Give students a robust conceptual foundation while building critical problem-solving skills

Robinson/McMurry/Fay’s *Chemistry*, known for a conceptual focus, extensive worked examples, and thoroughly constructed connections between organic, biological, and general chemistry, illustrates the application of chemistry to students’ lives and careers. With the 8th edition, lead author Jill Robinson draws upon her exceptional teaching skills to create more engaging, active learning opportunities for students and faculty, including new interactive experiences that help identify and address students’ preconceptions. In Mastering Chemistry and the Pearson eText, a new media program increases students’ awareness of their learning process and allows instructors to choose the level of interactivity appropriate for their classroom.
Facilitate active learning with new eText interactives

**BIG IDEA Question 4**

For which object would be it impossible to accurately know both the position and velocity: a thrown baseball, an electron in a cathode-ray tube, both, or neither?

**NEWLY INTERACTIVE! Big Idea questions**

NEWLY INTERACTIVE! Big Idea questions provide new interactivity within the eText and teach students how to actively read a science text by modeling the kinds of questions they should ask themselves, prompting them to summarize main points, and stimulating them to make connections between concepts and mathematical problems. These questions help ensure students are familiar with main concepts and terms before coming to class. Activities like this also improve retention and comprehension by asking students to answer questions at the end of reading a section for retrieval practice.

**NEWLY INTERACTIVE! Figure It Out questions**

Figure It Out questions provide new interactivity within the eText so students can test themselves at the point of learning and receive instant, answer-specific feedback written by author Jill Robinson. Questions appear with select figures and encourage students to look at each illustration more carefully and recognize general lessons offered in the figure.
Build students’ problem-solving skills

WORKED EXAMPLE 6.4

Higher Ionization Energies
Which has the larger fifth ionization energy, Ge or As?

STRATEGY
Look at their positions in the periodic table, and write the electron configuration. If the fifth electron must be removed from an inner shell, then that element will have the larger ionization energy.

SOLUTION
Ge: [Ar] 4s² 3d¹⁰ 4p²
As: [Ar] 4s³ 3d¹⁰ 4p⁵

The group 4A element germanium has four valence-shell electrons and thus has four relatively low ionization energies, whereas the group 5A element arsenic has five valence-shell electrons and has five low ionization energies. Germanium has a larger Z₂ than arsenic because the fifth electron to be removed in Ge occupies a lower electron shell (n = 3).

PRACTICE 6.7
Which has the largest third ionization energy: Be, C, or N?

CONCEPTUAL APPLY 6.8
The figure on the left represents the successive ionization energies of an atom in the third period of the periodic table. Which atom is this most likely to be?

NEW! Practice Tests provide assessment for chapter learning objectives and additional instruction in concepts and problem-solving skills in the printed text as well as in the eText and Mastering Chemistry. When students miss a problem, they are instructed to consult the study guide for additional instruction and practice problems. When a student answers incorrectly in Mastering Chemistry or the eText, their practice exam automatically links to worked examples and additional practice problems.

NEW! Problem-Solving Videos feature Jill Robinson working out problems in the text to help students see every step of the process. These dynamic videos are provided in Mastering Chemistry, referenced in the print text, and also embedded in the eText. These are also assignable in Mastering Chemistry along with follow-up assessment questions.

PRACTICE TEST

After studying this chapter, you can assess your understanding with these practice test questions, which are correlated with chapter learning objectives. If you answer a question incorrectly, refer to the learning objectives in the end-of-chapter Study Guide for assistance. The Study Guide provides a conceptual summary, references a Worked Example to model how to solve the problem, and gives additional problems for more practice.

1. Refer to a periodic table. Which pair of elements do you expect to be most similar in their chemical properties? (LO 2.3)
   (a) K and Cu
   (b) O and Se
   (c) Be and B
   (d) Rb and Sr

2. Identify the location of the element in period 4, group 6A, and classify it as a metal, nonmetal, or semimetal. (LO 2.2)

   (a) Element 1—An element in a Group 1A metal that is found in its pure form in nature.
   (d) Element 1—An element that is a solid at room temperature, brittle, and a poor conductor of electricity.

3. A compound containing sulfur and fluorine contains 8.00 g of S and 9.50 g of F. Which combination of S and F masses represents a different compound that obeys the Law of Multiple Proportions? (LO 2.8)
   (a) 32.0 g of S and 38.0 g of F
   (b) 4.00 g of S and 4.75 g of F
   (c) 8.00 g of S and 10.5 g of F
   (d) 16.0 g of S and 57.0 g of F

4. Which experiment and subsequent observation led to the discovery that atoms contain negatively charged particles, now known as electrons? (LO 2.10–2.12)
   (a) Oil is sprayed into a chamber and the speed at which the oil droplets fall is measured with and without an applied voltage. X rays in the chamber knock electrons out of air molecules. The electrons stick to the oil producing an overall negative charge on the drops. Adjusting the voltage changes the speed at which the negatively charged oil droplets fall.
   (b) When a high voltage is applied across metal electrodes at opposite ends of a sealed glass tube, a cathode ray is produced. The cathode ray is repelled by a negatively charged plate.

   (c) A radioactive substance emits alpha particles, which are directed in a thin gold foil. Most of the alpha particles pass through the foil, but a few alpha particles are slightly deflected and some even bounce back toward the radioactive source.

   (d) The mass of different elements in a pure chemical compound are measured. Different samples of the compound always contain the same proportion of elements by mass.

5. How many protons, neutrons, and electrons are present in an atom of \(^{127}\text{Te}\)? (LO 2.14)
   (a) 82 protons, 206 neutrons, 82 electrons
   (b) 124 protons, 82 neutrons, 124 electrons
   (c) 82 protons, 124 neutrons, 82 electrons
   (d) 82 protons, 82 neutrons, 124 electrons
Engage students

Interactive Simulations
cover some of the most difficult chemistry concepts. Written by leading authors in simulation development, these increase students’ understanding of chemistry and clearly illustrate cause-and-effect relationships.

Interactive solutions are assignable in Mastering Chemistry and include hints and wrong answer feedback to help students right when they need it.
in learning chemistry

Pause and Predict Video Quizzes bring chemistry to life with lab demonstrations illustrating key topics in general chemistry.

Students are asked to predict the outcome of experiments as they watch the videos. A set of multiple-choice questions, with hints and wrong answer feedback, challenge students to apply the concepts from the video to related scenarios.
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 when packaged with a new book; students can also purchase Mastering with Pearson eText online.
Reach every student with Mastering Chemistry

Dynamic Study Modules in Mastering Chemistry help students study effectively—and at their own pace—by keeping them motivated and engaged. The assignable modules rely on the latest research in cognitive science using methods—such as adaptivity, gamification, and intermittent rewards—to stimulate learning and improve retention.

The Chemistry Primer relies on videos, hints, and feedback to refresh students’ math skills in the context of chemistry and prepares them for success in the course. These tutorials can be assigned before the course begins or throughout the course as just-in-time remediation. They ensure students practice and maintain their math skills while building their chemical literacy.
Instructor support you can rely on

*Chemistry* includes a full suite of instructor support materials in the Instructor Resources area in Mastering Chemistry. Resources include new Ready-to-Go Teaching Modules, PowerPoint lecture outlines, all images and worked examples from the text, and a testbank.

**NEW! Ready-to-Go Teaching Modules** provide organized material for every tough topic in General Chemistry. Created for and by instructors, the modules provide a guide for easy-to-use assignments for before and after class plus in-class activities with clicker questions and questions in Learning Catalytics™. Modules can be easily accessed via Mastering Chemistry.
Preface

FOR THE STUDENT

Francie came away from her first chemistry lecture in a glow. In one hour she found out that everything was made up of atoms which were in continual motion. She grasped the idea that nothing was ever lost or destroyed. Even if something was burned up or rotted away, it did not disappear from the face of the earth; it changed into something else—gases, liquids, and powders. Everything, decided Francie after that first lecture, was vibrant with life and there was no death in chemistry. She was puzzled as to why learned people didn’t adopt chemistry as a religion.

—Betty Smith, A Tree Grows in Brooklyn

We know that not everyone has such a breathless response to their chemistry lectures, and few would mistake chemistry as a religion, yet chemistry is a subject with great logical beauty. We love chemistry because it explains the “why” behind many observations of the world around us and we use it every day to help us make informed choices about our health, lifestyle, and politics. Moreover, chemistry is the fundamental, enabling science that underlies many of the great advances of the last century that have so lengthened and enriched our lives. Chemistry provides a strong understanding of the physical world and will give you the foundation you need to go on and make important contributions to science and humanity.

HOW TO USE THIS BOOK

You no doubt have experience using textbooks and know they are not meant to read like a novel. We have written this book to provide you with a clear, cohesive introduction to chemistry in a way that will help you, as a new student of chemistry, understand and relate to the subject. While you could curl up with this book, you will greatly benefit from continually formulating questions and checking your understanding as you work through each section. The way this book is designed and written will help you keep your mind active, thus allowing you to digest important concepts as you learn some of the many principles of chemistry.

The 8th edition was revised to create an interactive study cycle based on research of effective learning methods. Many common study habits such as highlighting, rereading, and long study sessions create the illusion of fast progress, but these gains fade quickly. More deep and durable learning occurs from self-testing, difficulty in practice, and spaced practice of different skills. Let’s see how specific steps in the study cycle use proven strategies to maximize your learning.

Step 1. Learning New Material

The 8th edition eText contains many new interactive features (Big Idea Questions, Interactive Worked Examples, Practice problems, and Figure It Out Questions) that should be used to quiz yourself and receive feedback as you work through the material in each chapter.

• **Narrative:** As you read through the text, always challenge yourself to understand the “why” behind the concept. For example, you will learn that carbon forms four bonds, and the narrative will give the reason why. By gaining a conceptual understanding, you will not need to memorize a large collection of facts, making learning and retaining important principles much easier! **Big Idea Questions** were written to help you digest and apply the most important concepts. In the printed book, these
questions appear in the margins, and in the eText, they are multiple choice questions with feedback to help you identify common mistakes.

- **Figures**: Figures are not optional! Most summarize and convey important points. *Figure It Out Questions* draw your attention to a key principle and provide guidance in interpreting graphs. Answer the question by examining the figure and perhaps rereading the related narrative. We’ve provided answers to Figure It Out Questions near the figure in the printed book and use an interactive hide-and-reveal feature in the eText.

- **Worked Examples**: Numerous worked examples throughout the text show the approach for solving a certain type of problem. Each worked example uses a step-by-step procedure.

- **Identify**—The first step in problem solving is to identify key information and classify it as a known or unknown quantity. This step also involves translating between words and chemical symbols. Listing knowns on one side and unknowns on the other organizes the information and makes the process of identifying the correct strategy more visual. The *Identify* step is used in numerical problems.

- **Strategy**—The strategy describes how to solve the problem without actually solving it. Failing to articulate the needed strategy is a common pitfall; too often students start manipulating numbers and variables without first identifying key equations or making a plan. Articulating a strategy will develop conceptual understanding and is highly preferable to simply memorizing the steps involved in solving a certain type of problem.

- **Solution**—Once the plan is outlined, the key information is used to answer the question.

- **Check**—A problem is not completed until you have thought about whether the answer makes sense. Use both your practical knowledge of the world and knowledge of chemistry to evaluate your answer. For example, if heat is added to a sample of liquid water and you are asked to calculate the final temperature, you should critically consider your answer: Is the final temperature lower than the original? Shouldn’t adding heat raise the temperature? Is the new temperature above 100 °C, the boiling point of water? The *Check* step is used in problems when the magnitude and sign of a number can be estimated or the physical meaning of the answer verified based on familiar observations.

To test your mastery of the concept explored in Worked Examples, two problems will follow. **PRACTICE** problems are similar in style and complexity to the Worked Example and will test your basic understanding. Interactive Practice Problems are available in the eText and have answer-specific feedback to help you identify common mistakes.

Once you have correctly completed this problem, tackle the **APPLY** problem, in which the concept is used in a new situation to assess a deeper understanding of the topic. Answers to Apply Problems can be found at the end of the book or by using the hide-and-reveal feature in the eText.

- **Interactive Worked Examples**: Each chapter has two video tutorials for challenging problems that model the process of expert thinking. The videos are interactive and ask you to make predictions before moving forward to the complete solution.

- **Conceptual Problems**: Conceptual understanding is a primary focus of this book. Conceptual problems are intended to help you with the critical skill of visualizing the structure and interactions of atoms and molecules while probing your understanding of key principles rather than your ability to correctly use numbers in an equation. The time you spend mastering these problems will provide high long-term returns by solidifying main ideas.

**Step 2. Problem-Solving Practice**
We achieve more complex and long-lasting learning by practicing problems that require more effort and slow down the pace of learning.
• **End-of-Chapter Problem Sets:** Working problems is essential for success in chemistry! The number and variety of problems at the end of chapter will give you the practice needed to gain mastery of specific concepts. Answers to every other problem are given in the “Answers” section at the back of the book so that you can assess your understanding. Your instructor may assign problems in an online format using the Mastering™ Chemistry platform, which comes with the added benefit of tutorials, feedback, and links to relevant content in the eText.

**Step 3. Mastery**

Once you have read the chapter and completed the end-of-chapter problems, you will need to review for the exam and assess which topics you have mastered and which still need to be solidified. Inquiry sections and practice tests are chapter capstones that strengthen mental representations by replaying learning and giving it meaning.

• **Inquiries:** Inquiry sections connect chemistry to the world around you by highlighting useful links in the future careers of many science students. Typical themes are materials, medicine, and the environment. The goal of these sections is to deepen your understanding and aid in retention by tying concepts to memorable applications. These sections can be considered as a capstone for each chapter because Inquiry problems review several main concepts and calculations. These sections will also help you prepare for professional exams because they were written in the same style as new versions of these exams: a passage of text describing an application followed by a set of questions probing your ability to apply basic scientific concepts to the situation.

• **End-of-Chapter Practice Test and Study Guide:** The end-of-chapter practice test and study guide are useful tools for exam preparation. Each practice test question is linked to a learning objective in the study guide. If you answer a question incorrectly or want more practice on that skill, refer to the study guide, which matches the learning objective to a concept summary, key skills for solving the problem, Worked Examples for assistance, and end-of-chapter problems so that you can practice your mastery of that skill.