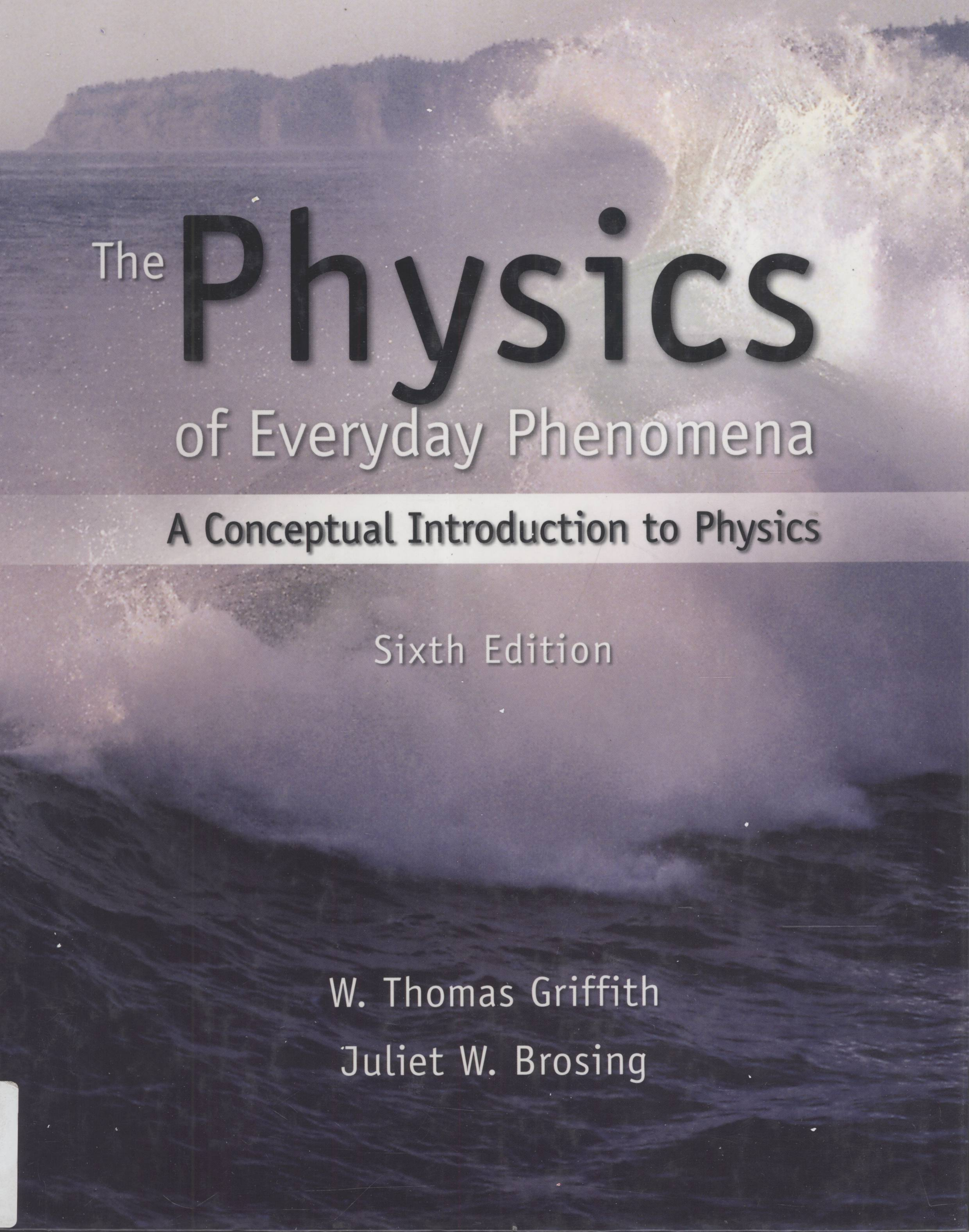
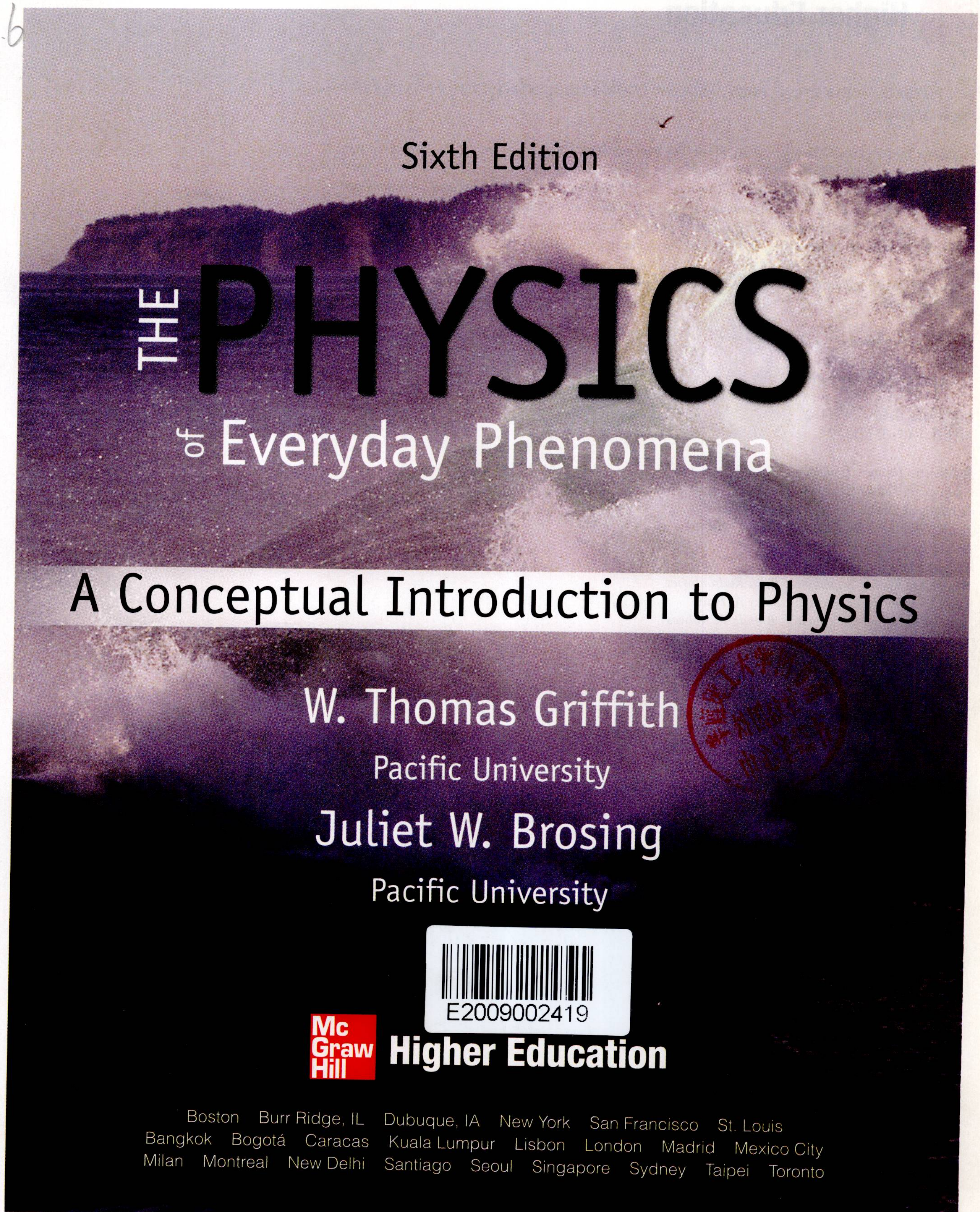


The Physics of Everyday Phenomena

A Conceptual Introduction to Physics

Sixth Edition

W. Thomas Griffith
Juliet W. Brosing



Sixth Edition

THE PHYSICS of Everyday Phenomena

A Conceptual Introduction to Physics

W. Thomas Griffith
Pacific University
Juliet W. Brosing
Pacific University

Mc Graw Hill Higher Education

Boston Burr Ridge, IL Dubuque, IA New York San Francisco St. Louis
Bangkok Bogotá Caracas Kuala Lumpur Lisbon London Madrid Mexico City
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THE PHYSICS OF EVERYDAY PHENOMENA: A CONCEPTUAL INTRODUCTION TO PHYSICS, SIXTH EDITION

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Conversion Factors

LENGTH
1 in = 2.54 cm
1 cm = 0.394 in
1 ft = 30.5 cm
1 m = 39.4 in = 3.281 ft
1 km = 0.621 mi
1 mi = 5280 ft = 1.609 km
1 light-year = 9.461×10^{15} m

MASS AND WEIGHT
1 lb ⇒ 0.4536 kg (where $g = 9.80$ m/sec^2)
1 kg ⇒ 2.205 lb (where $g = 9.80$ m/sec^2)
1 atomic mass unit (u) = 1.66061×10^{-27} kg

VOLUME
1 liter = 1.057 quarts = 0.2643 gallons
1 in^3 = 16.4 cm^3
1 gallon = 3.786 liter
1 ft^3 = 2.832×10^{-2} m^3

ENERGY AND POWER
1 cal = 4.186 J
1 J = 0.239 cal
1 kWhr = 3.60×10^6 J = 860 cal
1 hp = 746 W
1 J = 6.24×10^{18} eV
1 eV = 1.6022×10^{-19} J

TEMPERATURE
Absolute zero (0 K) = –273.15° C

SPEED
1 km/hr = 0.278 m/sec = 0.621 MPH
1 m/sec = 3.60 km/hr = 2.237 MPH = 3.281 ft/sec
1 MPH = 1.609 km/hr = 0.447 m/sec = 1.47 ft/sec
1 ft/sec = 0.305 m/sec = 0.682 MPH

FORCE
1 N = 0.2248 lb
1 lb = 4.448 N

PRESSURE
1 atm = 1.013 bar = 1.013×10^5 N/m^2 = 14.7 lb/in^2
1 lb/in^2 = 6.90×10^3 N/m^2
1 Pa = 1 N/m^2

ANGLE
1 rad = 57.30°
1° = 0.01745 rad
1 rev = 360° = 2π rad

METRIC PREFIXES

Prefix	Symbol	Meaning
Giga-	G	1 000 000 000 times the unit
Mega-	M	1 000 000 times the unit
Kilo-	k	1 000 times the unit
Hecto-	h	100 times the unit
Deka-	da	10 times the unit
Base Unit		
Deci-	d	0.1 of the unit
Centi-	c	0.01 of the unit
Milli-	m	0.001 of the unit
Micro-	μ	0.000 001 of the unit
Nano-	n	0.000 000 001 of the unit

PHYSICAL CONSTANTS AND DATA

Quantity	Approximate Value
Acceleration of gravity (near the earth's surface)	$g = 9.80$ m/sec^2
Gravitational law constant	$G = 6.67 \times 10^{-11}$ N · m^2/kg^2
Earth radius (mean)	6.38×10^6 m
Earth mass	5.98×10^{24} kg
Earth-sun distance (mean)	1.50×10^{11} m
Earth-moon distance (mean)	3.84×10^8 m
Fundamental charge	$e = 1.60 \times 10^{-19}$ C
Coulomb law constant	$k = 9.00 \times 10^9$ N · m^2/C^2
Electron rest mass	9.11×10^{-31} kg
Proton rest mass	1.6726×10^{-27} kg
Neutron rest mass	1.6750×10^{-27} kg
Bohr radius	5.29×10^{-11} m
Avogadro's number	6.02×10^{23}/mole
Boltzmann's constant	1.38×10^{-23} J/K
Planck's constant	6.626×10^{-34} J · s
Speed of light (vacuum)	3.00×10^8 m/s

MATHEMATICAL CONSTANTS AND FORMULAS

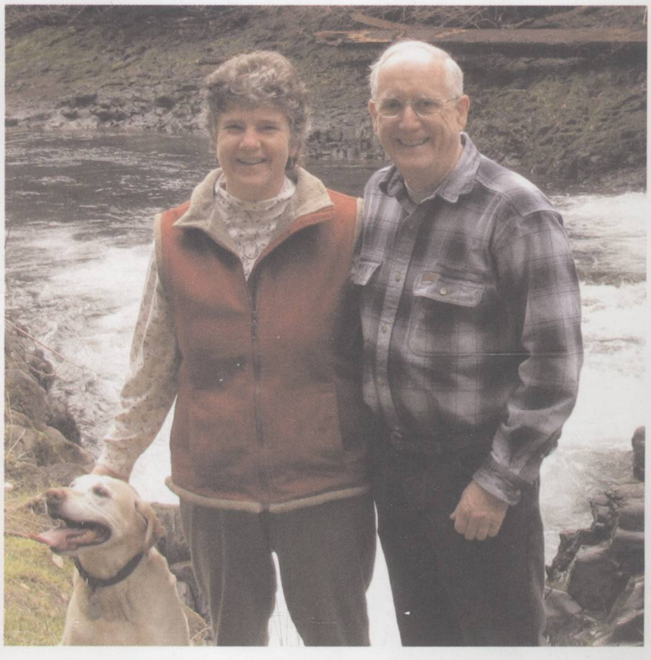
Pi	3.1416
Area of circle	πr^2
Circumference of circle	$2\pi r$
Area of sphere	$4\pi r^2$
Volume of sphere	$4/3\ \pi r^3$

about the authors

Tom Griffith is now Distinguished University Professor Emeritus at Pacific University in Forest Grove, Oregon, having recently retired after 36 years of teaching physics at Pacific. His continued interests in teaching and research mean that he can still be spotted about the halls of the science building or library, and he makes occasional guest appearances with his guitar in physics courses. Over the years he has also enjoyed hiking, bicycling, singing, reading, and performing in stage plays and musical comedies. During his years at Pacific, he has served as Physics Department Chair, Science Division Chair, Interim Dean of Enrollment Management, and Director of Institutional Research among other things, but his primary focus has always been teaching. He has been active in the Oregon Section of the American Association of Physics Teachers (AAPT) and the Pacific Northwest Association for College Physics (PNACP).

Juliet Brosing is a Professor of Physics at Pacific University in Forest Grove, Oregon, and has taught there for the past 20 years. Her research interests include nuclear physics, medical physics, and the application of teaching methods grounded in physics educational research. She helped run a summer science camp for 7th and 8th grade girls for ten years (as director for six). She is on the Reactor Operations Committee for the Reed Nuclear Reactor in Portland and often takes her students there for field trips. She is also the proud owner of three potato guns; therefore, parties with students at her home usually involve projectiles and noise. She remains active in both the state and national American Association of Physics Teachers (AAPT) and the Pacific Northwest Association for College Physics (PNACP). Above all, Dr. Brosing is dedicated to teaching pyhsics with a positive outlook and the use of methods that encourage and benefit her students, regardless of their chosen field of study.

The author and his wife, Adelia, hiking in the mountains of Oregon.



The author, Juliet Brosing, and her husband Keith LeComte at the Tualatin River near their home in Cherry Grove, Oregon.

Periodic Table of the Elements

24 — Atomic number
Cr
52.00 — Atomic mass

1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8	9 8B	10	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 **H** 1.008																	2 **He** 4.003
3 **Li** 6.941	4 **Be** 9.012											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.88	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.39	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57 **La** 138.9	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.9	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (210)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 **Ac** (227)	104 **Rf** (257)	105 **Db** (260)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs** (265)	109 **Mt** (266)	110	111	112	(113)	114	(115)	(116)	(117)	(118)

58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (147)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
90 **Th** 232.0	91 **Pa** (231)	92 **U** 238.0	93 **Np** (237)	94 **Pu** (242)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (249)	99 **Es** (254)	100 **Fm** (253)	101 **Md** (256)	102 **No** (254)	103 **Lr** (257)

Metals

Metalloids

Nonmetals

The 1–18 group designation has been recommended by the International Union of Pure and Applied Chemistry (IUPAC) but is not yet in wide use. No names have been assigned for elements 110–112 and 114. Elements 113 and 115–118 have not yet been synthesized.

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 has done a very respectable job in presenting his conceptual physics course in a clear, useable fashion. It is a fine work that is evidently quickly evolving into a top-notch textbook."*
>
> —Michael Bretz,
> University of Michigan

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 on the Instructor Center of the Online Learning Center.

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 level of presentation is pitch-perfect for a college physics course. I happen to have a need for a book at just this level, compromising between a math-free conceptual book and one that goes for the full college-level (but not university-level) treatment. The brevity of presentation also lends itself well to a one-semester survey course format."*
>
> —Brent Royuk,
> Concordia University

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 sixth 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, both in 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. The changes include the following:

1. **New Everyday Phenomenon Boxes.** We have added five new everyday phenomenon boxes to this edition. Three of these are related to energy issues designed to better support instructors interested in building an energy emphasis into their courses. The new boxes are:
   everyday phenomenon box 6.1 Conservation of Energy
   everyday phenomenon box 7.1 The Egg Toss
   everyday phenomenon box 12.1 Cleaning Up the Smoke
   everyday phenomenon box 15.1 Electric Power from Waves
   everyday phenomenon box 19.1 Smoke Detectors
2. **New Sample Exercises.** Many users have pointed out a need for more sample exercises in some chapters. We have added several new sample exercises in places where the need was apparent. Except for the first and the last chapter, most chapters now have three or four sample exercises.
3. **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. This is reflected in the new everyday phenomenon boxes, but also in other places within the body of the text. In the past few editions, we have added everyday phenomenon boxes on fuel cells and hybrid automobiles, and boxes on solar collectors and nuclear reactors were already included. We have enhanced the discussion of the greenhouse effect in everyday phenomenon box 10.1. A syllabus for instructors wishing to teach a course with an energy emphasis can be found on the Instructor Center of the text website. We plan to continue building this emphasis in future editions.
4. **New Home Experiments.** We have added several new home experiments and have also added a few new synthesis problems. Many users have found these features to be very useful.
5. **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 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 text. More noticeable changes include an improved and simplified discussion of planetory motion and Kepler's Laws in chapter 5 and on updated discussion of integrated circuits in chapter 21.

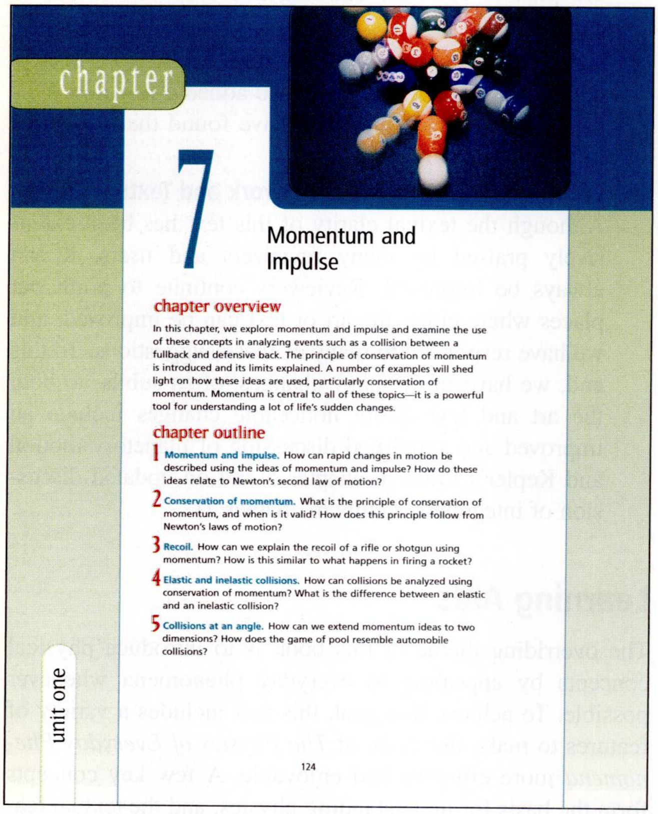
Learning Aids

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 presentation is outstanding: Clear, concise, not too complicated, not trivial either. The style is refreshing. Students are invited to think; they are not overwhelmed by complicated explanations. . . ."*
>
> —Klaus Rossberg,
> Oklahoma City University

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.)



chapter

7

Momentum and Impulse

chapter overview

In this chapter, we explore momentum and impulse and examine the use of these concepts in analyzing events such as a collision between a fullback and defensive back. The principle of conservation of momentum is introduced and its limits explained. A number of examples will shed light on how these ideas are used, particularly conservation of momentum. Momentum is central to all of these topics—it is a powerful tool for understanding a lot of life's sudden changes.

chapter outline

1 Momentum and impulse. How can rapid changes in motion be described using the ideas of momentum and impulse? How do these ideas relate to Newton's second law of motion?

2 Conservation of momentum. What is the principle of conservation of momentum, and when is it valid? How does this principle follow from Newton's laws of motion?

3 Recoil. How can we explain the recoil of a rifle or shotgun using momentum? How is this similar to what happens in firing a rocket?

4 Elastic and inelastic collisions. How can collisions be analyzed using conservation of momentum? What is the difference between an elastic and an inelastic collision?

5 Collisions at an angle. How can we extend momentum ideas to two dimensions? How does the game of pool resemble automobile collisions?

unit one

124

"Very good chapter overview and chapter outline for each chapter and for each unit. Very clear introduction and illustration of physics phenomena, concepts, and principles, and excellent exercises, problems, and home experiments/observations at the end of each chapter."

—Hai-Sheng Wu,
Minnesota State University, Mankato

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.

> Rotational displacement, rotational velocity, and rotational acceleration are the quantities that we need to fully describe the motion of a rotating object. They describe how far the object has rotated (rotational displacement), how fast it is rotating (rotational velocity), and the rate at which the rotation may be changing (rotational acceleration). These definitions are analogous to similar quantities used to describe linear motion. They tell us how the object is rotating, but not why. Causes of rotation are considered next.

"I found the liberal use of questions such as "Do you believe in atoms? And, if so, why?" to motivate the discussion to be outstanding. I also found the interwoven history used to guide the discussion to be excellent. I often use that approach myself. It usually leads to a natural flow of concepts and also informs the student how we know what we know, as well as giving them training in scientific thinking and showing them how science is done in real life. . . . Only someone who actively resisted understanding could fail to understand Griffith's text. He writes clearly, logically, and interestingly."

—Charles W. Rogers,
Southwestern Oklahoma
State University

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.

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

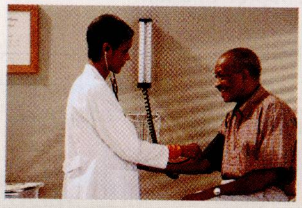
Visualizing these angular momentum vectors and their changes can be an abstract and difficult task. The effect will seem much more real if you can directly experience it. If a bicycle wheel mounted on a hand-held axle (such as that pictured in figure 8.23) is available, try the tilt effect yourself. Grasp the wheel with both hands by the handles on each side and have someone give it a good spin with the wheel in a vertical plane. Then try tilting the wheel downward to the left to simulate a fall. The wheel will seem to have a mind of its own and will turn to the left as suggested by figure 8.22.

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:

everyday phenomenon — box 9.1

Measuring Blood Pressure

The Situation. When you visit your doctor's office, the nurse will almost always take your blood pressure before the doctor spends time with you. A cuff is placed around your upper arm (as shown in the photograph) and air is pumped into the cuff, producing a feeling of tightness in your arm. Then the air is slowly released while the nurse listens to something with a stethoscope and records some numbers, such as 125 over 80.



Having your blood pressure measured is a standard procedure for most visits to a doctor's office. How does this process work?

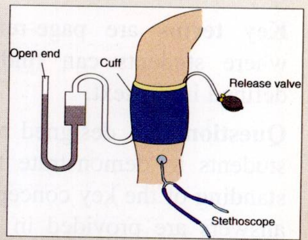
What is the significance of these two numbers? What is blood pressure and how is it measured? Why are these readings an important factor, along with your weight, temperature, and medical history, in assessing your health?

The Analysis. Your blood flows through an elaborate system of arteries and veins in your body. As we all know, this flow is driven by your heart, which is basically a pump. More accurately, the heart is a double pump. One-half pumps blood through your lungs, where the blood cells pick up oxygen and discard carbon dioxide. The other half of the heart pumps blood through the rest of your body to deliver oxygen and nutrients. Arteries carry blood away from the heart into small capillaries that interface with other cells in muscles and organs. The veins collect blood from the capillaries and carry it back to the heart.

We measure the blood pressure in a major artery in your upper arm at about the same height as your heart. When air is pumped into the cuff around your upper arm, it compresses this artery so that the blood flow stops. The nurse places the stethoscope, a listening device, near this same artery at a lower point in the arm and listens for the blood flow to restart as the air in the cuff is released.

The heart is a pulsating pump that pumps blood most strongly when the heart muscle is most fully compressed. The pressure therefore fluctuates between high and low values. The higher reading in the blood pressure measurement, the *systolic* pressure, is taken when the blood just begins to spurt through the compressed artery at the peak of the heart's cycle. The lower reading, the *diastolic* pressure, is taken when blood flow occurs even at the low point in the cycle. There are distinctive sounds picked up by the stethoscope at these two points.

The pressure recorded is actually the pressure in the air cuff for these two conditions. It is a *gauge* pressure, meaning that it is the pressure difference between the pressure being measured and atmospheric pressure. It is recorded in the units mm of mercury, which is the common way of recording atmospheric pressure. Thus a reading of 125 means that the pressure in the cuff is 125 mm of mercury *above* atmospheric pressure. A mercury manometer that is open to the air on one side (see the drawing) will measure gauge pressure directly.



An open-ended manometer can be used to measure the gauge pressure of the cuff. The stethoscope is used to listen for sounds indicating the restart of blood flow.

High blood pressure can be a symptom of many health problems, but most specifically, it is a warning sign for heart attacks and strokes. When arteries become constricted from the buildup of plaque deposits inside, the heart must work harder to pump blood through the body. Over time this can weaken the heart muscle. The other danger is that blood vessels might burst in the brain, causing a stroke, or blood clots might break loose and block smaller arteries in the heart or brain. In any case, high blood pressure is an important indicator of a potential problem.

Low blood pressure can also be a sign of problems. It can cause dizziness when not enough blood is reaching the brain. When you stand up quickly, you sometimes experience a feeling of "light-headedness" because it takes a brief time for the heart to adjust to the new condition where your head is higher. Giraffes have a blood pressure about three times higher than humans (in gauge pressure terms). Why do you suppose this is so?

"This book compared to others is simply interesting. Topics like physics of music and color perception really engaged me, even as I read most of the chapters in one sitting. It indeed does a good job at getting at everyday phenomena."

—Tim Bolton,
Kansas State University

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 $\quad v = v_0 + at$

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

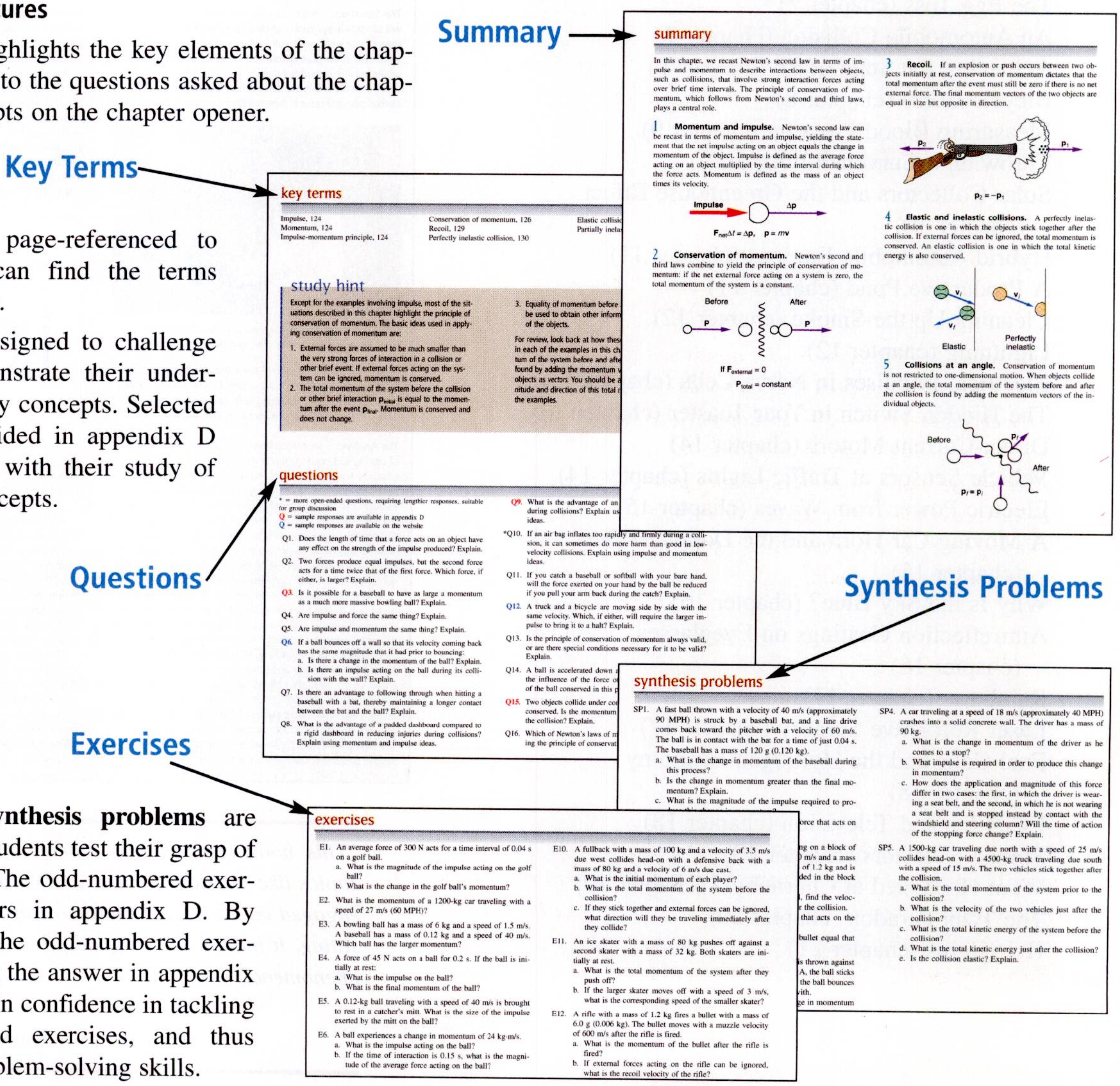
$t = 6$ s $\quad = 10$ m/s $+ 24$ m/s

$v = ?$ $\quad =$ **34 m/s**

v = 34 m/s due east

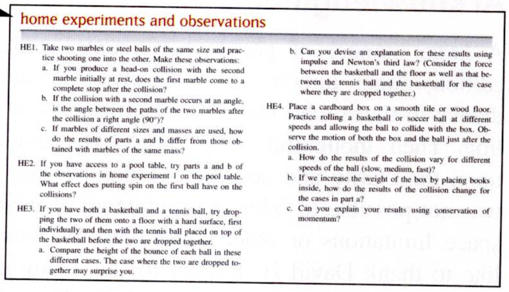
End-of-Chapter Features

- The **summary** highlights the key elements of the chapter and correlates to the questions asked about the chapter's major concepts on the chapter opener.
- **Key terms** are page-referenced to where students can find the terms defined in context.
- **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.
- **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 answer 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.

Home Experiments and Observations



home experiments and observations

HE1. Take two marbles or steel balls of the same size and practice shooting one into the other. Make these observations:
  a. If you produce a head-on collision with the second marble initially at rest, does the first marble come to a complete stop after the collision?
  b. If the collision with a second marble occurs at an angle, is the angle between the paths of the two marbles after the collision a right angle (90°)?
  c. If marbles of different sizes and masses are used, how do the results of parts a and b differ from those obtained with marbles of the same mass?

HE2. If you have access to a pool table, try parts a and b of the observations in home experiment 1 on the pool table. What effect does putting spin on the first ball have on the collisions?

HE3. If you have both a basketball and a tennis ball, try dropping the two of them onto a floor with a hard surface, first individually and then with the tennis ball placed on top of the basketball before the two are dropped together.
  a. Compare the height of the bounce of each ball in these different cases. The case where the two are dropped together may surprise you.
  b. Can you devise an explanation for these results using impulse and Newton's third law? (Consider the force between the basketball and the floor as well as that between the tennis ball and the basketball for the case where they are dropped together.)

HE4. Place a cardboard box on a smooth tile or wood floor. Practice rolling a basketball or soccer ball at different speeds and allowing the ball to collide with the box. Observe the motion of both the box and the ball just after the collision.
  a. How do the results of the collision vary for different speeds of the ball (slow, medium, fast)?
  b. If we increase the weight of the box by placing books inside, how do the results of the collision change for the cases in part a?
  c. Can you explain your results using conservation of momentum?

> *"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 that 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.

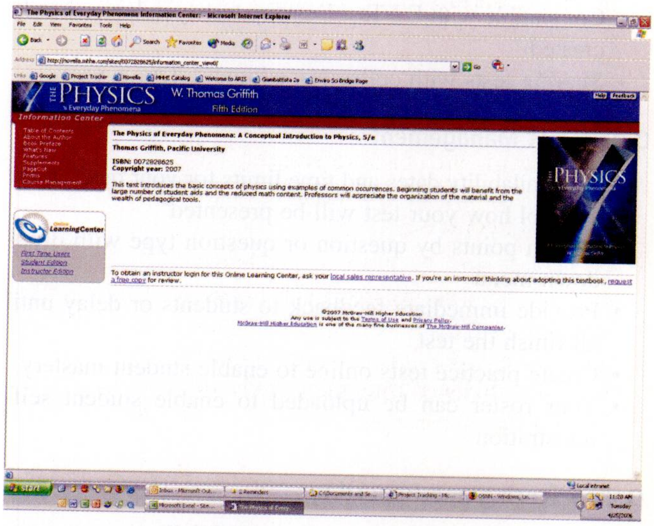
For Students

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
CPS eInstruction Questions for Personal Response Systems
Powerpoints of Art and Photos from the Text
Test Bank
Formula Summaries



Personal Response Systems

Personal Response Systems (clickers) can bring interactivity into the classroom or lecture hall. Wireless response systems give the instructor and students immediate feedback from the entire class. The wireless response pads are essentially remotes that are easy to use and engage students, allowing instructors to motivate student preparation, interactivity, and active learning. Instructors receive 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.

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.

Test Creation

- Author/edit questions online using the 14 different question type templates
- Create printed tests or deliver online to get instant scoring and feedback.
- Create question pools to offer multiple versions online—great for practice
- Export your tests for use in WebCT, Blackboard, PageOut, and Apple's iQuiz
- Compatible with EZ Test Desktop tests you have already created
- Sharing tests with collegues, adjuncts, TAs is easy

Online Test Management

- Set availability dates and time limits for your quiz or test
- Control how your test will be presented
- Assign points by question or question type with drop-down menu
- Provide immediate feedback to students or delay until all finish the test
- Create practice tests online to enable student mastery
- Your roster can be uploaded to enable student self-registration

Online Scoring and Reporting

- Automated scoring for most of EZ Test's numerous question types
- Allows manual scoring for essay and other open response questions
- Manual re-scoring and feedback is also available
- EZ Test's grade book is designed to easily export to your grade book
- View basic statistical reports

Support and Help

- User's Guide and built-in page-specific help
- Flash tutorials for getting started on the support site
- Support Website - www.mhhe.com/eztest
- Product specialist available at 1-800-331-5094
- Online Training: http://auth.mhhe.com/mpss/workshops/

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Last, but certainly not least, we would both like to acknowledge the support of our families, friends, and colleagues. Their encouragement has been essential and has allowed us to enjoy the pleasure of this endeavor.

Secrets to Success in Studying Physics

First of all, we should admit that there are no secrets. Conscientious work and follow-through with reading, problem assignments, and class participation will reap the rewards that students can expect from such efforts in other courses. Failing to do so will also lead to expected results.

There are some ways, however, in which studying physics is different from your studies in biology, history, or many other courses. Physics is not an area of study that can be mastered by memorizing discrete facts or by cramming before tests. Students sometimes bring study strategies to physics that have worked in other courses and are disappointed when they fail to work in their physics class. The suggestions that follow are sure-fire steps to getting the most out of your physics course and this textbook.

1. ***Experiment.*** Experiments play a key role in the development of physics but also in the growth of understanding for anyone approaching physics concepts. We often suggest in the text that you try simple experiments that might involve throwing a ball, walking across a room, or other very rudimentary activities. Do them right away as they arise in the text. Not only will you gain the benefit of increased blood flow to various parts of the body including the brain, but what follows in your reading will make more sense. Experience with everyday phenomena cannot be gained passively.
2. ***Get the big picture.*** Physics is a big-picture subject. Your understanding of Newton's laws of motion, for example, cannot be encapsulated by a formula or by memorizing the laws themselves. You need to see the entire context, understand the definitions, and work with how the laws are applied. The outlines and summaries provided at the beginning and end of each chapter can help to provide the context. They cannot stand alone, however. You need to place the examples and descriptions provided in the classroom and text in the framework provided by the outlines and summaries. If you grasp the big picture, the details will often follow.
3. ***Explore questions.*** The textbook provides a list of conceptual questions at the end of each chapter, but also raises questions in the body of the text. The greatest benefit is gained by attacking these questions first on your own and then by discussion with classmates. Write out answers to these questions using full sentences, not just short-answer phrases. Compare your answers with those provided at the back of the text for selected questions, but only after having a good crack at answering the questions yourself.
4. ***Try the exercises.*** The textbook also provides exercises and synthesis problems at the end of each chapter. Their purpose is to provide practice with simple numerical applications of physics concepts. They are only useful if you do them yourself and write out the solution steps in such a way that you can follow your work. Copying answers and steps from classmates or other sources may gain points on the assignment but provides no benefit in understanding. As in sports and many other activities, success on physics exams will come to those who practice.
5. ***Be there.*** College students set their own priorities for use of time, and sometimes class attendance is not at the top of the list. In some classes, this may be justified by the nature of the benefit of class activities, but that is seldom the case in physics. The demonstrations, explanations, working of exercises, and class discussions that are usually part of what occurs during a physics class provide an invaluable aid to grasping the big picture and filling in holes in your understanding. The demonstrations alone are often worth the price of admission. (You do pay—it's called tuition.)
6. ***Ask questions.*** If the explanations of demonstrations or other issues are not clear, ask questions. If you are confused, chances are good that many other students are likewise befuddled. They will love you for raising the flag. Unless the instructor is unusually insecure, he or she will also love you for providing the opportunity to achieve better clarity. Physics instructors already know this stuff, so they sometimes have difficulty seeing where student hang-ups may lie. Questions provide the lubrication for moving things forward.
7. ***Review understanding.*** Preparing for tests should not be a matter of last-minute cramming and memorization. Instead, you should review your understanding of the big picture and question yourself on why we did what we did in answering questions and working exercises done previously. Memorization is usually pointless because many physics instructors provide or permit formula sheets that may include definitions and other information. Late-night cramming is counterproductive because it detracts from getting a good night's sleep. Sleep can be critical to having a clear head the next day to meet the challenges provided by the test.

Although there is an element of common sense in most of these suggestions, you will probably not be surprised to learn that many students do not approach things following these guidelines. Old habits are hard to break and peer pressure can also be a negative influence at times. Students fall into patterns that they know are ineffective, but are unable to climb out of the rut. We have done our duty in disclosing these secrets. You are on your own if you choose a different path. Let us know if it works.

brief contents

detailed contents