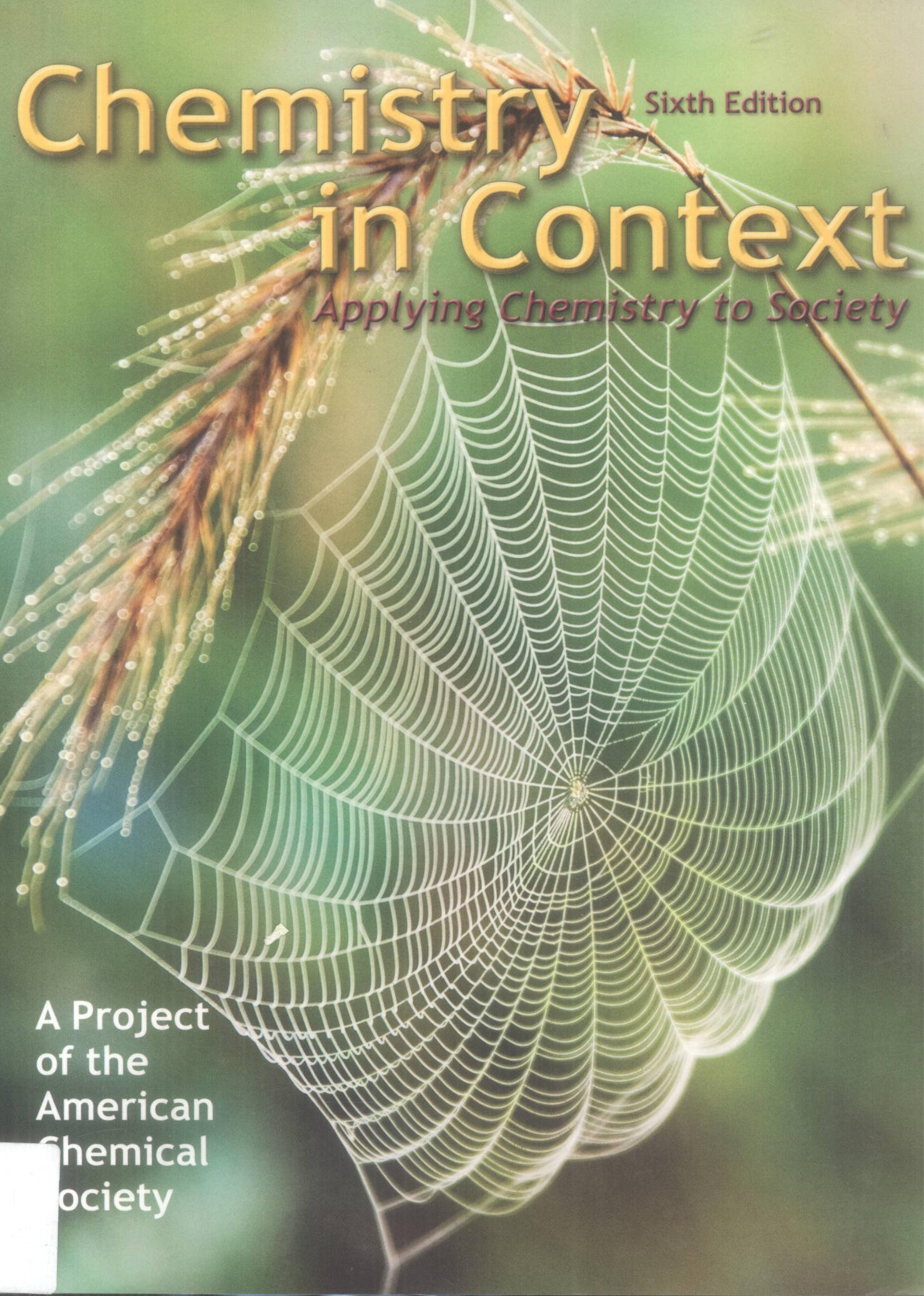
Chemistry in Context

Sixth Edition

Applying Chemistry to Society



A Project of the American Chemical Society

Chemistry in Context

Applying Chemistry to Society

Sixth Edition

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CHEMISTRY IN CONTEXT: APPLYING CHEMISTRY TO SOCIETY, SIXTH EDITION

This book is printed on acid-free paper.

1 2 3 4 5 6 7 8 9 0 DOW/DOW 0 9 8

ISBN 978–0–07–304876–5
MHID 0–07–304876–3

Publisher: *Thomas D. Timp*
Senior Sponsoring Editor: *Tamara Good-Hodge*
Managing Developmental Editor: *Shirley R.. Oberbroeckling*
Senior Marketing Manager: *Todd Turner*
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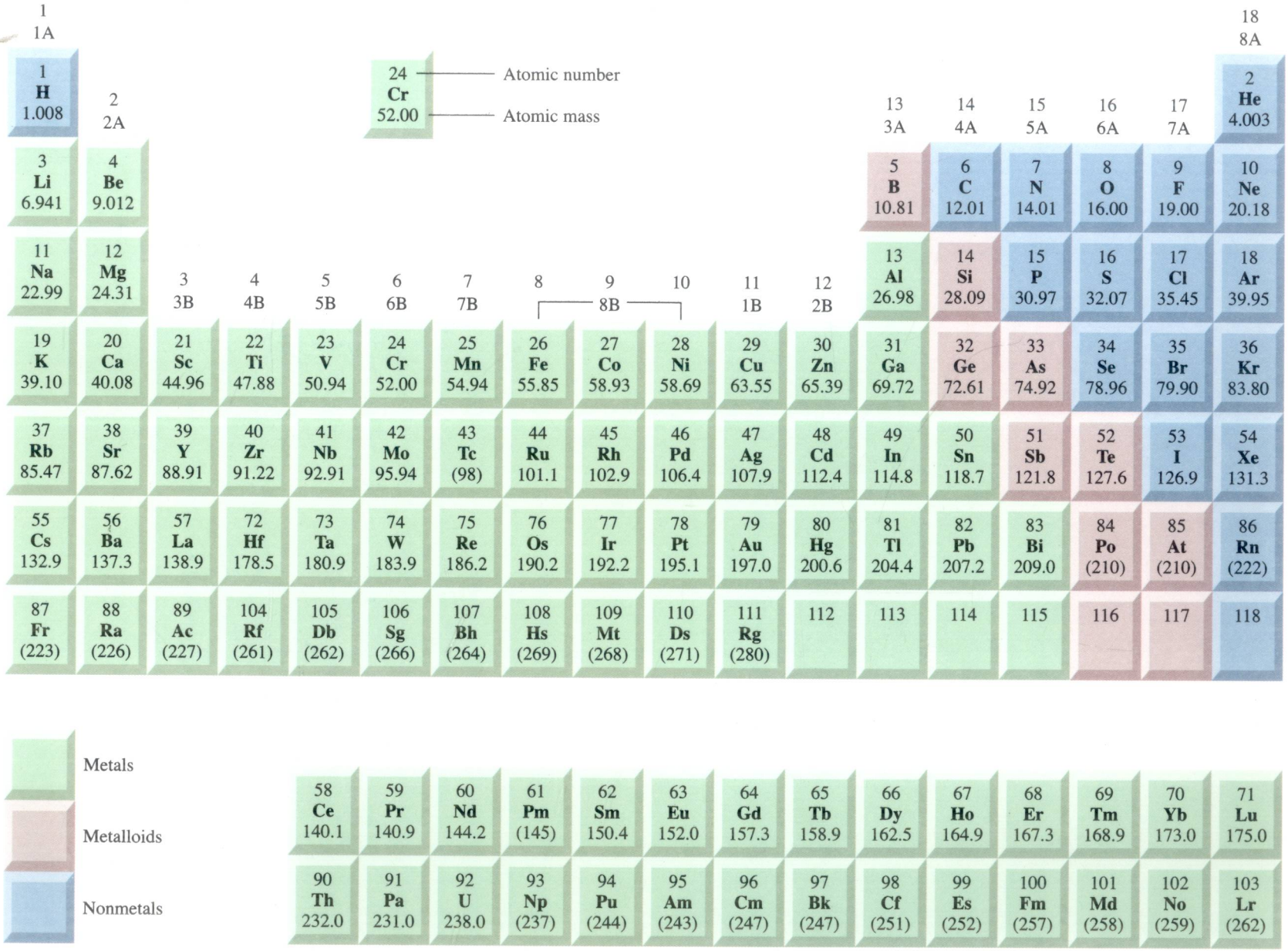
Senior Coordinator of Freelance Design: *Michelle D. Whitaker*
Cover/Interior Designer: *Rick Noel*
(USE) Cover Image: © *Jeremy Woodhouse/Masterfile*
Lead Photo Research Coordinator: *Carrie Burger*
Photo Research: *Pam Carley*
Supplement Producer: *Mary Jane Lampe*
Compositor: *Aptara*
Typeface: *10/12 Times Roman*
Printer: *R. R. Donnelley Willard, OH*

The credits section for this book begins on page 569 and is considered an extension of the copyright page.

Library of Congress Cataloging-in-Publication Data

Chemistry in context : applying chemistry to society — 6th ed. / Lucy Pryde Eubanks ... [et al.].
p. cm.
Includes index.
ISBN 978–0–07–304876–5 — ISBN 0–07–304876–3 (hard copy : alk. paper) 1. Biochemistry. 2. Environmental chemistry. 3. Geochemistry. I. Eubanks, Lucy T.
QD415.C482 2009
540 — dc22

2007040348



The 1–18 group designation has been recommended by the International Union of Pure and Applied Chemistry (IUPAC) but is not yet in wide use. In this text we use the standard U.S. notation for group numbers (1A–8A and 1B–8B). No name has been assigned for element 112. Elements 113–118 have not yet been synthesized.

Chemistry in Context

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Preface

Following in the tradition of its first five editions, the goal of *Chemistry in Context*, Sixth Edition, is to establish chemical principles on a need-to-know basis within a contextual framework of significant social, political, economic, and ethical issues. We believe that by using this approach, students not majoring in a science develop critical thinking ability, the chemical knowledge and competence to better assess risks and benefits, and the skills that can enable them to make informed and reasonable decisions about technology-based issues. The word *context* derives from the Latin word meaning "to weave." Thus, the spiderweb motif on the cover continues with this edition because a web exemplifies the complex connections between chemistry and society.

Chemistry in Context is not a traditional chemistry book for nonscience majors. In this book, chemistry is woven into the web of life. The chapter titles of *Chemistry in Context* reflect today's technological issues and the chemistry principles imbedded within them. Global warming, acid rain, alternative fuels, nutrition, and genetic engineering are examples of such issues. To understand and respond thoughtfully in an informed manner to these vitally important issues, students must know the chemical principles that underlie the sociotechnological issues. This book presents those principles as needed, in a manner intended to better prepare students to be well-informed citizens.

Organization

The basic organization and premise remain the same as in previous editions. The focal point of each chapter is a real-world societal issue with significant chemical context. The first six chapters are core chapters in which basic chemical principles are introduced and expanded upon on the need-to-know basis. These six chapters provide a coherent strand of issues focusing on a single theme—the environment. Within them, a foundation of necessary chemical concepts is developed from which other chemical principles are derived in subsequent chapters. Chapters 7 and 8 consider alternative (nonfossil-fuel) energy sources: nuclear power, batteries, fuel cells, and the hydrogen economy. The emphases in the remaining chapters are carbon-based issues and chemical principles related to polymers, drugs, nutrition, and genetic engineering. Thus, a third of the text has an organic/biochemistry flavor. These latter chapters provide students with the opportunity to focus on additional interests beyond the core topics, as time permits. Most instructors teach seven to nine chapters in a typical one-semester course. However, others find that *Chemistry in Context* contains ample material for a two-semester course.

What's New and Improved

Art Program

The art program for the sixth edition has been updated for consistency and accuracy, with new art added where needed. Chemical structures emphasize the important details of bonding and reactive sites. Details of chemical processes are emphasized in many figures, and real-world data have been updated and their presentation clarified to help students understand the information.

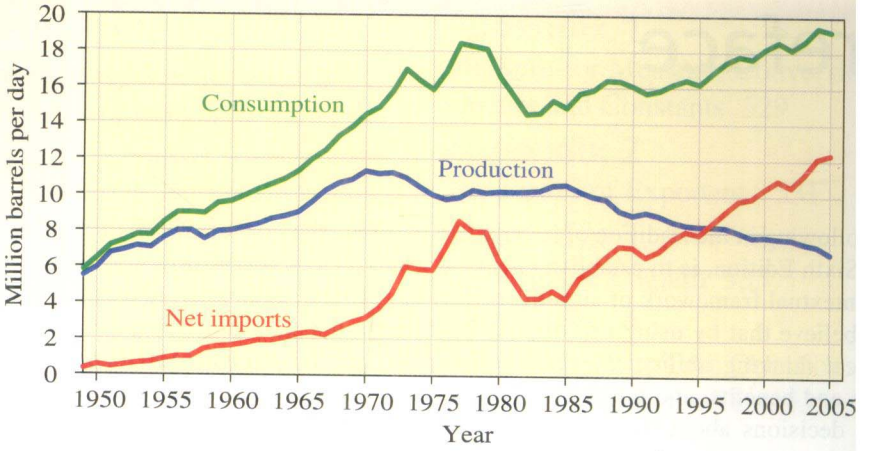


Figure 4.11

U.S. petroleum product use, domestic production, and imports. At present, more than 60% of the total oil used in the United States is imported, and projections show oil imports will continue to increase.

Source: Department of Energy, Energy Information Administration, *Annual Energy Review 2005.*

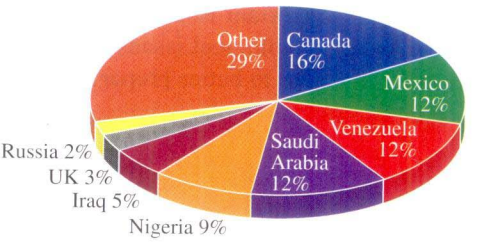


Figure 4.12

Sources of crude oil and petroleum products imported by the United States in 2004.

Source: Department of Energy/EIA.

Molecular Representations

Many types of representations are available to help the student understand molecular architecture. Lewis structures give essential information about bonding and can be interpreted to predict bond angles shown in structural formulas. Space-filling models provide another representation. This sixth edition uses the newest version of Spartan to produce charge-density diagrams. This type of representation shows charge distribution within molecules and is particularly helpful when explaining solubility, acidic and basic properties, and the reasons certain reactions take place.

More complex molecular structures are shown using structural formulas, but the sixth edition makes increased use of line-angle representations as well.

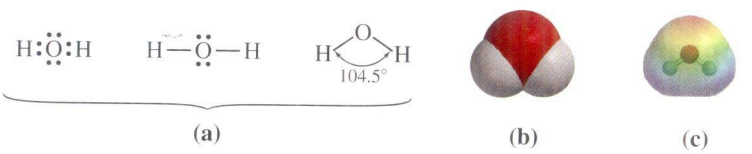


Figure 3.10

Representations of H_2O.
(a) Lewis structures and structural formula; **(b)** Space-filling model; **(c)** Charge-density model.

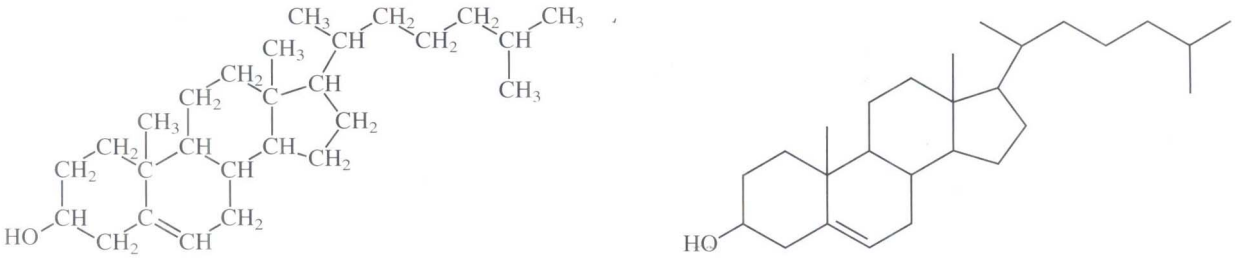


Figure 10.22

Representations of cholesterol.

Chapter 0, "Why the Spiderweb?"

Chapter 0, first introduced as a feature of the fifth edition, again walks the student through how to use all of the resources available to them in *Chemistry in Context*. Much of the information found in this preface in previous editions is now placed in the new introductory chapter. Although written for students, Chapter 0 also serves to explain to instructors the pedagogy, problem-solving opportunities, and many of the media resources of the sixth edition.

New and Updated Content

The major focus of a new edition is to update topical content. All information is as up-to-date as possible using a printed format. The resources on the Internet allow students to acquire real-time data, seek out current information, and make their own risk–benefit analysis about topics at the interface between science and society.

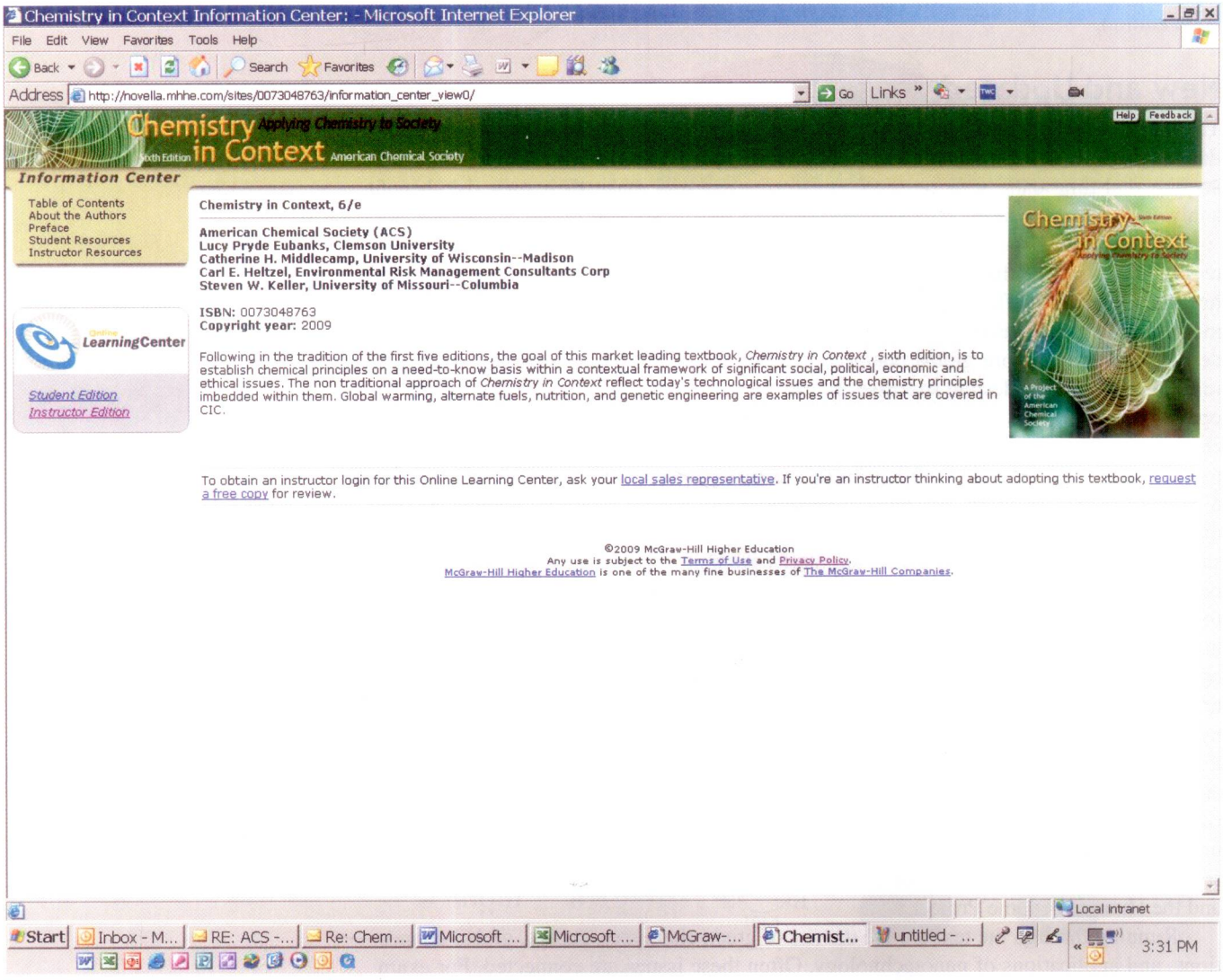
This edition introduces many new or expanded topics while keeping the same chapter organization. The discussion of air quality focuses on production of air pollutants and how they interact to affect both outdoor and indoor air quality. The role of particulates is more fully explored, as is the reality that air pollutants do not respect international borders. Looking at a more global perspective, ozone depletion is an issue that cannot be relegated to the past, despite successes in identifying major causes and obtaining the cooperation of much of the global community. Certainly global warming and its effects on climate change are now at the forefront of international attention. This edition provides more background for understanding Earth's energy processes and the molecular mechanisms producing warming, presents an accumulating base of scientific knowledge, and discusses the global implications of our actions (or lack thereof). The sixth edition has a sharper focus on biofuels, discussing alternatives to help us move away from dependence on fossil fuels. Measuring acidic precipitation has been given increased attention, as has the role of reactive nitrogen in understanding the problems of acid rain. Discussion of nuclear energy considers issues of the past, explores international practices, and assesses opportunities for resurgence in this industry. Other energy-related topics in the sixth edition include expanded coverage of newer generations of fuel cells, hybrid cars, and the hydrogen economy. Both biodegradable plastics and recycling receive more attention in this edition. There is new coverage of nanomedicine, the union of nanoscale technology and medical treatment, and an expanded discussion of drug discovery through combinatorial synthesis. Nutrition topics have again been reorganized to enable students to better understand and make decisions about popular diets. Current information on stem cell research is introduced in the final chapter of the text, along with cloning, transgenic foods, and the Human Genome Project.

Running through the text are the themes of green chemistry, energy, global connections, and applications of nanotechnology. Often these issues are connected. For example, how can the demand for increased energy use, necessary for equitable economic development around the world, be met in a globally responsible manner? How is energy produced in different parts of the world? Can nanotechnology help with challenges ranging from the safe storage of hydrogen for cleaner burning fuels to the development of

new sunscreens? What is the role of green chemistry in developing alternative products and processes? A broader view of how the themes mentioned here are carried out in the sixth edition can be found in the content grid on the Instructor Center of the *Online Learning Center*.

New and Updated Resources on the *Online Learning Center* (www.mhhe.com/cic)

The *Online Learning Center* (OLC) is a comprehensive, book-specific Web site offering excellent tools for both the instructor and the student. Instructors can create an interactive course with the integration of this site, and a secured Instructor Center stores your essential course materials to save you preparation time before class. This Instructor Center offers the Instructor's Resource Guide, additional labs, and a Presentation Center. The Student Center offers Web Exercises, Figures Alive Interactives, and quiz questions for each chapter. The *Online Learning Center* content has been created for use in most course management systems.



Figures Alive Interactives, marked by this icon near the figure in the text, lead the student through the discovery of various layers of knowledge inherent in the figure and enables them to develop their own understanding. Each chapter has an interactive learning experience tied to a specific figure in the chapter. The self-testing segments built into Figures Alive! are based on the same categories as the chapter-end problems—*Emphasizing Essentials, Concentrating on Concepts,* and in many cases, *Exploring Extensions*.

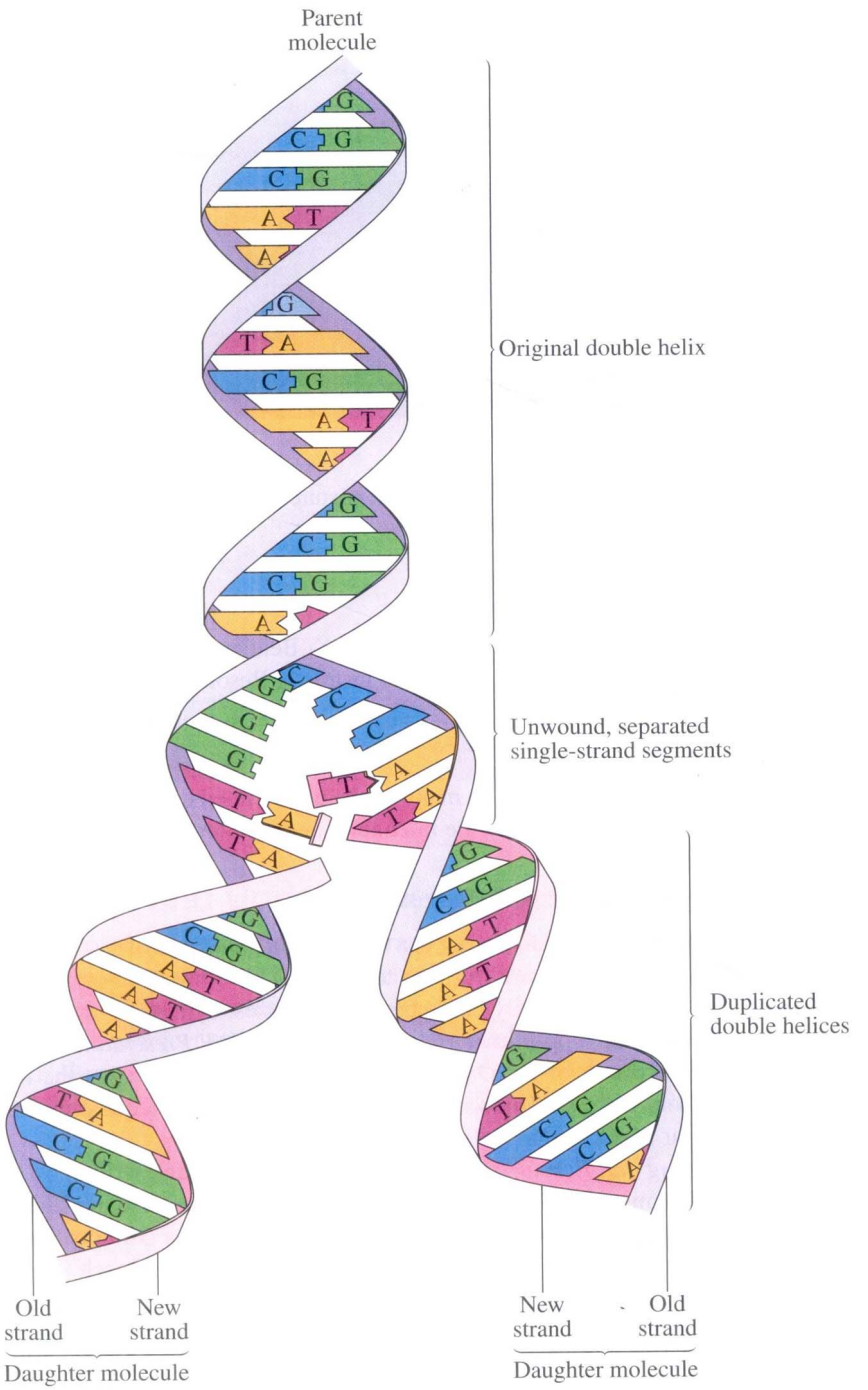


Figure 12.9

Diagram of DNA replication. The original DNA double helix (*top portion of figure*) partially unwinds, and the two complementary portions separate (*middle*). Each of the strands serves as a template for the synthesis of a complementary strand (*bottom*). The result is two complete and identical DNA molecules.

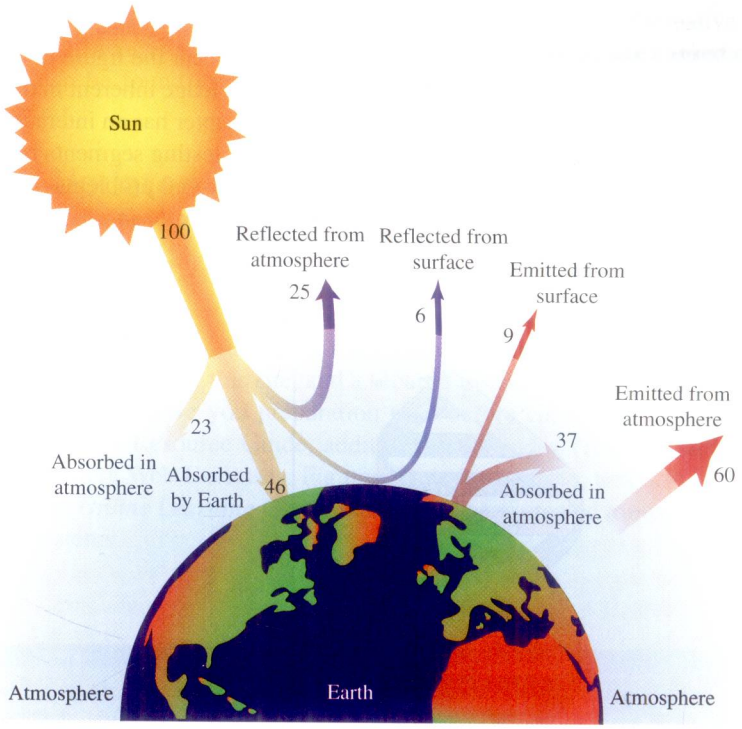


Figure 3.2

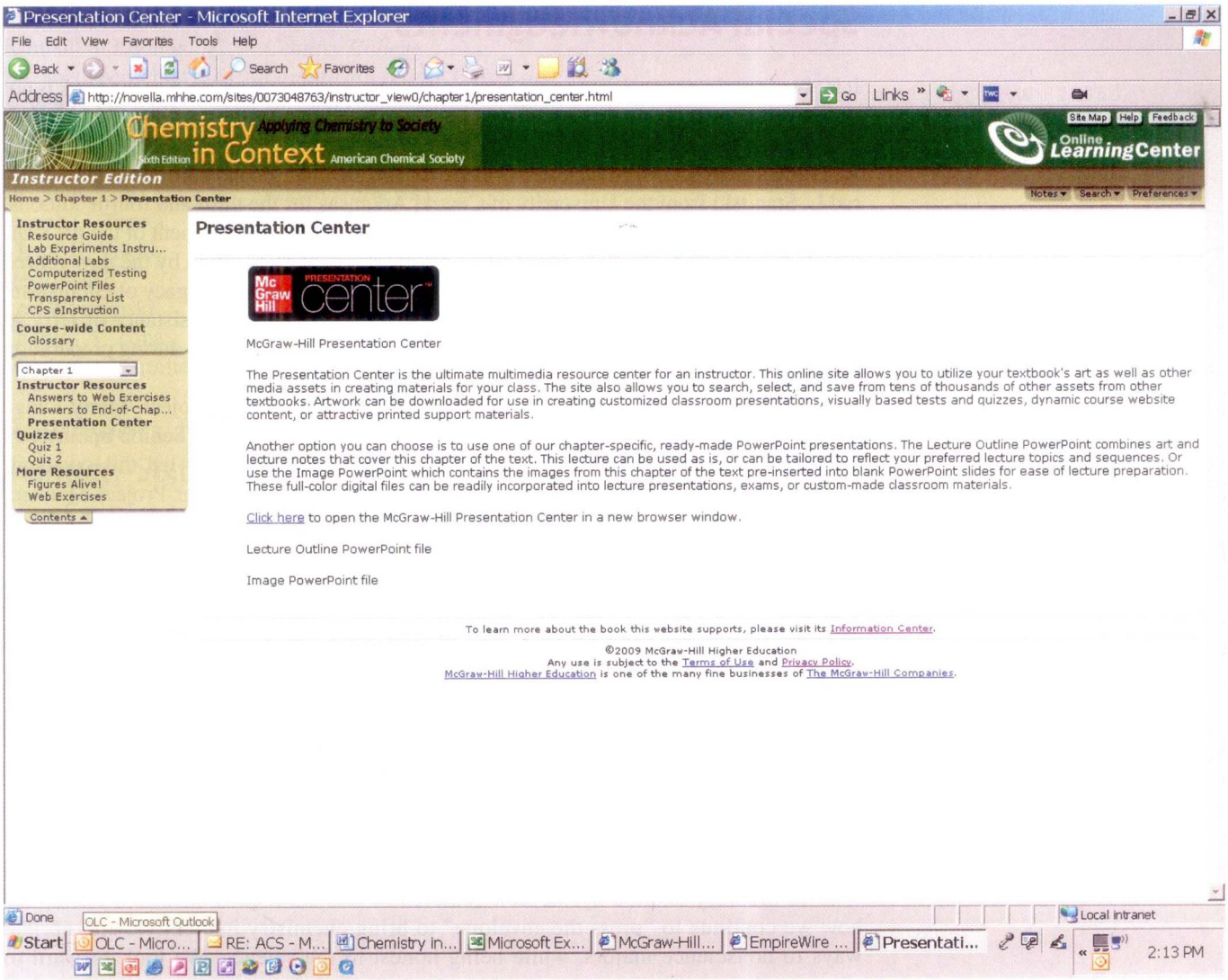
Earth's energy balance by percent. Yellow represents a mixture of wavelengths. Shorter wavelengths of radiation are shown in blue, longer in red.

The *Instructor's Resource Guide*, edited by Anne K. Bentley (Lewis & Clark College), can be found on the *Online Learning Center* under Instructor Resources. The guide contains:

- A chemical topic matrix that lists chemical principles commonly covered in a general chemistry course.
- Answers for suggested responses to many of the open-ended questions in the Consider This and the solutions to the in-chapter and chapter-end exercises and questions.
- The instructors guide for the laboratory experiments.

The *McGraw-Hill Presentation Center* is a multimedia collection of visual resources allowing instructors to utilize artwork from the text in multiple formats to create customized classroom presentations, visually based tests and quizzes, dynamic course Web site content, or attractive printer support materials. The *McGraw-Hill Presentation Center* is found in the instructor center of the *Online Learning Center* and contains the images, photos, and tables from the text. To access the Instructor materials, request registration information from your McGraw-Hill sales representative.

Instructor's Testing and Resources Online contains the Test Bank written by the author team of Julie M. Smist (Springfield College), Marcia L. Gillette (Indiana University-Kokomo), Mark B. Freilich (University of Memphis), Thomas Zona (Illinois State University), Amy J. Phelps (Middle Tennessee State University), and Eric Bosch (Southwest Missouri State University). This resource contains approximately 65 multiple-choice questions for every chapter. The questions are comparable to the problems in the text in content coverage. The Test Bank is formatted for easy integration into the following course management systems: WebCT, and Blackboard. You may also choose to use these questions as models for writing your own classroom-specific test questions.



Other New and Updated Resources

For those whose course includes a laboratory component, a *Laboratory Manual*, compiled and edited by Gail A. Steehler (Roanoke College), is available for the sixth edition. The experiments use microscale equipment (wellplates and Beral-type pipets) and common materials. Project-type and cooperative–collaborative laboratory experiments are included. *New* experiments are included on ozone and biodiesel. Additional experiments are available on the *Online Learning Center*, as is the Instructor's Resource Guide.

Special Acknowledgments

It is always a pleasure to bring a new textbook or new edition to fruition. But the work is not done by just one individual. It is a team effort, one that comprises the work of many talented individuals. The sixth edition builds on the proud tradition of prior author teams, led by A. Truman Schwartz of Macalester College for the first and second editions, and by Conrad L. Stanitski from the University of Central Arkansas for the third and fourth editions. We have been fortunate to have the unstinting support and encouragement of the ACS Division of Education, led during much of the preparation of this edition by the now-retired Sylvia A. Ware. The new director, Mary M. Kirchoff, continues this legacy of enthusiasm and understanding of our mutual goals. We also recognize the able assistance of Jerry A. Bell and Corrie Y. Kuniyoshi of the ACS Division of Education office during preparation of the sixth edition.

The McGraw-Hill team has been superb in all aspects of this project. Marty Lange (Director of Editorial), Thomas Timp (Publisher), Tamara Hodge (Senior Sponsoring Editor), and Shirley Oberbroeckling (Senior Developmental Editor) led this outstanding team. Todd Turner serves as the Marketing Manager. The Senior Project Manager is Gloria Schiesl, who coordinates the production team of Carrie Burger (Lead Photo Researcher), Kara Kudronowicz (Production Supervisor), and Melissa Leick (Projects Coordinator). The Lead Media Producer is Daryl Bruflodt and Sandra Schnee serves as Senior Media Project Manager. The team also benefited from the knowledgeable editing of Linda Davoli and from the persistent work of Pam Carley in tracking down elusive images. Dwaine Eubanks of LATEst IDEas, Inc., brought both his chemical knowledge and computer-based artistic skills together to continue the high standard for the art in this edition. His ability to respond quickly and expertly to the needs of the author team was integral to our success.

The sixth edition is the product of a collaborative effort among writing team members—Lucy Pryde Eubanks, Catherine H. Middlecamp, Carl E. Heltzel, and Steven W. Keller. This is the maiden voyage in this realm for Steve Keller as a new coauthor and colleague. We welcome him to the team and have benefited from his diverse expertise.

We are very excited by the new features of this sixth edition, which exemplify how we continue to "press the envelope" to bring chemistry in creative, appropriate ways to nonscience majors, while being honest to the science. We look forward to your comments.

Lucy Pryde Eubanks
Senior Author and Editor-in-Chief
January 2008

Further Acknowledgments

Reviewers for *Chemistry in Context*, Sixth Edition

A sincere thank you to the following individuals for their comments:

John R. Allen	*Southeastern Louisiana University*
Edward J. Baum	*Grand Valley State University*
Eric Bosch	*Missouri State University*
Donna Budzynski	*San Diego Mesa College*
Cynthia H. Coleman	*State University of New York–Potsdam*
Rebecca W. Corbin	*Ashland University*
Sheree J. Finley	*Alabama State University*
Lawrence A. Fuller	*State University of New York–Oswego*
Anne Gaquere	*University of West Georgia*
Amy Grant	*El Camino College*
Rick D. Huff	*Genesee Community College*
Milt Johnson	*University of South Florida*

Margaret G. Kimble	*Indiana University-Purdue University–Fort Wayne*
Kimball S. Loomis	*Century College*
Elizabeth Maschewske	*Grand Valley State University*
S. Walter Orchard	*Tacoma Community College*
Somnath Sarkar	*Central Missouri State University*
Stacy Sparks	*University of Texas at Austin*
Heeyoung Tai	*Miami University*
Joseph C. Tausta	*Oneonta State College*
Victor H. Vilchiz	*Virginia State University*
Jerry Walsh	*University of North Carolina at Greensboro*
Lou Wojecinski	*Kansas State University*
Thomas A. Zona	*Illinois State University*
Martin G. Zysmilich	*George Washington University*

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Scott Mason	*Mount Union College*
Sheldon L. Miller	*Chestnut Hill College*
Keith E. Peterman	*York College*
Pamela C. Turpin	*Roanoke College*

List of the Elements with Their Symbols and Atomic Masses*

Element	Symbol	Atomic Number	Atomic Mass†
Actinium	Ac	89	(227)
Aluminum	Al	13	26.98
Americium	Am	95	(243)
Antimony	Sb	51	121.8
Argon	Ar	18	39.95
Arsenic	As	33	74.92
Astatine	At	85	(210)
Barium	Ba	56	137.3
Berkelium	Bk	97	(247)
Beryllium	Be	4	9.012
Bismuth	Bi	83	209.0
Bohrium	Bh	107	(264)
Boron	B	5	10.81
Bromine	Br	35	79.90
Cadmium	Cd	48	112.4
Calcium	Ca	20	40.08
Californium	Cf	98	(251)
Carbon	C	6	12.01
Cerium	Ce	58	140.1
Cesium	Cs	55	132.9
Chlorine	Cl	17	35.45
Chromium	Cr	24	52.00
Cobalt	Co	27	58.93
Copper	Cu	29	63.55
Curium	Cm	96	(247)
Darmstadtium	Ds	110	(271)
Dubnium	Db	105	(262)
Dysprosium	Dy	66	162.5
Einsteinium	Es	99	(252)
Erbium	Er	68	167.3
Europium	Eu	63	152.0
Fermium	Fm	100	(257)
Fluorine	F	9	19.00
Francium	Fr	87	(223)
Gadolinium	Gd	64	157.3
Gallium	Ga	31	69.72
Germanium	Ge	32	72.59
Gold	Au	79	197.0
Hafnium	Hf	72	178.5
Hassium	Hs	108	(269)
Helium	He	2	4.003
Holmium	Ho	67	164.9
Hydrogen	H	1	1.008
Indium	In	49	114.8
Iodine	I	53	126.9
Iridium	Ir	77	192.2
Iron	Fe	26	55.85
Krypton	Kr	36	83.80
Lanthanum	La	57	138.9
Lawrencium	Lr	103	(262)
Lead	Pb	82	207.2
Lithium	Li	3	6.941
Lutetium	Lu	71	175.0
Magnesium	Mg	12	24.31
Manganese	Mn	25	54.94
Meitnerium	Mt	109	(268)
Mendelevium	Md	101	(258)
Mercury	Hg	80	200.6
Molybdenum	Mo	42	95.94
Neodymium	Nd	60	144.2
Neon	Ne	10	20.18
Neptunium	Np	93	(237)
Nickel	Ni	28	58.69
Niobium	Nb	41	92.91
Nitrogen	N	7	14.01
Nobelium	No	102	(259)
Osmium	Os	76	190.2
Oxygen	O	8	16.00
Palladium	Pd	46	106.4
Phosphorus	P	15	30.97
Platinum	Pt	78	195.1
Plutonium	Pu	94	(244)
Polonium	Po	84	(210)
Potassium	K	19	39.10
Praseodymium	Pr	59	140.9
Promethium	Pm	61	(147)
Protactinium	Pa	91	(231)
Radium	Ra	88	(226)
Radon	Rn	86	(222)
Rhenium	Re	75	186.2
Rhodium	Rh	45	102.9
Roentgenium	Rg	111	(280)
Rubidium	Rb	37	85.47
Ruthenium	Ru	44	101.1
Rutherfordium	Rf	104	(261)
Samarium	Sm	62	150.4
Scandium	Sc	21	44.96
Seaborgium	Sg	106	(266)
Selenium	Se	34	78.96
Silicon	Si	14	28.09
Silver	Ag	47	107.9
Sodium	Na	11	22.99
Strontium	Sr	38	87.62
Sulfur	S	16	32.07
Tantalum	Ta	73	180.9
Technetium	Tc	43	(98)
Tellurium	Te	52	127.6
Terbium	Tb	65	158.9
Thallium	Tl	81	204.4
Thorium	Th	90	232.0
Thulium	Tm	69	168.9
Tin	Sn	50	118.7
Titanium	Ti	22	47.88
Tungsten	W	74	183.9
Uranium	U	92	238.0
Vanadium	V	23	50.94
Xenon	Xe	54	131.3
Ytterbium	Yb	70	173.0
Yttrium	Y	39	88.91
Zinc	Zn	30	65.39
Zirconium	Zr	40	91.22

These values are recommended by the International Union of Pure and Applied Chemistry (IUPAC).
Values of atomic masses for radioactive elements are given in parentheses.

Brief Contents

Appendices

Contents