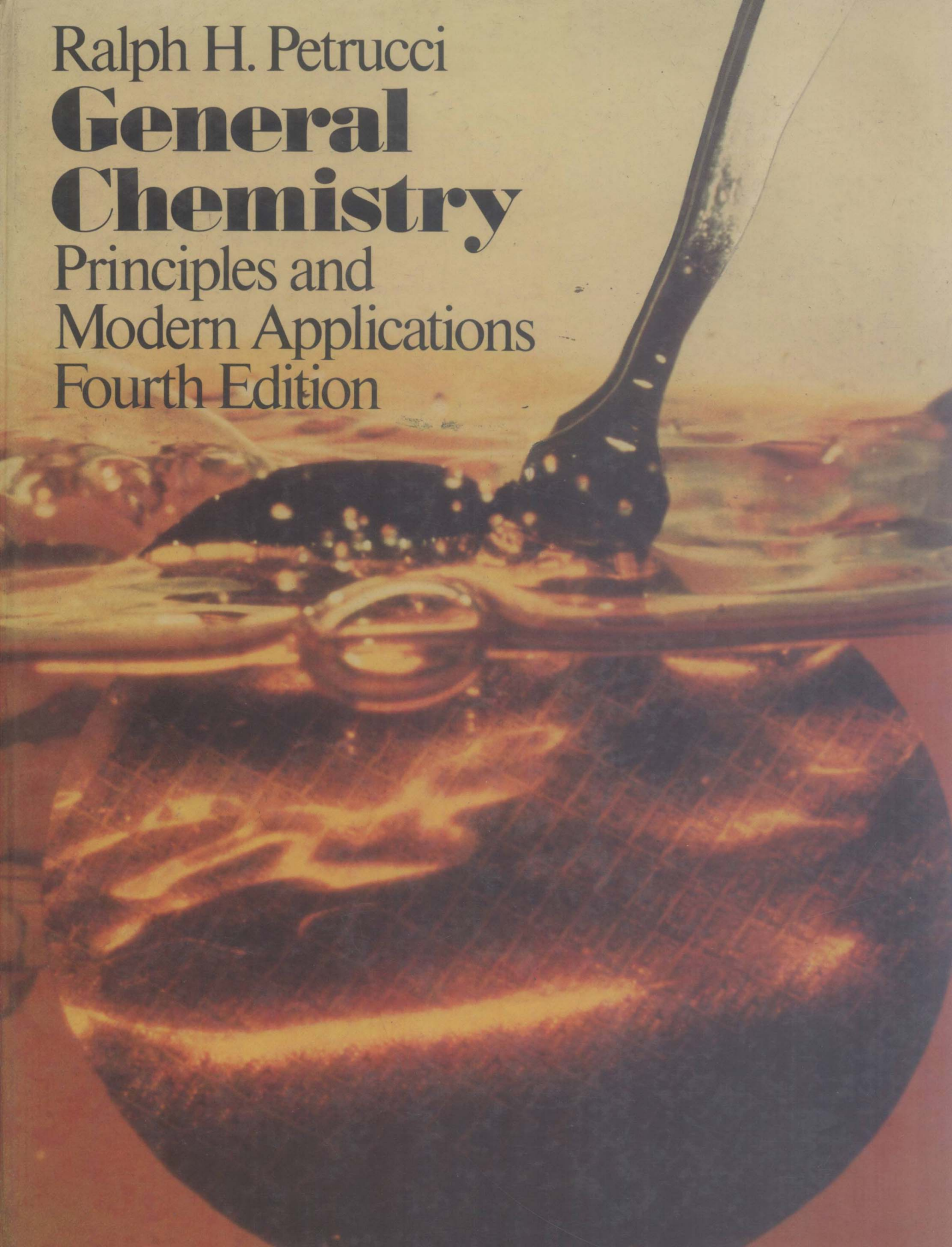


Ralph H. Petrucci

General Chemistry

Principles and
Modern Applications
Fourth Edition



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Ralph H. Petrucci

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General Chemistry

Principles and Modern Applications

Preface

Each edition of this text has differed in some important respects from those preceding it, but all have been written with this central idea in mind: The majority of students who study general chemistry have career interests in fields other than chemistry—biology, medicine, engineering, and the agricultural sciences, to name but a few. Not only should a general chemistry text provide such students with the modern chemical background they need for their specialized studies, but also it should be as readily understandable as possible, for these students have limited amounts of time available to study general chemistry. As with previous editions, I have attempted to strike the balances between principles and applications, between qualitative and quantitative discussions, and between rigor and simplification that seem most appropriate for these typical general chemistry students. I have been guided in my revision by comments from users of previous editions and reviewers of the present one; and I have given special attention to all suggestions, even minor ones, that might in some way improve the clarity of the presentation.

Perhaps the major changes between the previous edition and this one are the increased coverage of applications and descriptive inorganic chemistry and the more extensive integration of these topics throughout the text. Numerous applications are presented at the points where their underlying principles are considered. In addition, a new feature of this edition is the inclusion of special “Focus” sections at the ends of certain chapters (thirteen in all). For example, a discussion of the key chemicals of industry is included in Chapter 1, aspects of industrial chemistry in Chapter 4, semiconductors in Chapter 10, liquid crystals in Chapter 11, and polymers in Chapters 9 and 26. Descriptive inorganic chemistry is introduced in the middle of the text (Chapter 13) with a consideration of the first 20 elements. The topics chosen for this discussion are those that can be presented through principles developed in the first twelve chapters. The chemistry of these elements is revisited in Chapters 21 and 22 in a discussion of the representative elements that employs the full range of principles developed in the first twenty chapters of the text. Chapter 23 deals with the transition elements, Chapter 24 with coordination chemistry, and Chapter 25 with nuclear chemistry. As in earlier editions, one chapter (Chapter 26) is devoted to organic chemistry and one (Chapter 27) to biochemistry. Topics related to qualitative analysis of cations appear in several chapters (18, 19, 21, 23, and 24), each at a point appropriate to the principle involved.

Less apparent than those just described, but also important, are some changes made from a pedagogical standpoint. The discussion of oxidation states has been moved forward (from Chapter 9 to Chapter 3) to permit a more thorough early introduction of nomenclature. Basic concepts of oxidation–reduction and the oxidation state change method of balancing oxidation–reduction equations are now introduced in Chapter 4. This permits the use of oxidation–reduction chemistry as one of the principal themes in the

introductory chapter on descriptive chemistry. As in the third edition, solution stoichiometry is introduced early (Chapter 4) to coordinate with typical laboratory programs. Also as in the third edition, the subject of thermodynamics is divided between an early chapter on thermochemistry (Chapter 6) and a later one on additional aspects of thermodynamics (Chapter 16). The first law of thermodynamics has been moved from the first to the second of these chapters, so that most of the formalism of thermodynamics is now found in the later chapter. Solubility and complex ion equilibria have been combined into a single chapter (Chapter 19) that now follows the two chapters on acid-base equilibria. Several topics have been added to the chapter on coordination chemistry, the principal one being optical isomerism (previously introduced in the biochemistry chapter). In a few cases (e.g., crystal structures) sections have been rewritten to offer a new approach to the subject that may be more understandable to students. Toward this same end, some new in-text examples have been added and some existing ones have been worked out in greater detail.

I continue to believe that there exists no single ideal organizational scheme for a general chemistry text. This edition, like its predecessors, is so structured that a number of alternative orders of presentation are possible. For example, the "Focus" features can be studied as encountered, or some features may be deferred to later contexts (such as considering the features on key chemicals and industrial chemistry together at the close of Chapter 4). Also, some of these features can be made optional, for although they relate closely to fundamental principles from the portions of the text that precede them, these features introduce no material that is crucial to the development of later subject matter. Instructors who favor dealing with systematic descriptive inorganic chemistry as a single unit will find that Chapter 13 can easily be deferred and taken up together with Chapters 21–23. None of the material introduced in Chapter 13 is fundamental to the subject matter of Chapters 14–20. On the other hand, those who prefer to disperse descriptive topics more widely will find that Chapter 13 can be approached section by section in conjunction with other chapters. Instructors who wish to combine the material on thermodynamics into a single presentation may defer Chapter 6 until Chapter 16 is reached. Those who wish to limit organic chemistry to a description of bonding, structure, and nomenclature can take up these matters at any time after Chapters 9 and 10 on chemical bonding. In the separate *Instructor's Manual* that accompanies this text, several alternative organizational schemes are described.

As in the third edition, each chapter concludes with a number of study aids. First is a brief chapter summary, which is followed by a set of learning objectives. These objectives are stated in fairly general terms, and individual instructors may choose to emphasize some more than others or to add specific objectives of their own. The third end-of-chapter feature is a set of definitions of important new terms introduced in the chapter. Reference to each end-of-chapter definition is made through a **boldface** page number in the Index. The collection of these Index listings and end-of-chapter definitions constitutes a glossary of the entire text. New to this edition is a listing of a small number of references for each chapter. These "Suggestions for Further Study" are typically of several sorts: Some offer an alternative, often more elementary, approach to important concepts considered in the chapters. Some carry the subject matter beyond the level of the text. Many of the references deal with interesting applications of topics discussed in the chapter. A few provide historical background. Practically all of these references are from journals and magazines, rather than monographs or texts, in the belief that students are more likely to refer to supplementary materials if they are rather brief.

Each chapter has four categories of exercises. The first category, "Review Problems," is new to this edition. These problems require straightforward applications of principles introduced in the chapter, each problem usually involving just a single concept. In the category "Exercises," exercises are grouped by subject matter and are of a broader nature than the "Review Problems"; those that either are more difficult or require an extension beyond the concepts presented in the chapter are designated by a star *. The

“Additional Exercises” are not grouped by type. The final category, “Self-Test Questions,” presents a group of multiple-choice items, together with brief essay questions and/or problems, that are typical of examination questions. Answers to most of the “Review Problems” and the “Self-Test Questions” are provided at the end of the book. About one half of the “Exercises” are similarly answered, but answers for the “Additional Exercises” are not given. Complete solutions to all but the “Additional Exercises” are provided in a separate *Solutions Manual*. Solutions to the “Additional Exercises” are available in the *Instructor's Manual*.

Also available to accompany this text are a *Student Study Guide* and a laboratory manual, *Experiments in General Chemistry*. The study guide was written by Professor Robert K. Wismer and the laboratory manual by Professors Gerald S. Weiss, Robert K. Wismer, and Thomas G. Greco, all of Millersville University of Pennsylvania. The study guide is organized around the “Learning Objectives” in the textbook and features brief discussions of these objectives, drill problems, self-quizzes, and sample tests. The laboratory manual contains thirty-seven experiments that parallel the text, including a final group of six experiments on qualitative analysis.

If I have succeeded in improving this edition over previous ones, it is largely a result of the diligence with which reviewers have studied and commented on what I have written and of their willingness to share some of their own pedagogical ideas. The following have provided critiques of the third edition: R. Kent Murmann, University of Missouri, Columbia; Saul I. Shupack, Villanova University; Joseph Topich, Virginia Commonwealth University; and Mary S. Vennos, Essex Community College of Baltimore County (Maryland). Charles W. J. Scaife of Union College supplied helpful commentary on the Answers to Exercises in the third edition. Those who read and commented on portions of the manuscript of this edition are O. T. Beachley, SUNY, Buffalo; Billy L. Stump, Virginia Commonwealth University; and Carl Trindle, University of Virginia. Commenting on the entire manuscript were Michael F. Golde, University of Pittsburgh; Philip S. Lamprey, University of Lowell; and William H. McMahan, Mississippi State University. The following colleagues from my campus helped by reviewing manuscript, passing along student comments, and being available for consultation on various matters that arose during the preparation of this edition: Dennis Pederson, Arlo Harris, Kenneth Mantel, Lee Kalbus, and James Crum. As with the third edition, I owe a special debt of gratitude to Robert K. Wismer who, in addition to his own efforts in producing the accompanying study guide and contributing to the laboratory manual, commented extensively on the manuscript of the fourth edition, read proof, shared the rather onerous task of preparing the Solutions Manual, and was the willing recipient of countless long-distance (and sometimes long-winded) telephone calls.

Michael S. Smith and John Schultz helped to procure a number of the photographs in the text. In addition to many of the color plates, the photographs on the following pages were taken for this edition, some in association with Arlo Harris, by Carey B. Van Loon: 114, 234, 246, 312, 313, 319, 352, 383, 682, 817.

I have continued to receive assistance from many individuals associated with Macmillan Publishing Company, including a number, I am sure, who are not even known to me. Several individuals deserve special mention, however. Elisabeth Belfer supervised the conversion of a piecemeal manuscript into a bound volume in her usual calm professional manner. My editor, Peter Gordon, undertook several tasks on my behalf that really helped out in the pinch. Kate Aker, who contributed so much to the development of the third edition, was also on call when needed. And offering encouragement at appropriate times were Gregory Payne, Gary Ostedt, and John Snyder.

Top prize for forbearance goes to my wife, Ruth, and to members of my immediate and extended family. They have fashioned lives for themselves that include a special niche for a preoccupied textbook author. I am especially grateful to them for this.

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