

PEARSON

国外高校优秀化学教材——影印版

化学

时代行进中的科学

(第12版)

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Chemistry
For Changing Times
(Twelfth Edition)

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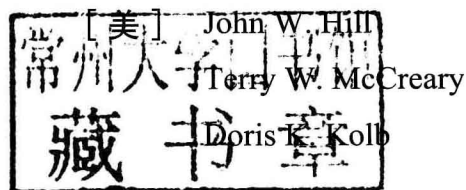
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Chemistry For Changing Times (Twelfth Edition)

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出版前言

随着经济全球化、教育国际化趋势的逐渐增强,迫切需要既精通专业知识又精通外语的高素质人才。化学是自然科学的“中心学科”,高等化学教育应面向世界,适应时代的需要,吸收国外先进的教学理念和教育教学形式,培养学生适应国际形势需要的综合素质。

为反映国外化学类教材的最新内容和编写风格,同时也为提高学生阅读专业文献和获取信息的能力,为高等学校使用英文原版教材进行双语教学服务,我们精选了国外优秀的化学类教材,组成“国外高校优秀化学教材——影印版”,本书即为其中的一册。所选教材均在国外广泛采用,多数已再版,书中不仅介绍了有关概念、原理及应用,给出了丰富的实例和数据,还反映了作者不同的学术观点。

我们希望这套丛书的出版能对高等学校师生有所帮助,并对我国高等化学教育的发展做出贡献。

清华大学出版社

2012年10月

PREFACE

Chemistry for Changing Times is now in its twelfth edition. Times have changed immensely since the first edition appeared in 1972 and continue to change more rapidly than ever—especially in the vital areas of biochemistry, the environment, energy, drugs, and health and nutrition—and we have thoroughly updated the material accordingly. The emphasis on the concept of green chemistry throughout the book, especially in the Green Chemistry essays (see page v), is one of the major changes to the twelfth edition.

A Special Kind of Course

Our knowledge base has expanded enormously since the first edition, never more so than in the last few years. We have faced tough choices in deciding what to include and what to leave out. We now live in what has been called the “information age.” Unfortunately, information is not knowledge; the information may or may not be valid. Our focus, more than ever, is on helping students evaluate information. May we all someday gain the gift of wisdom.

A major premise is that a chemistry course for students who are not majoring in science should be quite different from the course we offer our science majors. It must present basic chemical concepts with intellectual honesty, but it need not—and probably should not—focus on esoteric theories or rigorous mathematics. It should include lots of modern everyday applications. The textbook should be appealing to look at, easy to understand, and interesting to read.

Three-fourths of the legislation considered by the U.S. Congress involves questions having to do with science or technology, yet only rarely does a scientist or engineer enter politics. Most of the people who make important decisions regarding our health and our environment are not trained in science, but it is critical that these decision makers be scientifically literate. In the judicial system, decisions often depend on scientific evidence, but judges and jurors frequently have little education in the sciences. A chemistry course for students who are not science majors should emphasize practical applications of chemistry to problems involving such things as environmental pollution, radioactivity, energy sources, and human health. The students who take our liberal arts chemistry courses include future teachers, business leaders, lawyers, legislators, accountants, artists, journalists, jurors, and judges.

Objectives

Our main objectives in a chemistry course for students who are not majoring in science are as follows:

- To attract lots of students from a variety of disciplines. If students do not enroll in the course, we can't teach them.
- To help students learn so that they may become productive, creative, ethical, and engaged citizens.
- To use topics of current interest to illustrate chemical principles. We want students to appreciate the importance of chemistry in the real world.
- To relate chemical problems to the everyday lives of our students. Chemical problems become more significant to students when they can see a personal connection.

- To instill in students an appreciation for chemistry as an open-ended learning experience. We hope that our students will develop a curiosity about science and will want to continue learning throughout their lives.
- To acquaint students with scientific methods. We want students to be able to read about science and technology with some degree of critical judgment. This is especially important because many of the scientific problems discussed are complex and controversial.
- To show students—through Green Chemistry essays and exercises—that better, safer, and more environmentally friendly processes and products are being developed. We want students to know that “green chemistry” is not a buzzword but a goal to be pursued.
- To help students become literate in science. We want our students to develop a comfortable knowledge of science so that they find news articles relating to science interesting rather than intimidating.

New Features in the Twelfth Edition

In preparing this new edition, we have responded to suggestions from users and reviewers of the eleventh edition, and we have used our own writing and teaching experience. The text is fully revised and updated to reflect the latest scientific developments in a fast-changing world.

A very visible change to the twelfth edition is the reorganization of the chapters. At most institutions, the course for nonscience majors brings together a group of students who are quite heterogeneous both in their science backgrounds and in their academic interests. A major challenge to the instructor is to find the balance between these needs and interests. As authors we have tried to create a text that is flexible and that can be used in a variety of ways. One goal of the reorganization was to make it easier for the instructor to skip sections or (in some cases) whole chapters.

- Chapters 1 through 8 deal with some of the basic chemistry, including atoms and elements, structures of ionic and molecular compounds, acids and bases, and oxidation–reduction reactions. Most of the numerical manipulations are concentrated in Chapters 5 and 6.
- Chapters 9 and 10 introduce organic chemistry and polymers.
- Chapter 11 is concerned with nuclear chemistry. This was Chapter 4 in previous editions; it was moved to this new location in response to user feedback to present a more concise core. For those who so desire, Chapter 11 can still be taught after Chapter 3.
- Chapters 12 through 15 (which deal with Earth, air, water, and energy, respectively) focus on environmental issues. An environmental focus permeates the entire book, especially in the incorporation of the concept of green chemistry in the Green Chemistry essays and exercises.
- Chapter 16 introduces biochemistry and provides a background for the some of the material in subsequent chapters, especially Chapter 17 (Food) and eChapter 19 (Fitness and Health).
- Chapter 18 deals with various aspects of drugs: legal and illegal, life-sustaining and death-dealing.
- Another dramatic change is seen in Chapters 19 through 22, which are presented online. Most of today’s students use the Web routinely; for them this mode of delivery will probably be welcomed! By doing this, we also save paper—the book is now greener both in content and in fact—and the cost has been reduced. These four chapters delve into fitness and health, agriculture and gardening, household chemicals, and poisons, respectively.

Clearly, for a one-semester course, choices will have to be made. In some places, the text refers to later chapters where further details of a particular topic are to be found, but it is fairly easy for instructors to select the parts most important and useful to their students. If you have specific questions about skipping sections or chapters, please contact John Hill (jwhill602@comcast.net) or Terry McCreary (terry.mccreary@murraystate.edu).

Improvements in Pedagogy

The following changes have been made to strengthen and improve the pedagogy in this edition.

- We have incorporated Self-Assessment Questions at the end of most sections in the text. These multiple-choice items provide immediate feedback to test the student's understanding of the material.
- We extensively revised the Review Questions to account for the fact that many of them were superseded by the Self-Assessment Questions. We also revised about 25% of the end-of-chapter matched-set Problems and many of the Additional Problems.
- Several of the worked-out Examples and their accompanying Exercises have been modified or revised extensively.
- Each chapter starts with a set of *Questions You May Have Asked Yourself*. We have attempted to select real-life questions that may have arisen in an inquiring student's mind and are related to the chapter content. Answers to those questions are found in the margins of the chapter near the text content associated with the question.
- Critical Thinking Exercises have been added to or modified in certain chapters. These exercises require the student to apply information and learning from the chapter in both concrete and abstract fashion, in the evaluation of claims both hypothetical and real.
- Each chapter has a category of Collaborative Group Projects as a part of the end-of-chapter exercises. This will make it easy for instructors who want to encourage collaborative work and to make group assignments. In this way, the students' learning of chemistry can be extended far beyond the textbook.
- Some of the figures use voice balloons to point out important features. We also use voice balloons in text displays and problem solving to guide the student through the learning process and thus improve the pedagogy.
- The chapter summaries are organized by sections with key terms highlighted in red for easy recognition.
- We have added *More to Explore* notes in the margins, which suggest references for those who want to learn more about a particular topic.
- Keeping in mind that today's student is more visually oriented than ever, we have made extensive changes in the photographs, figures, graphs, and other illustrations. Figures that present numeric data have been updated where possible.

Applications

Periodically through the text, the reader will find box features. These essays focus on interesting, relevant applications of the chemistry covered in a particular chapter or section. Box features include the following:

- Nanoworld (Chapter 1)
- A Compound by Any Other Name Would Smell As Sweet. . . (Chapter 4)
- Photochromic Glass (Chapter 8)
- Cell Phones and Microwaves and Power Lines, Oh My! (Chapter 11)

- A Closed Ecosystem? (Chapter 13)
- Energy Return on Energy Invested (Chapter 15)
- Infectious Prions: Deadly Protein (Chapter 16)
- Enzymes and Green Chemistry (Chapter 16)
- It's a Drug! No, It's a Food! No, It's...a Dietary Supplement! (Chapter 17)
- Cisplatin: The Platinum Standard of Cancer Treatment (Chapter 18)
- Some Chemistry of Love, Trust, and Sexual Fidelity (Chapter 18)
- Chemistry and Athletic Performance (eChapter 19)
- Chemistry of Sports Materials (eChapter 19)
- Renaissance Poisoners and Chemistry and Counterterrorism (eChapter 22)

In addition, you will find short *It DOES Matter!* items in the margin. These features briefly discuss a specific application or phenomenon and show the student that the material being studied does relate to the world in which we live.

Visualization

Visual material adds greatly to the general appeal of a textbook. For that reason new color photographs and diagrams have been added throughout the text. Color diagrams can also be highly instructive, and colorful photographs relating to descriptive chemistry do much to enhance the learning process. We have added and revised illustrations that use both microscopic (molecular) and macroscopic (visual) views to help students visualize chemical phenomena. Some of the figure captions feature questions to focus attention on the concept illustrated in the figure.

Readability

Over the years, students have told us that they have found this textbook easy to read. The language is simple, and the style is conversational. Explanations are clear and easy to understand. The friendly tone of the book has been maintained in this edition. Since the format and the amount of open space on a page also contribute to readability, we have made conscious improvements in the design of this edition. For example, many of the margin notes of previous editions have been incorporated directly into the text to ensure that pages don't appear to be crowded.

Units of Measurement

The United States continues to use the traditional English system for many kinds of measurement even though the metric system has long been used internationally. A modern version of the metric system, the *Système International* (SI), is now widely used, especially by scientists. So what units should be used in a text for liberal arts students? In presenting chemical principles, we use primarily metric units. In other parts of the book we use those units that the students are most likely to encounter elsewhere in the same context.

Chemical Structures

The structures of many complicated molecules are presented in the text, especially in the later chapters. These structures are presented mainly to emphasize that they are actually known and to illustrate the fact that substances with similar properties often have similar structures. In many of the structures, functional groups or specific molecular features have been emphasized with color. For example, basic functional groups are usually shown in blue, acidic ones in red, and neutral in green. Students should not feel that they must learn all these structures, but they should take the time to look at them. We hope that they will come to recognize familiar features in these molecules.

Chapter Summaries and Glossary

The chapter summaries, with key terms highlighted in red, provide a quick review. The Glossary gives definitions of terms that appear in boldface throughout the text as well as some other terms frequently encountered. These terms include all key terms highlighted in the chapter summaries.

Questions and Problems

Worked-out Examples and accompanying Exercises are given within almost all of the chapters. Each Example carefully guides students through the process for solving a particular type of problem. It is then usually followed by one or more Exercises that allow students to check their comprehension right away. Many Examples are now followed by two Exercises, labeled A and B. The goal in an A Exercise is to apply to a similar situation the method outlined in the Example. In a B Exercise, students often must combine that method with other ideas previously learned. Because many of the B Exercises provide a context closer to that in which chemical knowledge is applied, they thus serve as a bridge between the worked Examples and the more challenging problems at the end of the chapter. The A and B Exercises provide a simple way for the instructor to assign homework that is closely related to the Examples. Answers to all the in-chapter Exercises are given in the Answers section at the back of the book.

The end-of-chapter exercises include the following:

- Review Questions that for the most part simply ask for a recall of material in the chapter. Answers to Review Questions identified by red numbers are given in the Answers section at the back of the book.
- A set of matched-pair Problems, arranged according to subject matter from each chapter, with answers to the odd-numbered Problems given in the Answers section.
- Additional Problems that are not grouped by type. Some of these are more challenging than the matched-pair Problems and often require a synthesis of ideas from more than one chapter. Other Additional Problems pursue further an idea in the text or introduce new ideas. Answers to odd-numbered Additional Problems are also given in the Answers section.
- Many colleges and universities now emphasize group learning as well as individual assignments. The Collaborative Group Projects permit an instructor to easily assign group work in an open-ended context; most of these Projects can have multiple directions and multiple focus points.

Supplementary Materials

The most important learning aid is the teacher. In order to make the instructor's job easier and enrich the education of students, we have provided a variety of supplementary materials.

Print Resources for Students

Study Guide and Selected Solutions Manual (0321612434). Prepared by Richard Jones of Sinclair Community College. This book assists students through the text material and contains learning objectives, chapter outlines, key terms, additional problems along with self-tests and answers, and answers to the odd-numbered problems from the text.

Chemical Investigations for Changing Times, Twelfth Edition (0321612450). Prepared by C. Alton Hassell and Paula Marshall. Contains 59 laboratory experiments and is specifically referenced to *Chemistry for Changing Times*.

Print Resources for Instructors

Transparency Set (0321615093). Selected by Terry McCreary and John W. Hill. This set contains 150 full-color acetates.

Printed Test Bank (0321612442). Prepared by Rill Ann Reuter, Winona State University. The *Test Item File* now contains over 2400 test questions that are referenced to the text.

Media Resources for Instructors

Online Instructor Manual for Chemical Investigations for Changing Times (0321615085). Prepared by Paula Marshall and C. Alton Hassell. This laboratory manual reference includes notes for experiments, safety regulations, procedural instructions, and specifications for equipment and supplies.

Instructor Resource Center on CD/DVD (0321612477). This integrated collection of resources includes everything you need organized in one easy-to-access place. It is designed to help you make efficient and effective use of your lecture preparation time as well as to enhance your classroom presentations and assessment efforts. This package features all of the art from the text, including tables; three prebuilt PowerPoint™ presentations; PDF files of the art for high-resolution printing; the *Instructor's Resource Manual*, and a set of "clicker" questions for use with Classroom Response Systems. Also included is the TestGen test-generation software and a TestGen version of the *Test Item File* that enables you to create and tailor exams to your needs or to create online quizzes for delivery in WebCT, Blackboard, or CourseCompass.

Online Instructor Resource Manual (0321612469). Prepared by Paul Karr and David Pietz of Wayne State College. This useful guide describes all the different resources available to instructors and shows how to integrate them into your course. Organized by chapter, this manual offers lecture outlines, answers and solutions to all questions and problems that are not answered by the authors in Appendix C, suggested in-class demonstrations recommended by Doris Kolb, and other suggested resources.

Course Management Options Pearson Prentice Hall offers three content cartridges for online, text-specific course management systems depending on your preferred platform. Hundreds of text-specific problems are provided.

Visit www.pearsonhighered.com/elearning for details on how to communicate with your students online, customize content to meet your course needs, create online quizzes and tests, track grades, and much more.

Acknowledgments

Through the last four decades we have greatly benefited from hundreds of helpful reviews. It would take far too many pages to list all of those reviewers here. Many of you have contributed to the flavor of the book and helped us minimize our errors. Please know that your contributions are deeply appreciated. For the twelfth edition, we are grateful for challenging reviews from

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We owe a special debt of gratitude to Doris K. Kolb (1927–2005), who was an esteemed coauthor of the seventh through the eleventh editions. Doris and her husband Ken were friends and helpful supporters long before Doris joined the author team. She provided much to the spirit and flavor of the book. Doris's contributions to *Chemistry for Changing Times*—and indeed to all of chemistry and chemical education—will live on for many years to come, not only in her publications but also in the hearts and minds of her many students, colleagues, and friends. Doris was a poet of some note. Her main interest was humorous poetry, and she consistently added a touch of fun to *Chemistry for Changing Times*. Four of her verses that appear in this volume were first published in the *Journal of Chemical Education*. We acknowledge, with thanks, the permission to reprint them here. Doris Kolb wrote those verses plus all of the others.

Throughout her career as a teacher, scientist, community leader, poet, and much more, Doris K. Kolb was blessed with a wonderful spouse, colleague, and companion, Kenneth E. Kolb. Over the years, Ken did chapter reviews, made suggestions, and gave invaluable help for many editions. All who knew her miss Doris greatly. Those of us who had the privilege of working closely with her miss her wisdom and wit most profoundly. Let us all dedicate our lives, as Doris did hers, to making this world a better place.

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Finally, we also thank all those many students whose enthusiasm has made teaching such a joy. It is gratifying to have students learn what you are trying to teach them, but it is a supreme pleasure to find that they want to learn even more. And, of course, we are grateful to all who have made so many helpful suggestions. We welcome and appreciate all your comments, corrections, and criticisms.

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Doris K. Kolb

To the Student

Welcome to Our Chemical World!

Chemistry is fun. Through this book, we would like to share with you some of the excitement of chemistry and some of the joy of learning about it. You do not need to exclude chemistry 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.

Learning chemistry involves thinking logically, critically, and creatively. Skills gained in this course can be exceptionally useful in many aspects of your life. You will learn how to use the language of chemistry: symbols, formulas, and equations. More important, you will learn how to obtain meaning from information. The most important thing you will learn is how to learn. Memorized material will quickly fade into oblivion unless it is arranged on a framework of understanding.

Chemistry Directly Affects Our Lives

How does the human body work? How does aspirin cure headaches, reduce fevers, and perhaps lessen the chance of a heart attack or stroke? Is ozone a good thing or a threat to our health? Are iron supplement pills poisonous? Is global warming real? If so, did humans contribute to it, and what are some of the possible consequences? Why do most weight-loss diets seem to work in the short run but fail in the long run? 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 such as 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, fuels, 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 better understand the benefits and hazards of this world and will 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. Innumerable chemical reactions that allow our bodies to function properly are constantly taking place within us. 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. Other substances, if consumed, can cause permanent disabilities, and still 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 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 and evaluating it carefully 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, our hope is that you will learn that the study of chemistry need not be dull and difficult. Rather, it can enrich your life in so many ways—through a better understanding of your body, your mind, your environment, and the world in which you live. After all, the search to understand the universe is an essential part of what it means to be human.

Highlights of the Twelfth Edition

Chemistry for Changing Times, the most successful book in liberal arts chemistry, defined the course in its first edition. With each subsequent revision, this text has reflected the changing times and the changing needs of the market.

Visually appealing, understandable, and interesting to read, the goal of the twelfth edition of *Chemistry for Changing Times* is to help inform students as scientifically literate consumers and decision makers. The authors present basic chemical concepts with abundant everyday applications, personalizing the chemistry experience for today's students. In this way, the text focuses students on evaluating information about real-life issues instead of memorizing rigorous theory and mathematics. Important in this new edition is the use of green chemistry as a theme to show the positive impact of chemistry on the future.

Green Chemistry

The concept of **green chemistry** is used throughout the book and appears prominently in the **Green Chemistry** essays in each chapter.

Critical Thinking

Critical Thinking Exercises. Critical thinking is introduced in Chapter 1 and carried throughout the text. At the end of every chapter is an expanded set of Critical Thinking Exercises that encourages students to think critically about and evaluate the most up-to-date, relevant issues. These exercises require the student to apply information and learning from the chapter in both concrete and abstract ways.

Collaborative Group Projects. These end-of-chapter exercises, which extend student learning of chemistry beyond the text, are available for instructors who want to engage students in collaborative work with group assignments.

Conceptual Problem Solving

Conceptual Examples guide students through the process of learning and understanding important chemical concepts.

- Each Example shows a title indicating the skill being covered.
- Solutions are expanded with more explanation to guide the students through solving the problem.
- **A and B Exercises** follow many of the Examples. The **A** Exercise parallels the Example; the **B** Exercise requires the student to incorporate information from earlier material. The dual Exercises help the students synthesize their learning into a coherent whole rather than just learning isolated facts.
- **Voice balloons** show students the logic of the problem-solving process.

Visualization

Illustrations using both microscopic (molecular) and macroscopic (visual) views help students visualize chemical phenomena.

Questions shown at the end of some of the figure captions direct the student to the things that are particularly important to visualize and to expand on the concept illustrated in the figure or photograph.

Chapter Summaries. The chapter summaries are presented by sections with key terms highlighted in red for easy recognition.

Applications That Focus on the Environment

Applications. Box features and *It DOES Matter!* discussions include many interesting, relevant, and environmental applications.

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PROMOTING GREEN CHEMISTRY

The concept of "Green Chemistry" is incorporated throughout the text by implementing a framework using the Twelve Principles of Green Chemistry written by experts in the field and tying in the Green Chemistry Essays at the end of each chapter.



TWELVE PRINCIPLES OF GREEN CHEMISTRY

- 1 PREVENTION**
It is better to prevent waste than to treat or clean up waste after it has been created.
- 2 ATOM ECONOMY**
Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.
- 3 LESS HAZARDOUS CHEMICAL SYNTHESSES**
Wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to human health and the environment.
- 4 DESIGNING SAFER CHEMICALS**
Chemical products should be designed to effect their desired function while minimizing their toxicity.
- 5 SAFER SOLVENTS AND AUXILIARIES**
The use of auxiliary substances (*e.g.*, *solvents*, *separation agents*, *etc.*) should be made unnecessary wherever possible and innocuous when used.
- 6 DESIGN FOR ENERGY EFFICIENCY**
Energy requirements of chemical processes should be recognized for their environmental and economic impacts and should be minimized. If possible, synthetic methods should be conducted at ambient temperature and pressure.
- 7 USE OF RENEWABLE FEEDSTOCKS**
A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable.
- 8 REDUCE DERIVATIVES**
Unnecessary derivatization (use of blocking groups, protection/deprotection, temporary modification of physical/chemical processes) should be minimized or avoided if possible, because such steps require additional reagents and can generate waste.
- 9 CATALYSIS**
Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.
- 10 DESIGN FOR DEGRADATION**
Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.
- 11 REAL-TIME ANALYSIS FOR POLLUTION PREVENTION**
Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.
- 12 INHERENTLY SAFER CHEMISTRY FOR ACCIDENT PREVENTION**
Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires.

*Originally published by Paul Anastas and John Warner in **Green Chemistry: Theory and Practice** (Oxford University Press: New York, 1998).

Twelve Principles Page

The Twelve Principles of Green Chemistry page, located at the front of the text, outlines the principles developed by Paul Anastas and John Warner that are used today by many in the chemistry community, including the American Chemical Society and the Environmental Protection Agency.