BASIC COLLEGE CHEMISTRY

Don Roach and Edmund Leddy, Jr.

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PREFACE

When most students are asked why they study chemistry, the answer almost invariably is "because I have to." This book is written for the large group of students who have to take chemistry, but who have never had chemistry before. We realize that many people regard science, and chemistry in particular, as difficult subjects. People we meet socially often express admiration and awe when they find out that we teach such a supposedly complicated subject. They express an unexplained fear of failure concerning the subject of chemistry. We, however, do not regard chemistry as difficult. We have attempted to write a book that starts with the basics and proceeds step by step for a clear understanding. We have constantly tried to keep the student in mind.

People study chemistry in preparation for many fields of work: agriculture, astronomy, biology, dentistry, environmental studies, engineering, forestry, geology, medicine, meteorology, oceanography, psychology, nursing, physical therapy, and physics. All these areas require some knowledge and understanding of chemistry. This is because all the material objects and substances in our world are chemical in nature. These chemicals include the fertilizers and insecticides used in agriculture, the silicon chips used in calculators and computers, and the glucose flowing along in our own bloodstream. The natural world and its beauty are also chemical: the rocks and soils that form our mountains, plains, and valleys; the water and salts in the oceans; and the air that covers our

Chemistry is not only a study of matter; it is also a study of the energy that matter produces or absorbs when it undergoes change. Chemical changes produce the light energy from a flashbulb, the electrical energy from a car battery, the sound energy from a firecracker, the mechanical energy in a moving car, and the heat energy from a match. Chemistry, then, is the central science. It is important and relevant to anyone who wants to become a professional or paraprofessional in any area of science, medicine, or engineering.

In this text we have attempted to show the importance of chemistry for various fields of study. Many of the questions at the end of each chapter are of a topical nature (concerning some subject or field that uses chemistry). In addition, there are numerous short discussions of relevant topics throughout the book. We hope these questions and discussions will attract students' attention and help them to stay motivated even when the material seems difficult.

To help simplify the study of chemistry, we have included a number of study aids. Each chapter has a short *introduction* explaining why the material in that chapter is important or how that chapter relates to other chapters. While studying a chapter, note that we have included many worked-out *examples.* Following many of these examples are short *exercises* to test knowledge up to that point. At the end of each chapter there is a *summary* of the main ideas discussed in the chapter. This summary gives an overall view and perspective of the chapter. Then follows a list of *objectives* that we feel a student with a thorough understanding of the chapter could complete. These objectives may seem somewhat technical; they are written more for the teacher's use and individual teachers may wish to delete some, add new ones, or alter some. Students can use the objectives to test their own knowledge of the chapter material. Before the end-of-chapter *questions* there is a list of *key terms* appearing in each chapter. Students should be able to write an explanation of each term in their own words. To help students learn the language of chemistry we have placed a *glossary* at the end of the book. It will be most helpful for finding a short definition of a term used in the text. In addition, we have tried to make the *index* as complete as possible.

The questions at the end of each chapter are of two types. The *drill questions* are there to provide plenty of practice. In many ways, learning how to solve chemistry problems is similar to many team sports: Faithful practice is necessary in order to know how to perform correctly in many different situations. In addition, we have many *topical questions* which we hope will stimulate and hold student interest. These topical questions require close, careful reading. Many topical questions are *starred.* They require more than an average understanding of the material and we

present them as a challenge to better students. If a question number is in color, the answer to that question is included in the answer section at the end of this book.

Calculators have helped to simplify and shorten the many calculations required to solve chemical problems. However, the calculator will be of no use without an understanding of what has to be done to find the answer. In Chapter 2 we introduce a technique for solving problems that we have found to be very successful for beginning students. This technique makes use of *conversion factors* or *unit factors* to solve simple problems in the beginning of the book and more involved problems in later chapters. There is appropriate material in the Appendix for reviewing *arithmetic, simple algebra, graphing,* and the use of *powers of ten.* This section includes material on *significant figures* and *rounding numbers* which will be most useful in the laboratory.

Many people have helped us with this text. Students and reviewers agreed with us that a glossary is an extremely useful tool, and we have included one at the end of the book. Phillip Frieder, a student and tutor, made suggestions that we have used to improve the illustrations of the mole concept. The librarians at Miami-Dade Community College, North Campus, graciously helped us locate numerous reference materials and our colleagues have class-tested parts of the text. We would like to acknowledge their help and advice, particularly that of Douglas McLean, Thomas DeRosa, Irving Lillian, Anthony Pappas, and Larry Bray, all of Miami-Dade Community College.

Among the many reviewers who offered useful suggestions were Professors David L. Adams of North Shore Community College, Robert S. Cichowski of California Polytechnic State University, John T. Healy of Chabot College, Helen K. McAferty of Orange Coast College, Raymond T. O'Donnell of the State University of New York at Oswego, and Richard C. Thompson of the University of Missouri. Our thanks to our editors, especially Donald Jackson, Sibyl Golden, and Catherine Cote, and to our typists Jane Morganroth and Mary Jane Mitchell. Most of all we would like to thank our families—Chris and Charissa; Rita, Jennifer, David, and Paul—for the sacrifices they made while we were busy writing.

Even after authors carefully plan, write, and rewrite a book, students and instructors often have useful suggestions for them. If you have any suggestions for us on how to improve this text, or if you enjoyed studying from it, please write us at the Chemistry Department, Miami-Dade Community College, Miami, Florida, 33167.

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1 INTRODUCTION

1.1 WHAT CHEMISTS DO

In the popular view, a chemist is a strange individual who wears a long white lab coat and works in a mysterious-looking laboratory. But if you were to ask most chemists what type of project they are carrying out, you might be surprised to discover that they are trying to solve the same problems that have concerned humans for thousands of years.

Consider our basic need for food. Humans have always struggled to obtain sufficient food for survival. Surely, many of our ancestors worried about getting sufficient rain for their crops. They must have also wondered how they could prevent insects and blight from destroying their young plants. Throughout the ages farmers have been faced with the problem of infertile soils. Today, a large number of chemists work in the various food-related industries. Chemists analyze soils to determine whether they are deficient in any of the plant nutrients. They are attempting to develop better and more economical fertilizers. Other chemists are searching for safer insecticides and fungicides. Chemists are also involved in the search for new methods of storing water and preventing its evaporation in dry areas. Chemists are among those who are looking for better ways to preserve, store, and package food to minimize spoilage. They are trying to determine the nutritional needs of our bodies and are looking for potential sources of nutritional foods.

A number of chemists work in health-related areas both in private companies and in public agencies. For example, chemists are involved in the preparation of drugs as well as in the search for new synthetic drugs. They also examine our food, water, and air to determine whether chemicals which may cause illness or disease are present.

Because most chemical changes either absorb or release energy, chemists study processes which involve energy changes. They search for ways in which to burn coal so that less pollution and more energy are produced. They are seeking alternate sources of energy to reduce our demand for petroleum and natural gas. Together with chemical engi-

This photograph of North and South America and western Africa, taken by a meteorological satellite, shows such phenomena as storms over Canada and the North Atlantic, fog and snow in California and Chile, ice breaking up in Hudson Bay, and dust blowing off the coast of Africa. Some of the dust from Africa will eventually fall on North and Central America. One result of space exploration and modern communication is our awareness of the relatively small size of Earth and the effects of events in one area on seemingly distant areas. (*NASA*)