INTRODUCTION TO

CHEMICAL PRINCIPLES

FIFTH EDITION

H. Stephen Stoker

Introduction to Chemical Principles

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Fifth Edition

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Introduction to Chemical Principles

Preface

Introduction to Chemical Principles is a text for students who have had little or no previous instruction in chemistry or who had such instruction long enough ago that a thorough review is needed. The text's purpose is to give students the background (and confidence) needed for a subsequent successful encounter with a main sequence college level general chemistry course.

Many texts written for preparatory chemistry courses are simply "watered down" versions of general chemistry texts; they treat almost all topics found in the general chemistry course, but at a superficial level. *Introduction to Chemical Principles* does not fit this mold. The author's philosophy is that it is better to treat fewer topics extensively and have the student understand those topics in greater depth. The very real temptation to include "lots and lots" of additional concepts in this new edition of the text was resisted. Instead the focus for the revision was on rewriting selected portions to improve the clarity of presentation.

Important Features of This Textbook

1. Because of the varied degrees of understanding of chemical principles possessed by students taking a preparatory chemistry course, development of each topic in this text starts at "ground level" and continues step by step until the level of sophistication required for a further chemistry course is attained.
2. Problem solving receives major emphasis. Nearly thirty years of teaching experience indicate to the author that student "troubles" in general chemistry courses are almost always centered in the inability to set up and solve problems. Whenever possible, dimensional analysis is used in problem solving. This method, which requires no mathematics beyond arithmetic and elementary algebra, is a powerful and widely applicable problem-solving tool. Most important, it is a method that an average student can master with an average amount of diligence. Mastering dimensional analysis also helps build the confidence that is so valuable for future chemistry courses.

3. Significant figure concepts are emphasized in all problem-solving situations. Routinely, electronic calculators display answers that contain more digits than are needed or acceptable. In all worked-out examples, students are reminded about these "unneeded digits" by the appearance of two answers to the example: the calculator answer (which does not take into account significant figures) and, in color, the correct answer (which is the calculator answer adjusted to the correct number of significant figures).
4. Numerous worked-out example problems are found within the textual material with detailed commentary accompanying each such example. In addition an unworked practice exercise is coupled to each example. It is intended that students will work this exercise immediately after "working through" the example. For immediate feedback, the answer to each practice exercise follows the exercise.
5. All end-of-chapter exercises occur in "matched pairs." In essence, each chapter has two independent, but similar, problem sets. Counting subparts to problems, there are over 5000 questions and problems available for a student to use in his or her "struggle" to become proficient at problem solving. Answers to all of the odd-number problems are found at the end of the text. Thus, two problem sets exist, one with answers and one without answers.
6. Each end-of-chapter problem set, except for Chapters 1 and 2, is divided into three sections: (1) Practice Problems, (2) Additional Problems, and (3) Cumulative Problems. The practice problems are categorized by topic and are arranged in the same sequence as the chapter's textual material. These problems, which are always single-concept, are "drill" problems which most students will find "routine." The additional problem section contains problems that involve more than one concept from the chapter and are usually more difficult than the practice problems. The cumulative-skills section draws not only on materials from the current chapter but also on concepts discussed in previous chapters. The working of problems in this third group allows students to continue to use, rather than forget, problem-solving techniques presented earlier.

NEW FEATURES OF THE FIFTH EDITION

1. All 197 of the worked out examples in the text are new to this edition.
2. At least 50% of the end-of-chapter problems in each chapter are new. Overall, 1124 of the 1972 end-of-chapter problems and questions are new.
3. The sequence of presentation of the covalent bonding topics in Chapter 7 has been altered. The geometry of molecules (VSEPR theory) is now more closely tied to the concept of electron-dot structures.
4. Chapter 8, Chemical Nomenclature, has been extensively rewritten. An important new feature of this chapter is the introduction of nomenclature flow charts ("decision trees").
5. Chapter 9 contains an expanded discussion of the calculation of empirical and molecular formulas.

6. The material in Chapter 15 dealing with balancing redox reactions using the half-reaction method has been simplified. A new procedure for balancing half-reactions in basic solution has been added.

SUPPLEMENTS

A *Student Solutions Manual* has been prepared by Dr. Garth L. Welch of Weber State University to accompany this text. There is also an appropriate lab manual, *Prentice Hall Laboratory Experiments for Introductory Chemistry* by Charles H. Corwin of American River College. A free supplement, *How to Study Chemistry*, stressing strategies for learning and achievement in chemistry, is available to students on request from the instructor.

Also available to adopters is an *Instructor's Solutions Manual* by Dr. Welch. A test bank compiled by Dr. Stoker is available as a manual or in computerized formats, both MAC and IBM. There is an *Instructor's Manual to the Laboratory Experiments* available to the instructor, and *The New York Times Themes of the Times*, a newsprint collection of timely topics relevant to chemistry in action in our world.

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H.S.S.

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The Science of Chemistry

1.1 Chemistry—A Scientific Discipline

Students who are required to take two years, one year, or just one course of chemistry all often ask the same question prior to beginning their "chemistry experience." That question is: Why must I take chemistry? The answer to this simple five-word question, which involves an appreciation for the relationships between various branches of scientific knowledge, serves as our entry point into the "realm" of chemistry.

Chemistry is part of a larger body of knowledge called *science*. **Science** *is the study in which humans attempt to organize and explain, in a systematic and logical manner, knowledge about themselves and their surroundings*.

Because of the enormous scope of science, the sheer amount of accumulated knowledge, and the limitations of human mental capacity to master such a large and diverse body of knowledge, science is divided into smaller subdivisions called *scientific disciplines*. A **scientific discipline** *is a branch of science limited in size and scope to make it more manageable*. Examples of scientific disciplines are *chemistry*, astronomy, botany, geology, physics, and zoology.

Figure 1.1 shows an organization chart, with emphasis on chemistry, for the various scientific disciplines. These disciplines can be grouped into *physical sciences* (the study of matter and energy) and *biological sciences* (the study of living organisms). Chemistry is a physical science.

Rigid boundaries between scientific disciplines *do not exist*. All scientific disciplines borrow information and methods from each other. No scientific discipline is totally independent. "Environmental problems" that scientists have encountered in the last two decades particularly show the interdependence of the various scientific disciplines. For example, chemists attempting to solve the problems of chemical contamination of the environment find that they need some knowledge of