Understanding Chemistry in our World

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Brief Contents

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Preface

We are all born with a natural curiosity about life and our surroundings. As children that curiosity takes us on a journey of experimentation and investigation. We start mixing things together, exploring new foods, and asking lots of questions! Why do bubbles form when baking soda is poured into a bottle of vinegar? Why does vanilla ice cream taste so good? What is that stuff we call water? *Understanding Chemistry in Our World* is a journey to find answers to these questions and more. Whether this is your first peek into the submicroscopic world of atoms, molecules, and ions, or you are revisiting this world, the chemistry in the chapters that follow will guide you to find the answers to these questions and much more.

Beginning with the study of atoms, this textbook will unlock the key to this infinitesimally tiny world so that you are able to experience how it connects to the world you see everyday. We know that all matter is made of atoms whether it is the ocean that laps at your feet on the beach, the magnificent rocks you see at Bryce National Park, the dog that greets you when you come home, or even the stars you see on a clear night. These bits of matter, living or not, are all made from the same fundamental particles—atoms. It is the chemistry that occurs at this level—the way these atoms combine, separate, and recombine—that makes all things possible.

It is our hope that this journey stimulates your quest for learning about the world we live in and inspires you to explore new topics that may possibly lead to solutions for climate change, energy production, and the challenge to provide clean water for everyone on this earth.

Textbook Goals

This textbook was written to accomplish five specific overall goals that take chemistry out of the lab and reveal it in the world around you. After reading this textbook and completing the activities, you will be able to:

- *Use the properties of matter and energy to identify chemistry at work in everyday situations.*

Nothing around you will look the same as it did before you entered this study of chemistry. You will begin to see the objects surrounding you—and, indeed, your own body—as a dynamic dance of the atoms, slowing down or speeding up as they interact with energy, and changing partners along the way as one substance transforms into another, and then another in an endless series of changes.

- *Use critical thinking and problem-solving skills to explain natural phenomena by applying qualitative and quantitative observations.*

Is the firewood dry enough to catch fire? Is your MP3 player warm enough to play without the danger of condensation ruining the circuitry? Are your tomato plants growing in soil containing enough nutrients? Is the air quality safe where you live? You'll apply your new knowledge of chemistry to think through problems and draw conclusions based on your own observations and calculations.

- *Be an informed consumer and global citizen by evaluating and discussing common chemical principles as they apply in the home and workplace.*

You'll have new tools to guide you in making many everyday decisions. Whether you are choosing gasoline at the pump, maintaining a swimming pool, or transforming raw eggs into quiche, chemistry will become a valuable guide in making smart choices.

- *Critically evaluate ideas and stories relating to chemistry for validity and reliability as they appear in popular media and culture.*

Is there really a car that runs on water? Is global warming a reality? What energy sources hold the key to a better future? Opinions abound, many of them contradictory and often citing scientific "facts" to support their case. By the time you finish reading this textbook, you'll be better able to sort out the scientifically valid information from misinformation and misunderstanding, as well as realistically assess proposed solutions.

Unifying Theme

Chemistry is all around you. Every second of every day, everywhere you look, there are thousands, perhaps even millions or billions of chemical processes occurring beneath the surface of life as you know it. This is the underlying theme and message of *Understanding Chemistry in Our World.* When you finish reading this book, nothing occurring in your world will look quite the same to you.

Text Organization

Understanding Chemistry in Our World is divided into 14 chapters, to fit within a typical college semester. The chapters teach key concepts in a step-by-step fashion, each chapter building upon previous chapters, revealing the material through a highly readable exploration of topics with immediate relevance to today's students.

Chapters 1–4 explore everyday chemistry as they lay out the basics of what atoms and ions are, and how they gain and lose electrons either by transferring or sharing them to form new substances. You'll get to know the Periodic Table of Elements and how to use it to make predictions about the chemistry that is likely to occur. Chapter 5 extends this foundation to take a look at the organic molecules and the groups of atoms within them that make life processes possible, both on our planet and possibly elsewhere in the universe.

In Chapter 6, we consider our planet's atmosphere as we expand our investigation into what actually occurs during chemical reactions—the processes and circumstances in which atoms join with other atoms or swap places to form new substances, absorbing or releasing energy to do so.

Chapter 7 examines energy itself, how it changes form, and how it can flow from one substance to another—an idea further expanded upon in Chapter 8, which uses climate change to delve more deeply into the subject of energy by examining how its application or removal affects the properties of substances.

In Chapter 9, we consider the world's water supply as we examine mixtures and solutions, their properties, and the ways in which their concentrations are calculated, expressed, and changed.

Chapter 10 turns again to the atmosphere to explore rates of reaction and chemical equilibrium as demonstrated by the production of ground ozone and depletion of stratospheric ozone.

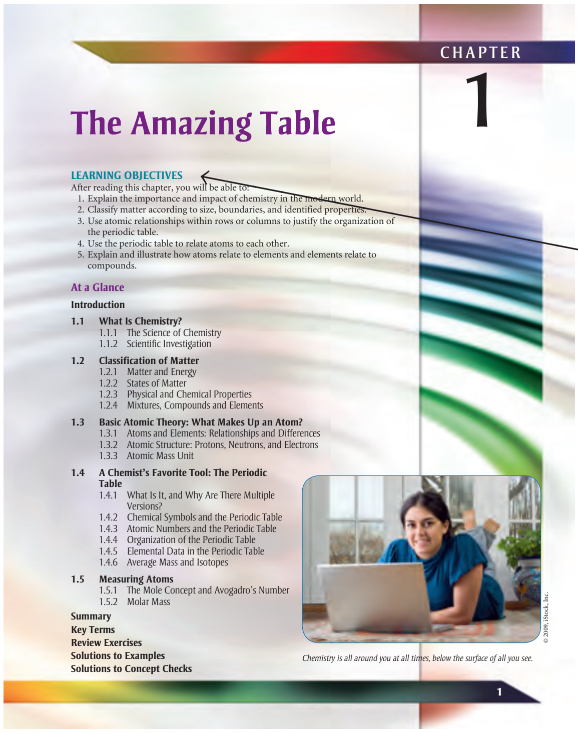
Chapter 11 investigates acid rain as it reveals the importance and properties of acids and bases.

The search for a better battery illustrates the principles of electrochemistry in Chapter 12, while the focus on nuclear reactions in Chapter 13 provides insights into the use of nuclear power as a long-term solution into our energy needs.

Finally, Chapter 14 revisits the human body, revealing the basics of biochemistry in its discussion of metabolism and metabolic disorders.

Textbook Features

Understanding Chemistry in Our World includes a number of features designed to make learning easier and more productive.



CHAPTER 1

The Amazing Table

LEARNING OBJECTIVES

After reading this chapter, you will be able to:

1. Explain the importance and impact of chemistry in the modern world.
2. Classify matter according to size, boundaries, and identified properties.
3. Use atomic relationships within rows or columns to justify the organization of the periodic table.
4. Use the periodic table to relate atoms to each other.
5. Explain and illustrate how atoms relate to elements and elements relate to compounds.

At a Glance

Chemistry is all around you at all times, below the surface of all you see.

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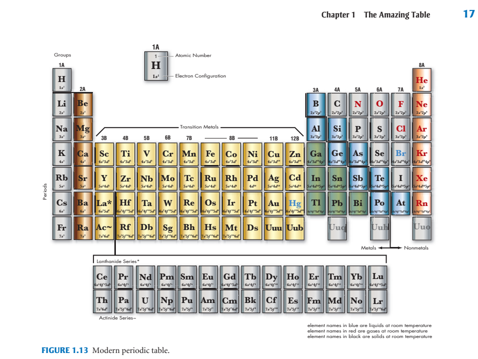
Each chapter begins with clearly defined learning objectives so that you know what you are expected to learn over the succeeding twenty or so pages. The objectives are phrased in terms of not just what you will understand, but what you will be able to do to demonstrate your understanding.

The style of *Understanding Chemistry in Our World* is informal and readable, using simple language and interesting examples drawn from everyday life. You will recognize yourself and your world as you digest the information necessary to achieve the learning objectives.



Chapter 1 The Amazing Table 17

FIGURE 1.13 Modern periodic table.

1.4.2 Chemical Symbols and the Periodic Table

In our version of the periodic table, the first thing you will probably notice is that each element is portrayed by a **chemical symbol**. The chemical symbol is a one- or two-letter shorthand for each element, the reason for which will become obvious in Chapter 2 and throughout the rest of this course. Figure 1.14 presents a complete list of the element names and the symbols used to represent them.

Some of the symbols are easy to guess; others are more difficult. This is because the symbols are based on the historically given names for the elements over the centuries. Because many of these originated as either Greek or Latin names, the symbols may not have any correlation with the English equivalents. For instance, the O for oxygen is easy for English speakers to guess; not so for Sn, the symbol for tin, which reflects its original Latin name, *stannum*.

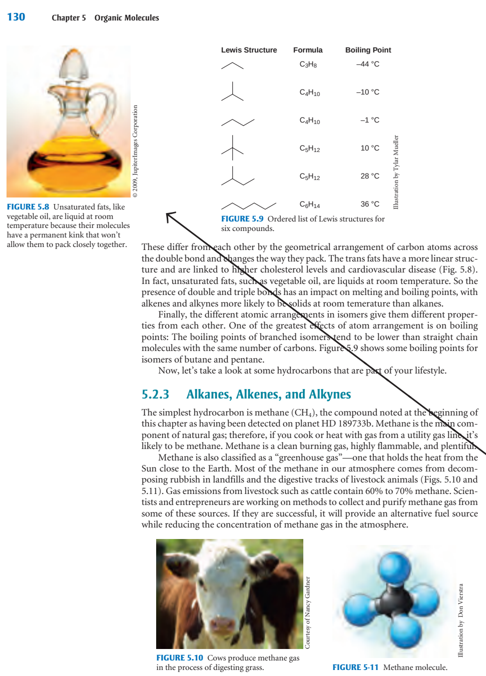
chemical symbol A one- or two- or three-letter shorthand for each element.

1.4.3 Atomic Numbers and the Periodic Table

The next thing to note about the periodic table is that each element has a number above its symbol. This is known as an **atomic number**. It indicates more than the element's position on the chart; it is a count of the number of protons the element has in the nucleus of its atoms.

The elements are arranged, left to right, in increasing order of their atomic numbers, just like reading a book. As the atomic number increases, so do the number of protons in each element's nucleus. For example, hydrogen with an atomic number of 1 has one proton in its nucleus, oxygen with an atomic number of 8 has 8 protons in its nucleus, and iodine with an atomic number of 53 has 53 protons in its nucleus.

atomic number The number of protons in the nucleus of an atom. In neutral atoms it is also the number of electrons in the atom.



130 Chapter 5 Organic Molecules

FIGURE 5.8 Unsaturated fats, like vegetable oil, are liquid at room temperature because their molecules have a permanent kink that won't allow them to pack closely together.

Lewis Structure	Formula	Boiling Point
	C_3H_8	−44 °C
	C_4H_{10}	−10 °C
	C_4H_{10}	−1 °C
	C_5H_{12}	10 °C
	C_5H_{12}	28 °C
	C_6H_{14}	36 °C

FIGURE 5.9 Ordered list of Lewis structures for six compounds.

These differ from each other by the geometrical arrangement of carbon atoms across the double bond and changes the way they pack. The trans fats have a more linear structure and are linked to higher cholesterol levels and cardiovascular disease (Fig. 5.8). In fact, unsaturated fats, such as vegetable oil, are liquids at room temperature. So the presence of double and triple bonds has an impact on melting and boiling points, with alkenes and alkynes more likely to be solids at room temerature than alkanes.

Finally, the different atomic arrangements in isomers give them different properties from each other. One of the greatest effects of atom arrangement is on boiling points: The boiling points of branched isomers tend to be lower than straight chain molecules with the same number of carbons. Figure 5.9 shows some boiling points for isomers of butane and pentane.

Now, let's take a look at some hydrocarbons that are part of your lifestyle.

5.2.3 Alkanes, Alkenes, and Alkynes

The simplest hydrocarbon is methane (CH_4), the compound noted at the beginning of this chapter as having been detected on planet HD 189733b. Methane is the main component of natural gas; therefore, if you cook or heat with gas from a utility gas line, it's likely to be methane. Methane is a clean burning gas, highly flammable, and plentiful.

Methane is also classified as a "greenhouse gas"—one that holds the heat from the Sun close to the Earth. Most of the methane in our atmosphere comes from decomposing rubbish in landfills and the digestive tracts of livestock animals (Figs. 5.10 and 5.11). Gas emissions from livestock such as cattle contain 60% to 70% methane. Scientists and entrepreneurs are working on methods to collect and purify methane gas from some of these sources. If they are successful, it will provide an alternative fuel source while reducing the concentration of methane gas in the atmosphere.

FIGURE 5.10 Cows produce methane gas in the process of digesting grass.

FIGURE 5-11 Methane molecule.

Key terms are highlighted, with formal definitions appearing in the margins for easy reference.

Vibrant illustrations and photographs bring key concepts to life in ways that help you visualize how chemistry works and what actually occurs during chemical processes.

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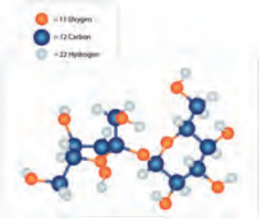


Illustration by Don Vierstra

FIGURE 2.12 Sugar (sucrose) molecule ($C_{12}H_{22}O_{11}$).

written as Na^+, the sulfate ion is written as SO_4^{2-}. Of course, when ions bond together to form an ionic compound, the charges are balanced so the chemical formula for the compound would not indicate a charge.

Eventually, you will run into a chemical formula that looks something like this: $CH_2{=}C(CN)COOCH_3$. This is the formula for the methyl-2-cyanoacrylate you met at the beginning of this chapter, better known as *Krazy Glue*. Note that hydrogen, carbon, and oxygen all appear more than once in this formula. Rest assured that this is not done to confuse introductory chemistry students! Formulas such as these are called *structural formulas* because they indicate the relative positions of some of the atoms. The chemical formula for methyl-2-cyanoacrylate is $C_5H_5NO_2$. If you count up all the atoms of the elements shown in each formula, you will find that the two formulas show equal quantities of each element's atoms.

Structural formulas are often for used for organic molecules, the molecules of life. The positions of some atoms in an organic molecule are critical to that molecule's function, so chemists often use such structural formulas to indicate where those atoms are located. You will learn more about organic molecules in Chapters 5 and 14.

Example

PROBLEM: List the number of atoms of the following elements that are in a molecule of ammonium perchlorate, NH_4ClO_4.

a. oxygen b. nitrogen
c. chlorine d. hydrogen

Solution on page 63.

Concept Check

PROBLEM: List the number of atoms of the following elements that are in a molecule of copper nitrate trihydrate, $Cu(NO_3)_2 \times 3H_2O$

a. nitrogen b. hydrogen
c. copper d. oxygen

Solution on page 65.

2.2 Illustrating Chemical Bonding

As useful as chemical formulas are in describing a compound, they are less useful in helping us to visualize what actually happens on the atomic level when molecular bonds form. Therefore, various tools have been developed to aid in that visualization. You may have seen drawings like this when you studied science in elementary or middle school (Fig. 2.13).

Although such diagrams are useful in illustrating the electrons that move around an atom, they can become ungainly as the atomic number increases and the number of

At the end of each section within chapters, test examples and concept checks test your comprehension, ensuring that you understand key concepts before building upon them in the next section.

6 Chapter 1 The Amazing Table

Antoine Lavoisier: The "Father of Chemistry"

The study of chemistry has made rapid strides in the past 250 years. A turning point in our understanding was brought about by a key experiment conducted by the French chemist Antoine Lavoisier (pronounced la-VWAH-see-ay) in the late 1700s—one that led to a shift in thinking about what occurs during the combustion process and, therefore, all chemical processes.

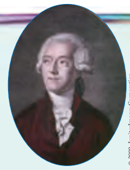
Lavoisier was investigating what happened when various substances were heated in the presence of oxygen. At the time, it was thought that a substance called *phlogiston* existed in all matter, in varying degrees, and was used up when something burned. It made sense; after all, a log disappears in a fire.

Experiments by a contemporary English chemist Joseph Priestley had led to the discovery of a gas that supported combustion better than air did. Priestley had named the new gas *dephlogisticated air*, surmising that the gas supported combustion better because it lacked phlogiston. He was wrong in his conclusions but close to the mark in identifying that a particular gas supported combustion.

Lavoisier, who had been conducting his own experiments with combustion, had come to some novel conclusions himself. He had been heating metals over a charcoal furnace for days until they turned into what we know as oxides, or metals that had combined with oxygen, such as rust. Mercury, in particular, when heated underwent a change from a silvery liquid to a red solid compound. Lavoisier's conclusion was that, rather than losing something (phlogiston), the mercury was gaining something—a mystery substance.

When Priestley told him about the dephlogisticated air, Lavoisier knew immediately that Priestley's gas was the missing element in his scheme, the one being added to a burning substance. He gave the dephlogisticated air a new name, *oxygine* (and grabbed most of the credit for the discovery).

Lavoisier's theory of combustion was a turning point in the history of chemistry as it led 18th and 19th century scientists to pursue new lines of thought that unlocked many of nature's mysteries. For this and other significant discoveries, Lavoisier is generally known as the "Father of Chemistry."



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Antoine Lavoisier (1743–1794): the "Father of Chemistry."

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The equipment with which Antoine Lavoisier discovered oxygen.

Sidebar articles chosen for their interest and relevance further illustrate the material presented in each chapter. The articles introduce some of the great minds whose explorations have forced chemistry to reveal its secrets, and probe into some of chemistry's most interesting revelations.

Finally, at the end of each chapter, a succinct summary capsulizes the material presented, followed by a list of review questions to test your understanding of the material and to remind you to flag any areas in which further study might be needed.

60 Chapter 2 Bonding: Atomic Glue

SUMMARY

1. Chemical Bonding (Section 2.1)
   - In chemistry, it is all about the electrons. The negative charge of an electron repels other electrons and is attracted to the positive charge of protons. Electrons swarm about the nucleus in shells and occupy specific regions within the shells called *orbitals*. The electrons in the outermost shell are valence electrons and are available to interact with other atoms.
   - Electrons fill orbitals in a specific order: *s* orbitals first, followed by *p*, *d*, and *f* orbitals. Each orbital contains no more than two electrons. Electron configurations for each element appear on the periodic table.
   - Atoms strive to either fill or empty their outermost valence shells to achieve the configuration of the nearest noble gas and will gain, lose, or share electrons to do so. This is known as the *octet rule*.
   - Ionic bonds form when electrons from one atom leave its outer shell to fill the outer shell of another atom. The atom that loses an electron becomes a cation, an ion with a positive charge. The atom that gains an electron becomes an anion, an ion with a negative charge. Because opposite charges attract each other, the cation and the anion bond.
   - Covalent bonds form when two or more atoms *share* electrons to fill their outer shells; the bonding electrons move about the nuclei of both atoms in the bond, as opposed to the transfer of electrons in an ionic bond. Two or more atoms covalently bonded together form a molecule.

SOLUTIONS TO EXAMPLES

(pg. 41)

a. 6 b. 1
c. 5 d. 2
e. 2

(pg. 44)

a. Calcium is a metal, so it will form a cation. b. Lithium is a metal, so it will form a cation.
c. Iodine is a nonmetal, so it will from an anion. d. Sulfur is a nonmetal, so it will form an anion.

(pg. 46)

a. 4 b. 1
c. 1 d. 4

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a partial negative charge; bonding electrons tend to spend less of their time around the nucleus of the atom with the lower electronegativity value, giving that atom a partial positive charge. If the difference in charge is significant enough, the bond is said to be polar. Water is an example of a polar molecule.

- The difference in electronegativity values between two atoms predicts the type of bond they will enter into. When the difference is great, the two atoms will enter into an ionic bond. When the difference is moderate, the two atoms will enter into a polar covalent bond. When the difference is low, the two atoms will enter into a nonpolar covalent bond.

KEY TERMS

anion, pg. 43	ionic compound, pg. 44	polar covalent bond, pg. 57
cation, pg. 43	Lewis dot structure, pg. 47	polar molecule, pg. 58
chemical formula, pg. 45	molecular compound, pg. 45	polyatomic ion, pg. 45
covalent bond, pg. 44	molecule, pg. 45	shell, pg. 37
electron density, pg. 49	nonpolar covalent bond, pg. 56	subscript, pg. 45
electronegativity, (EN) pg. 54	nonpolar molecule, pg. 58	superscript, pg. 43
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ionic bond, pg. 42	orbital, pg. 37	

REVIEW EXERCISES

Chemical Bonding

1. According to the content you read in this chapter, like charges
   a. attract. b. repel.
   c. dernatthings the hydroxide ion is covalent.) d. explode.

SOLUTIONS TO CONCEPT CHECKS

(pg. 41)

a. 8 b. 1
c. 4 d. 7
e. 2

(pg. 44)

a. Chlorine is a nonmetals, so it will take a negative charge (anion). b. Potassium is a metal, so it will take a positive charge (cation).
c. Fluorine is a nonmetal, so it will take a negative charge (anion). d. Phosphorous is a nonmetal, so it will take a negative charge (anion).
e. Beryllium is a metal, so it will take a postive charge (cation).

(pg. 46)

a. 2 b. 6
c. 4 d. 12

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About the Authors

Nancy Gardner, M.A., became interested in chemistry as a college student in another major. She discovered that the study of these bits of matter we call molecules and atoms and ions, explained why cakes rise, why some generic medications work and others don't, and even why when we burn fuel it produces so much heat! It inspired her to investigate further and discover why sunscreens work, why some metals corrode and others don't, as well as learning about what is in the water we drink and how these substances affect our health. But she was a busy student with grand plans and a world yet to discover. Although Nancy wanted very much to pursue this new quest into the world of molecules, atoms, and ions, she had to postpone this until a later time.

Years later after returning to the United States with two very curious children, it was time to embark on a new quest and learn more about this very small world. She juggled classes and research into her busy schedule and learned more about those curious bits of matter. In the midst of taking classes and raising children, she discovered a new passion in her life—to teach chemistry. She loved teaching her children chemistry, blowing up film canisters, making volcanoes, and let's not forget the mud solutions she and her kids made in the backyard to glue together bricks!

Nancy received her Master's degree with honors in Chemistry from California State University–Long Beach and was soon offered a position teaching. After teaching the introductory course for many years, she branched out into other topics in chemistry and e-learning.

Nancy currently lives in southern California, enjoys teaching, working with students, making podcasts, and having fun in the lab. Every class offers a range of new opportunities and new people to meet. She is incredibly appreciative to both of her parents and her children for giving her the gift of time to pursue this new passion and the opportunity to travel and learn about other cultures and the applications of chemistry that occur around the world.

Byron E. Howell, Ed.D., is currently coordinator of the South Central Microscale Chemistry Center (SCRMCC) and is a chemistry professor at Tyler Junior College. He taught in public schools for fourteen years, was an industrial analytical chemist for one and a half years, and has been at TJC for 17 years. Byron has received his doctorate in Secondary and Higher Education at Texas A&M–Commerce. He was also the recipient of the Thomas H. Shelby, Jr. Endowed Chair Teaching Excellence Award in 2001–2002, *Who's Who Among America's Teachers* (four editions), the NISOD 2001 Teaching Excellence Award, and the NISOD Master Presenter Certificate seven times.

While at Tyler Junior College, Dr. Howell was a contributing author to two books and the author of the *Student Solutions Manual and Study Guide for General, Organic, and Biological Chemistry,* Wiley & Sons, 2006. Besides serving as reviewer for many chemistry textbooks, Dr. Howell also designed the curriculum currently used for the non-majors chemistry course, CHEM1405 Introductory Chemistry, has taught the class for five years, and co-authored the laboratory manual that supports the class.

In addition to working with students, Dr. Howell has always enjoyed sharing and working with fellow teachers through conferences and workshops. To date, he has presented at dozens of conferences and workshops including the Conference for Advancement of Science Teaching (CAST), Two Year College Chemistry Conference, South Central Partnership for Environmental Technology Education, and the Conference for the New Mexico Science Teachers Association. As coordinator of SCRMCC, Dr. Howell is working closely with the Texas Education Agency to promote safe hands-on learning in Texas schools. As a co-writer for the *Texas Safety Standards: Kindergarten through Grade 12,* the Texas laboratory safety guidelines for public schools, Dr. Howell has been able to demonstrate how microscale chemistry techniques can allow school districts to bring hands-on science back into the classroom in a safe and financially sound manner. The Texas Education Service Center in which the SCRMCC is located, offers its full support and cooperation to the SCRMCC workshops for teacher training.

Kenneth Richard Ostrowski, M.A., earned both Biology and Chemistry undergraduate and post-graduate degrees from Purdue University. He worked much of his way through school playing and coaching both football and baseball teams to victory. Since 1982, he has capitalized on his championship-based coaching skills to lead students to victory on both the athletic field and in the academic arena. Ken has spent nearly 30 years teaching both honors and advanced Placement courses in Biology, Chemistry and Environmental Science. His efforts have earned him accolades from students and peers alike, including District Teacher of the year in 1997. Not being one to sit on his laurels, Ken started teaching college courses in the Coast Community College District in 1997. Over the last decade, "Mr. O" has devoted considerable energy to the development of innovative curriculum at both the high school and college levels. This has included work in the development of web-based tools for use in Chemistry, Biology, and Environmental Studies. He also sits on the Board of Directors of numerous educational software companies. Ken continues to serve actively as a member of the American Chemical Society, director of the Huntington Beach High School Science Bowl Team and advisor to the Science Olympiad Team. Ostrowski is also four years into the development of an innovative approach designed to incorporate "hands on" training for scientific studies in his Advanced Placement Environmental Science courses which includes partnering with local businesses, the Long Beach Aquarium of the Pacific, and the Huntington Beach Unified High School District. His non-science duties include spearheading a peer-oriented conflict resolution program. A California native from the City of Riverside, Ken currently resides in the community he works in, Huntington Beach, California, with his wife Mary, daughter Andrea and son Eric.

Einhard Schmidt, Ph.D., is currently an instructor of chemistry and physical sciences at Santa Monica College. He has also taught at UCLA, Los Angeles Pierce College, Los Angeles Harbor College, and Cleveland Chiropractic College. He has taught undergraduate chemistry (introductory, general, and organic) for over ten years. He has made it a practice to combine Research & Development with teaching and has had a lot of success. He was an invaluable contributor to this textbook.

Dr. Schmidt received his Ph.D. in Physical and Organic Chemistry from Michigan State University and did his post-doctoral work at the University of California, Los Angeles.

Susan Wilcox, M.A., considers it a personal mission to get liberal arts students excited about science. Her own love of the sciences is such that she once strongly considered changing her major from Mass Communications to Physics and Astronomy. She stayed on course, however, and graduated Magna cum Laude from the University of Wisconsin–Milwaukee with a B.A. in Mass Communications and Spanish, followed by an M.A. in Communications from the University of Hawaii.

Over the course of the next decade, she worked in radio, television, advertising, print media, and corporate communications. She became adept at designing communications that could communicate complex, high-tech subjects to "low-tech audiences." She also developed and taught courses at the University of Hawaii and at Leeward Community College in Honolulu. Leisure time was spent exploring the mountain and ocean environments of the 50th State, satisfying her curiosity about the islands' geology, biology, and chemistry.

Susan moved to California in 1988, where she continued her media work as well as her investigations into the physical and social sciences. A decade later, she and Coast Learning Systems found each other; it was a perfect fit. Since then, Susan has been a writer, producer, and both on numerous courses, including algebra, psychology, child development, biology, statistics, and geology. She especially enjoys translating scientific subjects into concepts that can be understood and appreciated by the nonscientific mind, emphasizing that science is behind everything that happens in our world—a point of view that rings throughout this textbook. Her media work has won numerous awards, including several Los Angeles area Emmy Awards and five *Telly* Awards. But to Susan, the even greater reward is to hear a student say, "I learned something, and it wasn't boring!"

About the Instructional Designer

Jon Stephenson, M.S., earned his undergraduate degree in History from UCLA and a graduate degree in Instructional Technology from USC. Jon is an instructional designer with experience designing and facilitating learning solutions for several Fortune 500 companies. Jon also has experience within public education as both a teacher and professional development instructor. Jon has worked with Coast Learning Systems on projects since 2004.