships more clearly than they can do with algebra alone. We emphasize the use of graphs and sketches in the text, in worked examples, and in the problems.

### Using Approximation, Estimation, and Proportional Reasoning

*Physics* is forthright about the constant use of simplified models and approximations in solving physics problems. One of the most difficult aspects of problem solving that students need to learn is that some kind of simplified model or approximation is usually required. We discuss how to know when it is reasonable to ignore friction or air resistance, treat  $g$  as constant, ignore viscosity, treat a charged object as a point charge, or ignore diffraction. A brief discussion of air resistance and terminal velocity in Chapter 4 enables us to discuss when it is reasonable to ignore air resistance—and also to show students that physics can account for these other effects.

Some Examples and Problems require the student to make an estimate—a useful skill both in physics problem solving and in many other fields. Similarly, we teach proportional reasoning as not only an elegant shortcut but also as a means to understanding patterns. We frequently use percentages and ratios to give students practice in using and understanding them.

“I use proportional reasoning all the time in my class, but have never seen a textbook that does it consistently. This is great! I also think that the student should understand that everything in physics is a model and is most likely an approximation at some level. The authors recognize this and consistently make this a part of the text. I really appreciate these two aspects of this book.”

Dr. Michael G. Strauss,  
University of Oklahoma



“I have tried a number of texts in this course over the past 30 years that I have taught *Physics* 116–117, and I can assure you that *G/R/R* is the one I (and the students . . .) like the best. The explanations are clear, and the graphics are excellent—the best I have seen anywhere. And the structure of the question and problem sets is very good. *G/R/R* is the best standard algebra-based text I have ever seen.”

Dr. Carey E. Stronach,  
Virginia State University

### Showcasing an Innovative Art Program

To help show that physics is more than a collection of principles that explain a set of contrived problems, in every chapter we have developed several innovative **Showcase Illustrations** to bring to life the connections between physics concepts and the complex ways in which they are applied. We believe these illustrations, with subjects ranging from three-dimensional views of electric field lines to the biomechanics of the human body and from representations of waves to the distribution of electricity in the home, will help students see the power and beauty of physics. A panel of experienced instructors advised us on how to revise illustrations to make them clearer and more useful. The panel also suggested where to add graphs, diagrams, simpler sketches, and free-body diagrams to enhance the text discussions and examples, with emphasis on simpler sketches and free-body diagrams similar to those that students should draw on their own homework or exams.

### Helping Students See the Relevance of Physics in Their Lives

Students in an introductory college physics course have a wide range of backgrounds and interests. We stimulate interest in physics by relating the principles to applications relevant to students’ lives and in line with their interests. The text, examples, and end-of-chapter problems draw from the everyday world; from familiar technological applications; and from other fields such as biology, medicine, archaeology, astronomy, sports, environmental science, and geophysics. (Applications in the text are marked with an icon in the margin  for applications in the biological or medical sciences and  for other applications.)

The **Physics at Home** experiments give students an opportunity to explore and see physics principles operate in their everyday lives. These activities are chosen for their simplicity and for the effective demonstration of physics principles.

Each **Chapter Opener** includes a photo and vignette, designed to capture student interest and maintain it through the chapter. The vignette describes the situation shown in the photo and asks the student to consider the relevant physics. A reduced version of the chapter opener photo marks where the question from the vignette is answered within the chapter.

### Instructor’s Resource Guide

The Instructor’s Resource Guide includes many unique assets for instructors, such as demonstrations, suggested reform ideas from physics education research, and ideas for incorporating just-in-time teaching techniques. It also includes answers to the end-of-chapter conceptual questions and complete, worked-out solutions for all the end-of-chapter problems from the text.