Preface

From the first edition, my aim has been to write a general chemistry text that provides a firm foundation in chemical concepts and principles and to instill in students an appreciation of the vital part chemistry plays in our daily life. It is the responsibility of the textbook author to assist both instructors and their students in their pursuit of this objective by presenting a broad range of topics in a logical manner. I have tried to strike a balance between theory and application and to illustrate basic principles with everyday examples whenever possible.

In this eleventh edition, as in previous editions, my goal is to create a text that is clear in explaining abstract concepts, concise so that it does not overburden students with unnecessary extraneous information, yet comprehensive enough so that it prepares students to move on to the next level of learning. The encouraging feedback I have received from instructors and students has convinced me that this approach is effective.

What's New in This Edition?

Kenneth Goldsby, Florida State University, has joined Raymond Chang as an author on the eleventh edition of *Chemistry*. Ken's background in inorganic chemistry has added insight into content and problems, and his extensive work with undergraduate students, both in the classroom and in the laboratory, reinforces Raymond's long tradition of understanding and respecting the student's view of the material as well as the instructor's.

New organization with the chapters in the latter part of the text reorganized as follows:

Chapter 17: Entropy, Free Energy, and Equilibrium

Chapter 18: Electrochemistry

Chapter 19: Nuclear Chemistry

Chapter 20: Chemistry in the Atmosphere

Chapter 21: Metallurgy and the Chemistry of Metals

Chapter 22: Nonmetallic Elements and Their Compounds

Chapter 23: Transition Metals Chemistry and Coordination Compounds

Chapter 24: Organic Chemistry

Chapter 25: Synthetic and Natural Organic Polymers

Reorganization of these chapters enables those who teach nuclear chemistry to introduce this material right after the coverage of electrochemistry. In addition to recognizing the growing importance of nuclear medicine and the ongoing debate about the role nuclear power will play in addressing future energy needs, the placement of nuclear chemistry before atmospheric chemistry aids the discussion of radon pollution.

Numerous new end-of-chapter problems have been added to this new edition. A number of these problems test the student's ability to interpret graphical data and explain concepts. A new type of problems, called **Interpreting, Modeling & Estimating,** has been added to this edition. These problems are designed to teach the students to solve real-world problems, and they require the art of estimation based on appropriate assumptions, finding the necessary information, and formulating a plan for obtaining ballpark answers in many cases. In Section 1.10, the new problem type is described and a worked example is provided.

New is the creation and versatility of our **Connect® Chemistry** system. McGraw-Hill has initiated a rigorous process to ensure high-quality electronic homework. Through careful observation of real students and active instructors we have been able to evolve the online homework tool to an online learning and engagement tool. The goal of Connect is to usher in a new era of meaningful online learning that balances the conceptual and calculated aspect of this most vital discipline.

McGraw-Hill is offering students and instructors an enhanced digital homework experience using **Connect Chemistry**. Each problem within Connect Chemistry carries the text problem-solving methodology and is tailored with specific hints, as well as answer-specific feedback for common incorrect answers. Each question has been accuracy checked by two or more chemistry professors. Several rounds of editorial and chemical accuracy checking, in addition to numerous instructor and student tests of all problems, ensure the accuracy of all content.

In addition to the specific hints and feedback provided for all questions, many questions allow students a chemical drawing experience that can be assessed directly inside of their homework. Connect Chemistry utilizes CambridgeSoft's ChemDraw, which is widely considered the "gold standard" of scientific drawing

programs and the cornerstone application for scientists who draw and annotate molecules, reactions, and pathways. This collaboration of Connect and ChemDraw features an easy-to-use, intuitive and comprehensive course management and homework system with professional-grade drawing capabilities.

New **Review of Concepts** sections have been added to most chapters. This is a quick knowledge test for the student to gauge his or her understanding of the concept just presented. The answers to the Review of Concepts are available in the Student Solutions Manual and on the companion website in Connect.

New **Chemistry in Action** boxed essays are added to Chapter 7 (Quantum Dots), Chapter 12 (Dialysis), and Chapter 13 (Pharmacokinetics). We have also updated Chemistry in Action boxed essays on White Fat Cells, Brown Fat Cells, and Cure for Obesity in Chapter 6, Buckyballs and Graphene in Chapter 10, and the Shroud of Turin in Chapter 13.

Many **chapters** and **sections** have new and revised content based on the comments from reviewers and users. Some examples include:

- Chapter 1—new Section 1.10 on Real-World Problem Solving: Information, Assumptions, and Simplifications including new Example 1.9.
- Chapter 3—revised Section 3.9 Limiting Reagents including new Example 3.16 showing how synthetic chemists often have to adjust excess reagents to compensate for side reactions.
- Chapter 4—new Example 4.4 on writing molecular, ionic, and net ionic equations involving weak diprotic and triprotic acids.
- Chapter 6—new is the change of the symbol *E* to *U* for internal energy to be consistent with accepted usage.
- Chapter 7—new Example 7.6 on quantum mechanics.
- Chapter 9—Example 9.11 provides insight into drawing Lewis structures for compounds containing elements in the third period and beyond, and addresses the controversy in drawing these structures.
- Chapter 13—new section on pseudo first-order reactions.
- Chapter 19—expanded and updated coverage of medical application of carbon-14 dating and new content on the island of stability.

Problem Solving

The development of problem-solving skills has always been a major objective of this text. The two major categories of learning are shown next.

Worked examples follow a proven step-by-step strategy and solution.

- **Problem statement** is the reporting of the facts needed to solve the problem based on the question posed.
- **Strategy** is a carefully thought-out plan or method to serve as an important function of learning.
- **Solution** is the process of solving a problem given in a stepwise manner.
- **Check** enables the student to compare and verify with the source information to make sure the answer is reasonable.
- **Practice Exercise** provides the opportunity to solve a similar problem in order to become proficient in this problem type. The Practice Exercises are available in the Connect electronic homework system. The marginal notes list additional similar problems to work in the end-of-chapter problem section.

End-of-Chapter Problems are organized in various ways. Each section under a topic heading begins with Review Questions followed by Problems. The Additional Problems section provides more problems not organized by section, followed by the new problem type of Interpreting, Modeling & Estimating.

Many of the examples and end-of-chapter problems present extra tidbits of knowledge and enable the student to solve a chemical problem that a chemist would solve. The examples and problems show students the real world of chemistry and applications to everyday life situations.

Visualization

Graphs and Flow Charts are important in science. In *Chemistry*, flow charts show the thought process of a concept and graphs present data to comprehend the concept. A significant number of Problems and Reviews of Concepts, including many new to this edition, include graphical data.

Molecular art appears in various formats to serve different needs. Molecular models help to visualize the three-dimensional arrangement of atoms in a molecule. Electrostatic potential maps illustrate the electron density distribution in molecules. Finally, there is the macroscopic to microscopic art helping students understand processes at the molecular level.

Photos are used to help students become familiar with chemicals and understand how chemical reactions appear in reality.

Figures of apparatus enable the student to visualize the practical arrangement in a chemistry laboratory.

Study Aids

Setting the Stage

Each chapter starts with the Chapter Outline and A Look Ahead.

Chapter Outline enables the student to see at a glance the big picture and focus on the main ideas of the chapter.

A Look Ahead provides the student with an overview of concepts that will be presented in the chapter.

Tools to Use for Studying

Useful aids for studying are plentiful in *Chemistry* and should be used constantly to reinforce the comprehension of chemical concepts.

Marginal Notes are used to provide hints and feedback to enhance the knowledge base for the student.

Worked Examples along with the accompanying Practice Exercise are very important tools for learning and mastering chemistry. The problem-solving steps guide the student through the critical thinking necessary for succeeding in chemistry. Using sketches helps the student understand the inner workings of a problem. (See Example 6.1 on page 238.) A marginal note lists similar problems in the end-of-chapter problems section, enabling the student to apply new skill to other problems of the same type. Answers to the Practice Exercises are listed at the end of the chapter problems.

Review of Concepts enables students to evaluate whether they understand the concept presented in the section. Answers to the Review of Concepts can be found in the Student Solution Manual and online in the accompanying Connect Chemistry companion website.

Key Equations are highlighted within the chapter, drawing the student's eye to material that needs to be understood and retained. The key equations are also presented in the chapter summary materials for easy access in review and study.

Summary of Facts & Concepts provides a quick review of concepts presented and discussed in detail within the chapter.

Key Words lists of all important terms help the student understand the language of chemistry.

Testing Your Knowledge

Review of Concepts lets students pause and check their understanding of the concept presented and discussed in the section. Answers to the Review of Concepts can be found in the Student Solution Manual and online in the accompanying Connect Chemistry companion website.

End-of-Chapter Problems enable the student to practice critical thinking and problem-solving skills. The problems are broken into various types:

- By chapter section. Review questions test basic conceptual understanding, followed by Problems to test the student's skill in solving problems for that particular section of the chapter.
- Additional Problems uses knowledge gained from the various sections and/or previous chapters to solve the problem.
- Interpreting, Modeling & Estimating problems teach students the art of formulating models and estimating ballpark answers based on appropriate assumptions.

Real-Life Relevance

Interesting examples of how chemistry applies to life are used throughout the text. Analogies are used where appropriate to help foster understanding of abstract chemical concepts.

End-of-Chapter Problems pose many relevant questions for the student to solve. Examples include: Why do swimming coaches sometimes place a drop of alcohol in a swimmer's ear to draw out water? How does one estimate the pressure in a carbonated soft drink bottle before removing the cap?

Chemistry in Action boxes appear in every chapter on a variety of topics, each with its own story of how chemistry can affect a part of life. The student can learn about the science of scuba diving and nuclear medicine, among many other interesting cases.

Chemical Mystery poses a mystery case to the student. A series of chemical questions provide clues as to how the mystery could possibly be solved. Chemical Mystery will foster a high level of critical thinking using the basic problem-solving steps built up throughout the text.

Enhanced Support for Faculty and Students

McGraw-Hill offers various tools and technology products to support *Chemistry* for both faculty and students alike. Instructors can obtain teaching aides by calling the McGraw-Hill Customer Service Department at

1-800-338-3987, visiting our online catalog at www.mhhe.com, or by contacting their local McGraw-Hill sales representative.

For the Instructor

McGraw-Hill ConnectPlus® is a Web-based, interactive assignment and assessment platform that incorporates cognitive science principles to customize the learning process. The chemical drawing tool found within Connect Chemistry is CambridgeSoft's ChemDraw, which is widely considered the "gold standard" of scientific drawing programs and the cornerstone application for scientists who draw and annotate molecules, reactions, and pathways. This combination of Connect and ChemDraw features an easy-to-use, intuitive, and comprehensive course management and homework system with professional-grade drawing capabilities.

End-of-chapter problems from this textbook are available in Connect Chemistry for instructors to build assignments that are automatically graded and tracked through reports that export easily to Excel. Instructors can edit existing problems and write entirely new problems; track individual student performance—by problem, assignment, concepts, or in relation to the class overall—with automatic grading; provide instant feedback to students; and store detailed grade reports securely online. Grade reports can be easily integrated with learning management systems such as WebCT and Blackboard. Single sign-on integration is available with Blackboard course management systems. Within Connect, instructors can also create and share materials with colleagues. Ask your McGraw-Hill representative for more information, and then check it out at www.mcgrawhillconnect.com/chemistry.

With ConnectPlus, if you or your students are ready for an alternative version of the traditional textbook, McGraw-Hill has your solution. EBooks from McGraw-Hill are smart, interactive, searchable, and portable. Included is a powerful suite of built-in tools that enable detailed searching, highlighting, note taking, or instructor-to-student note sharing. In addition, the media-rich eBook for ***Chemistry*** integrates relevant animations and videos into the textbook content for a true multimedia learning experience.

McGraw-Hill LearnSmart™, an adaptive diagnostic learning system, powered by Connect Chemistry and based on artificial intelligence, constantly assesses your knowledge of the course material. As you work within the system, LearnSmart develops a personal learning path adapted to what you have actively learned and retained. This innovative study tool also has features to enable your instructor to see exactly what you have accomplished, with a built-in assessment tool for graded assignments. You can access LearnSmart for general chemistry by going to www.mcgrawhillconnect.com/chemistry.

McGraw-Hill Higher Education and Blackboard have teamed up.

Blackboard, the Web-based course-management system, has partnered with McGraw-Hill to better enable students and faculty to use online materials and activities to complement face-to-face teaching. Blackboard features exciting social learning and teaching tools that foster more logical, visually impactful, and active learning opportunities for students. You'll transform your closed-door classrooms into communities where students remain connected to their educational experience twenty-four hours a day.

This partnership enables you and your students access to McGraw-Hill's Connect and Create™ right from within your Blackboard course—all with one single sign-on.

Not only do you get single sign-on with Connect and Create, you also get deep integration of McGraw-Hill content and content engines right in Blackboard. Whether you're choosing a book for your course or building Connect assignments, all the tools you need are right where you want them—inside Blackboard.

Gradebooks are now seamless. When a student completes an integrated Connect assignment, the grade for that assignment automatically (and instantly) feeds your Blackboard grade center.

McGraw-Hill and Blackboard can now offer you easy access to industry-leading technology and content, whether your campus hosts it, or we do. Be sure to ask your local McGraw-Hill representative for details.

McGraw-Hill Tegrity® is a service that makes class time available all the time by automatically capturing every lecture in a searchable format for students to review when

they study and complete assignments. With a simple one-click start and stop process, you capture all computer screens and corresponding audio. Tegrity indexes as it records your slideshow presentations and anything shown on your computer, so students can use keywords to find exactly what they want to study.

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- **Art** Full-color digital files of all illustrations in the book.
- **Photos** The photos collection contains digital files of photographs from the text.
- **Tables** Every table that appears in the text is available electronically.
- **Animations** Numerous full-color animations illustrating important processes are also provided.
- **PowerPoint Lecture Outlines** Ready-made presentations for each chapter of the text.
- **PowerPoint Slides** All illustrations, photos, and tables are pre-inserted by chapter into blank PowerPoint slides.

Access to all books from the Library tab in the Instructor version of your textbook's Connect website, Presentation Center's dynamic search engine enables you to explore by discipline, course, textbook chapter, asset type, or keyword.

Computerized Test Bank Online

A comprehensive bank of test questions is provided within a computerized test bank, enabling professors to prepare and access tests or quizzes anywhere, at any time. Instructors can create or edit questions, or drag-and-drop questions to prepare tests quickly and easily. Tests can be published to their online course, or printed for paper-based assignments.

Instructor's Solution Manual

The **Instructor's Solution Manual** is written by Brandon J. Cruickshank (*Northern Arizona University*), Raymond Chang, and Ken Goldsby. The solutions to all of the end-of-chapter problems are given in the manual. The manual also provides the difficulty level and category type for each problem. This manual is online in the text's Connect Library tab.

Instructor's Manual

The ***Instructor's Manual*** provides a brief summary of the contents of each chapter, along with the learning goals, reference to background concepts in earlier chapters, and teaching tips. This manual is online in the text's Connect Library tab.

For the Students

Students can order supplemental study materials by contacting their campus bookstore, calling 1-800-262-4729, or online at www.shopmcgraw-hill.com.

Designed to help students maximize their learning experience in chemistry, we offer the following options to students:

With **McGraw-Hill Connect® Chemistry**, students can practice solving assigned homework problems using the same problem-solving methodology they've learned

from their textbook. Algorithmic problems serve up multiple versions of similar problems for mastery of content, and hints and feedback for common incorrect answers help students stay on track. Where appropriate, students will learn accurate, professional-grade chemical drawing through the use of CambridgeSoft's ChemDraw tool, which is implemented directly into their homework problems.

McGraw-Hill LearnSmart™, an adaptive diagnostic learning system, powered by Connect Chemistry and based on artificial intelligence, constantly assesses your knowledge of the course material. As you work within the system, LearnSmart develops a personal learning path adapted to what you have actively learned and retained. This innovative study tool also has features to enable your instructor to see exactly what you have accomplished, with a built-in assessment tool for graded assignments. You can access LearnSmart for general chemistry by going to www.mcgrawhillconnect.com/chemistry.

Student Solutions Manual

The ***Student Solutions Manual*** is written by Brandon J. Cruickshank (*Northern Arizona University*), Raymond Chang, and Ken Goldsby. This supplement contains detailed solutions and explanations for even-numbered problems in the main text. The manual also includes a detailed discussion of different types of problems and approaches to solving chemical problems and tutorial solutions for many of the end-of-chapter problems in the text, along with strategies for solving them. Note that solutions to the problems listed under Interpreting, Modeling & Estimating are not provided in the manual.

Student Study Guide

This valuable ancillary contains material to help the student practice problem-solving skills. For each section of a chapter, the author provides study objectives and a summary of the corresponding text. Following the summary are sample problems with detailed solutions. Each chapter has true–false questions and a self-test, with all answers provided at the end of the chapter.

Animations for MP3/iPod

A number of animations are available for download to your MP3/iPod through the textbook's Connect website.

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—Raymond Chang and Ken Goldsby