

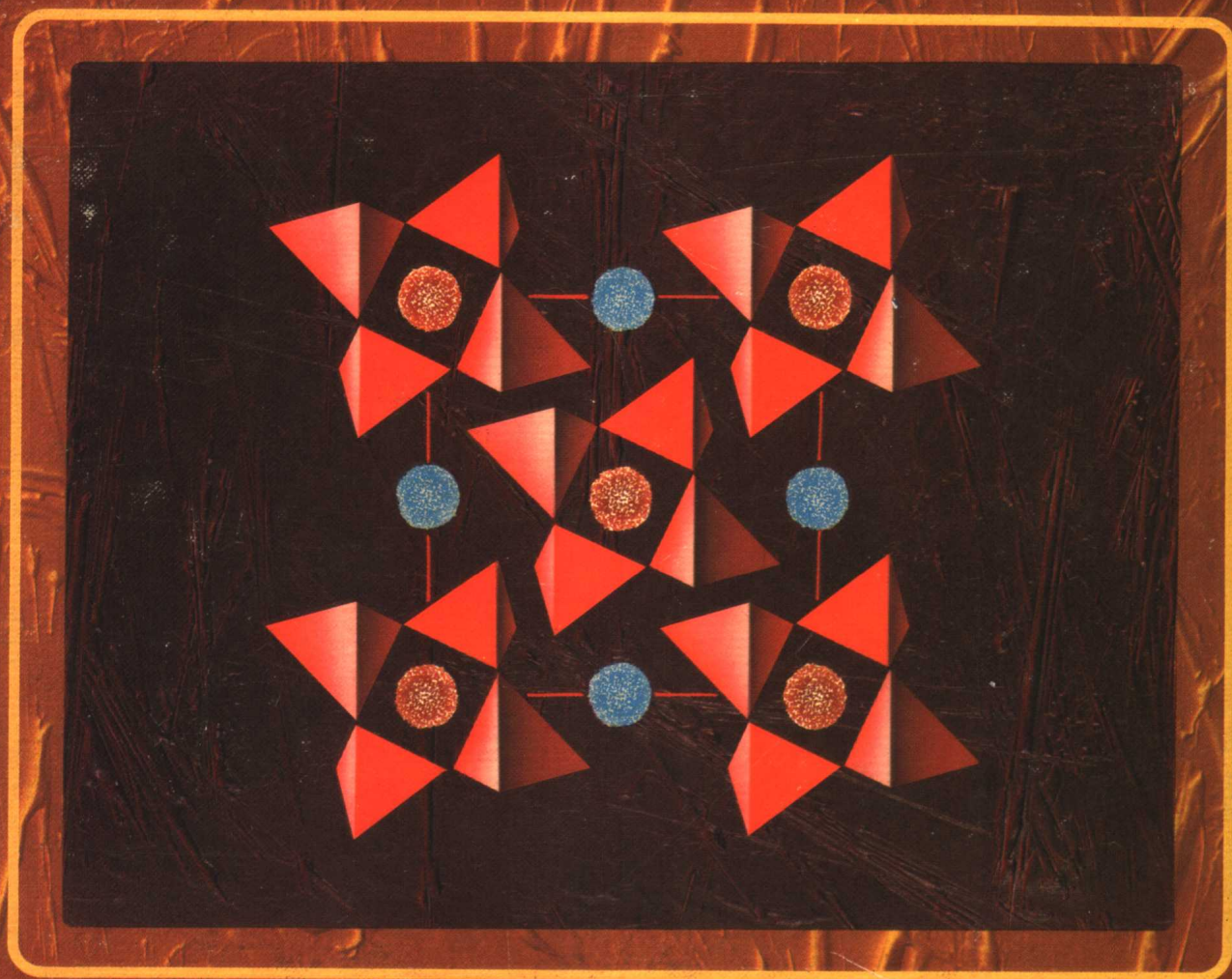
NEBERGALL

HOLTZCLAW

ROBINSON

GENERAL CHEMISTRY

Sixth Edition



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6th
edition

GENERAL CHEMISTRY

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The cover picture shows a portion of the crystal structure of potassium strontium tetrametaphosphate, $K_2Sr(PO_3)_4$. The linked tetrahedra represent tetrametaphosphate anions, $P_4O_{12}^{4-}$; the blue spheres, Sr^{2+} ions; and the red spheres, K^+ ions located above the anions. Illustrated by Leonard Preston.

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Preface

The Sixth Edition of *General Chemistry* represents an extensive revision to improve further a textbook that has been widely accepted in each of its previous editions. Theory and principles have been increased, but the text retains its excellent balance between theory and reaction chemistry. Particular attention has been paid to emphasizing the role theory plays in explaining the chemical behavior of the elements and how the behavior of the elements follows from the principles developed. The authors have added two completely new chapters and have rewritten much of the material in many chapters. All subject matter is presented at a sound pedagogical level, with close attention given to achieving a clear presentation that students can understand.

General Chemistry, Sixth Edition, as in previous editions, presents the study of the metals organized according to the groups of the Periodic Table. Its companion edition, *College Chemistry*, Sixth Edition, is identical in level and in most of the content but differs in organization, with discussion of the metals presented according to the qualitative analysis scheme and including a section of complete qualitative analysis laboratory procedures. The first 32 chapters are the same in both texts.

Of special note among the many new features are the two new chapters. One of these new chapters, "Applications of Chemical Stoichiometry" (Chapter 3), expands on the material of Chapter 2 by treating more advanced concepts of stoichiometry. The other new chapter, "The Relationship of the Periodic Classification to Chemical Behavior" (Chapter 8), describes the relationship of the

location of an element in the Periodic Table to its chemical behavior. This new chapter, expanding on an earlier discussion of the Periodic Table in Chapter 4, identifies classes of chemical compounds (salts, electrolytes and nonelectrolytes, acids, bases), classes of chemical reactions (addition, decomposition, acid-base, oxidation-reduction), and metallic and nonmetallic behavior. The chapter also discusses periodic variation of oxidation state. This new chapter attempts to give the student a basic understanding of the types of reactions commonly observed in the laboratory, and to help the student begin to make some elementary predictions of the kinds of reactions an element or compound is likely to undergo.

Other special features of the Sixth Edition include the following:

1. Significant figures, dimensional analysis, and unit conversion factors are introduced in Chapter 1 when conversion between systems of units is discussed. This prepares the student for the consistent use of dimensional analysis and significant figures throughout the remainder of the text. Dimensional analysis is used extensively in problem-solving in all chapters.

2. Both metric and SI units are introduced and used in appropriate sections since both systems are currently in use in the scientific literature. Later in the text the emphasis tends toward greater use of SI units.

3. Elementary chemical stoichiometry based on mass and concentration, including a discussion of molarity, is introduced in Chapter 2 in order to prepare the student for quantitative laboratory work. A more extensive discussion of concentration measurements is provided later, in Chapter 13. All stoichiometry calculations in Chapter 2 and in the new Chapter 3 are presented using dimensional analysis.

4. The chapter on the structure of the atom (Chapter 4) has been extensively rewritten. Material on the Periodic Law is introduced here, and the discussion on periodicity of physical properties of the elements has been shifted into this chapter for an earlier presentation.

5. Chapters 5 and 6 on chemical bonding continue the successful treatment of earlier editions, with an added emphasis in Chapter 5 on directions for writing Lewis structures and in Chapter 6 on treating molecular orbitals for diatomic systems with two different elements. At the option of the instructor, Chapter 6 ("Molecular Orbitals") can be postponed to a later time in the course.

6. In Chapter 7, "Molecular Structure," we have chosen to use the student's new knowledge of Lewis structures to predict molecular geometries instead of introducing the set of rules used in the Fifth Edition. This reinforces the concept of Lewis structures and illustrates one use of such structures.

7. The treatment of oxygen and hydrogen has been combined into one chapter (Chapter 9), instead of two as in previous editions. This is the first chapter on truly descriptive chemistry in the text, and it follows the new Chapter 8 on relationships of the periodic classification to chemical behavior. The chapter on oxygen and hydrogen is written in a way that reinforces and illustrates the concepts introduced in the first eight chapters.

8. Chapter 10 ("The Gaseous State and the Kinetic-Molecular Theory") proceeds from experimental observations (Boyle's Law and Charles' Law) through the

Ideal Gas Law to the molecular behavior of gases and the kinetic-molecular theory. The Ideal Gas Law is introduced earlier than in previous editions, and greater use is made of it in gas-law problems.

9. A section on the structures of crystalline solids has been added to the chapter on the liquid state and the solid state (Chapter 11). Crystal structures can be omitted or postponed at the option of the instructor.

10. Chapter 12 ("Water and the Environment; Hydrogen Peroxide") has been reordered to present the structure, physical properties, and chemical properties of water first, followed by sections on natural waters, water pollution, purification, and softening.

11. The two chapters on solutions have been combined into a single chapter (Chapter 13) in the Sixth Edition. The section on colloids is at the end of the chapter.

12. The discussion of equivalent weights of acids and bases has been shifted into the chapter on acids and bases (Chapter 14). A new discussion on the strengths of acids and bases has been added. It should be noted that a preliminary discussion of some of the concepts of acids and bases is presented earlier in the new Chapter 8.

13. The chapter on chemical kinetics and equilibrium (Chapter 15) has been kept as a single chapter, but the kinetics sections have been rewritten to emphasize the molecular phenomena that give rise to reaction rates and rate laws.

14. The material on equilibria of weak electrolytes and solubility product (Chapters 16 and 17) has been retained with minor changes.

15. The chapter on thermodynamics (Chapter 18) has been significantly rewritten to emphasize the application of thermodynamics to chemical systems. Thus the student is extensively exposed to the idea that thermodynamics is useful in describing how chemicals behave. The chapter first treats thermochemistry, then entropy and free energy.

16. The discussion of oxidation-reduction reactions has been shifted to the chapter on electrochemistry (Chapter 20).

17. An expanded section on structure and isomerism of organic compounds has been added to the chapter on carbon compounds (Chapter 25). In addition, more interconversions between the various organic functional groups have been included. The mechanisms by which organic reactions occur have been described as a guide to correlation of various types of organic reactions.

18. The biochemistry chapter (Chapter 26) has been completely rewritten and updated.

19. The material on nuclear chemistry (Chapter 29) has been significantly revised and updated with new material on nuclear power reactors, breeder reactors, and fusion reactors.

20. Increased emphasis on the occurrence and use of coordination compounds has been added to an updated chapter on coordination chemistry (Chapter 31). The chapter now includes a discussion of the colors and magnetic moments of complex ions in terms of elementary crystal field theory.

21. Descriptive chapters have been updated, with emphasis on the relationship of the behavior of the elements to their locations in the Periodic Table.

22. New material on natural waters and water pollution, air pollution, fuel cells, energy, nuclear reactors, and some problems associated with the storage of nuclear waste has been introduced where appropriate throughout the book.

23. All artwork has been redrawn, and many new figures have been added.

24. Problems have been written so that the first problems in a given set provide straightforward no-frill problems for drill on the concepts presented in the chapter. The problems become more involved and challenging later in each problem set with increased emphasis on relevant topics, or on the application of a concept to determine the composition, properties, or behavior of a chemical system. Over 600 new problems have been written; these, along with more than 1000 questions, provide complete sets of end-of-chapter exercises.

25. References to pertinent articles in the literature have been extensively updated at the ends of chapters.

26. The index, as in previous editions, is unusually complete and hence truly useful, with over 6000 separate entries.

27. The authors have meticulously examined the present edition word-by-word and have rewritten many phrases and sentences for added clarity in the new edition.

The extensive supplemental materials especially designed for use with the text are: (1) A problems manual, *Problems and Solutions for General and College Chemistry, Sixth Editions*, by F. Keith Ault, John H. Meiser (both of Ball State University), Henry F. Holtzclaw, Jr. (University of Nebraska-Lincoln), and William R. Robinson (Purdue University); the manual includes the worked-out solutions to approximately one-third of the text problems, those marked \square , at the ends of chapters. (2) A study guide to assist the student, written by Norman E. Griswold of Nebraska Wesleyan University. (3) An instructor's guide by the same author. (4) A laboratory manual, *Basic Laboratory Studies in College Chemistry, Sixth Edition*, by Grace Hered, William H. Nebergall, and William Hered; this manual complements the text but is also suitable for use with most other beginning chemistry texts.

The authors wish to express their special gratitude to George Bodner (Purdue University), who prepared the biochemistry chapter, and to those who read all or parts of the manuscript and made many valuable suggestions: In addition to Ault, Meiser, Griswold, and Hered, they include David Brooks and Sheldon Schuster of the University of Nebraska-Lincoln; Jack Dalton, Boise State University; James Erman, Northern Illinois University; Philip A. Kinsly, University of Evansville; Ronald Marks, Indiana University, Pennsylvania; and R. Thomas Myers, Kent State University.

We are also indebted to many present users of the text for a large number of good ideas based upon their own teaching experience. The authors also express their appreciation to Paul P. Bryant and to the editorial staff at D.C. Heath and Company for their gracious help and willing cooperation. The several revisions of the manuscript were typed by Roberta Molander and Martha Moll. Charles W. McLaughlin checked independently the answers to problems at the ends of chapters and the worked-out examples of problems within the chapters.

Finally, the authors especially wish to pay a warm tribute to our colleague, William H. Nebergall, whose unexpected death came shortly after the initial planning for the Sixth Edition and his participation in selecting and welcoming William R. Robinson of Purdue University as a new co-author for our texts. Bill Nebergall was a fine teacher, author, and person, an esteemed colleague, and a good friend.

HENRY F. HOLTZCLAW, JR.
WILLIAM R. ROBINSON

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