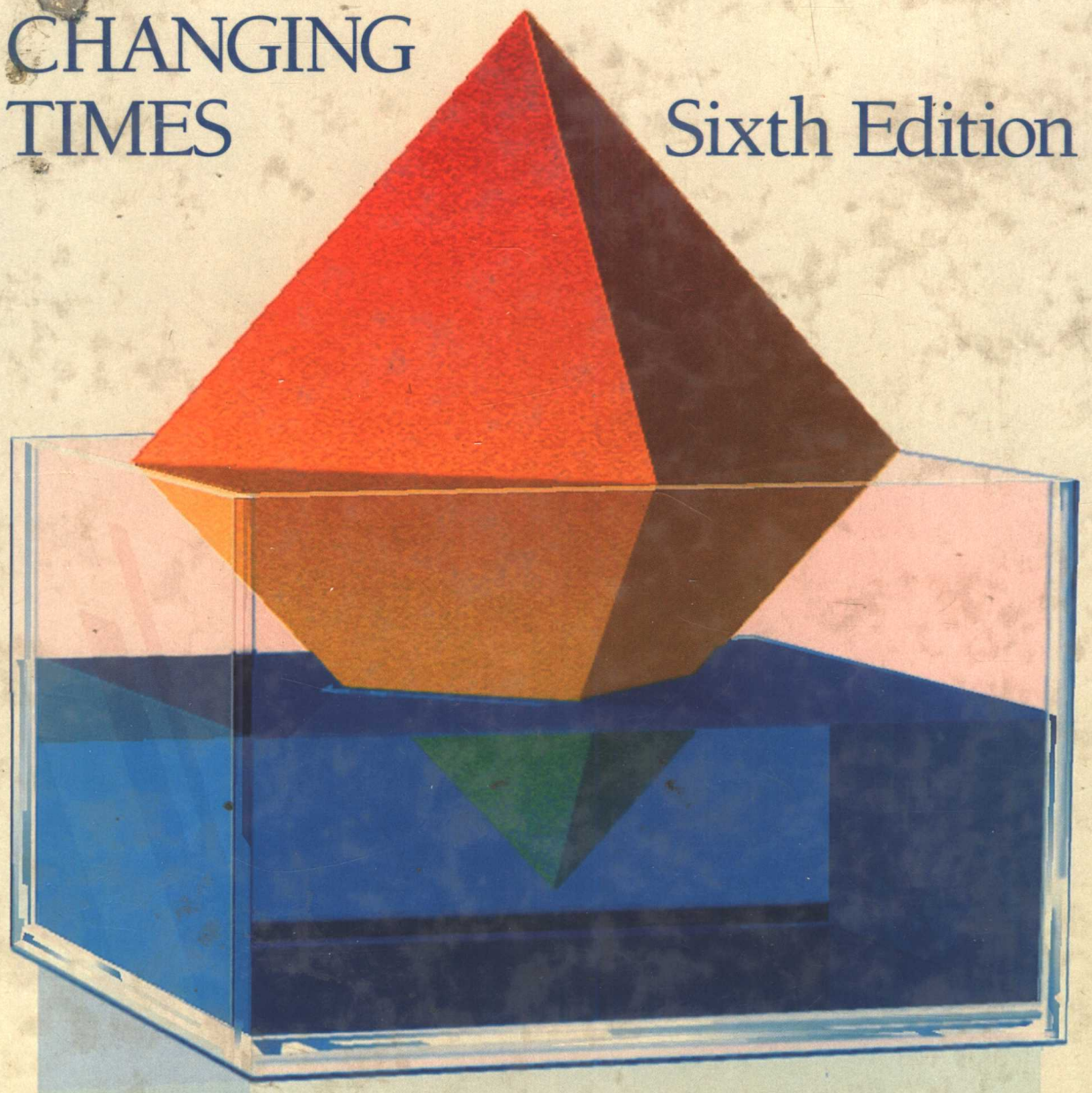
CHEMISTRY FOR CHANGING TIMES

John W. Hill

Sixth Edition



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John W. Hill

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Preface

The first edition of *Chemistry for Changing Times* was written with the firm conviction that chemistry can be presented in an intellectually honest way to students with little background or prior interest in the subject. That philosophy has served us well through the years. It continues to guide us in this revision. We also believe that a course for students not majoring in a science must be different from the type usually taught to science majors. Our philosophy is described in some detail in the paper, "Chemistry for Citizens: Content and Strategies," *Journal of Chemical Education*, 62, 765–767 (1985). Reprints of the paper are available from the author.

Our Goals

We can no longer feel we have done our duty to our students and to society by teaching all of them the same chemistry courses. A traditional course will not stimulate the interest of a typical liberal arts student or kindle much of a desire to know more about our chemical world. Yet most of our problems won't be solved without intelligent applications of chemistry. If we fail to motivate our students or if we allow them to complete our courses without having gained an understanding of or an appreciation for the chemical world, all of us lose. We live in an age of difficult daily decisions that affect our health and well-being. Choices we make also affect the future of the world. The stakes are enormously

high. We are engaged in great global experiments that may make our world much warmer or poison its oceans or sterilize our planet with ultraviolet radiation. Only through our best possible efforts as teachers and students, as scientists and citizens, can we understand and alleviate these problems. Three-fourths of all legislation considered by the United States Congress involves scientific or technological questions. Our economic competition with other nations depends on excellence in science and on scienctifically literate citizens. Our government and our scientific leaders are now committed to improving science education at all levels and to finding more effective ways to reach those who will not become scientists. If we who teach chemistry fail to take advantage of our present opportunities, we will contribute to the very maladies we hope to correct.

Our Students

Generally, students enrolled in the liberal arts chemistry course are not interested in the austere abstractness and the elegant mathematics of the physical theories that we scientists find so beautiful. If they were, they would most likely be science majors. Because of their temperament and training, most of these students are not prepared to understand the awesome mathematical theories of quantum mechanics and thermodynamics. Even simple stoichiometric relationships inspire fear in many of them. We must use care in presenting the essential quantitative nature of chemistry to these students to avoid intimidating them.

Our Objectives

The principal objectives in a chemistry course for liberal arts students are these.

Design the course to attract as many students as possible. If they don't enroll, we won't have the opportunity to teach them.

Use topics of current interest to illustrate chemical principles. This will enable our students to incorporate into their lives a feel for how chemists approach and solve problems.

Relate problems with chemical aspects to our students' own lives so that they will be better able to appreciate the significance of such problems.

Instill in students an appreciation for chemistry as an open-ended learning experience that will continue throughout their lives. Chemistry should not be a subject that is memorized before the final exam and then quickly forgotten.

Acquaint students with scientific methods so that they will be able to distinguish between science and its applications in technology.

These objectives have been met to a most gratifying extent in our own course. Course enrollment rose sharply during the early years of the course, and it has continued high through times of capped university enrollment.

Major Changes in This Revision

The entire book has been updated. A new chapter (13) on biochemistry provides expanded treatment of carbohydrates, lipids, proteins, and nucleic acids. New material throughout the book includes the latest on gene therapy in humans, biomass fuel, global warming, the ozone hole, AIDS, alcohol, cigarette smoke, natural toxins in food, solid wastes, and many other topics of vital interest to everyone. Despite the awesome problems we face, the theme of the book remains positive: The problems can be alleviated, and an understanding of chemistry is essential to their solution.

Much of the traditional material, especially in the early chapters, has been revised in a way that enhances student understanding. Worked-out examples have been added, and in-chapter exercises included to provide students an immediate check on their mastery of the material.

For those who need it, the treatment of atomic structure, the periodic table, bonding, and the shapes of molecules has been expanded.

The number of end-of-chapter review questions and problems has been increased. The problems are provided in matching sets so that the teacher can assign the odd-numbered ones (with answers in Appendix F) or the even-numbered one (without answers in the text). The problems also are organized in groups that parallel the sections in the text.

Use of Color

Visual material is especially important for learning chemistry. Color is used in this edition to enhance the learning process. Color also enhances the attractiveness of the design and helps maintain student interest. Special color photographs show descriptive chemistry at its best. Many of the illustrations are made more meaningful by the judicious use of color.

Readability

A chemistry text need not be stodgy in order to present its subject well. It is not always easy to learn chemistry, but if the chemical information is conveyed in a clear and understandable way, it can be especially rewarding. With this thought in mind, we have created a chemistry textbook that hundreds of thousands over the years have found to be both clearly readable and thoroughly enjoyable.

Units of Measurement

Most of the world has adopted the metric system of measurement. Our students have studied it since elementary school. A modern version of the metric system, the International System of Units (SI), is used in many countries, especially by scientists. What units should be used in a text for liberal arts students? In real life these students encounter all three: the traditional units, the old metric system, and sometimes SI. In most of the book, we use the units the students are most likely to come across elsewhere, except that we give them a gentle nudge toward metric where to do so does not hinder learning. For the presentation of chemical principles, we use SI units and symbols for the most part.

Complicated Chemical Structures

Structures of complicated molecules are presented in the text, particularly toward the end, but students should not feel that they are expected to memorize them. They have been presented merely to emphasize the fact that these structures are known and that molecular properties depend upon them. Students may, however, come to recognize familiar functional groups, even in the most complicated molecules.

Glossary

A glossary is provided in Appendix E. Definitions are given there for terms in **boldface** in the text.

Problems

There are over 1600 end-of-chapter exercises, including review questions, problems, and suggested projects. Some chapters have a section of additional problems to provide more flexibility in assignments. Instructors should assign the problems at their own discretion. Answers to selected review questions and to all odd-numbered problems are given in Appendix F. Detailed, worked-out solutions to all questions and problems (except those that are projects and those that ask for an opinion) are provided in the Instructor's Manual.

References and Suggested Readings

A list of recommended books and articles appears at the end of each chapter. Students whose interest and enthusiasm have been sparked can delve more deeply into those subjects about which they are curious. Instructors will also find this information helpful.

Supplementary Materials

The most important teaching aid in any course is the teacher. To make your task a bit easier as you teach the course, we have provided a variety of supplementary materials. These will also serve to enrich and round out the education of your students.

The following items complete the *Chemistry for Changing Times*, Sixth Edition, teaching and learning package.

Study Guide by Diane Bunce

Instructor's Resource Manual by John W. Hill with Emerson E. Garver

Chemical Investigations for Changing Times, Sixth Edition, by Alton Hassell, Emerson E. Garver, and John W. Hill (laboratory manual) with Instructor's Guide by Alton Hassell

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I deeply appreciate the many of you who have pointed out my mistakes in the manuscript and in previous editions. With help from so many, I should have a perfect book. Despite your best efforts, however, I am sure that errors remain. They are a burden that I alone must bear.

Above all, though, I would like to thank the many students who with zest and enthusiasm have gone on to learn for themselves more about chemistry than I ever taught them. Teaching is a joy, but learning is a real celebration. I have learned far more from my students than I can ever teach them; for that I am eternally grateful. Comments, corrections, suggestions, and criticisms are always welcome.

J. W. H.

To the Student

Welcome to Our Chemical World!

Chemistry is fun. Through this book, I would like to share with you some of the excitement of chemistry and some of the joy in learning about it. I hope to convince you that chemistry does not need to be excluded from your learning experiences. Learning chemistry will enrich your life—now and long after this course is over—through a better understanding of the natural world, the technological questions now confronting us, and the choices we must face as citizens within a scientific and technological society.

Chemistry Directly Affects Our Lives

How does the human body work? How does aspirin cure our headaches? Do steroids enhance athletic ability? Is table salt poisonous? Can scientists cure genetic diseases? Why do most weightloss diets seem to work in the short run but fail in the long run? Does fasting "cleanse" the body? Why do our moods swing from happy to sad? Can a chemical test on urine predict possible suicide attempts? How does penicillin kill bacteria without harming our healthy body cells? Chemists have found answers to questions like these and continue to seek the knowledge that will unlock still other secrets of our universe. As these mysteries are resolved, the direction of our lives often changes—sometimes dramatically.

We live in a chemical world—a world of drugs, biocides, food additives, fertilizers, detergents, cosmetics, and plastics. We live in a world with toxic wastes, polluted air and water, and dwindling petroleum reserves. Knowledge of chemistry will help you to better understand the

benefits and hazards of this world and enable you to make intelligent decisions in the future.

Chemical Dependency

We are all chemically dependent. Even in the womb, we depend on a constant supply of oxygen, water, glucose, and a multitude of other chemicals.

Our bodies are intricate chemical factories. They are durable but delicate systems. A myriad of chemical reactions are constantly taking place within us that allow our bodies to function properly. Thinking, learning, exercising, feeling happy or sad, putting on too much weight or not gaining enough, and virtually all life processes are made possible by these chemical reactions. Everything that we ingest is part of a complex process that determines whether our bodies work effectively or not. The consumption of some substances can initiate chemical reactions that will stop body functions altogether. Other substances, if consumed, can cause permanent handicaps, and others can make living less comfortable. A proper balance of the right foods provides the chemicals and generates the reactions we need in order to function at our best. The knowledge of chemistry that you will soon be gaining will help you to better understand how your body works so that you will be able to take proper care of it.

Changing Times

We live in a world of increasingly rapid change. It has been said that the only constant is change itself. At present, we are facing some of the greatest problems that humans have ever encountered, and the dilemmas with which we are now confronted seem to have no perfect solutions. We are sometimes forced to make a best choice among only bad alternatives, and our decisions often provide only temporary solutions to our problems. Nevertheless, if we are to choose properly, we must understand what our choices are. Mistakes can be costly, and they cannot always be rectified. It is easy to pollute, but cleaning up pollution once it is there is enormously expensive. We can best avoid mistakes by collecting as much information as possible before making critical decisions. Science is a means of gathering and evaluating information, and chemistry is central to all the sciences.

Chemistry and the Human Condition

Above all else, my hope is that you will learn that chemistry need not be dull and difficult. Rather, it can enrich you life in so many ways—through a better understanding of your body, your mind, your environment, and the world in which we live. After all, the search to understand the universe is an essential part of what it means to be human.

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