

BROWN & LEMAY

4TH EDITION

CHEMISTRY
The Central Science

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The Central Science

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Preface

Chemistry: The Central Science, fourth edition, has been written to introduce you to modern chemistry. During the many years we have been practicing chemists, we have found chemistry to be an exciting intellectual challenge and an extraordinarily rich and varied part of our cultural heritage. We hope that as you advance in your study of chemistry, you will share with us some of that enthusiasm and appreciation. As authors, we have, in effect, been engaged by your instructor to help you learn chemistry. Based on the comments of students and instructors who have used this book in its previous editions, we believe that we have done that job well. Of course, we expect the text to continue to evolve through future editions. We invite you to write to us to tell us what you like about the book, so that we will know where we have helped you most. Also, we would like to learn of any shortcomings, so that we might further improve it in subsequent editions.

As you page through any chapter of this text, you will see sections entitled *Sample Exercise*. Each exercise illustrates the use of a key concept or skill. The accompanying solution provides the reasoning required to answer the exercise. Paired to every *Sample Exercise* is a *Practice Exercise*, which addresses the same concept. Test your understanding by working the *Practice Exercise* and comparing your answer with the one that is given.

Full-color illustrations, which include photographs, charts, graphs, and diagrams, help you to visualize abstract ideas. Don't neglect to study the figures and their captions as you read the text.

Three kinds of brief *supplemental sections* appear throughout the text as enrichment material. The *Chemistry at Work* sections introduce interesting applications of the concepts under consideration in the text. Those supplements entitled *A Closer Look* enrich the discussion by delving more deeply into a topic. Those entitled *A Historical Perspective* expand your knowledge of what led to a particularly important development or discovery in chemistry.

Each chapter closes with a mini-study guide—entitled *For Review*—to help you master key concepts. The *Summary* points out the chapter highlights. The *Learning Goals* outline the skills you are expected to have learned in studying the chapter. The *Key Terms* help you build your vocabulary.

The *Exercises* at the end of each chapter test your understanding of the material. Many exercises are grouped according to topic, and these are

TO THE STUDENT

Features of the Text

also arranged in matched pairs. Each exercise in a pair deals with the same principle or procedure, so if you have difficulty with a particular exercise, its companion will provide you with further practice. The answer to the odd-numbered exercise of each pair is given in a section following the appendices. *Additional exercises* appear at the end of each chapter's exercise set. The additional exercises test your ability to solve problems that are not identified by topic. These exercises often combine ideas from more than one part of the chapter. The additional exercises and the matched-pair exercises whose answers appear near the end of the book are numbered in color. The more challenging exercises are marked with brackets.

Finally, you should note that there are several *appendices* near the back of the book, as well as useful tables in the front and back inside covers. You should find the pull-out periodic table at the front inside cover to be particularly useful.

Advice for Studying Chemistry

Keep up with your studying day to day. New material builds on the old. It is important not to fall behind; if you do, you will find it much harder to follow the lectures and discussions on current topics. Trying to “cram” just before an exam is generally a very ineffective way to study chemistry.

Focus your study. The amount of information you will receive in your chemistry course can sometimes seem overwhelming. Certainly, there are more facts and details than any student can hope to assimilate in a first course. It is important to focus on the key concepts and skills. Listen intently for what your lecturer and discussion leader emphasize. Pay attention to the skills stressed in the sample exercises and homework assignments. Notice the italicized statements in the text, and study the concepts presented in the chapter summaries.

Keep good lecture notes, so that you have a clear and concise record of the required material. You will find it easier to take useful notes if you *skim topics in the text before they are covered in lecture.* To skim a chapter, first read the introduction and summary. Then quickly read through the chapter, skipping Sample Exercises and supplemental sections. Pay attention to section heads and subheads, which give you a feeling for the scope of topics. Avoid the compulsion to learn and understand everything right away.

After lecture, *carefully read the topics covered in class.* Remember, though, that you'll need to read assigned material more than once to master it. As you read, pay particular attention to the Sample Exercises. Once you think you understand a Sample Exercise, test your understanding by working the accompanying Practice Exercise.

Finally, *attempt all of the assigned end-of-chapter exercises.* If you get stuck on a problem, get help from your instructor, tutor, or a fellow student. It is rarely effective to spend more than 20 minutes on a single exercise.

TO THE INSTRUCTOR

Philosophy

Throughout the evolution of this text, certain goals have guided our writing efforts. The first is that a text should endeavor to show students the usefulness of chemistry in their major areas of study as well as in the

world around them. It has been our experience that as students become aware of the importance of chemistry to their own goals and interests, they become more enthusiastic about learning the subject. With this in mind, we have attempted, as much as space and our imaginations permit, to bring in interesting and significant applications as an integral part of the subject matter development. We attempt to show that chemistry is indeed the *central science*. At the same time, of course, we seek to provide students with the background in modern chemistry that they will need for their specialized studies, including more advanced chemistry courses.

Second, we want to show not only that chemistry provides the basis for much of what goes on in our world, but that it is a vital, continually developing science. We have tried to keep the book up-to-date in terms of new concepts and applications and to convey some of the excitement of the field.

Third, we feel that any text should be written to the students and not just to their instructors. We have sought to keep our writing clear and interesting and the book attractive and well illustrated. Furthermore, we have provided numerous in-text study helps for students. A more subtle aspect of this student orientation is the care we have taken to describe problem-solving strategies.

In the present edition, the first four chapters give a largely macroscopic, phenomenological view of chemistry. They introduce many basic concepts (including nomenclature and stoichiometry) that provide the background required for many of the laboratory experiments usually performed in general chemistry. Chapter 5, also macroscopic in breadth, gives an introduction to some of the common elements and to the use of the periodic table. It serves as a bridge to the next four chapters, which deal with electronic structure and bonding (Chapters 6–9). After the treatment of bonding, the orientation changes to a focus on the states of matter (Chapters 10 and 11) and solutions (Chapters 12 and 13). Chapter 14 is an optional chapter in which the concepts developed in the preceding chapters are applied to a discussion of the atmosphere and hydrosphere. The next several chapters examine the factors that determine the speed and extent of chemical reactions: kinetics (Chapter 15), equilibria (Chapters 16–18), thermodynamics (Chapter 19), and electrochemistry (Chapter 20). After a discussion of nuclear chemistry (Chapter 21), the final block of material surveys the chemistry of nonmetals, metals, organic chemistry, and biochemistry (Chapters 22–28).

Although this is a fairly standard organization, not everyone teaches all of these topics in exactly this order. For example, many instructors prefer to introduce gases after stoichiometry or after thermochemistry rather than with states of matter. Some instructors may prefer an earlier introduction to redox reactions, and others may choose to discuss equilibria before kinetics. We have structured our writing so that changes in teaching sequence may be made with no loss in student comprehension.

We have introduced students to the properties of elements and their compounds in several ways throughout the text. Most obvious are those chapters that emphasize descriptive chemistry (especially Chapters 5, 13, 14, and 22–28). In addition, material on the properties of elements and compounds is woven throughout the text to illustrate principles and

Organization

applications. Furthermore, such descriptive chemistry is also used in end-of-chapter exercises.

Changes in this Edition

The most obvious change in this edition is the new full-color design and the inclusion of a large number of *full-color photographs and illustrations*. There were 454 figures in the third edition; the fourth edition contains over 600, most of them in full color. The greatly increased use of color photographs allows us to illustrate chemical reactions and convey the beauty and excitement of chemistry. The functional use of color throughout the text helps call the students' attention to aspects of chemistry that we wish to emphasize and helps make the text attractive and inviting.

Many sections have been extensively rewritten to improve clarity and to incorporate full-color graphics and photos. For example, material on elements and compounds has been moved to the beginning of Chapter 1 so the book begins with a discussion of chemical concepts. Treatment of units, significant figures, and dimensional analysis remains in Chapter 1, however.

More applications and *descriptive chemistry* have been added to the first half of the text. The most significant of these changes is the new Chapter 5, Introduction to the Elements and the Periodic Table. This chapter discusses the discovery and use of the periodic table from an empirical perspective and introduces the chemistry of many of the common representative elements. It provides a background for discussing electronic structure and bonding in subsequent chapters. The chapter is short and can be skipped, if so desired, with no adverse effect on students' grasp of subsequent material.

Chapter 13, Reactions in Aqueous Solution, is another new chapter. It brings together a variety of topics dealing with aqueous solution chemistry: net ionic equations, solubility rules and precipitation reactions, Brønsted acids and bases, and oxidation-reduction reactions. In earlier editions, most of this material was discussed in various later chapters.

A *Practice Exercise* has been added to each Sample Exercise. Practice Exercises provide an opportunity for students to test and reinforce their understanding of the concepts or skills treated in the Sample Exercises.

The *end-of-chapter exercises* that are arranged by topic are now also arranged in matched pairs. The answer to the odd-numbered member of each pair and the answer to selected additional exercises are given in a section following the appendices. Each exercise that is answered is labeled in red. As with earlier editions, we use real-life situations as often as possible as the context for exercises. Furthermore, the large variety of exercises allows the instructors to select those that are most appropriate for their course.

AVAILABLE SUPPLEMENTS

Several supplements accompany *Chemistry: The Central Science*, fourth edition:

An *Instructor's Guide* to the text includes suggested readings, alternate arrangement of chapters, and a general commentary on each chapter.

Student's Guide has been written by Professor James C. Hill of California State University, Sacramento. This soft-cover book has been carefully structured to help students in their study of chemistry. It is filled with

helpful ideas, problem-solving techniques, and fresh insights into the materials presented in the text. Each chapter of the text has a corresponding chapter in the student's guide that gives an overview of the chapter, summarizes the major topics and concepts, offers sample problems, and features an end-of-chapter test. These chapter tests include true-false, multiple-choice, and essay problems. Solutions are also given to each question.

Laboratory Experiments for Chemistry: The Central Science, written by Professors John H. Nelson and Kenneth C. Kemp of the University of Nevada, Reno, includes 40 experiments sequenced to follow the topical development of the text. *The instructor's manual* that accompanies *Laboratory Experiments* includes sample data and calculations for all answer sheets, as well as directions for preparation of all solutions.

A combination text and laboratory manual on *Qualitative Inorganic Analysis* has been prepared by the authors of this text. This supplement contains chapters on laboratory techniques, a review of aqueous solution equilibria, and discussions of the chemistry of the qualitative analysis groups, including complete laboratory procedures for identifying both cations and anions.

Solution manuals are available that provide completely worked-out solutions either to all of the end-of-chapter exercises (*Solutions to Exercises in Chemistry: The Central Science*) or to only those exercises whose short answers are provided in the text (*Solutions to Selected Exercises in Chemistry: The Central Science*).

Several other supplements are also available. We offer a new *test-bank file*, in hard copy or on IBM-compatible or Apple-compatible disks. Using our *telephone testing service*, with a toll-free number, the instructor may select questions from the test bank to be prepared by Prentice-Hall for the instructor at no charge. The supplements package also includes *transparencies* for key illustrations and tables in the text. Also, a text on problem solving, *Chemical Problem Solving Using Dimensional Analysis*, second edition, by Robert Nakon, focuses on strategies useful in working problems. Several interactive *software packages* are available free to the instructor upon adoption of the text. Contact your sales representative for further details.

This book owes its final shape and form to the assistance and hard work of many people. Several colleagues reviewed the manuscript and helped us immensely by sharing their insights and criticizing our initial writing efforts. We would like especially to thank the following:

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Professor Brown has been an Alfred P. Sloan Research Fellow and has received the American Chemical Society Award for Research in Inorganic Chemistry. He has also been awarded a Guggenheim Fellowship and has held several offices with the American Chemical Society. He is a member of the Board of Governors of Argonne National Laboratory and Chairman of the Scientific and Technical Advisory Committee of the Laboratory.

H. Eugene LeMay, Jr., received his Ph.D. in 1966 from the University of Illinois. He then joined the faculty of the Chemistry Department at the University of Nevada, Reno, where he has served as Vice-Chairman, Director of Freshman Chemistry, and Interim Chairman. He is presently Associate Chairman and Professor of Chemistry. He has enjoyed Visiting Professorships at the University of North Carolina at Chapel Hill and at the University College of Wales in Great Britain.

Professor LeMay has received university awards for outstanding teaching at the undergraduate and graduate levels. He is the author of thirty research publications and review articles, mainly in the area of solid-phase reactions. In addition to *Chemistry: The Central Science*, Professors Brown and LeMay are coauthors of *Qualitative Inorganic Analysis*.

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