BUILT FROM THE GROUND UP FOR MORE EFFECTIVE LEARNING

- **An NSF-funded educational research program**
- **Input from an unprecedented 4,500 student**
- **Detailed reviews by 250 instructors**

This is just some of the unusual history that shaped ***Physics for Scientists and Engineers*** by Randy Knight into the most widely adopted new physics text published in more than 30 years. In ***College Physics: A Strategic Approach***, Randy Knight is joined by Brian Jones and Stuart Field to apply the best solutions from educational research to the algebra-based introductory physics course and the particular needs of these students.

Built from the ground up on a wealth of research into how students learn physics, and how they can be taught more effectively, ***College Physics***:

- **builds** students' problem-solving abilities and confidence
- **integrates** relevant examples and interesting topics
- **promotes** deeper understanding by explicitly addressing students' preconceptions, misconceptions, and common stumbling-blocks
- **provides** a highly readable text and research-based visual pedagogy

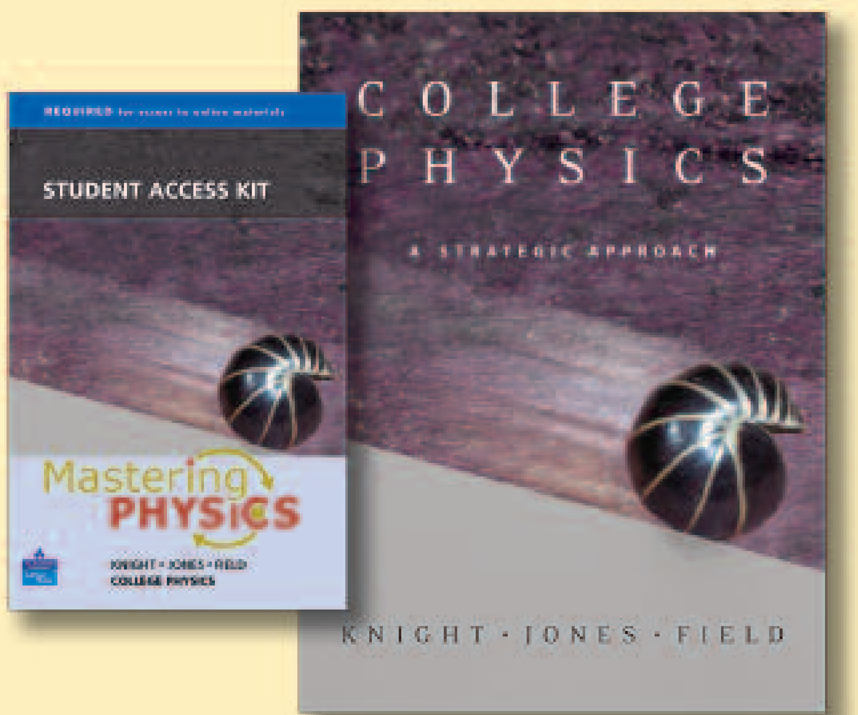
The following pages provide an overview of how ***College Physics*** is designed to achieve these goals based on input from thousands of students and hundreds of instructors to date.

"Visual pedagogy is a critical feature of physics textbooks because so much of physics is expressed in graphics. I am extremely impressed with the care and research-based ideas that have gone into the unique instructional design of the graphics in Knight's textbooks. His physics textbooks are leaders in applying research-based principles of visual pedagogy to support student learning."

—Richard E. Mayer, *Professor of Psychology, University of California, Santa Barbara*

"No text I have seen has done more to lead students to thinking than Knight/Jones/Field."

—Dieter R. Brill, *University of Maryland*



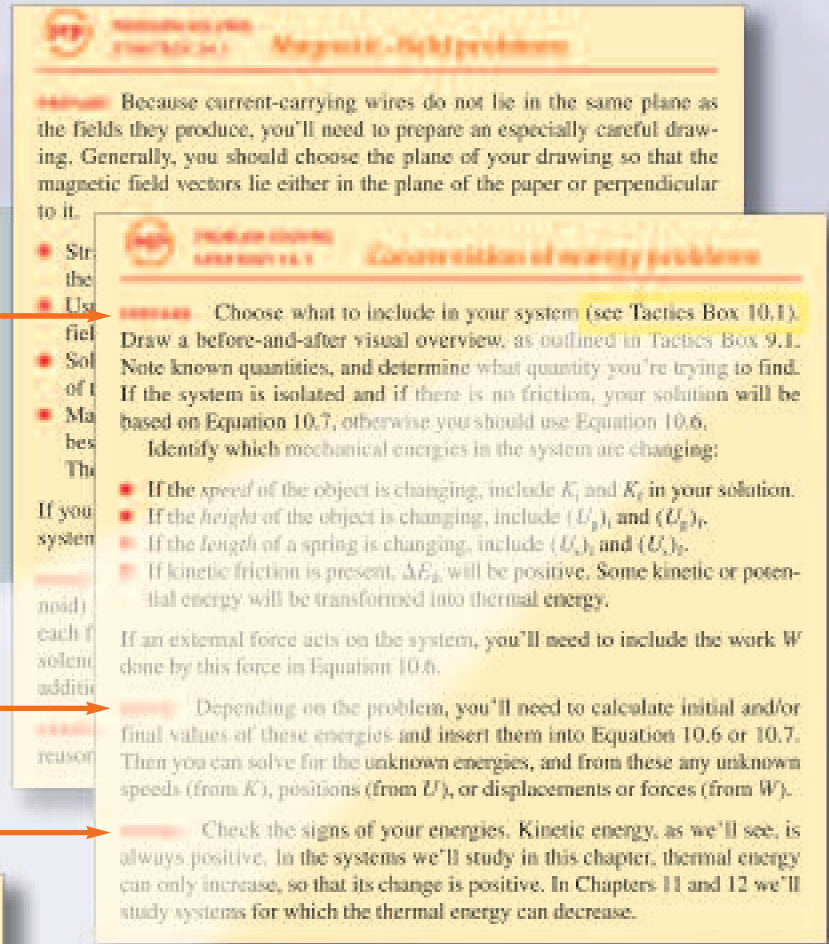
BUILDS PROBLEM-SOLVING SKILLS AND CONFIDENCE

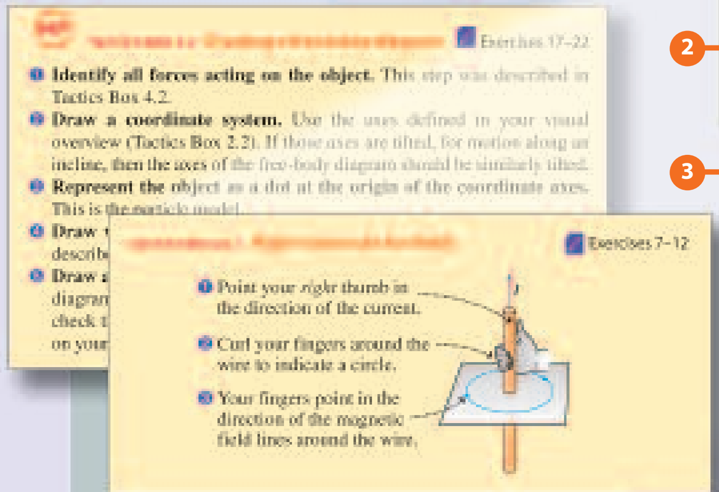
Clear, consistent instruction

Students build confidence and success through a consistent 3-step approach that encourages them to **Prepare** the problem, before trying to **Solve it** and **Assess** their answer.

Topic-specific ***Problem-Solving Strategies*** follow the same 3-step framework and provide more detailed guidance.

1. PREPARE reinforces the value of gathering information, drawing figures, making assumptions, and planning—key steps research shows students otherwise skip.
2. SOLVE carefully works through the mathematical steps of the solution, explaining algebraic manipulations and use of key information.
3. ASSESS reminds the student to verify whether their answer makes sense—numerically and in context.

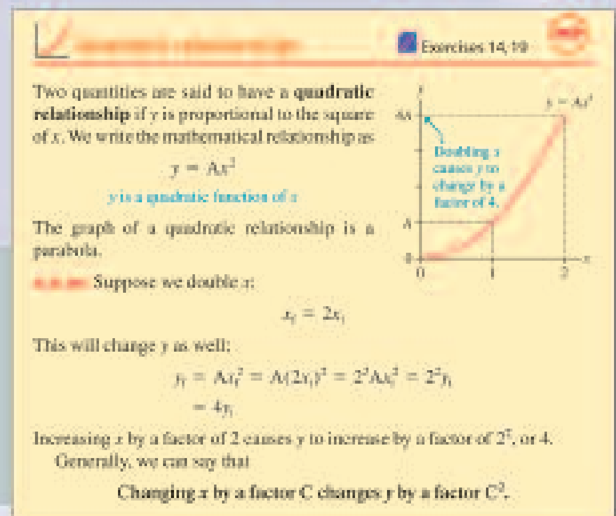




Tactics Boxes provide step-by-step procedures that build key skills the student will use over and over—such as drawing free-body diagrams, and using ray tracing.

"The Prepare, Solve, and Assess steps are right on, not too many steps to confuse the students, but enough to thoroughly discuss the problem. The strategies are well thought-out and expertly executed."

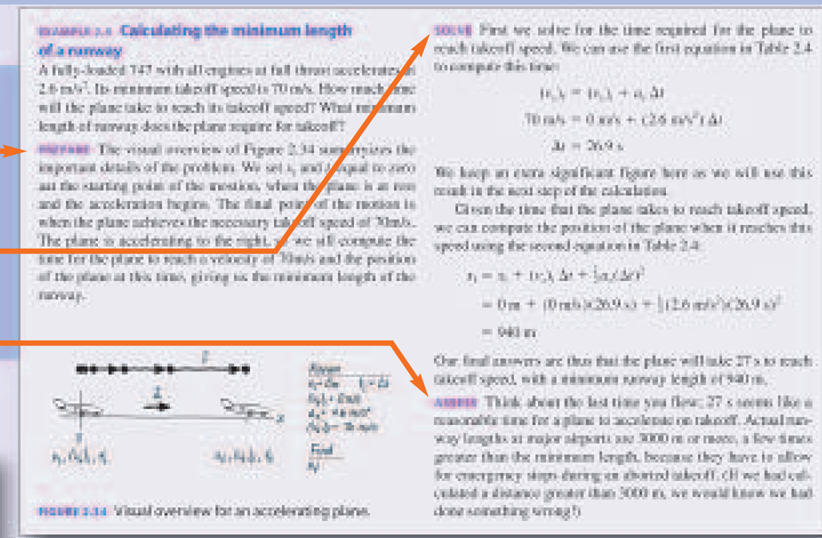
—Toby Moleski, *Muskegon Community College*

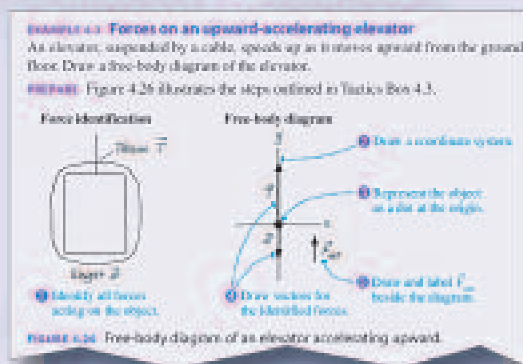


Math Relationship Boxes ensure the student is confident with the key mathematical relationships most common in this course. Each relationship is consolidated in words, math, and graphics, along with tips on reasoning with limiting cases and scaling. Icons in the text refer back to these boxes to help students see connections in the math they use.

Explicit, guided practice

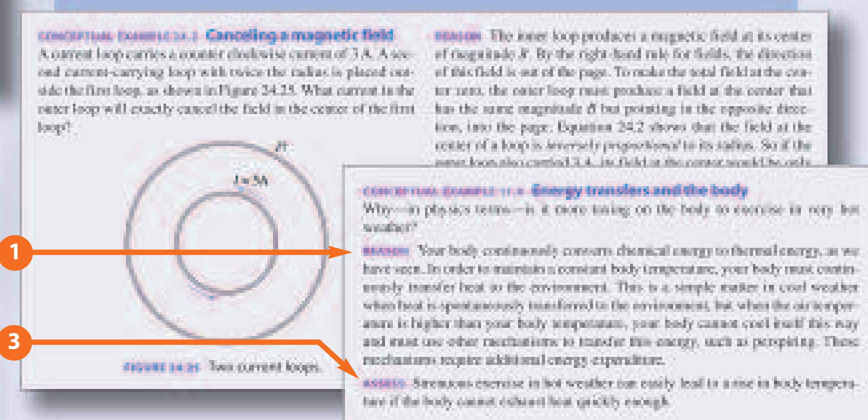
Worked Examples implement the Strategies and follow the same PREPARE/SOLVE/ASSESS framework as part of developing good problem-solving habits. They carefully walk the student through the underlying reasoning and pitfalls to avoid.

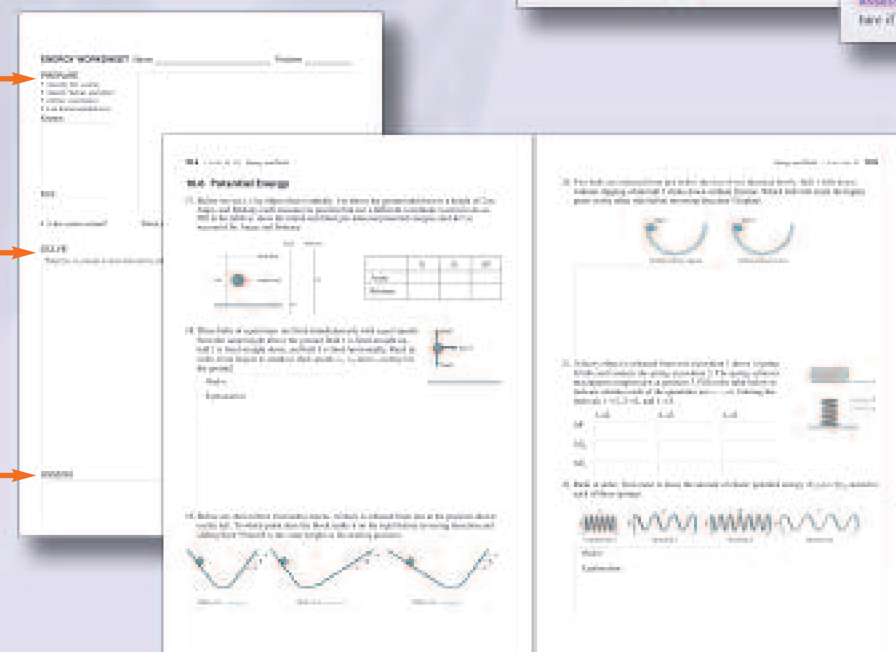




Pencil Sketches provide students with an explicit and accessible example of what to draw in solving a problem—a key step research indicates students often skip—often following steps outlined in Tactics Boxes.

Conceptual Examples target students' qualitative reasoning skills. Since no math is involved, they follow a Reason and Assess approach.





The ***Student Workbook*** provides straightforward confidence- and skill-building exercises—bridging the gap between worked examples and end-of-chapter problems. Also included are worksheets—research-based templates that help students structure their approach to solving problems. Workbook activities are referenced throughout the text by .

INTEGRATES INTERESTING AND RELEVANT TOPICS

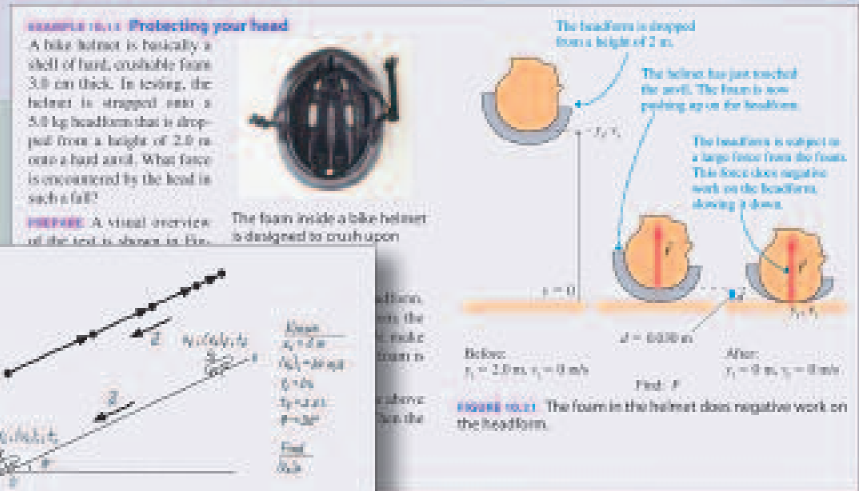
An active, inductive approach

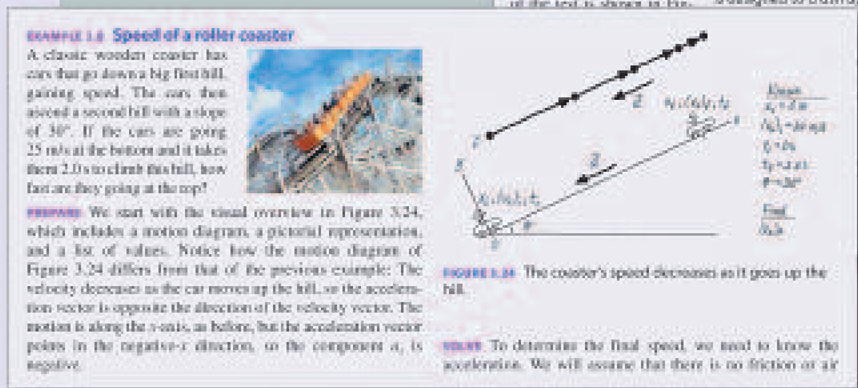
Drawing from students' majors and the world around them, relevant examples and interesting topics are carefully woven into the text. These provide students with motivation, a means to consolidate their understanding, and a clear context for how physics is valuable to them.

"The writing is clear and engaging. The coverage is well thought-out. *College Physics* is better than any other text I have encountered for algebra-based physics."

—Bruce A. Schumm, *University of California, Santa Cruz*

Worked Examples incorporates scenarios from everyday life and the world around us.





Free-standing Applications, provided in the margin with photographs and a self-contained caption, connect the physical principles with the real world.


Less of a drag At the high speeds attained by racing cyclists, air drag can become very significant. The world record for the farthest distance traveled in one hour on an ordinary bicycle is 56.38 km, set by Chris Boardman in 1996. But a bicycle with an aerodynamic shell has a much lower drag force, allowing it to attain significantly higher speeds. The bike shown here was pedaled 84.22 km in one hour by Sam Whittingham in 2004, for an amazing average speed of 52.3 mph!

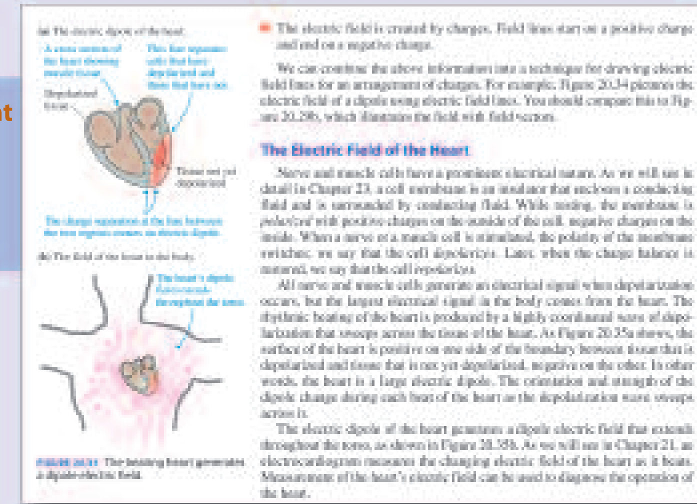
Try It Yourself Activities throughout the text provide students with simple real-world experiments designed to quickly reinforce a key idea through direct experience.

"Extremely readable and instructive."

—Tiffany Landry, *Folsom Lake College*

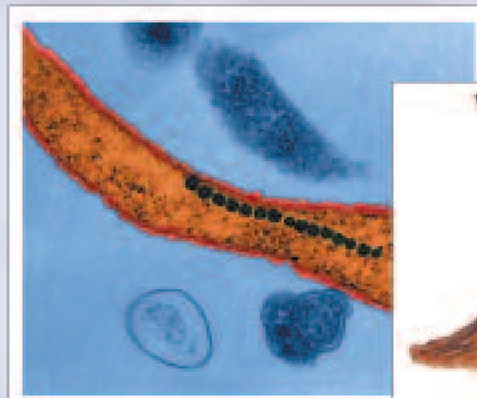
Engaging life-science students

Optional sections provide **in-depth treatment on key topics for biomedical students**—such as electrical conduction in the nervous system, the workings of an EKG, and how to correctly measure blood pressure.

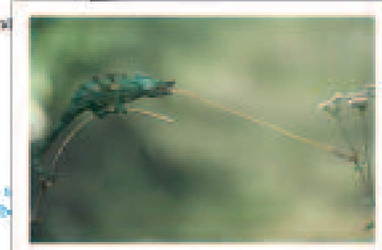


"*College Physics* answers better than other texts I've seen the issues particular to teaching physics to life science students."

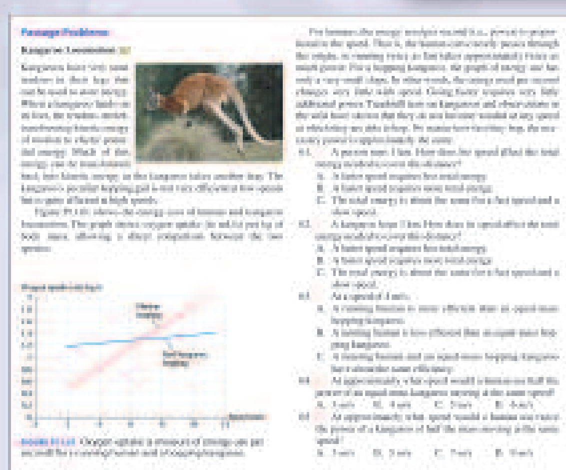
—Robert W. Lutz, *Drake University*


Magnetotactic Bacteria BIO Several organisms use the earth's magnetic field to navigate. The clearest example of this is *magnetotactic bacteria*. The dark areas in this image are small pieces of iron; each piece is a single domain and hence a very strong magnet. Such a bacterium possesses a very strong magnetic moment: It acts like a bar magnet, lining up with the earth's magnetic field! In the temperate regions where such bacteria live, the earth's field has a large vertical component. The bacteria use their alignment with this vertical field component to navigate up and down.

Spring in your step BIO As you run, you lose some of your mechanical energy each time your foot strikes the ground; this energy is transformed into unrecoverable thermal energy. Luckily, about 35% of the decrease of your mechanical energy when your foot lands is stored as elastic potential energy in the stretchable Achilles tendon of the lower leg. On each plant of the foot the tendon is stretched, storing some energy. The tendon springs back as you push off the ground again, helping to propel you forward. This recovered energy reduces the amount of internal chemical energy you use, increasing your efficiency.


Dinner at a distance BIO A chameleon's tongue is a powerful tool for catching prey. Certain species can extend the tongue to a distance of over 1 ft in less than 0.1 s! A study of the kinematics of the motion of the chameleon tongue, using techniques like those in this chapter, reveals that the tongue has a period of rapid acceleration followed by a period of constant velocity. This knowledge is a very valuable clue in the analysis of the evolutionary relationships between chameleons and other animals.

Fascinating, self-contained ***Life-science Applications*** are provided throughout the text to illustrate how physics helps students understand the world around them and life-science students with their chosen career.



"The authors' use of everyday and especially biological examples is superior to any other text I've seen. Students with biomedical interests will have plenty to sink their teeth into."

—Taner Edis, *Truman State University*

Multiple-choice and Passage Problems are designed to carefully test student understanding by targeting common misconceptions and providing context-rich situations—modeling the latest MCAT and other progressive physics exams.

PROMOTES DEEPER UNDERSTANDING

A structured learning path

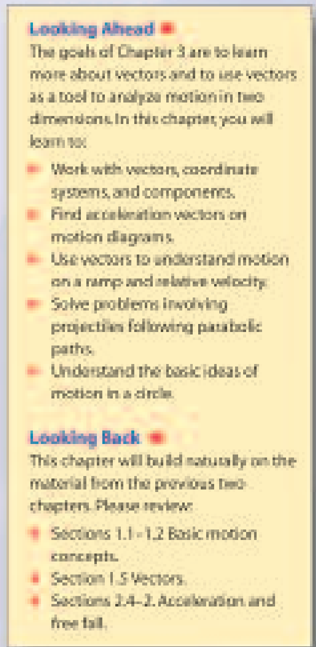
This text incorporates many subtle but powerful techniques from cognitive science that improve student learning and retention, including a self-evident and structured learning path and a unique visual pedagogy.

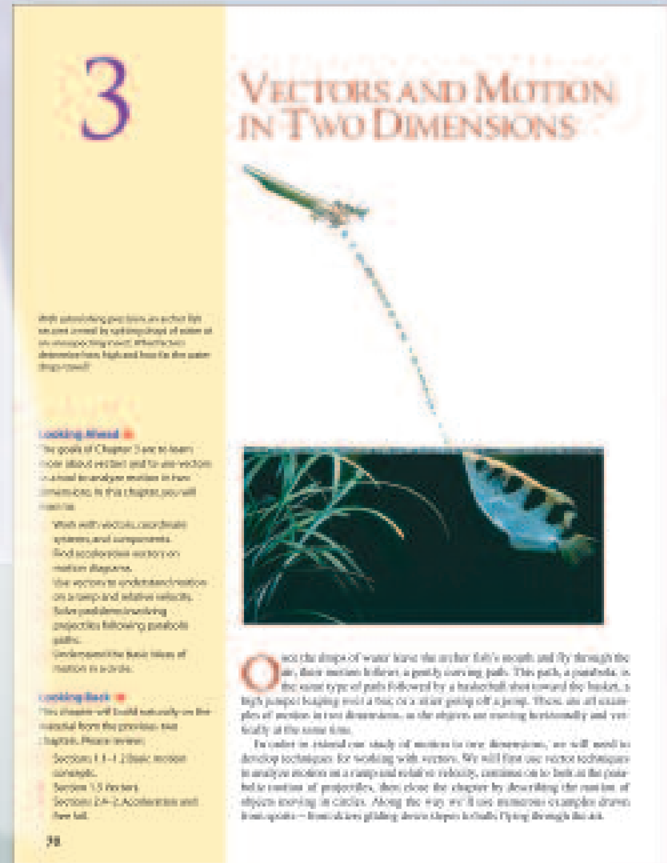
"Clearly written by experienced, knowledgeable teachers who have spent time in the trenches… *College Physics* sets a new standard."

—Marllin L. Simon, *Auburn University*

"The text is exceptionally easy to read… and takes special care to explain the fundamentals and debunk common misconceptions…"

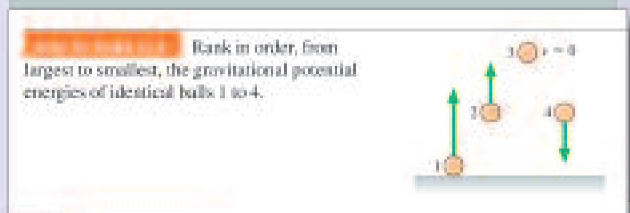
—Michael Pravica, *University of Nevada–Las Vegas*

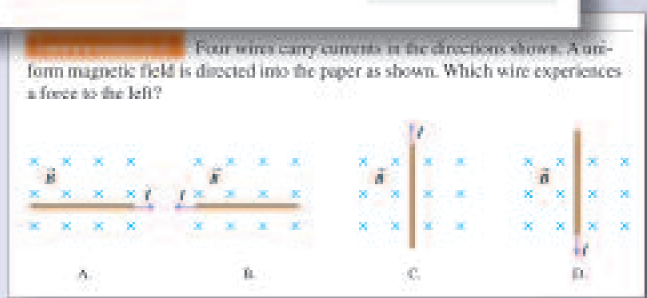




Each chapter begins with a motivational roadmap—***Looking Ahead*** provides learning goals to keep the student focused on the key ideas, and ***Looking Back*** consolidates connections with earlier material.

Stop to Think Questions at the end of a section allow the student to quickly check their understanding. Using powerful ranking-task and graphical techniques, they are designed to efficiently probe key misconceptions and encourage active reading. (Answers are provided at the end of the chapter.)





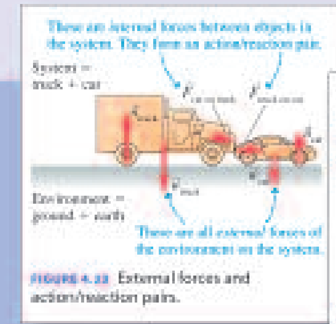
NOTE Paragraphs throughout guide students away from known preconceptions, around common sticking points, and highlight many math-related issues that cause difficulties.

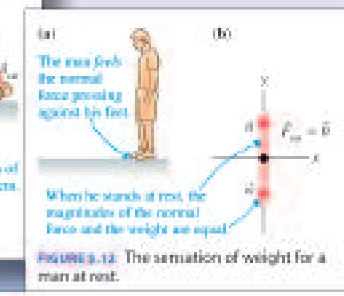
Proven visual pedagogy

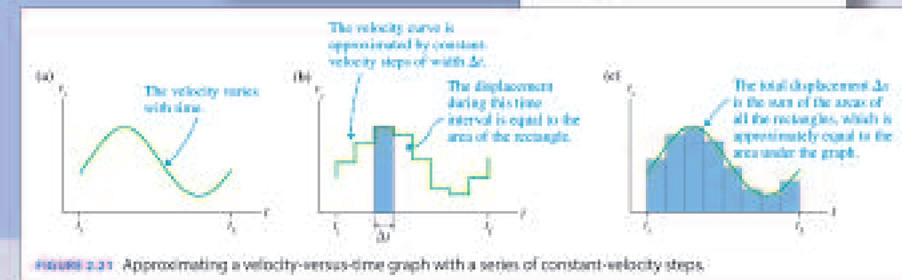
Figures are carefully streamlined in detail and color so students focus on the physics—for instance, the object of interest in mechanics—using an instructional approach well documented to improve learning.

The proven technique of annotation—adding chalkboard-like dialog onto the figure (rather than providing as a lengthy caption beneath)—is used to more effectively guide students in:

- interpreting a graph or figure
- understanding a process
- translating between text, math, graphs, and figures
- grasping a difficult concept through a visual analogy



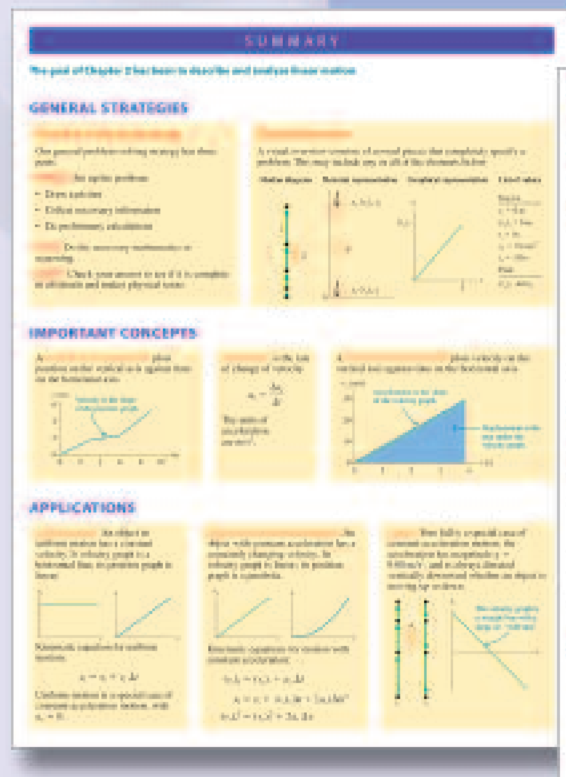


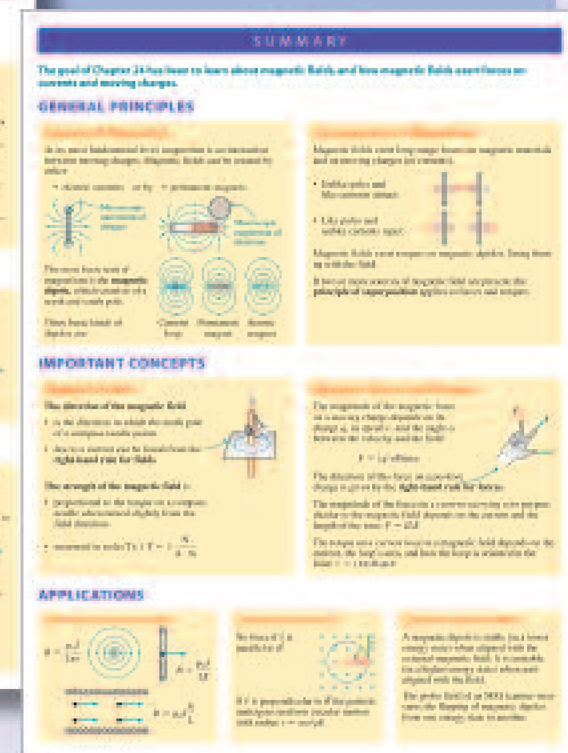


"The summaries are very effective in helping students to identify the key ideas and uniting principles of the chapter."

—Kristi D. Concannon, *King's College*

Critically acclaimed ***Visual Chapter Summaries*** consolidate understanding by providing each concept in words, math, and figures and organizing these into a coherent hierarchy—from General Principles to Applications.

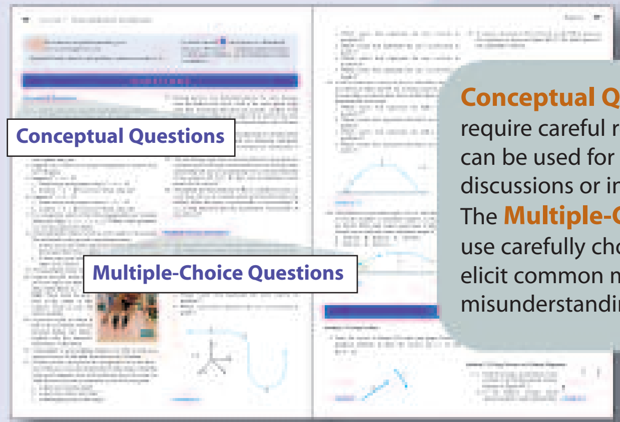




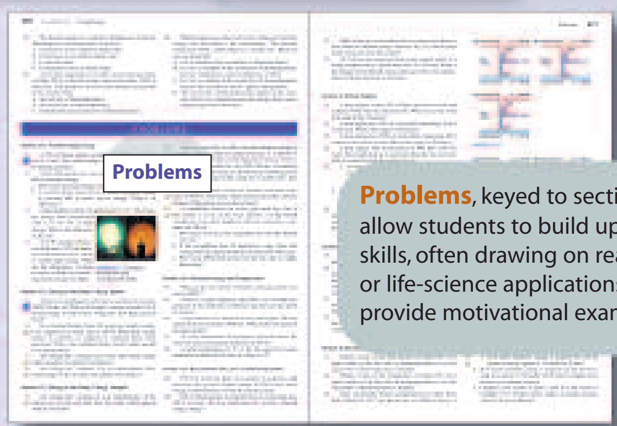
THE BEST-TESTED PROBLEMS

Enhanced by analysis

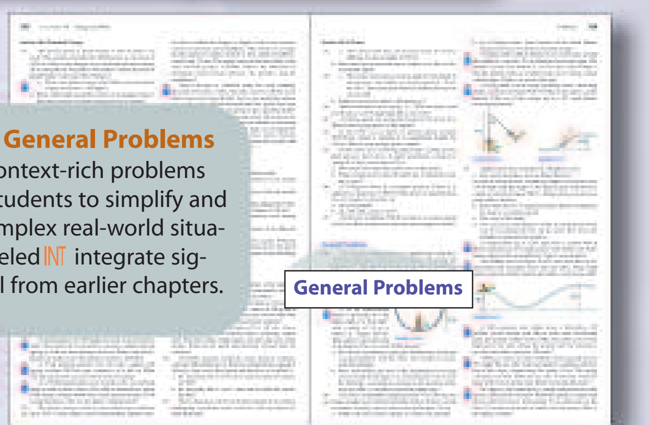
End-of-chapter problems of superior quality and diversity have been carefully crafted to exercise and test the full range of qualitative and quantitative problem-solving skills. The wealth of 3,000 problems in ***College Physics: A Strategic Approach*** are the first problems to be pre-tested for reliability, difficulty, and duration on thousands of students nationally before publication in a new textbook. *(See pull-out grid inside front cover for more details).*



Conceptual Questions require careful reasoning and can be used for either group discussions or individual work. The **Multiple-Choice Questions** use carefully chosen distractors to elicit common misconceptions and misunderstandings.



Problems, keyed to sections, allow students to build up their skills, often drawing on real-world or life-science applications to provide motivational examples.



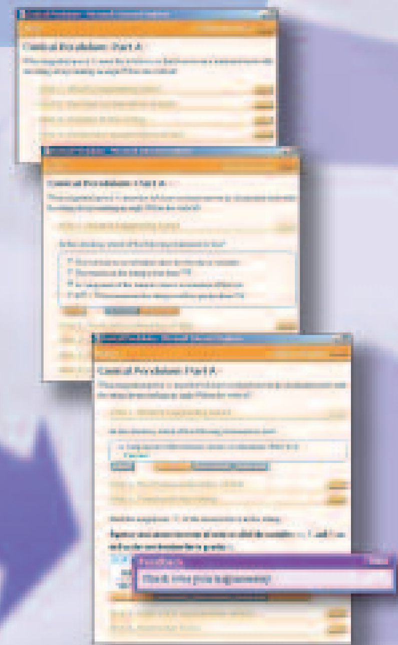
More advanced **General Problems** include many context-rich problems which require students to simplify and model more complex real-world situations. Those labeled INT integrate significant material from earlier chapters.

INTEGRATED WITH MASTERINGPHYSICS™

Unparalleled teaching diagnostics and individualized tutoring

MasteringPhysics™ is the most widely used and educationally proven physics homework and tutorial system in the world. NSF-sponsored research and independent studies at a wide range of schools show that students who use MasteringPhysics™ significantly improve their scores on final exams and conceptual tests such as the Force Concept Inventory. Drawing from the world's largest metadatabase of the step-by-step work of how real students solve problems, accumulated over eight years of research, MasteringPhysics™ offers unparalleled individualized guidance.

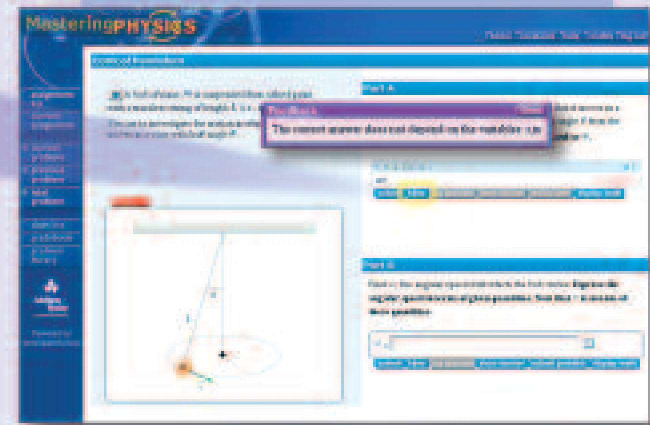
Simpler subproblems are provided upon request when a student gets stuck.

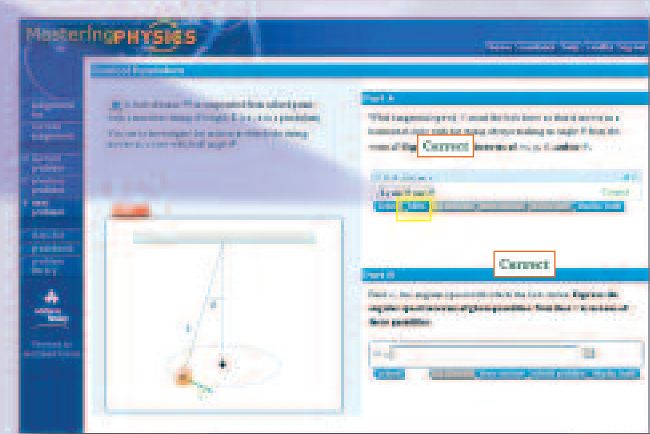


Students select only the specific help they need. Thousands of solution paths are allowed.

*See the **MasteringPhysics**™ brochure for more details on how it enables instructors to more quickly build assignments of just the right coverage, difficulty, and duration, and the time-saving and probing diagnostics it provides (including most-common wrong answers by a class at each step, the step-by-step work of each student, even national average comparison data).*

Instantaneous feedback is provided specific to the most common wrong answers.





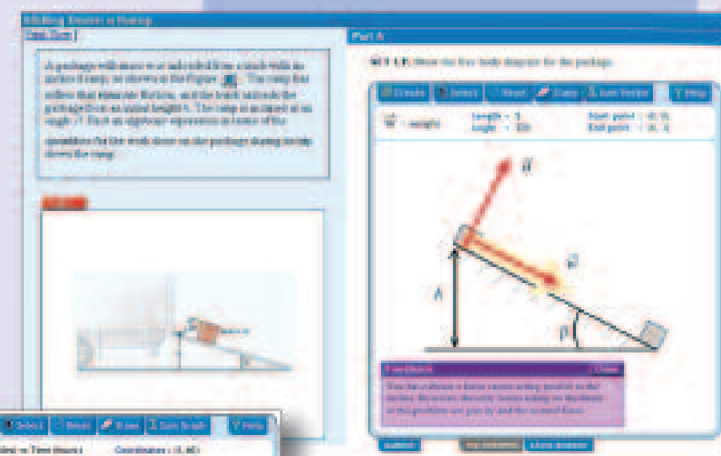
Partial credit is provided for the method, not just the final numerical answer.

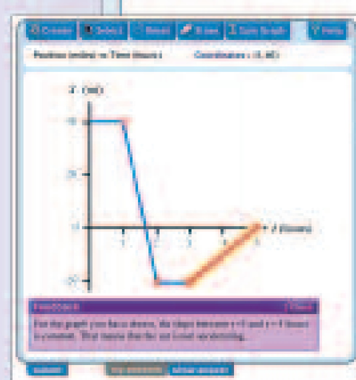
MasteringPhysics™ provides instructors with more than 3,000 problems from which to build wide-ranging weekly assignments that include:

- end-of-chapter textbook problems
- tutorials for practicing the Problem-Solving Strategies, Conceptual Analysis, and Quantitative Analysis problems in every chapter
- skill-building tutorials for mastering key concepts, and self-tutoring problems for guided practice
- math-specific skill-building tutorials, ranking task problems, even essay questions

Numerical problems provide randomized numbers and sig-fig feedback, and tutorial problems provide wrong-answer specific feedback and simpler subproblems upon request.

A **vector-drawing tool** provides grading and feedback on student-drawn free-body diagrams embedded in the tutorials.





A **graph-drawing tool** provides similar grading and feedback in tutorials that develop students' graph-reading skills.

MasteringPHYSICS

www.masteringphysics.com

WE TAKE THE GUESSWORK OUT OF CHOOSING GREAT HOMEWORK PROBLEMS

Two-Way LEARNING™ APPROVED

THE BEST PHYSICS PROBLEMS—ENHANCED THROUGH ANALYSIS

College Physics: A Strategic Approach provides the first problems to be pre-tested on students nationally for reliability, difficulty, and duration *before* publication in a new textbook.

Pre-testing by Two-Way Learning™ is the most sophisticated problem approval and improvement procedure ever developed. Utilizing the most advanced item-analysis tool in the world—**MasteringPhysics**™—these textbook problems have been pre-tested on a wide variety of students.

Sophisticated analysis of the captured student metadata of difficulty, time spent, most common wrong answers, and comment rate on every step of every problem has been used to systematically improve quality, educational effectiveness, efficiency of teaching and learning, and assessment accuracy to provide you with:

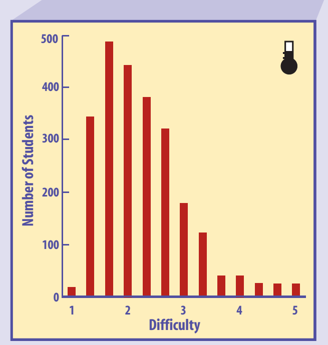
- the best physics problems
- the most accurate solutions
- the most reliable assessment items
- the only problems with accurate, student-calibrated difficulty and duration (time-to-complete) ratings

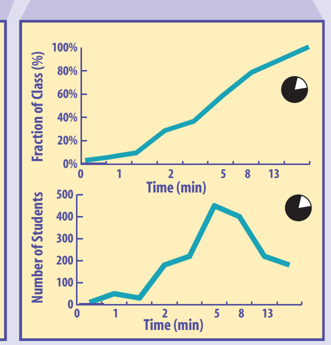
PART I: FORCE AND MOTION
Chapter 2: Motion in One Dimension

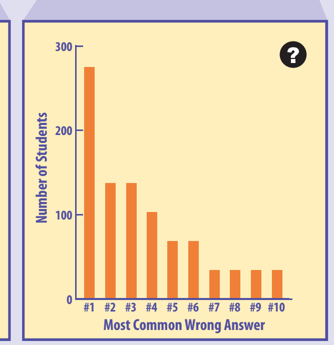
Sample End-of-chapter Questions and Problems starting on page 61.		Difficulty (1-5)	Time	Student Metadata
P 2.4	Write a short description of a real object...	1	4 min.	
P 2.5	Suppose a car is moving with constant velocity...	2	4 min.	
P 2.6	A car starts at the origin and moves...	1	1 min.	
P 2.8	Alan leaves Los Angeles at 8:00 A.M...	2	4 min.	
P 2.9	Richard is driving home to visit his parents...	3	5 min.	
P 2.11	In an 8.00 km race, one runner runs...	5	5 min.	
P 2.12	A bicyclist has the position-versus-time graph...	2	4 min.	
P 2.14	A car starts from $x_i = 10$ m...	3	8 min.	
P 2.16	The figure shows the velocity graph of a train...	1	1 min.	
P 2.17	The figure shows the velocity graph of a bicycle...	2	3 min.	
P 2.20	A Thompson's gazelle can reach a speed...	1	1 min.	
P 2.21	When striking, the pike, a predatory fish...	2	4 min.	
P 2.22	What constant acceleration, in SI units, must a car...	3	10 min.	
P 2.23	A car travels with constant acceleration...	3	5 min.	
P 2.24	A jet plane is cruising at 250 m/s...	4	5 min.	
P 2.25	A speed skater moving across the frictionless ice...	3	6 min.	

PART II: CONSERVATION LAWS
Chapter 10: Energy and Work

Sample End-of-chapter Questions and Problems starting on page 327.		Difficulty (1-5)	Time	Student Metadata
Q 10.28	If you walk up a flight of stairs...	2	2 min.	
Q 10.30	A woman uses a pulley and a rope...	1	2 min.	
Q 10.31	A hockey puck sliding along frictionless ice...	1	2 min.	
Q 10.33	A wrecking ball is suspended...	2	5 min.	
P 10.1	During an etiquette class, you walk slowly...	1	2 min.	
P 10.5	At the airport, you ride a "moving sidewalk"...	3	9 min.	
P 10.6	A boy flies a kite...	1	4 min.	
P 10.10	Sam's job at the amusement park...	3	4 min.	
P 10.12	The turntable in a microwave oven...	1	1 min.	
P 10.13	An energy storage system...	1	3 min.	
P 10.19	A car is parked at the top...	2	3 min.	
P 10.21	A 1500 kg car is approaching the hill...	3	6 min.	
P 10.27	The elastic energy stored in your tendons...	4	7 min.	
P 10.32	A fireman of mass 80 kg...	3	5 min.	
P 10.36	Two balls undergo a perfectly elastic...	1	4 min.	
P 10.41	A 1000 kg sports car accelerates...	3	5 min.	
P 10.42	In just 0.30 s, you compress...	3	6 min.	
P 10.43	In the winter sport of curling...	4	6 min.	







PART III: PROPERTIES OF MATTER
Chapter 12: Thermal Properties of Matter

Sample End-of-chapter Questions and Problems starting on page 406.		Difficulty (1-5)	Time	Student Metadata
Q 12.28	Suppose you do a calorimetry experiment...	1	1 min.	
P 12.2	How many grams of water (H_2O)...	4	5 min.	
P 12.3	How many atoms of hydrogen are in 100 g...	3	3 min.	
P 12.6	A straight rod consists of a 1.2-cm-long piece...	1	1 min.	
P 12.10	If a container holds 0.865 L of ethyl alcohol...	3	2 min.	
P 12.15	7.5 mol of helium are in a 15 L cylinder...	4	13 min.	
P 12.19	10 g of liquid water is placed in a flexible bag...	5	7 min.	
P 12.20	A cylinder contains 3.0 L of oxygen...	2	3 min.	
P 12.29	It is possible to make a thermometer...	3	3 min.	
P 12.30	How much energy must be removed...	2	2 min.	
P 12.37	A copper block is removed from a 300°C oven...	5	3 min.	
P 12.39	A 500 g metal sphere is heated to 300°C...	1	1 min.	
P 12.40	Marianne really likes coffee, but on summer days...	5	8 min.	
P 12.49	What is the rate of energy transfer...	3	6 min.	
P 12.61	Suppose you inflate your tires to 35 psi...	5	4 min.	
P 12.73	Suppose you drop a water balloon...	3	7 min.	
P 12.84	What is the heat Q_H extracted...	4	7 min.	

98% of students ultimately answered correctly

2% of students ultimately requested solution

Average of 0.26 wrong answers per student

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Part IV: Oscillations and Waves
Chapter 14: Oscillations

Sample End-of-chapter Questions and Problems starting on page 477.		Difficulty (1-5)	Time	Student Metadata
Q 14.18	A string has an unstretched length...	1	5 min.	
Q 14.19	The figure represents the motion of a mass...	2	4 min.	
Q 14.20	A ball of mass *m* oscillates on a spring...	1	10 min.	
P 14.2	In the aftermath of an intense earthquake...	1	2 min.	
P 14.3	You hear a faucet dripping steadily...	1	1 min.	
P 14.5	Make a table with 3 columns and 8 rows...	1	9 min.	
P 14.6	An air-track glider attached to a spring oscillates...	2	8 min.	
P 14.8	What are the (a) amplitude and (b) frequency...	1	2 min.	
P 14.13	Some passengers on an ocean cruise...	2	4 min.	
P 14.19	The position of a 50 g oscillating mass...	4	20 min.	
P 14.20	A 200 g mass attached to a horizontal spring...	2	14 min.	
P 14.21	A 507 g mass oscillates with an amplitude...	3	14 min.	
P 14.25	The angle of a pendulum is given by...	3	7 min.	
P 14.26	It is said that Galileo discovered a basic principle...	1	1 min.	
P 14.27	The acceleration due to gravity on the moon...	2	3 min.	
P 14.29	A building is being knocked down....	2	3 min.	
P 14.30	Interestingly, there have been several studies...	1	3 min.	
P 14.31	A pendulum clock keeps time...	3	10 min.	
P 14.32	A thin, circular hoop with a radius of 0.22 m...	1	2 min.	
P 14.37	A 25 kg child sits on a 2.0-m-long rope...	1	2 min.	
P 14.38	Vision is blurred if the head is vibrated...	2	5 min.	
P 14.40	A 0.40 kg ball is attached to a spring...	1	3 min.	
P 14.48	Astronauts in space cannot weigh themselves...	1	4 min.	
P 14.49	A 100 g ball attached to a spring...	4	14 min.	
P 14.55	The figure shows two springs, each with spring constant...	5	7 min.	

Part V: Optics
Chapter 18: Ray Optics

Sample End-of-chapter Questions and Problems starting on page 609.		Difficulty (1-5)	Time	Student Metadata
Q 18.18	In the figure, a beam of light in the air...	1	<1 min.	
Q 18.20	Is there an angle of incidence between...	2	<1 min.	
Q 18.22	You are 2.4 m from a plane mirror...	2	1 min.	
Q 18.24	A real image of an object can be formed by...	1	1 min.	
P 18.2	A student has built a 20-cm-long pinhole camera...	1	9 min.	
P 18.5	The human eye has a lot in common with...	1	3 min.	
P 18.6	The mirror in the figure deflects a horizontal laser...	1	1 min.	
P 18.8	A light ray leaves point A in the figure...	3	5 min.	
P 18.9	It is 165 cm from your eyes to your toes...	2	4 min.	
P 18.12	An underwater diver sees the sun...	3	9 min.	
P 18.14	A 1.0-cm-thick layer of water...	5	2 min.	
P 18.18	The glass core of an optical fiber...	3	1 min.	
P 18.19	A thin glass rod is submerged in oil...	5	12 min.	
P 18.20	A narrow beam of light with wavelengths from...	5	5 min.	
P 18.27	An object is 30 cm in front of a converging lens...	1	1 min.	
P 18.28	An object is 6.0 cm in front of a converging lens...	1	2 min.	
P 18.31	A concave cosmetic mirror...	1	4 min.	
P 18.32	A light bulb is 50 cm from a concave mirror...	1	3 min.	
P 18.36	An object is 6 cm in front of a convex mirror...	2	2 min.	
P 18.46	A ray of light traveling through air...	1	3 min.	
P 18.49	A 1.0-cm-thick layer of water stands...	3	10 min.	
P 18.59	There is just one angle of incidence...	2	8 min.	
P 18.62	A microscope is focused on an amoeba...	1	5 min.	
P 18.63	A ray diagram can be used to find...	2	12 min.	
P 18.64	A 2.0-cm-tall object is located 8.0 cm in front...	1	6 min.	

Part VI: Electricity and Magnetism
Chapter 20: Electric Forces and Fields

Sample End-of-chapter Questions and Problems starting on page 677.		Difficulty (1-5)	Time	Student Metadata
Q 20.23	Two lightweight, electrically neutral conducting balls...	1	1 min.	
Q 20.24	All the charges in the figure have the same magnitude...	1	<1 min.	
P 20.1	A glass rod is charged to +5.0 nC...	2	4 min.	
P 20.4	A plastic rod that has been charged...	1	5 min.	
P 20.6	Two identical metal spheres...	5	14 min.	
P 20.9	Two 1.0 kg masses are 1.0 m apart...	1	4 min.	
P 20.10	Two small plastic spheres each have a mass...	2	8 min.	
P 20.11	A small plastic sphere with a charge of −5.0 nC...	2	5 min.	
P 20.12	The figure shows the magnitude of the attractive...	4	7 min.	
P 20.13	A small glass bead has been charged to +20 nC...	4	7 min.	
P 20.14	What are the magnitude and direction of the electric force...	1	4 min.	

Part VII: Modern Physics
Chapter 28: Quantum Physics

Sample End-of-chapter Questions and Problems starting on page 961.		Difficulty (1-5)	Time	Student Metadata
Q 28.26	A light sensor is based on a photodiode...	2	2 min.	
Q 28.29	In the photoelectric effect, the frequency...	1	1 min.	
Q 28.31	Two radio stations have the same power output...	1	1 min.	
Q 28.34	Photon P in the figure moves an electron...	1	1 min.	
P 28.11	Zinc has a work function of 4.3 eV...	1	7 min.	
P 28.14	When an ultraviolet photon is absorbed...	1	1 min.	
P 28.15	A firefly glows by the direct conversion...	1	1 min.	
P 28.22	550 nm is the average wavelength...	1	2 min.	
P 28.39	An electron with a 2.0 eV of kinetic energy...	1	1 min.	