ANDER & SONNESSA

PRINCIPLES of CHEMISTRY

An Introduction to Theoretical Concepts

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PRINCIPLES of CHEMISTRY

CONCEPTS OF CHEMISTRY SERIES

PAUL ANDER
Associate Professor of Chemistry
Seton Hall University

ANTHONY J. SONNESSA
Associate Professor of Chemistry
Seton Hall University

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TO OUR FAMILIES

Preface

During the past few years it has been generally recognized that the initial college course in chemistry should employ a more quantitative approach to the subject matter. There are two principal reasons for this point of view. First, research today requires more rigorous training in the quantitative aspects of science. Second, high school graduates currently seem to exhibit great enthusiasm for the modern ideas in chemistry; they have heard or read about many exciting topics in chemistry, such as bonding theory, nuclear chemistry, and the structure of nucleic acids and proteins. To maintain and extend this interest, the rudiments of some modern topics should be presented in the freshman course.

For these and other reasons, chemistry curricula are in the process of revision. Course content has been updated for analytical, inorganic, organic, and physical chemistry. In each of these courses, stress has been placed upon *principles* rather than upon descriptive aspects. One need only look at recently published textbooks in these areas to become aware of this trend. The movement toward presenting material of a more advanced nature in these courses creates two basic needs which must be satisfied in the introductory course. First, it is essential that the freshman course prepare the student for the advanced material presented in these upper-level courses by introducing him to the language used; and second, freshman course

should include those topics that are either omitted or treated superficially in the later courses to provide more time for the advanced material.

The nature of the work performed today in physics, biology, and engineering requires an understanding of chemical principles, and the freshman chemistry course taken by students in these areas should provide them with the necessary background. This book has been written to meet the needs of such students, as well as the chemistry major. Most of the material has been presented to a select group of science majors at Seton Hall University in a course that has been most stimulating to both the instructor (P. A.) and the students.

Wherever possible, the research approach has been employed: First, the experimental facts are presented, then a theory is advanced to explain the facts. For thorough understanding of the later chapters, the student must be familiar with certain basic physical and mathematical terms. These are therefore reviewed in Chapter 1 as an integral part of the text, rather than being relegated to an appendix. Chapter 2 deals with the experimental foundations of the quantum theory. The application of this theory to atomic structure is discussed, and the theory is correlated with the properties of atoms and molecules. In Chapter 3, the quantum theory is extended to the bonding of atoms in molecules. The student is introduced to the qualitative ideas of the bonding theories and to the results derived from these theories. Descriptive inorganic and organic chemistry has not been discussed systematically in this book because the authors feel that it is covered more adequately in the upper-level courses. However, the principles described in the book are applied to the chemistry of the elements whenever possible, and it is hoped that later courses will extend this application.

Chapter 4 extends the application of the principles to the formation of ionic compounds and to their properties in the solid state and in solution. The importance of understanding the arrangement of atoms and ions in the solid state cannot be denied. The elementary presentation of this material in the second part of the chapter should enable the student to better grasp the more advanced presentation given in physical chemistry courses.

Chapter 5 treats the properties of gases. The approach, once again, is to start with the experimental facts, then to explain the facts by using a theoretical model. The modifications in the model of an ideal gas necessary to explain the observed properties of real gases illustrate for the beginning student the need for reviewing theories in the light of new experimental findings.

The empirical and theoretical aspects of chemical equilibrium are treated separately in Sections I and II of Chapter 8. The student is first given a firm feeling for equilibrium by treating many types of equilibria empirically, in order to enable him to understand more readily the more abstract and difficult theoretical aspects of the subject. The breakdown is also for

the convenience of those instructors who desire to omit the theoretical aspects entirely because of time limitations.

There is great interest today in biological macromolecules, which are usually discussed in elementary biochemistry and biology courses. Accordingly, an introduction to the nature of macromolecules has been presented in Chapter 10. Also presented are the mechanisms for the formation of polymers which provide the student with excellent, simple examples of reaction mechanisms.

Although nuclear chemistry is usually included in physical chemistry texts, it is rarely presented in physical chemistry courses and the principles of this subject are generally not provided for in the undergraduate curriculum. Since the principles of nuclear chemistry can be presented using only algebra, it can be part of a freshman course.

The authors have tried to arrange the material in this book so that certain topics can be omitted if the teacher desires. This material, however, is there for the more interested student. Hopefully, the student will find the problems challenging. The authors have tried to include some problems which illustrate important principles not fully developed in the text, so that the student can deduce them for himself.

A minimum knowledge of calculus is required for Chapters 8 (Section II), 9, and 10 only. The other chapters require only knowledge of algebra.

The authors thank those who have aided them, both directly and indirectly, in this project. We are indebted to Professors Kenneth Wiberg and Jack Halpern for their helpful comments on the manuscript. We are further indebted to Professor Eugene Kupchik for his perusal of the entire manuscript. We are grateful to Professor Charles Erickson for making sets of problems available to us for inclusion in the book. We gratefully acknowledge the support and encouragement given us during this project by several of our colleagues at Seton Hall University. Special thanks are due Mrs. Sally Kynor Johnson, whose excellent typing of the manuscript was of great aid, and Miss Lynn Ebbets, who assisted with the typing. We are particularly indebted to our past teachers and to our students, who have been, and remain, sources of stimulation.

We will be grateful for any constructive criticism of this book.

Paul Ander
Anthony J. Sonnessa

South Orange, New Jersey

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