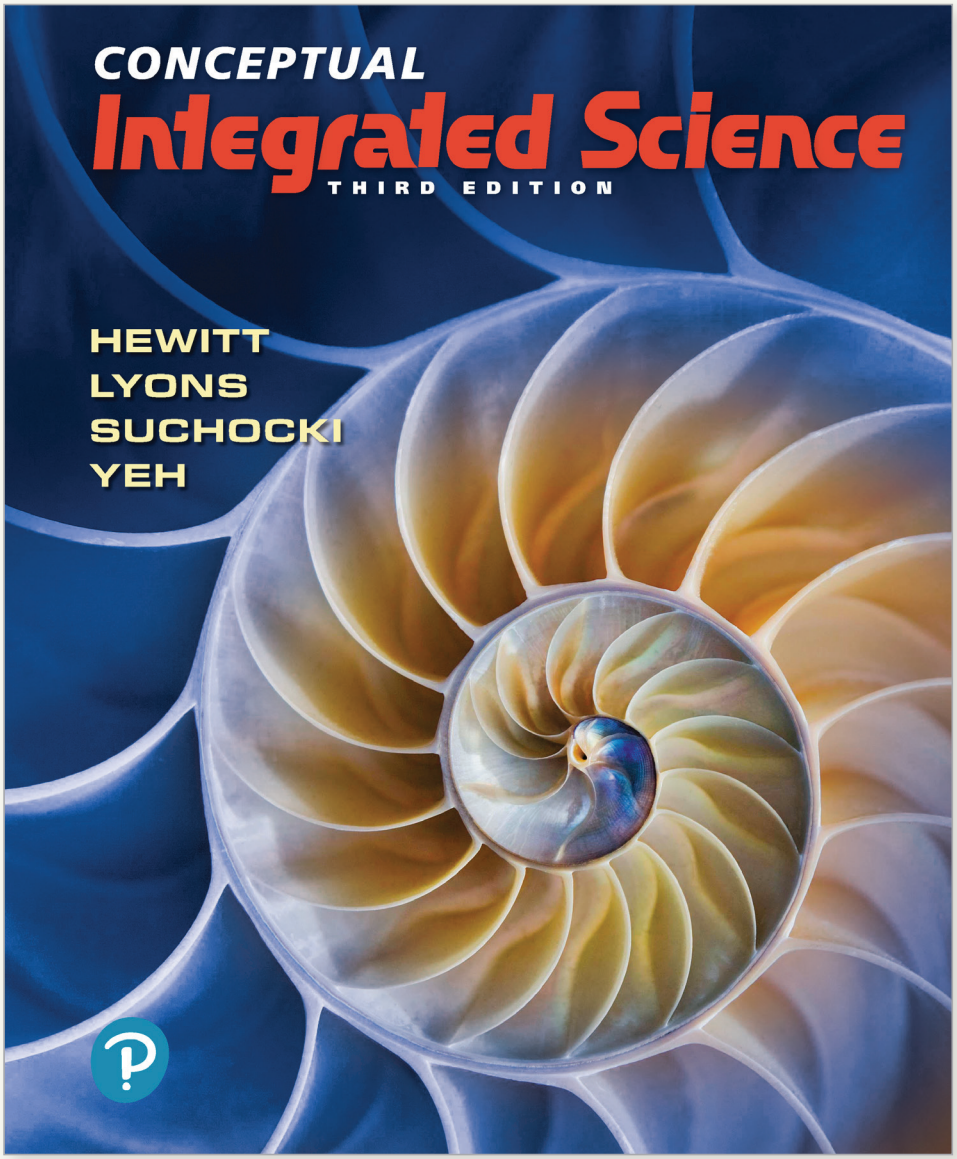
Emphasize concepts and enable students to connect ideas across the sciences

The best-selling ***Conceptual Integrated Science*** provides an engaging overview of physics, chemistry, earth science, astronomy, and biology at a level appropriate for non-science students. Hewitt's engaging narrative emphasizes unifying concepts across physical and life sciences through a clear, friendly writing style, and fun, relevant examples that motivate students. Enhanced digital tools and additional practice problems in **Mastering Physics** and the **Pearson eText** ensure students master the basic content needed to succeed in this course.



Pearson

Build a foundation across the sciences

LEARNING OBJECTIVE
Relate energy conservation to living things.

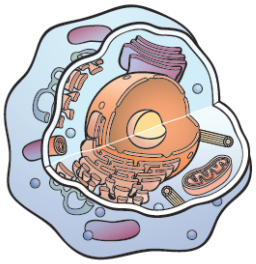


FIGURE 4.27
This cutaway view of a generalized animal cell shows various specialized structures, including the orange and yellow nucleus in the center. The pink structure at the lower right and the others scattered throughout the cell are *mitochondria*, which provide the cell with energy through cellular respiration.

FIGURE 4.28
Plants capture solar energy and transform it into chemical energy, which is stored in large molecules. When other organisms consume the plants, they obtain the energy they need for life.

Integrated Science 4B
BIOLOGY AND CHEMISTRY

Glucose: Energy for Life

Your body is in many ways a machine—a fantastically complex machine. It is made up of smaller machines, the living cells (Figure 4.27). Like any machine, a living cell needs a source of energy. The principal energy source used by most living things is the sugar glucose, $C_6H_{12}O_6$. One glucose molecule contains six atoms of carbon (C), twelve atoms of hydrogen (H), and six atoms of oxygen (O). The glucose molecule is rich in stored energy (chemical potential energy). Organisms break down glucose in their cells and harvest the energy it contains to power the chemical and physical processes that sustain life, as discussed in more detail in Chapter 15.

You obtain glucose from the food you eat indirectly, by way of some rather complex chemical reactions. A few super-sweet foods contain glucose, but most consist of other, more complex carbohydrates, such as starch, or some combination of carbohydrates, fats, and proteins. Your body must break down these nutrients to produce glucose, a raw fuel that is then passed on to your cells. Glucose molecules are taken apart inside your cells, where energy is liberated from them. The actual energy harvesting typically takes place through ***cellular respiration***, a process that occurs in specialized structures within the cell—mitochondria, the "power plants" of the cells. Cells use the released energy to do all the tasks they must do to stay alive and to perform their specialized functions.

Green plants, on the other hand, manufacture glucose directly during *photosynthesis*. Photosynthesis is the process by which plants, algae, and certain kinds of bacteria convert light energy from the Sun into chemical energy in sugar molecules. Almost all life on Earth is either directly or indirectly dependent on photosynthesis. The overall chemical reaction for photosynthesis is

$$6CO_2 + 6H_2O + \text{sunlight} \rightarrow C_6H_{12}O_6 + 6O_2$$

Carbon dioxide, water, and sunlight go in; glucose and oxygen come out. Glucose is typically converted by plant tissues into complex carbohydrates, which are long molecules built of glucose units. Some plants, of course, don't have the opportunity to consume the glucose they make for themselves, instead donating it to the animals that consume them. A potato, for instance, is crammed with glucose stored in a thicket of starch molecules. The potato's starch molecules are broken down to glucose in your mouth and small intestine, and the glucose is transported to your cells, powering their lives—and yours.

P. 70

New and Revised!
Integrated Science sections in every chapter, and at the end of each part, show how foundational ideas in science connect the different sciences. Added visuals accompany this feature, and end-of-chapter questions are tied to the sections and assignable within Mastering Physics.

Expanded!
Think Integrated Science questions at the end of each chapter tie in more closely with the chapter content.

THINK INTEGRATED SCIENCE

4A—The Impulse–Momentum Relationship in Sports

28. (a) Why is it a good idea to have your hand extended forward when you are getting ready to catch a fast-moving baseball with your bare hand? (b) In boxing, why is it advantageous to roll with the punch? (c) In karate, why is it advantageous to apply a force for a very brief time?
29. In Figure 4.8, how does the force that Cassy exerts on the bricks compare with the force exerted on her hand?
30. How will the impulse differ if Cassy's hand bounces back when striking the bricks?
31. We know that falling on a mat is preferable to falling on a concrete floor. Explain why in terms of the impulse-momentum relationship.
32. In terms of the impulse-momentum relationship, explain why falling and bouncing from a solid pavement is more forceful than merely coming to rest upon impact.

4B—Glucose: Energy for Life

33. The word *burn* is often used to describe the process of cellular respiration, in which cells release energy from the chemical bonds in food molecules. How is the "burning" that goes on in cells different from literal burning—for example, burning a log on a campfire?
34. In what sense are you powered by solar energy?

P. 87

with an integrated and relevant approach

First we talked about force × time: impulse. Now we talk about force × distance: work.

The word *work*, in common usage, means physical or mental exertion. Don't confuse the science definition of work with the everyday notion of work.

P. 74

Updated! FYI marginal notes provide a more applied focus with information relevant to today's students.

Updated! Technology boxes present contemporary and relevant applications that connect science with students' everyday lives. New topics include Thermal Windows and Glassware (Chapter 6), Genome Editing with CRISPR-Cas9 (Chapter 16), and Wind Power and Global Winds (Chapter 26).

TECHNOLOGY

Reducing Fluid Friction

Have you experienced frustration with ketchup that resists flowing from a bottle? Or with mayonnaise that stubbornly remains behind in a jar? Or paint that sticks to the inside of a pail when the pail is "empty"? The culprit is unwanted friction. In 2012, a new product called LiquiGlide was invented at Massachusetts Institute of Technology (MIT) that greatly reduces friction and enhances slipperiness.

LiquiGlide is a transparent thin film that adheres to the inner surfaces of the smooth walls of glass, plastic, ceramic, or metal containers. The film surface is impregnated with nano-sized grooves. At this point, LiquiGlide is not yet slippery; not until a specially customized liquid is introduced that nestles in the grooves to form a coating held in place by capillary forces. This liquid coating creates a slippery surface fixed to the interior surface that enables the liquid product, ketchup for example, to easily slide from the bottle. The ketchup is not in contact with the glass or plastic bottle, but with the customized film coating. Hence the near frictionless flow of the ketchup, which pours out of the bottle leaving nothing behind. What works for ketchup, however, won't work for mayonnaise. Each specific liquid coating in the grooves of the LiquiGlide works with the product liquid. One customized coating for ketchup, another for spaghetti sauce, and another for mayonnaise.

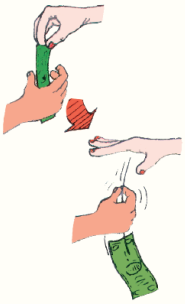
LiquiGlide is without flavor, odor, and is composed of non-toxic FDA-approved materials. Furthermore, the coating does not interfere with recycling. A container completely clean of the once-held product improves recycling and decreases waste. Watch for this amazing new reducer of friction—not only in bottles in your kitchen or bathroom, but in medical devices, oil pipelines, and in yet unexpected places.

P. 28

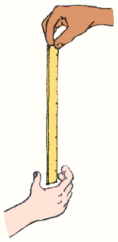
Help students succeed

THINK AND DO (HANDS-ON APPLICATION)

38. Place your phone on top of a sheet of paper on a desk or table. Pull the paper horizontally with a quick snap. What concept of physics does this illustrate?
39. By any method you choose, determine both your walking speed and your running speed.
40. Try this with your friends: Hold a dollar bill so that the midpoint hangs between a friend's fingers and challenge your friend to catch it by snapping her fingers shut when you release it. She won't be able to catch it! Explanation: From $d = \frac{1}{2}gt^2$, the bill will fall a distance of 8 centimeters (half the length of the bill) in a time of 1/8 second, but the time required for the necessary impulses to travel from her eyes to her brain is at least 1/7 second.



41. Drop a ruler between a friend's fingers as shown. The number of centimeters that pass through his fingers relates to his reaction time. You can express the result in fractions of a second by rearranging $d = \frac{1}{2}gt^2$. Expressed for time it is $t = \sqrt{2d/g} = 0.045\sqrt{d}$, where d is in centimeters.

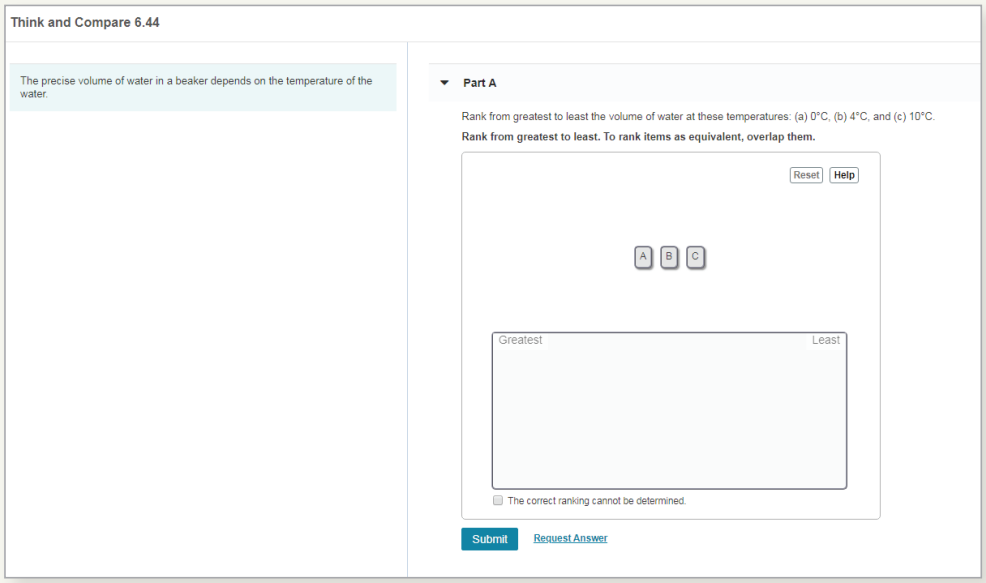


42. Stand flat-footed next to a wall and make a mark at the highest point you can reach. Then jump vertically and make another mark at the highest possible point. The distance between these two marks is your vertical jumping distance. Use this distance to calculate your personal hang time.

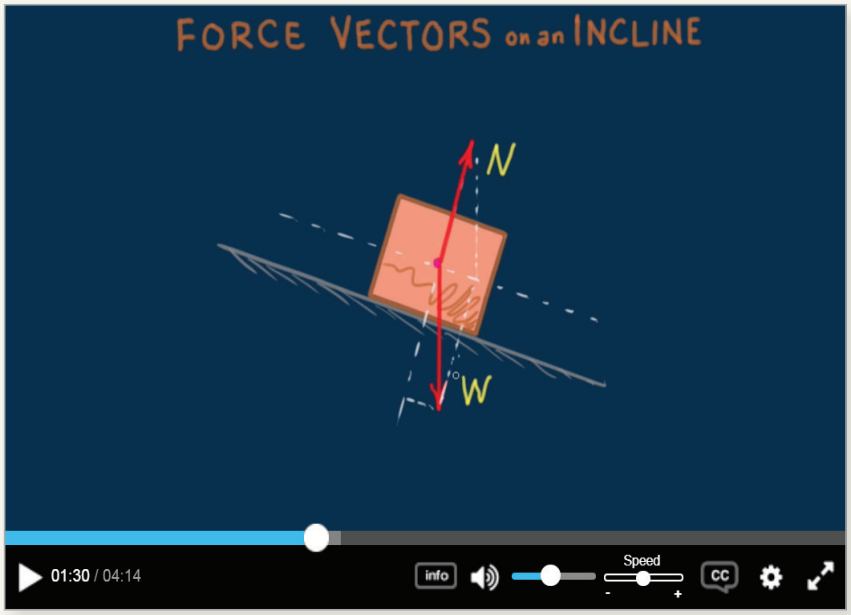
P. 36

New and Updated! End-of-chapter questions allow students to practice their knowledge, comprehension, hands-on application, formula familiarization, analysis, mathematical application, synthesis, and evaluation skills by answering questions that relate to the chapter material.

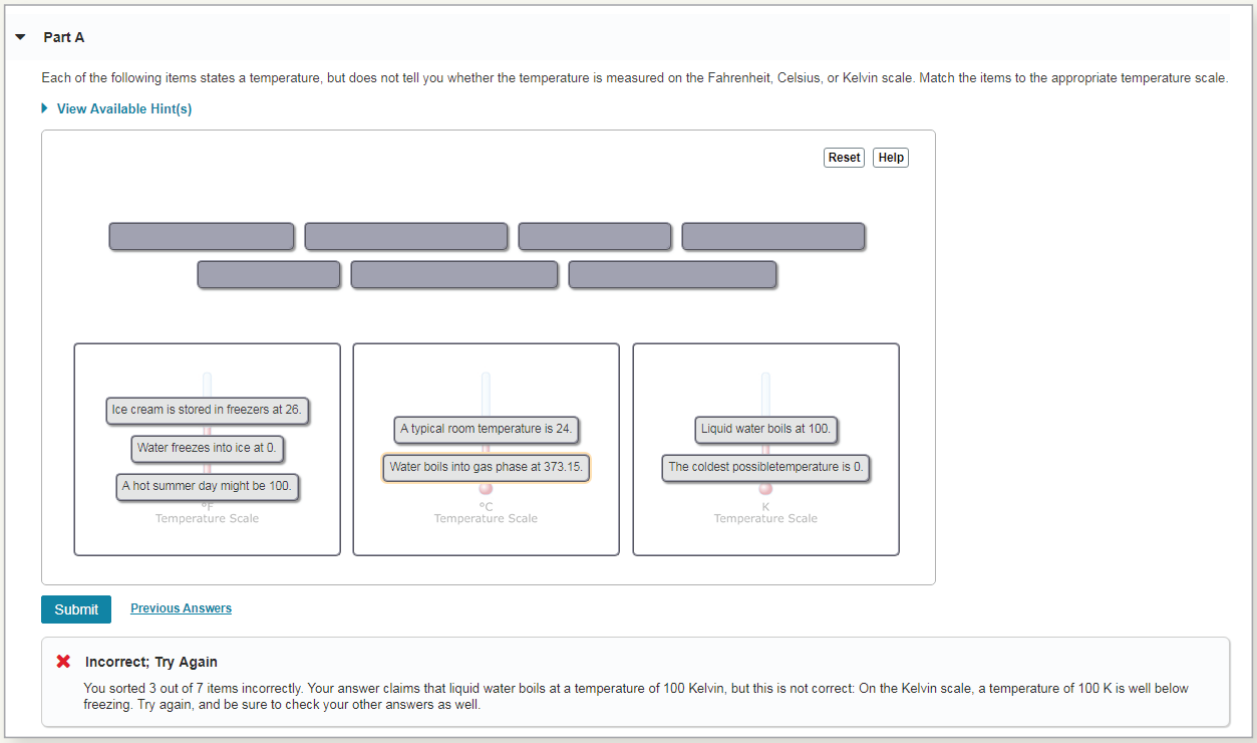
In Mastering Physics, enhanced end-of-chapter questions provide students with opportunities to practice, providing personalized feedback when and where students need it, including links to the eText, tutorials, and wrong-answer feedback for homework assignments.



with effective pedagogy and engaging content



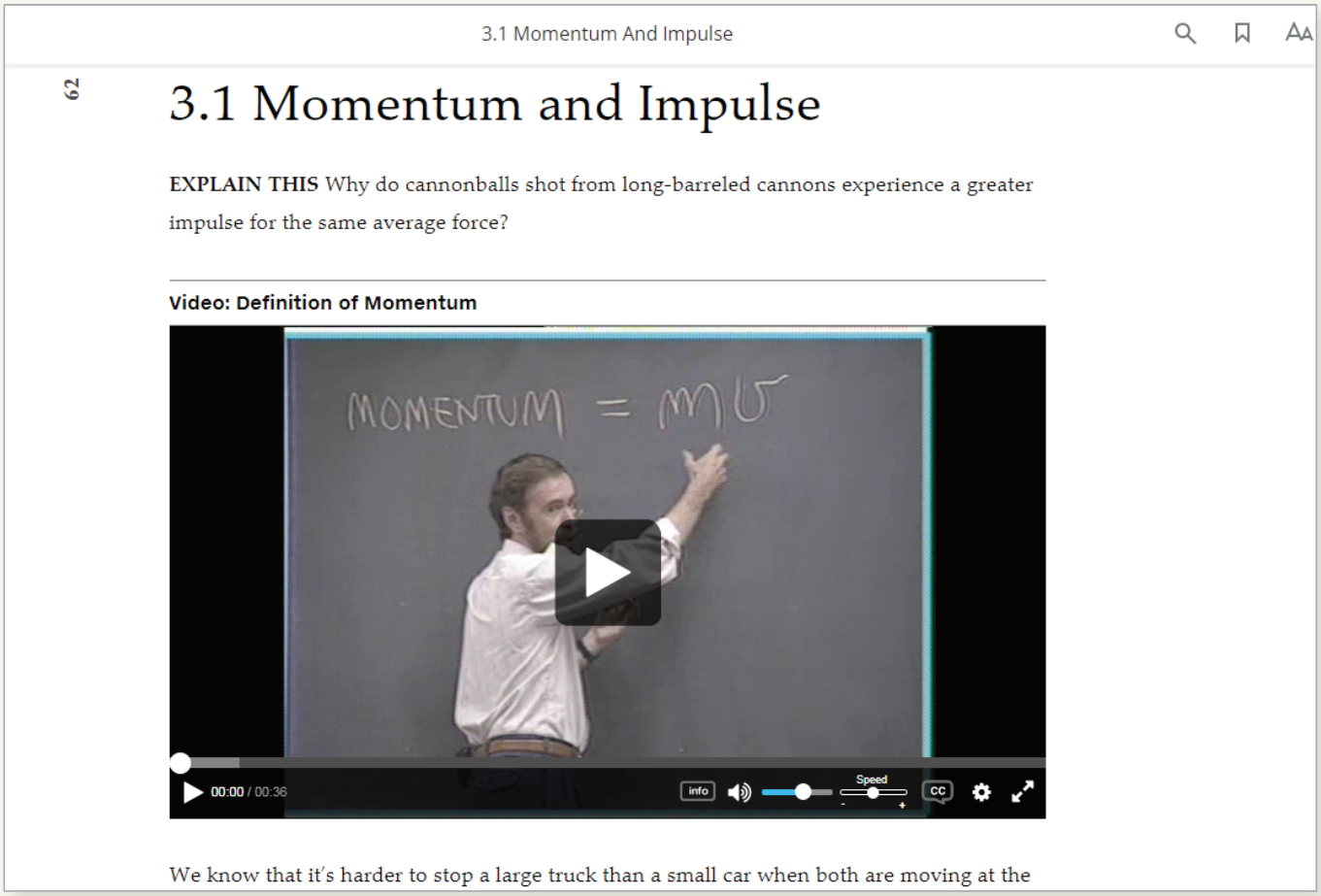
Video tutorials include screencasts created by the authors to help students arrive in class prepared. These lessons complement chapter material by giving students the context they need to read with greater understanding. In the eText, students can access and view by clicking on the video icon.



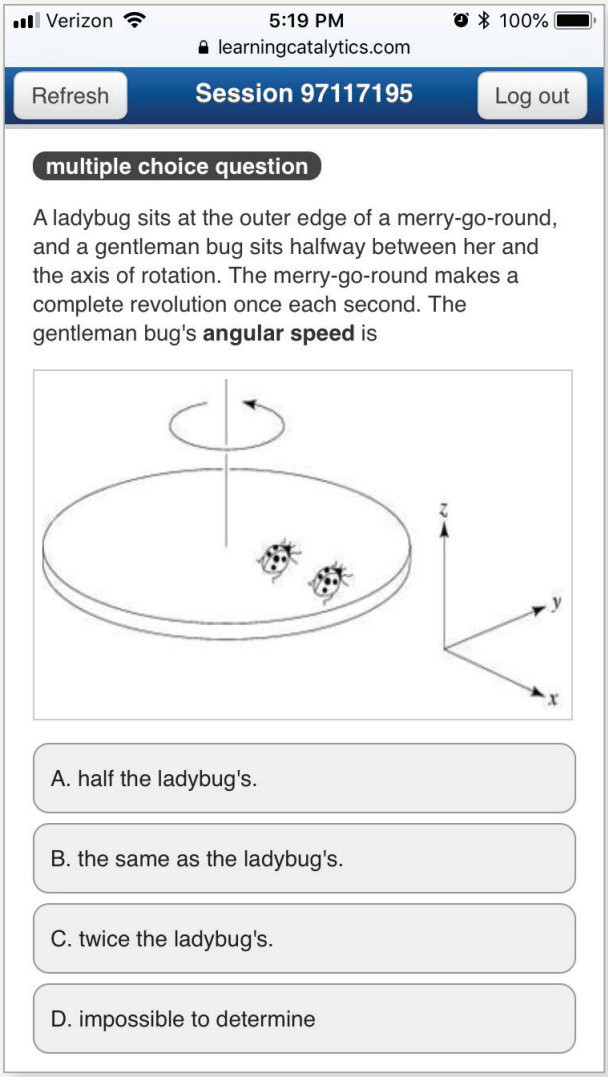
Tutorials and Coaching Activities help students learn science by practicing science. Assignable activities guide students through the toughest topics with wrong answer feedback and hints that emulate the office hour experience.

Give students anytime, anywhere access with Pearson eText

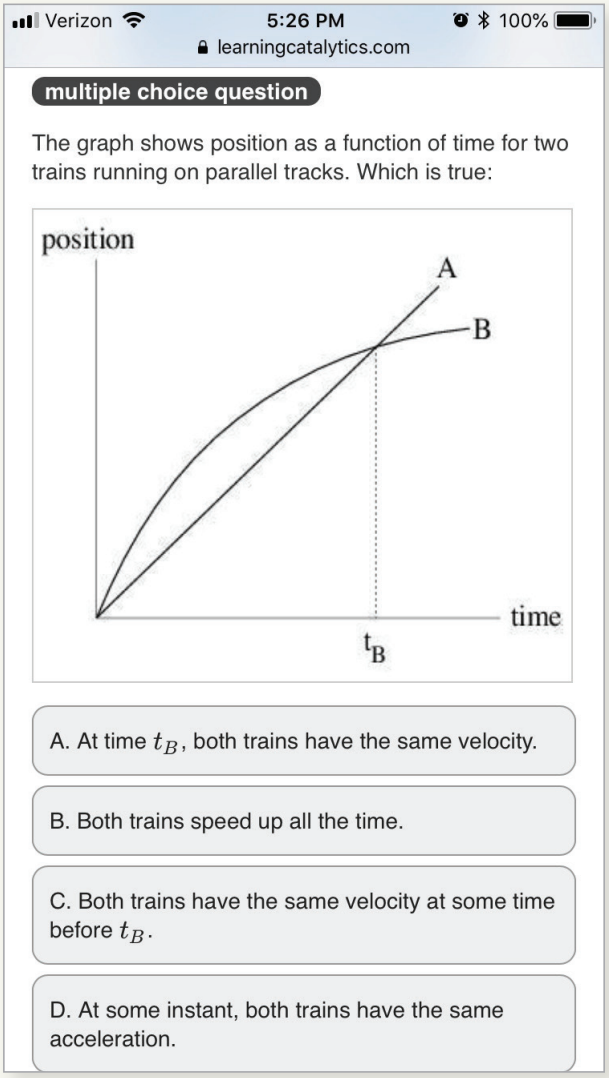
Pearson eText is a simple-to-use, mobile-optimized, personalized reading experience available within Mastering. It allows students to easily highlight, take notes, and review key vocabulary all in one place—even when offline. Seamlessly integrated videos, rich media, and interactive self-assessment questions engage students and give them access to the help they need, when they need it. Pearson eText is available within Mastering Physics when packaged with a new book; students can also purchase Mastering with Pearson eText online. For instructors not using Mastering, Pearson eText can also be adopted on its own as the main course material.



Reach every student with Learning Catalytics



With **Learning Catalytics,** you'll hear from every student when it matters most. You pose a variety of questions that help students recall ideas, apply concepts, and develop critical-thinking skills. Your students respond using their own smartphones, tablets, or laptops.



You can monitor responses with real-time analytics and find out what your students do — and don't — understand. Then, you can adjust your teaching accordingly, and even facilitate peer-to-peer learning, helping students stay motivated and engaged. Learning Catalytics includes prebuilt questions for topics in ***Conceptual Integrated Science,* 3rd Edition.**

Instructor support you can rely on

Conceptual Integrated Science **includes a full suite of instructor support materials in the Instructor Resources area in Mastering Physics. Resources include lecture presentations, images and clicker questions in PowerPoint; all figures and photos from the text; interactive figures and videos; answers to all end-of-chapter questions; an instructor's manual; and a test bank.**

Download instructor resources from the links below.

PowerPoint Presentation Tools

Chapter 7 Image PowerPoint	pptx, 25.9 MB
Chapter 7 Lecture Outline PowerPoint	zip, 16.4 MB
Chapter 7 Reading Quiz Clicker PowerPoint	pptx, 3.4 MB
Chapter 7 Review Clicker PowerPoint	pptx, 3.3 MB

JPEG Images

Appendices Labeled JPEG Images Labeled images from appendices in the text.	zip, 11.5 MB
Chapter 7 Labeled JPEG Images Labeled images from the text.	zip, 24.7 MB
Chapter 7 Unlabeled JPEG Images Unlabeled images from the text.	zip, 6.2 MB

CONCEPTUAL Integrated Science

THIRD EDITION

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Saint Michael's College

Jennifer Yeh
University of California, San Francisco

Pearson

To the Student

Welcome to *Conceptual Integrated Science*. The science you'll learn here is INTEGRATED. That means we'll explore the individual science disciplines of physics, chemistry, biology, Earth science, and astronomy PLUS the areas where these disciplines overlap. Most of the scientific questions you're curious about, or need to know about, involve not just one discipline, but several of them in an overlapping way. How did the universe originate? That's astronomy + physics. How are our bodies altered by the foods we eat, the medicines we take, and the way we exercise? That's chemistry + biology. What's the greenhouse effect? Will it trigger irreversible global warming, threatening life on our planet? Physics, chemistry, biology, and Earth science are all needed to understand the answers.

We're convinced that the CONCEPTUAL orientation of this book is the way in which students best learn science. That means that we emphasize concepts *before* computation. Although much of science is mathematical, a firm qualitative grasp of concepts is also important. Too much emphasis on mathematical problem solving early in your science studies can actually distract you from the concepts and prevent you from fully comprehending them. If you continue in science, you may follow up with classes requiring advanced mathematical methods. Whether you do or don't, we think you'll be glad you learned the concepts first with just enough math to make them clearer.

This course provides plenty of resources beyond the text as well. For example, the interactive figures, interactive tutorials, and demonstration videos on www.masteringphysics.com will help you visualize science concepts, particularly processes that vary over time, such as the velocity of an object in free fall, the phases of the Moon, or the formation of chemical bonds. The activities in the *Laboratory Manual* will build your gut-level feeling for concepts and your analytical skills. Ponder the puzzlers in the *Conceptual Integrated Science Practice Book* and work through the simple review questions—all this will increase your confidence and mastery of science.

As with all things, what you get out of this class depends on what you put into it. So study hard, ask all the questions you need to, and most of all enjoy your scientific tour of the amazing natural world!

To the Instructor

THIS THIRD EDITION OF *Conceptual Integrated Science*, with its important ancillaries, provides your students an enjoyable and readable introductory coverage of the natural sciences. As with the previous edition, the 29 chapters are divided into five main parts—Physics, Chemistry, Biology, Earth Science, and Astronomy. We begin with physics, the basic science that provides a foundation for chemistry, which in turn underlies biology, which extends to Earth science and astronomy.

For the nonscience student, this book affords a means of viewing nature perceptively. One can see that surprisingly few relationships make up its rules, most of which are the laws of physics presented in Part One. Physics laws are nature's secret codes. Here they are expressed both in words and in equation form. We view equations as *guides to thinking*. Even students who shy away from mathematics can learn to read equations to guide their thinking—to see how concepts connect. The symbols in equations are akin to musical notes that guide musicians.

For the science student, this same foundation affords a springboard to further study. For quantitatively oriented students, ample end-of-chapter material provides problem-solving activity through the *Think and Solve* problems.

Physics begins with static equilibrium so that students can start with forces before studying velocity and acceleration. After success with simple forces, the coverage touches lightly on kinematics, enough preparation for Newton's laws of motion. The pace picks up with the conventional order of mechanics topics followed by heat, thermodynamics, electricity and magnetism, sound, and light. Physics chapters lead to the realm of the atom—a bridge to chemistry.

The chemistry chapters begin with a look at the submicroscopic world of the atom, which is described in terms of subatomic particles and the periodic table. Students are then introduced to the atomic nucleus and its relevance to radioactivity, nuclear power, as well as astronomy. Subsequent chemistry chapters follow a traditional approach covering chemical changes, bonding, molecular interactions, and the formation of mixtures. With this foundation, students are then set to learn the mechanics of chemical reactions and the behavior of organic compounds. As with previous editions, chemistry is related to the student's familiar world—the fluorine in their toothpaste, the Teflon on their frying pans, and the flavors produced by various organic molecules. The environmental aspects of chemistry are also highlighted—from how our drinking water is purified to how atmospheric carbon dioxide influences the pH of rainwater and our oceans.

The biology section begins by asking—what constitutes life? Each of the first three chapters focuses on a key feature of living things. We begin with a discussion of cells, move on to genes, and finally, tackle evolution and the origin of life. From here, we proceed to an overview of the different kinds of living things found on Earth. This overview is followed by two chapters on humans, our own species. In these chapters, we study the human body and how it works. Finally, we look at ecology, the study of how living organisms interact with their environments.

The Earth science chapters begin with plate tectonics, the theory that establishes the underlying framework of the geosciences. The next chapter is about rocks and minerals, the principal materials that make up the solid Earth. Then comes a tour of Earth's landforms, surface features, and geography followed by a chapter on surficial processes—those processes of weathering, erosion, and deposition that originate at Earth's surface and shape the planet's contours. Plate tectonics is about Earth's interior, and the chapters on rock, landforms, and surficial processes describe Earth's

surface. The next chapter in the sequence rises higher still—into the atmosphere—with weather. The subject of weather is broken down into elements from atmospheric pressure to wind to precipitation that can be learned separately but then applied to complex phenomena such as weather systems. The Earth science unit concludes with a chapter on environmental geology, which is new to the second edition. It provides an updated review of earthquakes, tsunami, hurricanes, volcanic eruptions, and other geologic hazards. Most importantly, it features expanded coverage of our changing climate including extensive discussion of natural and anthropogenic climate change.

The applications of physics, chemistry, biology, and the Earth sciences applied to other massive bodies in the universe culminate in Part Five—astronomy. This unit introduces the basic structure of the universe from our local solar system and the stars we see at night to galaxies and superclusters of galaxies. Focus is given to modern theories describing how this structure evolved and is continuing to evolve. Many recent discoveries are featured in this edition, illustrating that science is more than a growing body of knowledge; it is an arena in which humans actively and systematically reach out to learn more about our place in the universe.

What's New to This Edition

Conceptual Integrated Science now comes with a powerful media package including **Mastering Physics®**, the most widely used, educationally proven, and technologically advanced tutorial and homework system available.

Mastering Physics contains:

- A **library of assignable and automatically graded content**, including tutorials, visual activities, end-of-chapter problems, and test bank questions so instructors can create the most effective homework assignments with just a few clicks. A **color-coded gradebook** instantly identifies vulnerable students or topic areas that are challenging for students in the class.
- A **student study area** with practice quizzes, Interactive Figures, self-guided tutorials, flashcards, videos, access to the Pearson eText version of the book, and more.
- An **instructor resources section** with PowerPoint lectures, clicker questions, Instructor Manual files and more.

Another significant revision for this third edition lies with the development of the end-of-chapter review. New questions were added while older ones were either discarded or reworded for improved quality. All questions were then organized following Bloom's taxonomy of learning as follows:

Summary of Terms (Knowledge)
These key terms match the definitions given within the chapter and are now listed in alphabetical order so that they appear as a mini-glossary for the chapter.

Reading Check Questions (Comprehension)
These questions frame the important ideas of each section in the chapter. They are for review and a check of reading comprehension. They are simple questions and all answers can easily be discovered in the chapter.

Think Integrated Science
Questions pertaining to the Integrated Science sections of each chapter are contained in this section. Questions range from straightforward, reading-check type questions to critical-thinking exercises.

Think and Do (Hands-On Application)
The *Think and Do* items are easy-to-perform hands-on activities designed to help students experience physical science concepts for themselves.

Think and Solve (Mathematical Application)
The *Think and Solve* questions blend simple mathematics with concepts. They allow students to apply problem-solving techniques, many of which are featured in the Math Connection boxed features.

Think and Compare (Analysis)
The *Think and Compare* questions ask students to make comparisons of quantities. For example, when asked to rank quantities such as momentum or kinetic energy, appreciably more judgment is called for than in providing numerical answers. Some *Think and Compare* analyze trends, as in ranking atoms in order of increasing size based upon student understanding of the periodic table. This feature elicits critical thinking that goes beyond *Think and Solve*.

Think and Explain (Synthesis)
The *Think and Explain* questions, by a notch or two, are the more challenging questions at the end of each chapter. Many require critical thinking while others are designed to prompt the application of science to everyday situations. All students wanting to perform well on exams should be directed to the *Exercises* because these are the questions that directly assess student understanding. Accordingly, many of the *Exercises* have been adapted to a multiple-choice format and integrated into the *Conceptual Integrated Science, 3e* test bank. This will hopefully allow the instructor to reward those students who put time and effort into the *Exercises*.

Think and Discuss (Evaluation)
The *Think and Discuss* topics provide students the opportunity to apply science concepts to real-life situations, such as whether a cup of hot coffee served to you in a restaurant cools faster when cream is added promptly or a few minutes later. Other discussion questions allow students to present their educated opinions on a number of science-related hot topics, such as the appearance of pharmaceuticals in drinking water.

Readiness Assurance Test
Each chapter review concludes with a set of 10 multiple-choice questions that students can take for self-assessment. They are advised to study further if they score less than 7 correct answers.

Also in this edition are the solutions to the odd-numbered end-of-chapter questions in the back of this book. As before, solutions to all end-of-chapter questions are available to instructors through the Instructor Manual for *Conceptual Integrated Science*, which is found in the Instructor Resource Center and in the Instructor Resource area of Mastering Physics.

This third edition features a new and, we think, refreshing page layout design. Integrated into this design are **learning objectives** that appear alongside each chapter section head. Each learning objective begins with an active verb that specifies what the student should be able to do after studying that section, such as "Calculate the energy released by a chemical reaction." These section-specific learning objectives are further integrated into the new Mastering Physics online tutorial/assessment tool.

The text of all chapters has been edited for accuracy, better readability, and also updated to reflect current events, such as the new data and images from space crafts and orbiting telescopes and the popularity of personal DNA testing.

The scope and sequence of chapters is revised for this second edition. The material on the atom has been folded into the chemistry unit so that the atomic theory is explained at the point of use. In Part Three—Biology, the genetics chapter has been reorganized, and much new material has been added on DNA technology, its uses, and its potential dangers. The ecology chapter has also been reorganized with new attention to human population growth and human ecological footprints. The Earth science material has been reorganized such that the geography material is now separated from the discussion of surficial processes, allowing for more discussion of the oceans. A chapter

on Historical Geology was eliminated with the most important concepts (such as the geologic time scale, Cretaceous extinction, and the nature of the rock record) being integrated into other chapters. The elimination of Historical Geology allowed the new chapter on Environmental Geology to be added with in-depth coverage of climate change. In Part Five—Astronomy, aside from updates from recent discoveries, the first section of Chapter 28 has been heavily revised in its presentation of nebular theory and the second chapter of this unit is expanded greatly to include discussions of cosmology.

Ancillary Materials

Most significantly, *Conceptual Integrated Science* is available with Mastering Physics—a homework, tutorial, and assessment system based on years of research into how students work problems and precisely where they need help. Studies show that students who use Mastering Physics significantly increase their scores compared to hand-written homework. Mastering Physics achieves this improvement by providing students with instantaneous feedback specific to their wrong answers and simpler sub-problems upon request when they get stuck. Instructors can also assign End-of-Chapter (EOC) problems from every chapter including multiple-choice questions, section-specific exercises, and general problems. Quantitative problems can be assigned with numerical answers and randomized values or solutions.

The Pearson eText of *Conceptual Integrated Science* is available through Mastering Physics. Allowing students access to the text wherever they have access to the Internet, the Pearson eText comprises the full text, including figures that can be enlarged for better viewing, popup definitions and terms, a note-taking feature, and more.

Tutorial video lessons and screencasts featuring the authors are now available to students at ConceptualAcademy.com. This is a must-visit website for any student who needs a bit of extra help. It is also a great tool for the online component of any course and as a support for instructors seeking to include more student activities during class.

The ***Instructor Manual for Conceptual Integrated Science*** (ISBN 978-0-135-47973-5), which you'll find to be different from most instructors' manuals, allows for a variety of course designs to fit your taste. It contains many lecture ideas and topics not treated in the textbook as well as teaching tips and suggested step-by-step lectures and demonstrations. It has full-page answers to all the end-of-chapter material in the text.

The ***Conceptual Integrated Science Practice Book*** (ISBN 978-0-135-47975-9) is a pencil and paper workbook that we see as our most creative work. Student interactions include filling in the blanks, making calculations, completing diagrams, and visualizing concepts being learned—all of which is student engagement with subject matter at its best. And quite nicely, this third edition has added Practice Pages to all five parts of the textbook. It spans a wide use of analogies and intriguing situations, all with a user-friendly tone.

The ***Test Bank for Conceptual Integrated Science*** (ISBN 978-0-135-47965-0) has more than 3000 multiple-choice questions. The questions are categorized according to level of difficulty. The Test Bank allows you to edit questions, add questions, and create multiple test versions.

Another valuable media resource available to you is the ***Instructor Resource Center (Download Only) for Conceptual Integrated Science*** (ISBN 978-0-135-47970-4). Available in Mastering Physics, these resources provide instructors with the largest library available of purpose-built, in-class presentation materials, including all the images from the book in high-resolution JPEG format; interactive figures™ and videos; PowerPoint® lecture outlines and clicker questions in PRS-enabled format for each chapter, all of which are written by the authors; and Hewitt's acclaimed Next-Time Questions in PDF format. The *Instructor Resource Center* provides you with everything you need to prepare for dynamic, engaging lectures in no time.

Go to it! Your conceptual integrated science course really can be the most interesting, informative, and worthwhile science course your students will ever take.