preface

The satisfaction of understanding how rainbows are formed, how ice skaters spin, or why ocean tides roll in and out—phenomena that we have all seen or experienced—is one of the best motivators available for building scientific literacy. This book attempts to make that sense of satisfaction accessible to non-science majors. Intended for use in a one-semester or two-quarter course in conceptual physics, this book is written in a narrative style, frequently using questions designed to draw the reader into a dialogue about the ideas of physics. This inclusive style allows the book to be used by anyone interested in exploring the nature of physics and explanations of everyday physical phenomena.

> *"[Griffith and Brosing] incorporated changes recommended by physics education research, such as multiple representations, connections to real life, etc. . . . This book is beyond a typical general education class level, yet does not start beyond my students. It supports my students' growth in understanding when combined with the inquiry activities."*
>
> —Beth Basista,
> Wright State University

How This Book Is Organized

With the exception of the reorganization of chapters 15, 16, and 17 introduced in the fourth edition, we have retained the same order of topics as in the previous editions. It is traditional with some minor variations. The chapter on energy (chapter 6) appears prior to that on momentum (chapter 7) so that energy ideas can be used in the discussion of collisions. Wave motion is found in chapter 15, following electricity and magnetism and prior to chapters 16 and 17 on optics. The chapter on fluids (chapter 9) follows mechanics and leads into the chapters on thermodynamics. The first 17 chapters are designed to introduce students to the major ideas of classical physics and can be covered in a one-semester course with some judicious paring.

The complete 21 chapters could easily support a two-quarter course, and even a two-semester course in which the ideas are treated thoroughly and carefully. Chapters 18 and 19, on atomic and nuclear phenomena, are considered essential by many instructors, even in a one-semester course. If included in such a course, we recommend curtailing coverage in other areas to avoid student overload. Sample syllabi for these different types of courses can be found in the Instructor Center of the companion website.

Some instructors would prefer to put chapter 20 on relativity at the end of the mechanics section or just prior to the modern physics material. Relativity has little to do with everyday phenomena, of course, but is included because of the high interest that it generally holds for students. The final chapter (21) introduces a variety of topics in modern physics—including particle physics, cosmology, semiconductors, and superconductivity—that could be used to stimulate interest at various points in a course.

One plea to instructors, as well as to students using this book: Don't try to cram too much material into too short a time! We have worked diligently to keep this book to a reasonable length while still covering the core concepts usually found in an introduction to physics. These ideas are most enjoyable when enough time is spent in lively discussion and in consideration of questions so that a real understanding develops. Trying to cover material too quickly defeats the conceptual learning and leaves students in a dense haze of words and definitions. Less can be more if a good understanding results.

Mathematics in a Conceptual Physics Course

The use of mathematics in a physics course is a formidable block for many students, particularly non-science majors. Although there have been attempts to teach conceptual physics without any mathematics, these attempts miss an opportunity to help students gain confidence in using and manipulating simple quantitative relationships.

Clearly mathematics is a powerful tool for expressing the quantitative relationships of physics. The use of mathematics can be carefully limited, however, and subordinated to the physical concepts being addressed. Many users of the first edition of this text felt that mathematical expressions appeared too frequently for the comfort of some students. In response, we substantially reduced the use of mathematics in the body of the text in the second edition. Most users have indicated that the current level is about right, so we have not changed the mathematics level in subsequent editions.

> *"The Griffith/Brosing text is right on target for the needs of my students. It uses an appropriate and technically accurate level of vocabulary. The problem sets at the ends of each chapter have pertinent question and exercises to let the student explore the concepts covered in class in more depth. The in-text examples are provided in just the right spots [so] that the students can cement their understanding."*
>
> —Robert Gist,
> The University of Colorado - Colorado Springs

Logical coherence is a strong feature of this book. Formulas are introduced carefully after conceptual arguments are provided, and statements in words of these relationships generally accompany their introduction. We have continued to fine tune the example boxes that present sample exercises and questions. Most of these provide simple numerical illustrations of the ideas discussed. No mathematics prerequisite beyond high school algebra should be necessary. A discussion of the basic ideas of very simple algebra is found in appendix A, together with some practice exercises, for students who need help with these ideas.

New to This Edition

We have made several significant changes to the eighth edition. As the book has evolved, however, we have tried to remain faithful to the principles that have guided the writing of the book from the outset. One of these has been to keep the book to a manageable length, in both the number of chapters and the overall content. Many books become bloated as users and reviewers request more and more pet topics. We have tried to add material judiciously and have pared material elsewhere so that the overall length of the book has not changed.

As many of you may realize, creating clear, meaningful conceptual questions is difficult and we are proud of the many conceptual questions we have developed. We consistently get praise from reviewers and users alike about the value of these questions. Thus we have not changed the conceptual questions with this edition, but we have added nine new ones at the ends of chapters 2, 4, 12, and 19.

Several reviewers have asked over the years that we change the numbers in the exercises so that students are not just copying the answers from their friends whom took the class the year before. Several other reviewers have asked that we not change the numbers in the exercises as they have built up solutions that they don't want to revise. We have compromised and changed the numbers in 137 of the even numbered exercises and 27 synthesis problems at the end of the chapters. We have kept the numbers the same in all the odd numbered ones (and those answers appear in Appendix D).

The example boxes have been praised by many users. As many of the students whom use this book are somewhat math phobic, we strive to make the example boxes helpful and clear. Every edition we make improvements in these boxes, and we have not only improved several for this edition, but also added three new ones. We have expanded example box 3.3 to help students understand how to interpret their answers when a ball is thrown up and then comes back down below the starting point. We have also expanded the first example box in chapter 9 so the computation of the area is clearer, and we have updated example box 9.2 so that it now deals with a scuba diver. We have added two new example boxes in this chapter, one dealing with applying Archimedes' Principle, and one with the continuity equation. In chapter 11, example box 11.2 has been expanded to discuss work and efficiency of a steam engine. In chapter 17, a new example box has been added dealing with a real image and negative magnification.

The everyday phenomenon boxes are a way to help students see the connections between the physics they are learning and the everyday world. We have replaced the everyday phenomenon box 19.2 that was about the nuclear accident at Chernobyl with the more recent (2011) disaster in Japan, when the nuclear reactors at Fukushima were impacted by the tsunami.

In addition to these specific changes, we have updated the photos and diagrams for a more modern look. We have also revised the text in many places to enhance understanding of some of the more difficult concepts.

Building an Energy Emphasis. Although this book remains a basic conceptual physics text, we are working to make the book better serve instructors who want to teach a conceptual physics course with an energy emphasis. A syllabus for instructors wishing to teach a course with an energy emphasis can be found on the companion website. We plan to continue building this emphasis in future editions.

Continued Refinements in Artwork and Textual Clarity. Although the textual clarity of this text has been extensively praised by many reviewers and users, it can always be improved. Reviewers continue to point out places where either the art or the text can be improved, and we have responded to many of these suggestions. To this end, we have made many changes, often subtle, to both the art and the text.

Digital Learning Tools

Connect Physics

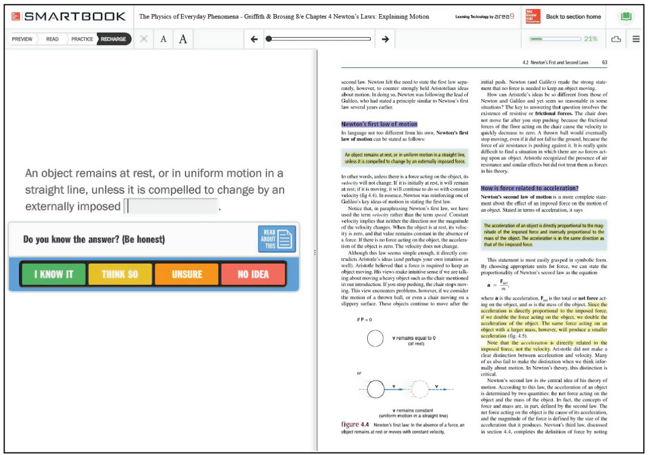
McGraw-Hill Connect® Physics provides online presentation, assignment, and assessment solutions. Questions and activities are presented and aligned with the textbook's learning outcomes. Integrate reports easily with Learning Management Systems (LMS), such as WebCT and Blackboard–and much more. ConnectPlus® Physics provides students with all the advantages of Connect Engineering, plus 24/7 online access to an adaptive eBook. www.mcgrawhillconnect.com.

LearnSmart

McGraw-Hill LearnSmart® is available as a standalone product or an integrated feature of McGraw-Hill Connect Engineering. It is an adaptive learning system designed to help students learn faster, study more efficiently, and retain more knowledge for greater success. LearnSmart assesses a student's knowledge of course content through a series of adaptive questions. It pinpoints concepts the student does not understand and maps out a personalized study plan for success. This innovative study tool also has features that allow instructors to see exactly what students have accomplished and a built-in assessment tool for graded assignments. See www.mhlearnsmart.com.

SmartBook

Powered by the intelligent and adaptive LearnSmart engine, SmartBook™ is the first and only continuously adaptive reading experience available today. Distinguishing what students know from what they don't, and honing in on concepts they are most likely to forget, SmartBook personalizes content for each student. Reading is no longer a passive and linear experience but an engaging and dynamic one, where students are more likely to master and retain important concepts, coming to class better prepared. www.mhlearnsmart.com.



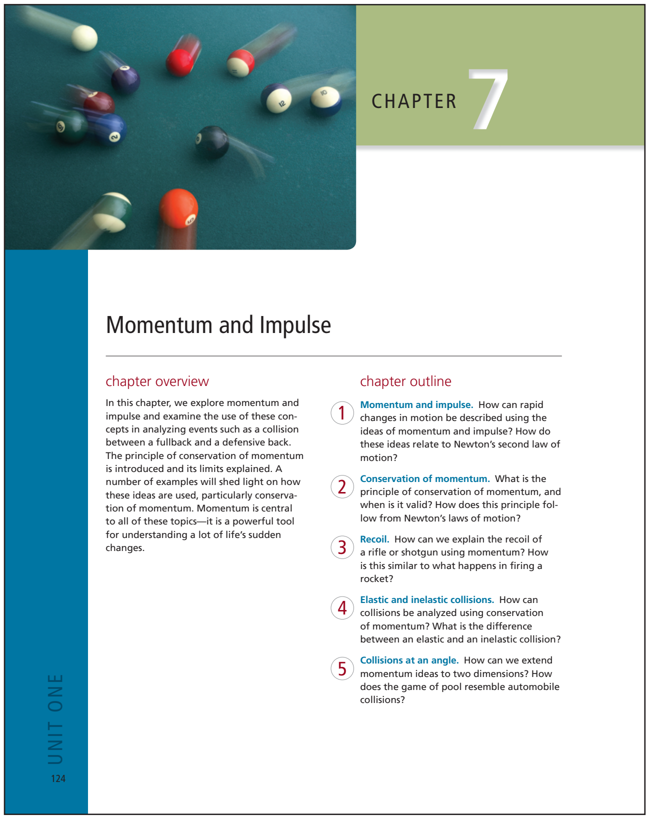
Learning Aids

The overriding theme of this book is to introduce physical concepts by appealing to everyday phenomena whenever possible. To achieve this goal, this text includes a variety of features to make the study of *The Physics of Everyday Phenomena* more effective and enjoyable. A few key concepts form the basis for understanding physics, and the textual features described here reinforce this structure so that the reader will not be lost in a flurry of definitions and formulas.

> *"The text presents a good conceptual overview of physics, but also includes some basic mathematical models for added depth. The discussion is conversational and detailed without being too technical."*
>
> —Paul Haar,
> Southeast Community College

Chapter Openers

Each chapter begins with an illustration from everyday experience and then proceeds to use it as a theme for introducing relevant physical concepts. Physics can seem abstract to many students, but using everyday phenomena and concrete examples reduces that abstractness. The chapter **overview** previews the chapter's contents and what students can expect to learn from reading the chapter. The overview introduces the concepts to be covered, facilitating the integration of topics, and helping students to stay focused and organized while reading the chapter for the first time. The



chapter **outline** includes all the major topic headings within the body of the chapter. It also contains questions that provide students with a guide of what they will be expected to know in order to comprehend the major concepts of the chapter. (These questions are then correlated to the end-of-chapter summaries.)

> *"Each section and each chapter has a clearly delineated introduction and summary, exemplifying the pedagogy of 'tell them what you're about to teach, teach it, then tell them what you taught.' . . .The in-text examples are well placed and supported with description and calculation."*
>
> —Robert Gist,
> University of Colorado - Colorado Springs

The chapter outlines, questions, and summaries provide a clear framework for the ideas discussed in each chapter. One of the difficulties that students have in learning physics (or any subject) is that they fail to construct the big picture of how things fit together. A consistent chapter framework can be a powerful tool in helping students see how ideas mesh.

Other Text Features

Running summary paragraphs are found at the end of each chapter section to supplement the more general summary at the end of the chapter.

> Acceleration is the rate of change of velocity and is found by dividing the change in the velocity by the time required to produce that change. Any change in velocity involves an acceleration, whether an increase or a decrease in speed, or a change in direction. Acceleration is a vector having a direction corresponding to the direction of the change in velocity, which is not necessarily the same direction as the instantaneous velocity itself. The concept of change is crucial. The graphical representations in section 2.4 will help you visualize changes in velocity as well as in other quantities.
>
> *See clicker questions 2.4 to 2.6 on the instructor website.*

Subsection headings are often cast in the form of questions to motivate the reader and pique curiosity.

> **What is the difference between speed and velocity?**
>
> Imagine that you are driving a car around a curve (as illustrated in figure 2.5) and that you maintain a constant speed of 60 km/h. Is your velocity also constant in this case? The answer is no, because **velocity** involves the direction of motion as well as how fast the object is going. The direction of motion is changing as the car goes around the curve.

Everyday phenomenon boxes relate physical concepts discussed in the text to real-world topics, societal issues, and modern technology, underscoring the relevance of physics and how it relates to our day-to-day lives. The list of topics includes

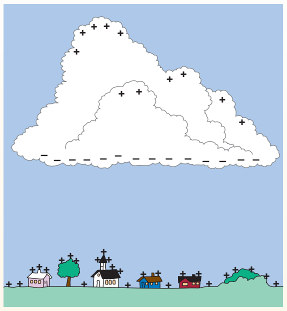
- The Case of the Malfunctioning Coffee Pot (chapter 1)
- Transitions in Traffic Flow (chapter 2)
- The 100-m Dash (chapter 2)
- Reaction Time (chapter 3)
- Shooting a Basketball (chapter 3)
- The Tablecloth Trick (chapter 4)
- Riding an Elevator (chapter 4)
- Seat Belts, Air Bags, and Accident Dynamics (chapter 5)
- Explaining the Tides (chapter 5)
- Conservation of Energy (chapter 6)
- Energy and the Pole Vault (chapter 6)
- The Egg Toss (chapter 7)
- An Automobile Collision (chapter 7)
- Achieving the State of Yo (chapter 8)
- Bicycle Gears (chapter 8)
- Measuring Blood Pressure (chapter 9)
- Throwing a Curveball (chapter 9)
- Heat Packs (chapter 10)
- Solar Collectors and the Greenhouse Effect (chapter 10)
- Hybrid Automobile Engines (chapter 11)
- A Productive Pond (chapter 11)
- Cleaning Up the Smoke (chapter 12)
- Lightning (chapter 12)
- Electrical Impulses in Nerve Cells (chapter 13)
- The Hidden Switch in Your Toaster (chapter 13)
- Direct-Current Motors (chapter 14)
- Vehicle Sensors at Traffic Lights (chapter 14)
- Electric Power from Waves (chapter 15)
- A Moving Car Horn and the Doppler Effect (chapter 15)
- Why Is the Sky Blue? (chapter 16)
- Antireflection Coatings on Eyeglasses (chapter 16)
- Rainbows (chapter 17)
- Laser Refractive Surgery (chapter 17)
- Fuel Cells and the Hydrogen Economy (chapter 18)
- Electrons and Television (chapter 18)
- Smoke Detectors (chapter 19)
- What Happened at Fukushima? (chapter 19)
- The Twin Paradox (chapter 20)
- Holograms (chapter 21)

everyday phenomenon box 12.2

Lightning

The Situation. We have all observed the awe-inspiring beauty and power of a good electrical storm. The flashes of lightning, followed at varying time intervals by claps of thunder, can be both fascinating and frightening. What is lightning? How are thunderclouds capable of producing the impressive electrical discharges that we see? What happens in an electrical storm?

Flashes of lightning illuminate the area. What is lightning, and how is it produced?



The charge distribution within a thundercloud induces a positive charge on objects on the Earth directly below the cloud.

The Analysis. Most thunderclouds generate a separation of charge within the cloud that produces a net positive charge near the top of the cloud and a net negative charge near the bottom. Highly turbulent convection taking place in the cloud separates and transports the charge: thunderclouds consist of rapidly rising and falling columns of air and water, with cells of rising air often being found next to cells of falling air and water.

The charge separation within a thundercloud produces strong electric fields in the cloud as well as between the cloud and the earth. Since moist soil is a reasonably good conductor of electricity, a positive charge is induced on the surface of the Earth below the cloud because of the negative charge on the bottom of the cloud.

The electric field generated by this charge distribution (pictured in the drawing) can be several thousand volts per meter. Since the base of the cloud usually floats several hundred meters above the Earth's surface, the potential difference between the cloud's base and the Earth can easily be several million volts! (Even during fair weather, there is an electric field

Study hints and **study suggestions** provide students with pointers on their use of the textbook, tips on applying the principles of physical concepts, and suggestions for home experiments.

study hint

If you have the materials handy, you should try the battery-and-bulb experiment before reading further. The delight of figuring out how to get the bulb to light is something not to be spoiled by reading on prematurely. Once you get it to light (without, we hope, killing the battery), you may wish to experiment with other configurations and try to understand what distinguishes working arrangements from non-working ones. Experimenting will help to make the concept of a circuit more vivid.

Example boxes are included within the chapter and contain one or more concrete, worked examples of a problem and its solution as it applies to the topic at hand. Through careful study of these examples, students can better appreciate the many uses of problem solving in physics.

example box 2.4

Sample Exercise: Uniform Acceleration

A car traveling due east with an initial velocity of 10 m/s accelerates for 6 seconds at a constant rate of 4 m/s^2.

a. What is its velocity at the end of this time?
b. How far does it travel during this time?

a. $v_0 = 10$ m/s

$a = 4$ m/s^2

$t = 6$ s

$v = ?$

$v = v_0 + at$

$= 10$ m/s $+ (4$ m/s$^2) (6$ s$)$

$= 10$ m/s $+ 24$ m/s

$= \mathbf{34}$ **m/s**

v = 34 m/s due east

Debatable Issues provide open-ended, opinion questions on–but not limited to–energy and environmental issues to be used as class discussion, as writing assignments, and/or for internet forums. Notes on discussion ideas and results are included in the instructor's manual.

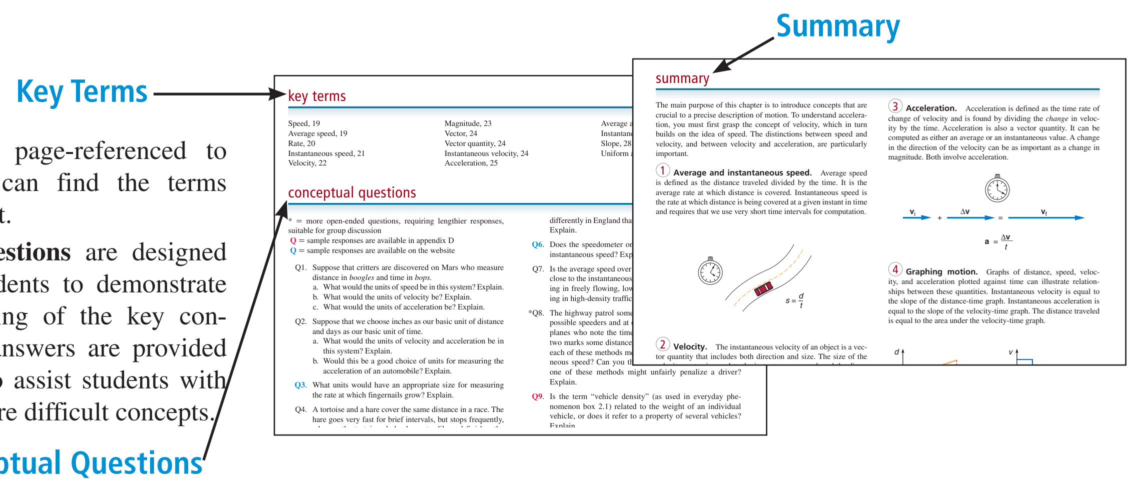
debatable issue

Some people believe that the moon landing in 1969 was just an elaborate hoax. Is this a reasonable belief? What evidence or arguments could you use to counter this claim?

End-of-Chapter Features

- The **summary** highlights the key elements of the chapter and correlates to the questions asked about the chapter's major concepts in the chapter opener.

- **Key terms** are page-referenced to where students can find the terms defined in context.
- **Conceptual Questions** are designed to challenge students to demonstrate their understanding of the key concepts. Selected answers are provided in appendix D to assist students with their study of more difficult concepts.



key terms

Speed, 19
Average speed, 19
Rate, 20
Instantaneous speed, 21
Velocity, 22
Magnitude, 23
Vector, 24
Vector quantity, 24
Instantaneous velocity, 24
Acceleration, 25
Slope, 28

conceptual questions

* = more open-ended questions, requiring lengthier responses, suitable for group discussion
Q = sample responses are available in appendix D
Q = sample responses are available on the website

Q1. Suppose that critters are discovered on Mars who measure distance in *boogles* and time in *bops*.
a. What would the units of speed be in this system? Explain.
b. What would the units of velocity be? Explain.
c. What would the units of acceleration be? Explain.

Q2. Suppose that we choose inches as our basic unit of distance and days as our basic unit of time.
a. What would the units of velocity and acceleration be in this system? Explain.
b. Would this be a good choice of units for measuring the acceleration of an automobile? Explain.

Q3. What units would have an appropriate size for measuring the rate at which fingernails grow? Explain.

Q4. A tortoise and a hare cover the same distance in a race. The hare goes very fast for brief intervals, but stops frequently,

Q9. Is the term "vehicle density" (as used in everyday phenomenon box 2.1) related to the weight of an individual vehicle, or does it refer to a property of several vehicles?

summary

The main purpose of this chapter is to introduce concepts that are crucial to a precise description of motion. To understand acceleration, you must first grasp the concept of velocity, which in turn builds on the idea of speed. The distinctions between speed and velocity, and between velocity and acceleration, are particularly important.

1 **Average and instantaneous speed.** Average speed is defined as the distance traveled divided by the time. It is the average rate at which distance is covered. Instantaneous speed is the rate at which distance is being covered at a given instant in time and requires that we use very short time intervals for computation.

$s = \frac{d}{t}$

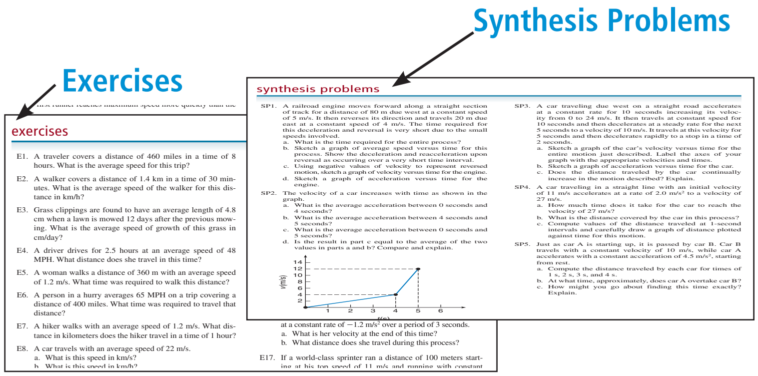
2 **Velocity.** The instantaneous velocity of an object is a vector quantity that includes both direction and size. The size of the

3 **Acceleration.** Acceleration is defined as the time rate of change of velocity and is found by dividing the *change* in velocity by the time. Acceleration is also a vector quantity. It can be computed as either an average or an instantaneous value. A change in the direction of the velocity can be as important as a change in magnitude. Both involve acceleration.

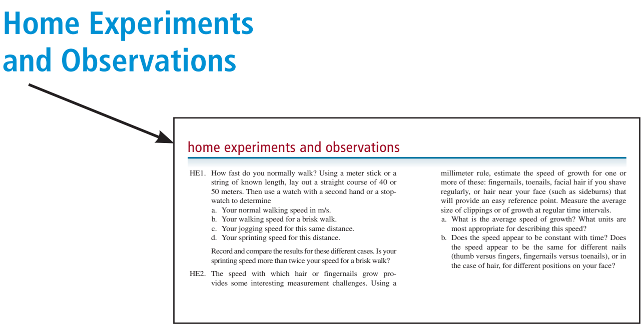
$\mathbf{a} = \frac{\Delta \mathbf{v}}{t}$

4 **Graphing motion.** Graphs of distance, speed, velocity, and acceleration plotted against time can illustrate relationships between these quantities. Instantaneous velocity is equal to the slope of the distance-time graph. Instantaneous acceleration is equal to the slope of the velocity-time graph. The distance traveled is equal to the area under the velocity-time graph.

- **Exercises** and **synthesis problems** are intended to help students test their grasp of problem solving. The odd-numbered exercises have answers in appendix D. By working through the odd-numbered exercises and checking the answers in appendix D, students can gain confidence in tackling the even-numbered exercises, and thus reinforce their problem-solving skills.



- Because many courses for non-science majors do not have a laboratory component, **home experiments and observations** are found at the end of each chapter. The spirit of these home experiments is to enable students to explore the behavior of physical phenomena using easily available rulers, string, paper clips, balls, toy cars, flashlight batteries, and so on. Many instructors have found them useful for putting students into the exploratory and observational frame of mind that is important to scientific thinking. This is certainly one of our objectives in developing scientific literacy.



> *"The selection of problems and questions at the end of each chapter is excellent. They provide students with a comprehensive review of the chapters and at the same time present challenges to reinforce the concepts. . . . Many students taking an introductory physics course do not have a chance to take a lab component with the course. The home experiments can go a long way toward addressing this deficiency."*
>
> —Farhang Amiri,
> Weber State University

Supplements

Text Website

A text-specific website provides students with useful study tools designed to help improve their understanding of the material presented in the text and class. For the instructor, the website is designed to help ease the time burdens of the course by providing valuable presentation and preparation tools.

For Students

Student Study Guide Integration
- Mastery Quiz
- Know
- Understand
- Study Hints
- Practice Problems
- Answers to Selected Questions

Animations
Crossword Puzzles
Links Library
Chapter Summary
Chapter Objectives

For Instructors

All Student Content
PowerPoint Lectures
Instructor's Manual
Sample Syllabi
Clicker Questions
PowerPoints of Art and Photos from the Text
Test Bank
Formula Summaries

Personal Response Systems

Personal Response Systems can bring interactivity into the classroom or lecture hall. Wireless response systems such as Poll Everywhere give the instructor and students immediate feedback from the entire class. Poll Everywhere allows students can use their computer, smartphone, tablet, or text message device to respond to questions. Instructors are able to motivate student preparation, interactivity, and active learning, receiving immediate feedback to gauge which concepts students understand. Questions covering the content of *The Physics of Everyday Phenomena* text are formatted in PowerPoint and are available on the text website for use with any personal response system.

Computerized Test Bank Online

A comprehensive bank of test questions is provided on the text website within a computerized test bank powered by McGraw-Hill's flexible electronic testing program EZ Test Online (www.eztestonline.com). EZ Test Online allows you to create paper and online tests or quizzes in this easy-to-use program!

Imagine being able to create and access your test or quiz anywhere, at any time, without installing the testing software. Now, with EZ Test Online, instructors can select questions from multiple McGraw-Hill test banks, or author their own, and then either print the test for paper distribution or give it online.

CourseSmart

This text is available as an eBook at www.CourseSmart.com. At CourseSmart your students can take advantage of significant savings off the cost of a print textbook, reduce their impact on the environment, and gain access to powerful web tools for learning. CourseSmart eBooks can be viewed online or downloaded to a computer. The eBooks allow students to do full text searches, add highlighting and notes, and share notes with classmates. CourseSmart has the largest selection of eBooks available anywhere. Visit www.CourseSmart.com to learn more and to try a sample chapter.

Acknowledgments

A large number of people have contributed to this eighth edition, either directly or indirectly. We extend particular thanks to those who participated in reviews of the seventh edition. Their thoughtful suggestions have had direct impact upon the clarity and accuracy of this edition, even when it was not possible to fully incorporate all of their ideas due to space limitations or other constraints. We also thank the contributors of the eighth edition supplements: Edward Ackad, Robert Gist, and Alberto Pinkas.

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