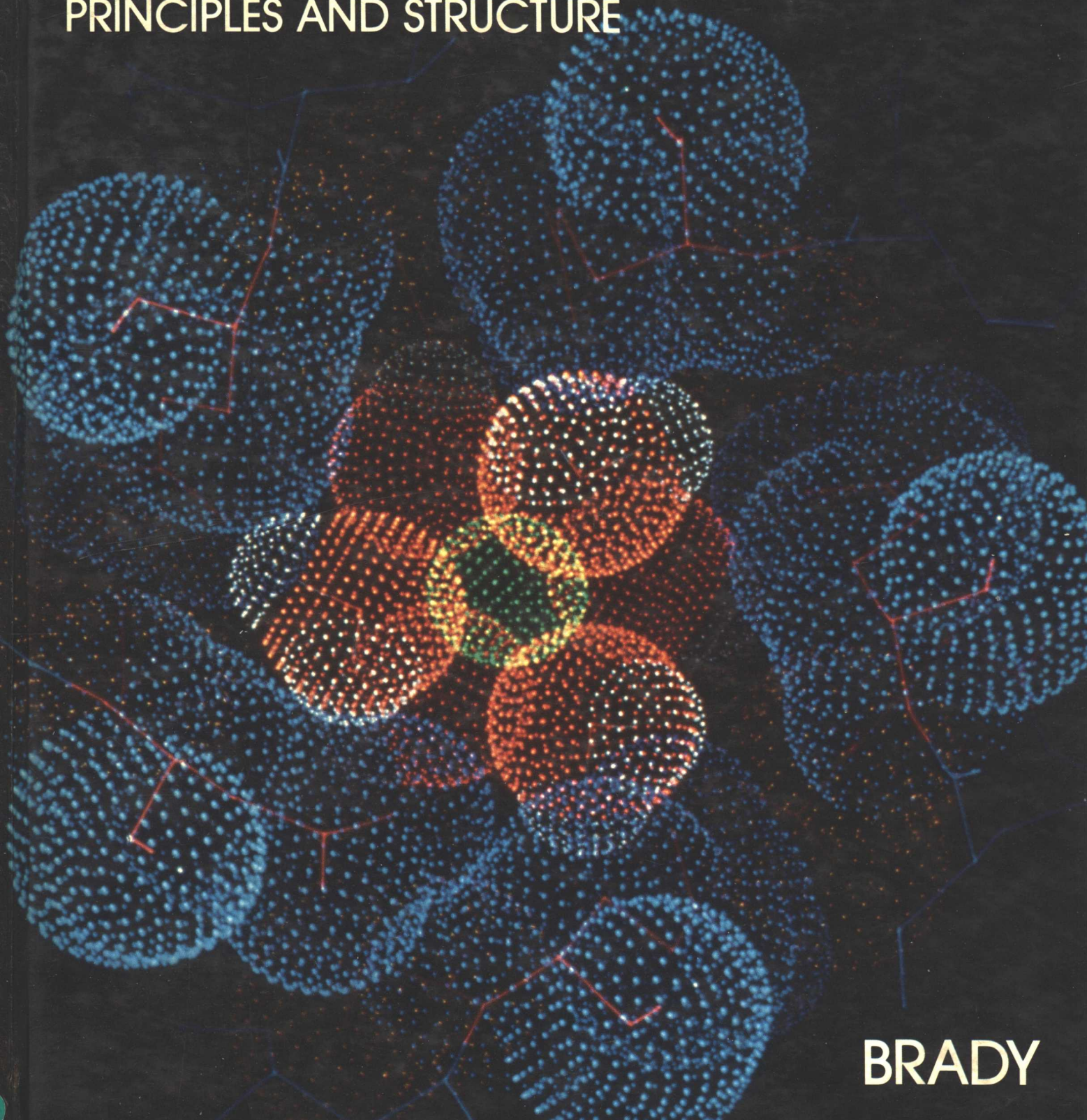


GENERAL CHEMISTRY 4/E

PRINCIPLES AND STRUCTURE



BRADY

HUMISTON

Fourth Edition
GENERAL CHEMISTRY

PRINCIPLES AND STRUCTURE

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PREFACE

Throughout the evolution of this book we have pursued two principal goals. First, we wished to make the book interesting and easily understood, thereby making it useful to the student. Second, we wished to keep the book up-to-date with respect to current trends in the teaching of chemistry, and thereby make it useful to the teacher. As we undertook preparation of this Fourth Edition these remained our goals, and as in previous editions we have kept what has proven valuable while responding to suggestions for changes and improvements. The level of the book and its general approach therefore remain unchanged; the text continues to be designed and written for the first year chemistry course for science majors.

In this edition we have continued to focus attention on improving the usefulness and readability of the text. Major sections have been rewritten to improve clarity, and in some places entire discussions have been reworked to make them easier to understand. Additional worked examples have been included, and in this edition each includes a title that describes the kind of problem being solved. To aid the student as well as the teacher, end-of-chapter exercises have been sorted and arranged by category. The more difficult problems are marked by asterisks. Answers to approximately half the Review Problems as well as to selected Review Questions are included in Appendix C at the back of the book.

Even a casual thumbing of the pages will reveal a large number of full-color photographs distributed throughout the text. These serve two purposes. One, of course, is illustrating such things as the colors in a continuous spectrum or the colors of chemicals. The other, which we feel is equally important, is to make the book more interesting and thereby help students realize that chemistry is not simply an abstract subject, but one that relates in a very direct way with their day-to-day activities. This is emphasized further by frequent reference to everyday chemicals and common examples of principles.

Also new to this edition is the availability of a unique software package, THE CHEMISTRY TUTOR, which is keyed to the critically important first eight chapters of the book. This tutorial software was designed to complement discussions in the text and to improve student performance in such diverse areas as balancing equations, writing Lewis structures, predicting the products of metathesis reactions, and naming chemical compounds. To assist students who wish to avail themselves of this valuable supplement, we have indicated in the margin of the text at appropriate locations the titles of the programs that provide the necessary tutorial assistance. Additional details concerning this software supplement appear on a separate page following this preface.

In response to suggestions from users of the previous edition and from

reviewers, we have made some changes in topic sequence. In doing so, there were two objectives. First, we wished to make it more apparent to students that chemistry is an experimental science, and that theory is developed to explain observed facts. Second, we wished to integrate additional descriptive chemistry with discussions of principles so instructors would find it easier to teach and students would appreciate that learning chemical facts is an important part of learning chemical principles. Toward these ends, former Chapter 9 (Periodic Table Revisited) and Chapter 14 (Acids and Bases) have been dismantled and the material in them redistributed principally among earlier chapters. For example, the general properties of metals, nonmetals, and metalloids now introduce the chapter that covers the periodic table; the molecular structures of the nonmetals are discussed in the chapter on modern theories of covalent bonding to illustrate how an atom's ability to form pi bonds can determine the complexity of molecules; and all of acid-base chemistry is now discussed together in Chapter 7. We have also added a new section at the beginning of the elementary bonding chapter that describes the properties of ionic and molecular compounds. This serves as a prelude to discussions of ionic and covalent bonding.

Among other significant changes is the division of the very long former Chapter 3 (Atomic Structure and the Periodic Table) into two chapters. The first discusses the periodic table and the experiments that led to the discovery of atomic structure. The next examines the electronic structures of atoms. We have also divided former Chapter 6 into two chapters. One (now Chapter 7) focuses on reaction types, including ionic, acid-base, and redox reactions. This chapter also presents an opportunity to introduce some related topics in descriptive chemistry. Here we include sections on metals as reducing agents and nonmetals, especially molecular oxygen, as oxidizing agents. This is followed by a second chapter (Chapter 8) that examines ionic reactions in solution in greater detail, including solution stoichiometry. Equivalent and normality are now discussed in a separate section so that those who wish to omit it can easily do so. Because the details of solution stoichiometry have now been postponed until Chapter 8, some aspects of this topic are introduced toward the end of Chapter 2.

There have been some other changes as well. The chapter on physical properties of solutions now includes a section that treats the properties of colloids. The discussion of metallurgy has been moved to Chapter 18. The chapter on nuclear chemistry has been moved forward to precede organic and biochemistry. A glossary has been added, and for each entry there is a reference to the section in the text where the term is discussed.

Despite these changes, features that have appealed to users of previous editions have been retained. As in the past, we assume no prior student background in chemistry, and mathematical sophistication is limited to simple algebra. Generally it is assumed that students who use this book will have a scientific calculator at their disposal, and there is a section in Appendix A that discusses the use of calculators. A table of common logarithms is still included, however, for the rare student willing to use it. New terms have been set in bold type and nearly all are included in the glossary.

The question of SI usage continues. As before, we carefully describe the SI, but for practical laboratory reasons we have once again retained the atmosphere and torr as pressure units and the liter (now abbreviated L) and milliliter (mL) as volume units. Almost all energy calculations are now worked in joules, but tables continue to list energy values in both joules and calories. We feel that to effectively use the literature, students must be at least familiar with both of these energy units.

Although there have been changes made in topic sequence, concepts continue to be presented in a logical sequence that permits early introduction of

quantitative experiments in the laboratory. Chapters 1 and 2 introduce the concepts of atoms, molecules, and the mole. The next four chapters go on to explore the makeup of atoms and the kinds of bonds that they form with each other. In reworking these chapters we have woven in descriptive topics that serve as a foundation for theory.

Once atomic structure and chemical bonding have been discussed, we turn our attention in Chapters 7 and 8 to reaction types. We begin with ionic reactions, including aqueous acid–base chemistry. The acid–base concept is then extended to Brønsted–Lowry and Lewis acids and bases. Redox reactions are discussed next, and that leads to an examination of periodic trends in the ease of oxidation of metals and the tendencies of nonmetals to serve as oxidizing agents. The special role of oxygen as an oxidizing agent and the products formed in typical reactions are also included.

Chapters 9 and 10 consider the physical properties of the states of matter, and they are followed by a chapter dealing with the physical properties of mixtures, especially solutions.

The next three chapters cover the topics of thermodynamics, kinetics, and equilibrium. They are discussed in this sequence because they address the questions: “Is a reaction possible, how fast does it occur, and what is the system like when it reaches equilibrium?” In the chapter on thermodynamics, the discussions of the First Law and of entropy have been revised. The equilibrium chapter focuses on gaseous and heterogeneous systems, the way thermodynamics relates to equilibrium, and a thorough discussion of Le Châtelier’s principle.

Chapters 15 and 16 treat ionic equilibria in detail. Chapter 15 deals with acid–base equilibria in aqueous solutions; Chapter 16 covers solubility and complex ion equilibria. In Chapter 14, the discussion of hydrolysis of salts has been totally revised in terms of Brønsted–Lowry acid–base chemistry. These chapters are followed by one on electrochemistry.

Chapters 18 through 21 are descriptive chemistry chapters. They provide a systematic discussion of the chemistry of the most important elements. Frequent reference to important and familiar chemicals illustrates how the elements and their compounds impact modern society. Next is a chapter on nuclear chemistry, and the book finishes with organic and biochemistry—topics that serve as an introduction to the second year course.

We have been gratified by the reception this text has received in its previous editions. It has been a source of great satisfaction that both students and teachers have found the book and its associated supplements useful. We hope that this edition will also please you, and we invite your comments and suggestions.

James E. Brady
Gerard E. Humiston

THE CHEMISTRY TUTOR

THE CHEMISTRY TUTOR is a computer software package consisting of six units of learning tools for students that complement traditional learning methods. Each unit is composed of from three to five tutorial programs. *THE CHEMISTRY TUTOR* is designed for students to use at home or in learning labs, and bridges the learning gap that occurs between the time students encounter difficulties and the time they are able to receive help from their instructors.

Each program poses a problem that tests a critical skill and then analyzes the student response. If the student cannot perform a particular task, the program reacts as a tutor would, by probing systematically to see what elements of the task are known to the student. Missing knowledge or information (e.g., an interpretation of a chemical formula) is evoked or provided explicitly, but only as needed. Thus, each dialog is intended to mimic, to the extent possible, a typical tutorial exchange between an instructor and a student. This is possible because each computer response refers explicitly to the problem at hand, and because tutorial strategies vary with the nature of the problem being studied.

Because the approach is intensive, programs selectively focus on the development of critical skills. Skills selected for treatment are those necessary to navigate through the first part of an introductory chemistry course. They also have applicability throughout the entire chemistry curriculum. The six units in the series, and the topics included are:

- *Basic Math Tools For Chemistry* Scientific notation, significant figures, units conversions, moles conversions, density problems.
- *Balancing Equations And Stoichiometry* Balancing equations, mass relationships, limiting reagent calculations.
- *Covalent Bonding and Molecular Structure* Lewis structures, VSEPR shape predictions, orbital hybridization.
- *Ion Chemistry and Nomenclature* Writing formulas for salts, nomenclature, predicting products of ionic reactions.
- *Oxidation-Reduction Reactions* Oxidation number assignments, balancing redox equations.
- *Solution Stoichiometry* Molarity calculations, stoichiometric relationships in solution, limiting reagent calculations for reactions in solution.

To order the Chemistry Tutor from the Publisher, please write to Dennis Sawicki, Department 6666, John Wiley & Sons, 605 Third Avenue, New York, New York 10158.

Please specify Apple or IBM version and enclose a check or money order for the full amount.

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SUPPLEMENTS

A complete package of supplements to accompany this text is available to assist both the teacher and the student.

Study Guide to Accompany General Chemistry, Principles and Structure, Fourth Edition, by James E. Brady. This softcover book has been carefully structured to assist students in mastering concepts and developing problem-solving skills. It is keyed section by section to the text, and for each section there is a set of objectives, a brief review (sometimes with additional worked examples), a self-test with answers, and a list of the new terms (each carefully defined) that are introduced in that section.

The Chemistry Tutor, by Frank Rinehart. This software, available for the IBM PC and Apple II/II+ /IIf computers, provides tutorial assistance for major topics that serve as a foundation in the learning of general chemistry. It is discussed more fully on a preceding page.

Laboratory Manual for General Chemistry, Principles and Structure, Third Edition, by Jo Beran and James E. Brady. This manual features a thorough techniques section with photographs that illustrate important apparatus and manipulations, and 47 experiments sequenced to follow the topical development of the text. For the teacher, an instructor's manual accompanies the laboratory manual.

Solutions Manual for General Chemistry, Principles and Structure, by M. Larry Peck. This softcover supplement provides detailed solutions to all the numerical problems in the text, as well as answers to all the questions.

Problem Exercises for General Chemistry, Third Edition, by G. Gilbert Long and Forrest C. Hentz, Jr. Intended to bridge the gap between textbook-style exercises and those that students encounter on examinations, this softcover book features over 1000 problems and questions in multiple-choice format. Throughout the book students are taught to use the basic "tools of the chemical trade."

Lecture Outline for General Chemistry, Principles and Structure, by Ronald Ragsdale. This outline provides the student with a framework about which meaningful class notes can be built. Through its structure, it provides the instructor with more class time to cover difficult topics.

Test File for General Chemistry, Principles and Structure, by David Becker. This package of multiple choice questions is available from Wiley at no charge for teachers who adopt this book.

Microcomputerized Testing System for the IBM PC and Apple II/II+ /IIf. This testing system, with questions, allows the user to prepare multiple choice examinations. It can be obtained from Wiley without charge by instructors who adopt this book.

Transparency Masters Instructors who adopt this book may obtain from Wiley, without charge, a set of 8 1/2 × 11-inch black and white line drawings that duplicate key figures in the text. They can be used to prepare transparencies.


TO THE STUDENT

If you own, or have access to an IBM PC or Apple II series computer, you should be aware of the special tutorial computer programs that were designed specifically to help you over the rough spots in the first eight chapters of this book. This program supplement is called THE CHEMISTRY TUTOR and is available either as part of the textbook package itself or from the Publisher for \$15.00.

THE CHEMISTRY TUTOR consists of a series of computer programs divided into six *learning units*. To make you aware of topics that are covered by these programs, and to guide you quickly to the proper program, we have placed markers in the margin of the text at appropriate locations. For example, in the margin on page 7 of the book you will find the following:



Basic Math Tools for Chemistry
Scientific Notation

The symbol  represents a "floppy disk," which is the medium used to store the computer programs. Its presence alerts you to the fact that tutorial assistance is available for the topic being covered at that point. You are also told that the title of the learning unit is "BASIC MATH TOOLS FOR CHEMISTRY," and that within that unit you should select the program titled *Scientific Notation*. To actually use the programs, follow the directions that accompany THE CHEMISTRY TUTOR. We are confident you will find this supplement of great assistance in your study of chemistry.

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