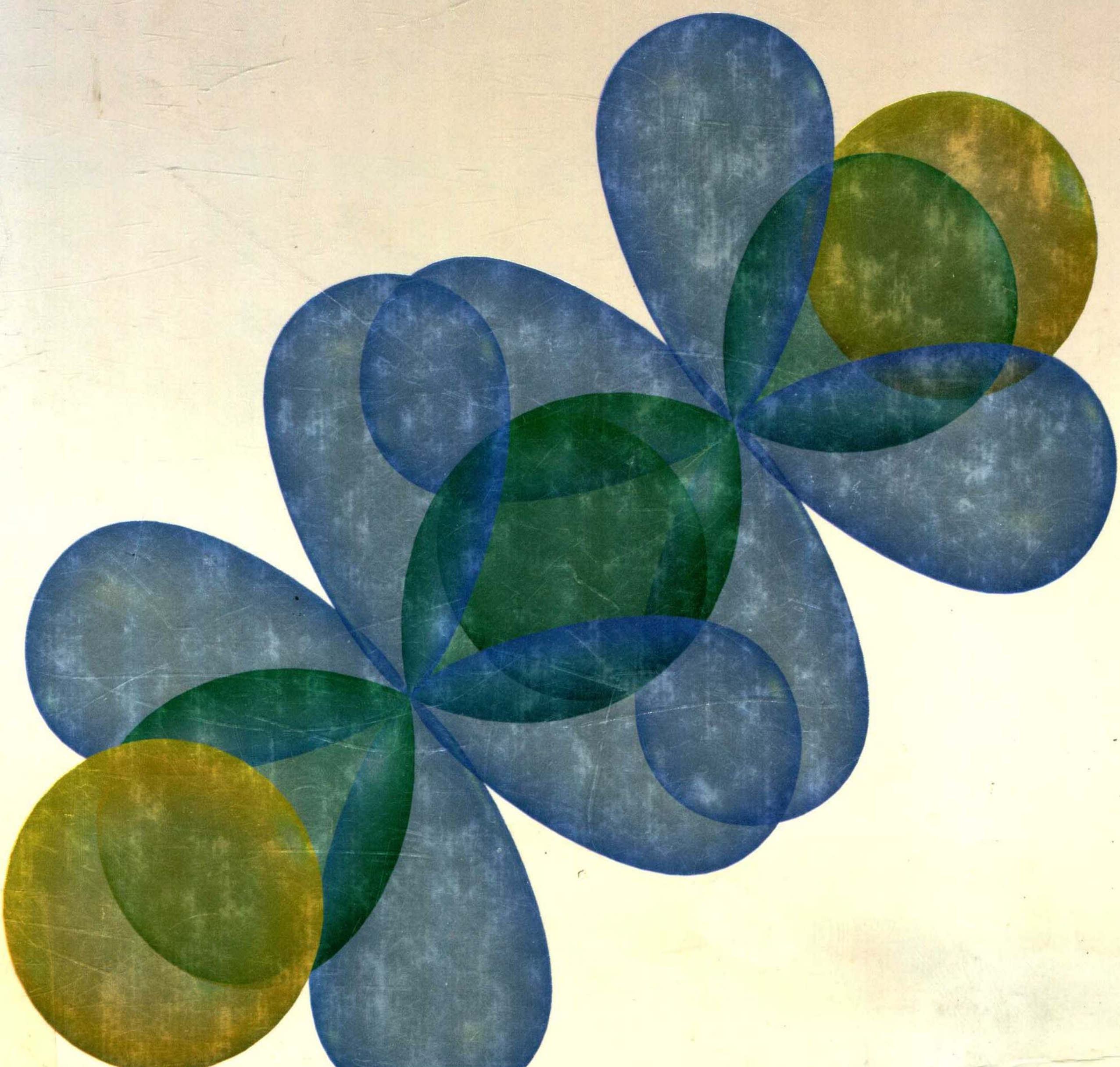
Chemistry

Julia Burdge



Chemistry

JULIA BURDGE

With significant contributions
from Raymond Chang

McGraw-Hill Higher Education

Boston Burr Ridge, IL Dubuque, IA New York San Francisco St. Louis
Bangkok Bogotá Caracas Kuala Lumpur Lisbon London Madrid Mexico City
Milan Montreal New Delhi Santiago Seoul Singapore Sydney Taipei Toronto

McGraw-Hill Higher Education

CHEMISTRY

Published by McGraw-Hill, a business unit of The McGraw-Hill Companies, Inc., 1221 Avenue of the Americas, New York, NY 10020.

This book is printed on acid-free paper.

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

ISBN 978–0–07–302554–4
MHID 0–07–302554–2

ISBN 978–0–07–327176–7 (Annotated Instructor's Edition)
MHID 0–07–327176–4

Publisher: *Thomas Timp*
Vice-President New Product Launches: *Michael Lange*
Senior Sponsoring Editor: *Tamara L. Hodge*
Senior Developmental Editor: *Shirley R. Oberbroeckling*
Marketing Manager: *Todd L. Turner*
Senior Project Manager: *Gloria G. Schiesl*
Senior Production Supervisor: *Laura Fuller*
Senior Media Project Manager: *Sandra M. Schnee*
Senior Designer: *David W. Hash*
Interior Designer: *Kaye Farmer*
(USE) Cover Image: *Gary Hunt, Precision Graphics*
Senior Photo Research Coordinator: *Lori Hancock*
Photo Research: *David Tietz*
Project Coordinator: *Melissa M. Leick*
Compositor: *Precision Graphics*
Typeface: *10/12 Times*
Printer: *R. R. Donnelley Willard, OH*

The credits section for this book begins on page C-1 and is considered an extension of the copyright page.

Library of Congress Cataloging-in-Publication Data

Burdge, Julia R.
Chemistry / Julia R. Burdge. -- 1st ed.
p. cm.
Includes index.
ISBN 978–0–07–302554–4 — ISBN 0–07–302554–2 (hard copy : alk. paper) 1. Chemistry--Textbooks. I. Title.
QD33.2.B865 2009
540--dc22

2007042216

www.mhhe.com

Periodic Table of the Elements

Key

Atomic number → 6; Symbol → C; Name → Carbon; Average atomic mass → 12.01

An element

Main group (1A–2A) · Transitional metals (3B–2B) · Main group (3A–8A)

Period number	1A 1	2A 2	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8	8B 9	8B 10	1B 11	2B 12	3A 13	4A 14	5A 15	6A 16	7A 17	8A 18	
1	1 H Hydrogen 1.008																	2 He Helium 4.003	1
2	3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18	2
3	11 Na Sodium 22.99	12 Mg Magnesium 24.31											13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95	3
4	19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.41	31 Ga Gallium 69.72	32 Ge Germanium 72.64	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80	4
5	37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3	5
6	55 Cs Cesium 132.9	56 Ba Barium 137.3	71 Lu Lutetium 175.0	72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.8	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)	6
7	87 Fr Francium (223)	88 Ra Radium (226)	103 Lr Lawrencium (262)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (269)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (272)	112 — - (285)	113 — - (284)	114 — - (289)	115 — - (288)	116 — - (292)	117	118 — - (294)	7

Lanthanides 6	57 La Lanthanum 138.9	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolium 157.3	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	6
Actinides 7	89 Ac Actinium (227)	90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	7

List of the Elements with Their Symbols and Atomic Masses*

Element	Symbol	Atomic Number	Atomic Mass†	Element	Symbol	Atomic Number	Atomic Mass†
Actinium	Ac	89	(227)	Mendelevium	Md	101	(258)
Aluminum	Al	13	26.9815386	Mercury	Hg	80	200.59
Americium	Am	95	(243)	Molybdenum	Mo	42	95.94
Antimony	Sb	51	121.760	Neodymium	Nd	60	144.242
Argon	Ar	18	39.948	Neon	Ne	10	20.1797
Arsenic	As	33	74.92160	Neptunium	Np	93	(237)
Astatine	At	85	(210)	Nickel	Ni	28	58.6934
Barium	Ba	56	137.327	Niobium	Nb	41	92.90638
Berkelium	Bk	97	(247)	Nitrogen	N	7	14.0067
Beryllium	Be	4	9.012182	Nobelium	No	102	(259)
Bismuth	Bi	83	208.98040	Osmium	Os	76	190.23
Bohrium	Bh	107	(264)	Oxygen	O	8	15.9994
Boron	B	5	10.811	Palladium	Pd	46	106.42
Bromine	Br	35	79.904	Phosphorus	P	15	30.973762
Cadmium	Cd	48	112.411	Platinum	Pt	78	195.084
Calcium	Ca	20	40.078	Plutonium	Pu	94	(244)
Californium	Cf	98	(251)	Polonium	Po	84	(209)
Carbon	C	6	12.0107	Potassium	K	19	39.0983
Cerium	Ce	58	140.116	Praseodymium	Pr	59	140.90765
Cesium	Cs	55	132.9054519	Promethium	Pm	61	(145)
Chlorine	Cl	17	35.453	Protactinium	Pa	91	231.03588
Chromium	Cr	24	51.9961	Radium	Ra	88	(226)
Cobalt	Co	27	58.933195	Radon	Rn	86	(222)
Copper	Cu	29	63.546	Rhenium	Re	75	186.207
Curium	Cm	96	(247)	Rhodium	Rh	45	102.90550
Darmstadtium	Ds	110	(281)	Roentgenium	Rg	111	(272)
Dubnium	Db	105	(262)	Rubidium	Rb	37	85.4678
Dysprosium	Dy	66	162.500	Ruthenium	Ru	44	101.07
Einsteinium	Es	99	(252)	Rutherfordium	Rf	104	(261)
Erbium	Er	68	167.259	Samarium	Sm	62	150.36
Europium	Eu	63	151.964	Scandium	Sc	21	44.955912
Fermium	Fm	100	(257)	Seaborgium	Sg	106	(266)
Fluorine	F	9	18.9984032	Selenium	Se	34	78.96
Francium	Fr	87	(223)	Silicon	Si	14	28.0855
Gadolinium	Gd	64	157.25	Silver	Ag	47	107.8682
Gallium	Ga	31	69.723	Sodium	Na	11	22.8976928
Germanium	Ge	32	72.64	Strontium	Sr	38	87.62
Gold	Au	79	196.966569	Sulfur	S	16	32.065
Hafnium	Hf	72	178.49	Tantalum	Ta	73	180.94788
Hassium	Hs	108	(269)	Technetium	Tc	43	(98)
Helium	He	2	4.002602	Tellurium	Te	52	127.60
Holmium	Ho	67	164.93032	Terbium	Tb	65	158.92535
Hydrogen	H	1	1.00794	Thallium	Tl	81	204.3833
Indium	In	49	114.818	Thorium	Th	90	232.03806
Iodine	I	53	126.90447	Thulium	Tm	69	168.93421
Iridium	Ir	77	192.217	Tin	Sn	50	118.710
Iron	Fe	26	55.845	Titanium	Ti	22	47.867
Krypton	Kr	36	83.798	Tungsten	W	74	183.84
Lanthanum	La	57	138.90547	Uranium	U	92	238.02891
Lawrencium	Lr	103	(262)	Vanadium	V	23	50.9415
Lead	Pb	82	207.2	Xenon	Xe	54	131.293
Lithium	Li	3	6.941	Ytterbium	Yb	70	173.04
Lutetium	Lu	71	174.967	Yttrium	Y	39	88.90585
Magnesium	Mg	12	24.3050	Zinc	Zn	30	65.409
Manganese	Mn	25	54.938045	Zirconium	Zr	40	91.224
Meitnerium	Mt	109	(268)				

*These atomic masses show as many significant figures as are known for each element. The atomic masses in the periodic table are shown to four significant figures, which is sufficient for solving the problems in this book.

†Approximate values of atomic masses for radioactive elements are given in parentheses.

Chemistry

About the Author

Julia Burdge did most of her undergraduate work at Iowa State University and completed her degree in Chemistry at the University of South Florida in Tampa. Julia received her Ph.D. (1994) from the University of Idaho in Moscow, Idaho. Her research and dissertation focused on instrument development for analysis of trace sulfur compounds in air and the statistical evaluation of data near the detection limit.

In 1994 she accepted a position at The University of Akron in Akron, Ohio, as an assistant professor and director of the Introductory Chemistry program. In the year 2000, she was tenured and promoted to associate professor at The University of Akron on the merits of her teaching, service, and research in chemistry education. In addition to directing the general chemistry program and supervising the teaching activities of graduate students, she helped establish a future-faculty development program and served as a mentor for graduate students and post-doctoral associates who wanted to gain some experience teaching at the undergraduate level. In 2001, Julia relocated to the Honors College of Florida Atlantic University.

Julia lives in Florida with her family. Her personal interests include horseback riding with her children and involvement in the Pasco County Sheriff's Mounted Posse.

To the people who will always matter the most: Katie, Beau, and Sam

Preface

Welcome to the exciting and dynamic world of chemistry! My desire to create a new general chemistry textbook grew out of my concern for the interests of students and faculty alike. Having taught general chemistry for many years and having helped new teachers and future faculty develop the skills necessary to teach general chemistry, I believe I have developed a distinct perspective on the common problems and misunderstandings that students encounter while learning the fundamental concepts of chemistry—and that professors encounter while teaching them. I believe that it is possible for a textbook to address many of these issues while conveying the wonder and possibilities that chemistry offers today. With this in mind, I have tried to write a text that balances the necessary fundamental concepts with engaging real-life examples and applications while utilizing a step-by-step problem-solving approach and an innovative art and media program.

Modern Content—Solid Science

The world we live in is constantly changing, and the science of chemistry continues to expand and evolve to meet the challenges of our modern world. I have developed this new textbook to provide a solid grounding in the basic principles of chemistry while setting them within a context of up-to-date information that serves to capture and hold students' attention and prepare them for studies in a variety of fields. I have tried to connect the study of chemistry to the study of other sciences—including physical, biological, environmental, medical, and engineering. My goal is to help students build a solid conceptual understanding and to encourage mastery of chemical conventions including models, laws and equations, and such universally important principles as nomenclature, stoichiometry, measurement, and scale. While doing so I integrate coverage of organic chemistry, biochemistry, green chemistry, and other examples to enhance the relevance of fundamental principles.

Toward this end I have also placed my chapter on organic chemistry (Chapter 10) earlier than most texts. It is not an exhaustive chapter, but presents a handful of organic reactions, germane to applications presented in the book, in the context of bonding and molecular structure. One example is the reaction of the hydroxide ion with carbon dioxide to form the hydrogen carbonate ion. Examples such as this are intended to serve both as a functional introduction to organic chemistry and as reinforcement of bonding theories and the importance of hybridization, molecular polarity, and electron density. I believe that this approach will be beneficial to those who go on to take organic chemistry.

Each individual chapter outline serves as an advance organizer for key concepts and is followed by a set of chapter learning objectives—these are two of the many pedagogical devices designed to foster crucial organization and good study habits. Additionally, I have used my own teaching experiences to identify and address common student misconceptions. One way that I have done this is through the use of margin notes written specifically for the student. These notes include "bite-sized" additional information such as common pitfall alerts, analogies to clarify concepts, pertinent reminders, and alternative perspectives.

Building Problem-Solving Skills

The entirety of the text emphasizes the importance of problem solving as a crucial element in the study of chemistry. Beginning with Chapter 1, a basic guide fosters a consistent approach to solving Worked Examples and Sample Problems throughout the text. Each **Sample Problem** is divided into four consistently applied steps:

1. **Strategy.** This step lays the basic framework for the problem. We begin by reading the problem thoroughly to determine exactly what is being asked. Next, we determine what skills are necessary, and lay out a plan for solving the problem. Where appropriate, we make a ballpark estimate of the magnitude of the correct result.
2. **Setup.** In this step we gather the necessary information for solving the problem, including information given within the problem itself, equations, constants, and tabulated data.
3. **Solution.** Using the information gathered in the second step, we now calculate the answer to the problem. A particular emphasis on attention to units is made during this step. The final step here is to ensure that the answer has the correct number of significant figures.
4. **Think About It.** At this stage we consider whether or not the result makes sense. In some cases, the Think About It section shows an alternate route to the same answer. In other cases, it may include information that illustrates the relevance of the problem.

After working through this problem-solving approach in the Sample Problems, there is always at least one **Practice Problem** to complete. This is very similar to the sample problem and can be solved using a similar strategy. Most Sample Problems also have a second Practice Problem that tests the same skills but requires an approach slightly different from the one used to solve the preceding Sample and Practice Problems. The regular use of the Sample Problems and Practice Problems in this text will help students develop an effective set of problem-solving skills and assess their readiness to move on to the next concept.

Greater Relevance Through Modern Examples and Applications

I believe that the study of chemistry can be less daunting for students if they know how it applies to interesting, real-life examples. For this reason, I introduce each chapter with a brief and interesting story that relates the concepts in the chapter to something familiar. Examples include *Chemical Reactions and Chemotherapy* (Chapter 3) and *Lasers in Medicine* (Chapter 6). The **Applying What You've Learned** feature at the end of each chapter recalls the subject of the opening story and includes a multipart exercise requiring students to use several of the skills they have just learned. **Bringing Chemistry to Life** segments also work toward this goal, utilizing engaging narrative to further explore applications in the real world, such as *The Stoichiometry of Metabolism* (Chapter 3) or *Heat Capacity and Hypothermia* (Chapter 5). **Inquiry Boxes** always address a question of interest. These may tackle a topical subject such as *How Important Are Units?* (Chapter 1) but many also address important fundamental skills such as *How Do I Assign Oxidation Numbers?* (Chapter 4) or *How Am I Supposed to Remember All These Reactions?* (Chapter 3). The end-of-chapter Problem Sets also include a wide range of real-world problems and specific science, medical, and engineering applications. By using so many authentic, modern, real-world examples, I have placed the science of chemistry within a human context that will provide for a more engaging learning environment and lead to a fuller understanding of the subject matter and a greater capacity to retain the material.

Greater Understanding Through Chemical Visualization

This text seeks to enhance student understanding through a variety of both unique and conventional visual techniques. A truly unique new element in this text is the inclusion of a distinctive new feature entitled **Visualizing Chemistry.** These two-page spreads appear as needed to emphasize fundamental, vitally important principles of chemistry. Setting them apart visually makes them easier to find and revisit as needed throughout the course term. As an example, Chapter 4 includes a Visualizing Chemistry section on *Preparing a Solution from a Solid.* Each Visualizing Chemistry feature concludes with a **What's the Point** box that emphasizes the take-away message.

The use of both **Macro-Micro Art** and **Three-Dimensional Art** build on the principle of breaking down the complex into simpler, more user-friendly concepts. Breaking down chemical processes into molecular-level figures makes it easier for students to grasp what is happening on an atomic level. The same theory of breaking down the complex is evident in the treatment of hybrid orbitals. Through experience, I have learned that this is often a difficult—yet fundamentally crucial—element to grasp. So, for example, I have broken down the process of hybridization through a simple step-by-step visual treatment. **Flow Charts** and a variety of intertextual materials such as **Rewind** and **Fast Forward Buttons** and **Chapter Checkpoint** sections are meant to enhance student understanding and comprehension by reinforcing current concepts and connecting new concepts to those covered in other parts of the text.

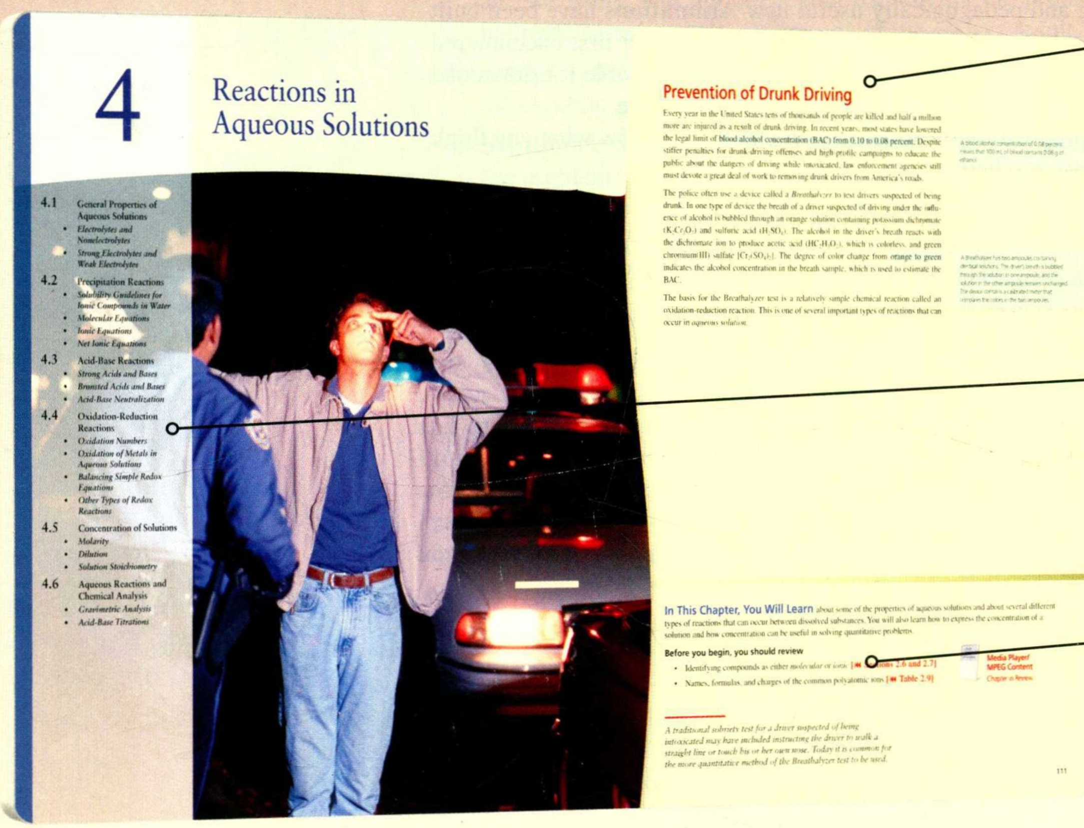
In addition to the text itself, students will have access to innovative applications of new educational technologies. Captivating and pedagogically useful new **Animations** have been built based upon the textual art, providing additional reinforcement of subject matter first encountered in the textbook. **MPEG Files** of the Visualizing Chemistry pieces will be available for download as **Podcasts,** allowing for convenient viewing to foster increased comprehension.

For me, this remains a work in progress, and I encourage you to let me know what you think of my efforts and what I can do to serve you better.

Julia Burdge
juliaburdge@hotmail.com

Focusing on Student Success . . .

Setting the Stage . . .



4

Reactions in Aqueous Solutions

Prevention of Drunk Driving

Every year in the United States tens of thousands of people are killed and half a million more are injured as a result of drunk driving. In recent years, most states have lowered the legal limit of blood alcohol concentration (BAC) from 0.10 to 0.08 percent. Despite stiffer penalties for drunk-driving offenses and high-profile campaigns to educate the public about the dangers of driving while intoxicated, law enforcement agencies still must devote a great deal of work to removing drunk drivers from America's roads.

The police often use a device called a *Breathalyzer* to test drivers suspected of being drunk. In one type of device the breath of a driver suspected of driving under the influence of alcohol is bubbled through an orange solution containing potassium dichromate ($K_2Cr_2O_7$) and sulfuric acid (H_2SO_4). The alcohol in the driver's breath reacts with the dichromate ion to produce acetic acid ($HC_2H_3O_2$), which is colorless, and green chromium(III) sulfate [$Cr_2(SO_4)_3$]. The degree of color change from orange to green indicates the alcohol concentration in the breath sample, which is used to estimate the BAC.

The basis for the Breathalyzer test is a relatively simple chemical reaction called an oxidation-reduction reaction. This is one of several important types of reactions that can occur in *aqueous solution*.

In This Chapter, You Will Learn about some of the properties of aqueous solutions and about several different types of reactions that can occur between dissolved substances. You will also learn how to express the concentration of a solution and how concentration can be useful in solving quantitative problems.

Before you begin, you should review

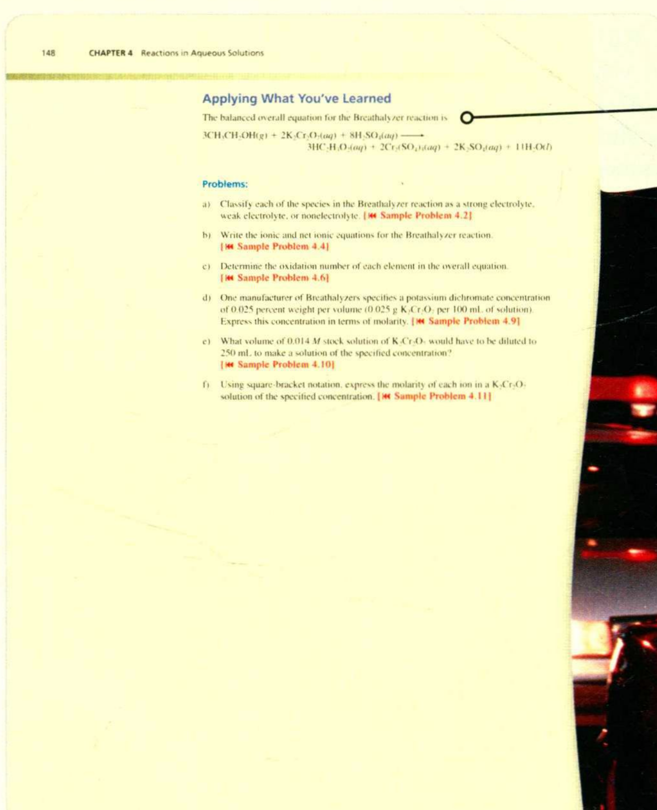
- Identifying compounds as either *molecular* or *ionic* [Sections 2.6 and 2.7]
- Names, formulas, and charges of the common polyatomic ions [Table 2.9]

Media Player/
MPEG Content
Chapter in Review

A traditional sobriety test for a driver suspected of being intoxicated may have included instructing the driver to walk a straight line or touch his or her own nose. Today it is common for the more quantitative method of the Breathalyzer test to be used.

111

- Set the stage for understanding concepts in this chapter with an engaging real-world situation.
- Begin with the chapter outline to understand the big picture and focus on the main ideas.
- Before reading this chapter, review important material from previous chapters.



148 CHAPTER 4 Reactions in Aqueous Solutions

Applying What You've Learned

The balanced overall equation for the Breathalyzer reaction is

$$3CH_3CH_2OH(g) + 2K_2Cr_2O_7(aq) + 8H_2SO_4(aq) \longrightarrow 3HC_2H_3O_2(aq) + 2Cr_2(SO_4)_3(aq) + 2K_2SO_4(aq) + 11H_2O(l)$$

Problems:

a) Classify each of the species in the Breathalyzer reaction as a strong electrolyte, weak electrolyte, or nonelectrolyte. [Sample Problem 4.2]

b) Write the ionic and net ionic equations for the Breathalyzer reaction. [Sample Problem 4.4]

c) Determine the oxidation number of each element in the overall equation. [Sample Problem 4.6]

d) One manufacturer of Breathalyzers specifies a potassium dichromate concentration of 0.025 percent weight per volume (0.025 g $K_2Cr_2O_7$ per 100 mL of solution). Express this concentration in terms of molarity. [Sample Problem 4.9]

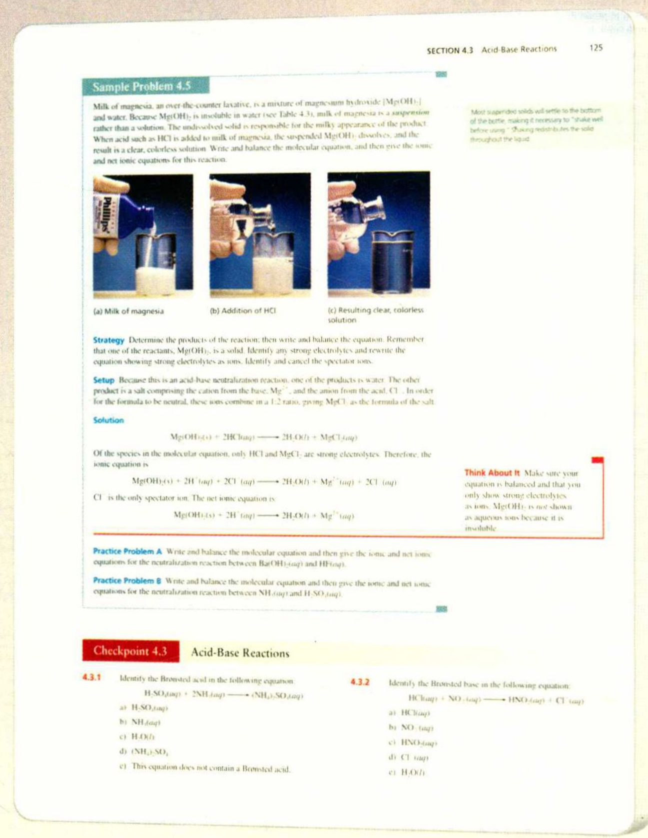
e) What volume of 0.014 *M* stock solution of $K_2Cr_2O_7$ would have to be diluted to 250 mL to make a solution of the specified concentration? [Sample Problem 4.10]

f) Using square-bracket notation, express the molarity of each ion in a $K_2Cr_2O_7$ solution of the specified concentration. [Sample Problem 4.11]

- Reinforce the chapter concepts by working the realistic situational problems found in the Applying What You've Learned sections at the end of each chapter.

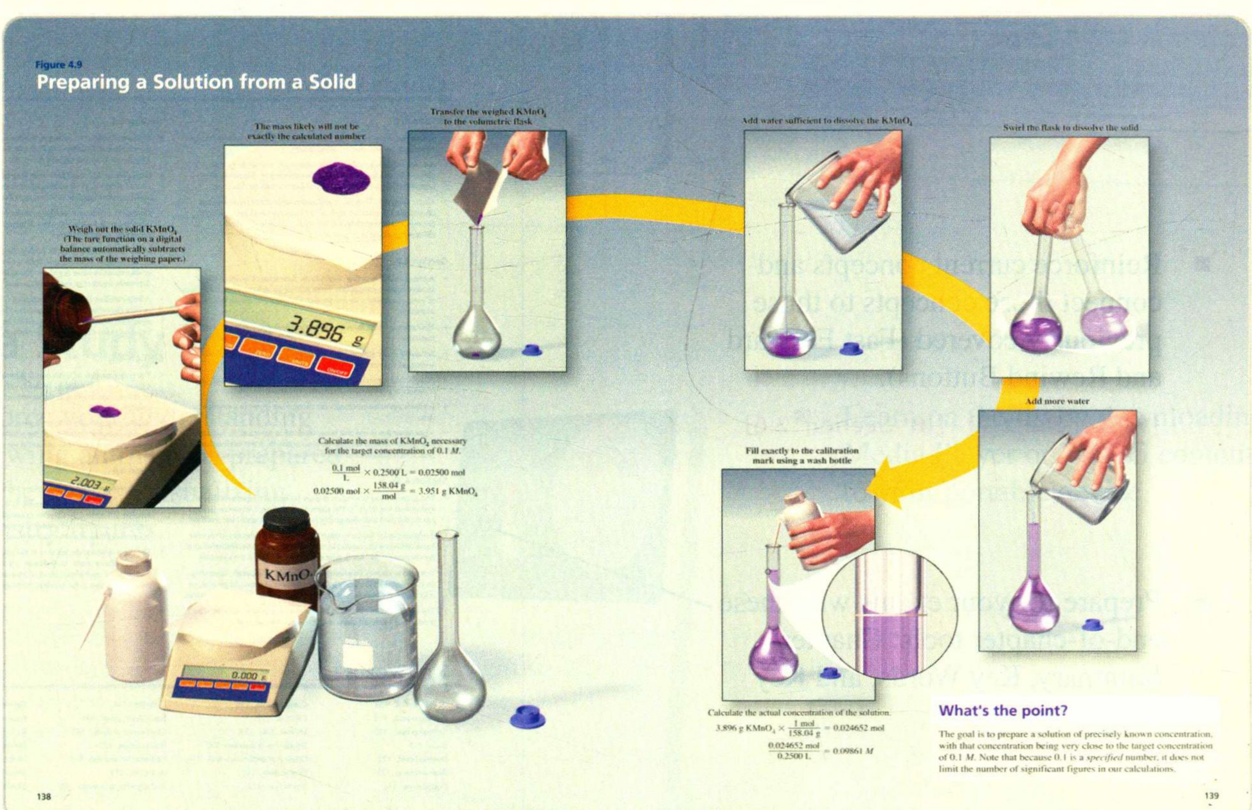
Problem Solving . . .

- Master these problem-solving skill steps to build a consistent strategy for success.

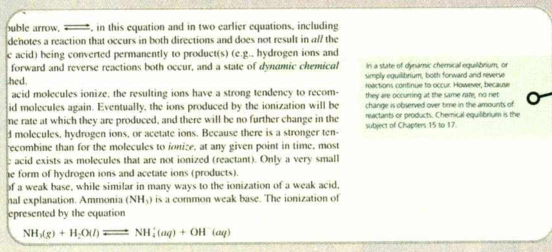


Visualizing . . .

- Understand chemical principles by comprehending the visual breakdown of important chemical concepts.



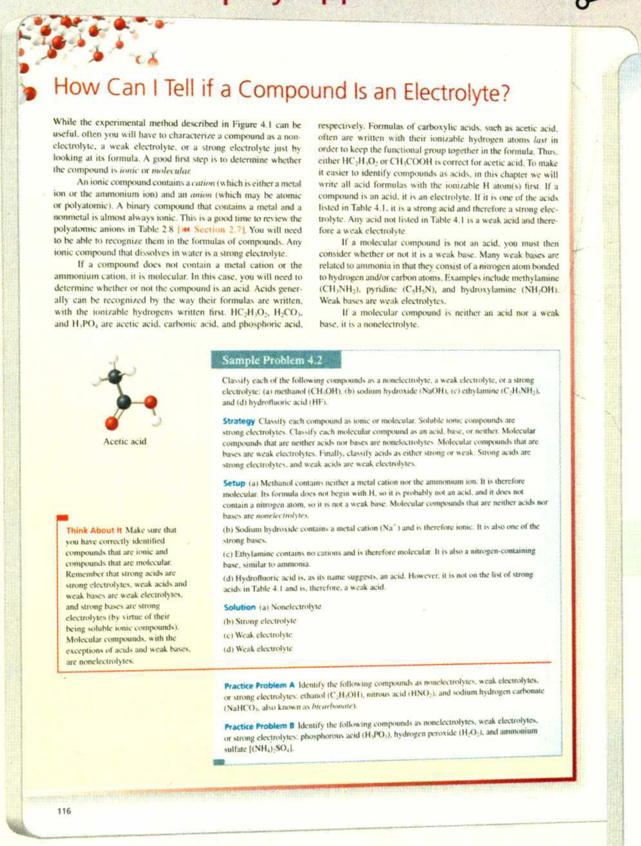
Further Study Tools . . .



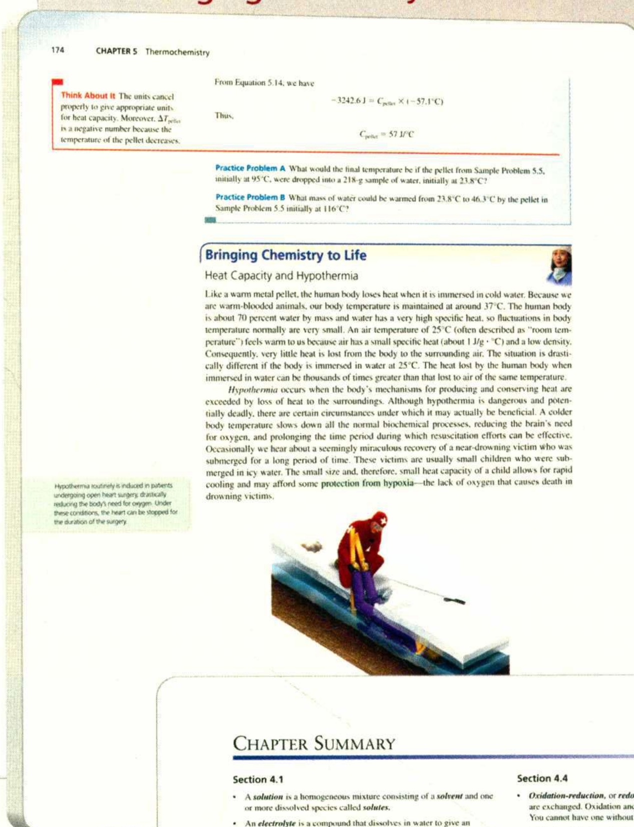
- Use the helpful hints and simple suggestions found in the margin to gain further comprehension.

- Delve more deeply into a concept by reading these engaging applications.

Inquiry Application

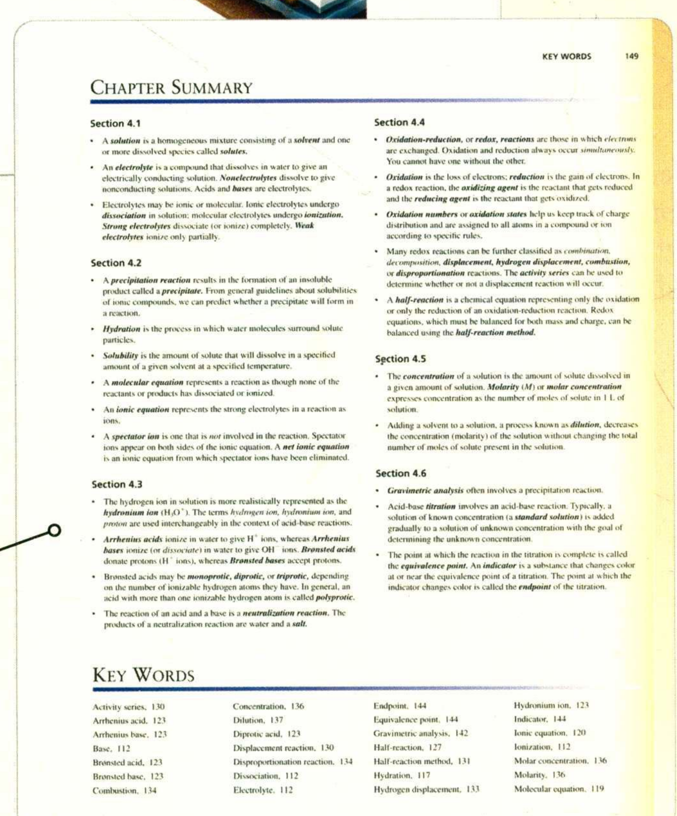


Bringing Chemistry to Life



- Reinforce current concepts and connect those concepts to those previously covered (Fast Forward and Rewind Buttons).

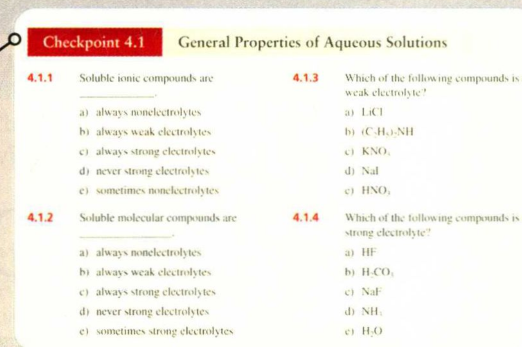
  [⏭ Appendix 1] [⏮ Section 2.6]



- Prepare for your exams with these end-of-chapter tools: Chapter Summary, Key Words, and Key Equations.

Test Your Knowledge . . .

- Immediately check your understanding after you answer the questions found in the Section Checkpoints.
- Master the chapter content by solving the Questions and Problems found at the end of each chapter! The Questions and Problems are organized by section for easy reference.
- Solve these problems before taking standardized pre-professional examinations.

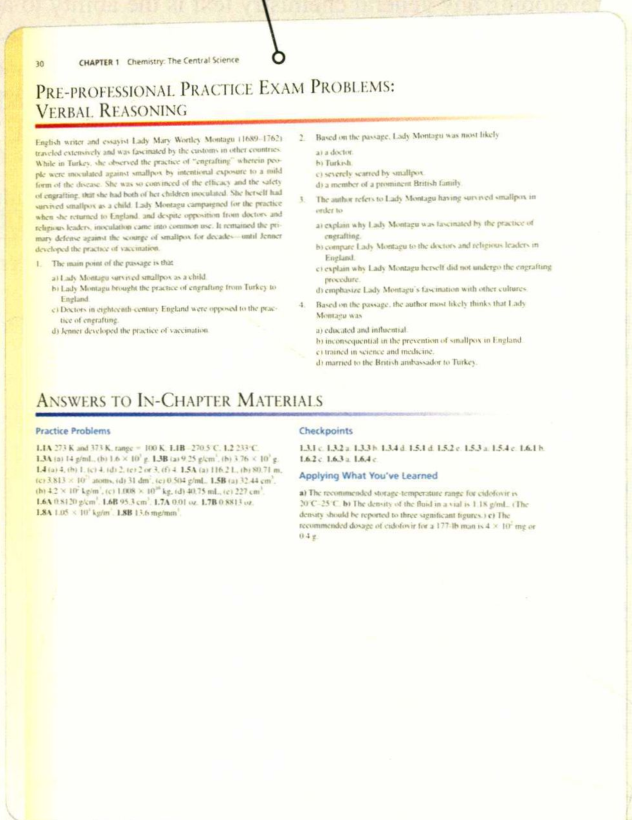

Checkpoint 4.1 General Properties of Aqueous Solutions

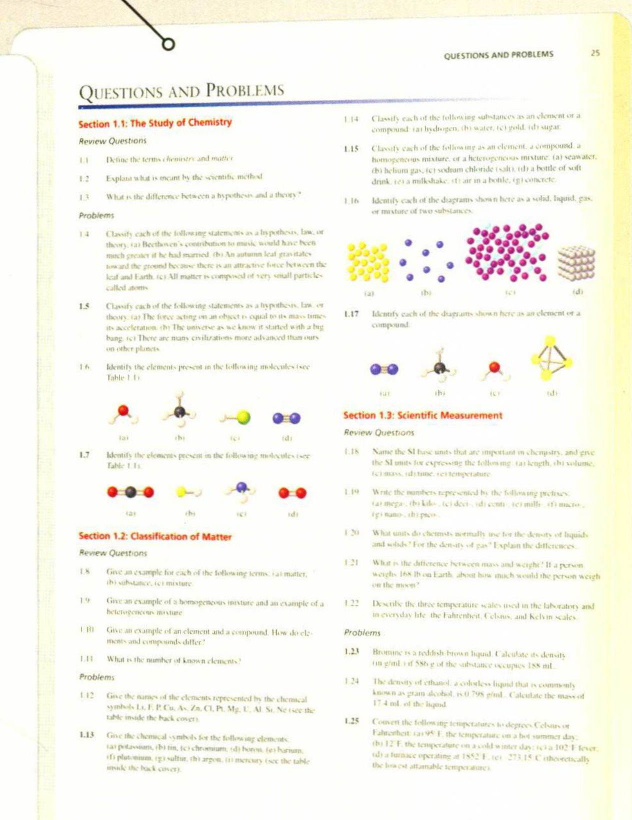
4.1.1 Soluble ionic compounds are ________.
a) always nonelectrolytes
b) always weak electrolytes
c) always strong electrolytes
d) never strong electrolytes
e) sometimes nonelectrolytes

4.1.2 Soluble molecular compounds are ________.
a) always nonelectrolytes
b) always weak electrolytes
c) always strong electrolytes
d) never strong electrolytes
e) sometimes strong electrolytes

4.1.3 Which of the following compounds is a weak electrolyte?
a) LiCl
b) $(C_2H_5)_2NH$
c) KNO_3
d) NaI
e) HNO_3

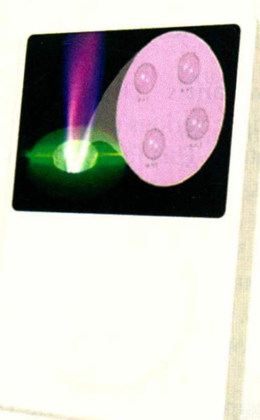
4.1.4 Which of the following compounds is a strong electrolyte?
a) HF
b) H_2CO_3
c) NaF
d) NH_3
e) H_2O





Media Study Tools . . .

- Reinforce your understanding by viewing animations prepared from the unique Visualizing Chemistry figures.



- Learn on the fly by downloading Media Player or MPEG content to your portable device.

360° Development Process

A key principle in developing any general chemistry text is the ability to adapt to teaching specifications in a universal way. The only way to do so is by contacting those universal voices—and learning from their suggestions. Raymond Chang, a veteran author of general chemistry texts, has been involved in the development of this text from the beginning. Raymond's guidance and expertise have proven to be instrumental in the creation of this first-edition text. However, our desire to achieve excellence does not stop with him.

We are confident that our book has the most current content the industry has to offer, thus pushing our desire for accuracy and up-to-date information to the highest standard possible. To accomplish this, we have moved along an arduous road to production. Extensive and open-minded advice is critical in the production of a superior text.

Here is a brief overview of the initiatives included in the 360° Development Process of *Chemistry,* First Edition, by Julia Burdge.

Board of Advisors A hand-picked group of trusted teachers active in general chemistry courses served as chief advisors and consultants to the author and editorial team during manuscript development. The Board of Advisors reviewed parts of the manuscript; served as a sounding board for pedagogical, media, and design concerns; consulted on organizational changes; and attended a focus group to confirm the manuscript's readiness for publication.

Symposia Every year McGraw-Hill conducts a general chemistry symposium that is attended by instructors from across the country. These events are an opportunity for editors from McGraw-Hill to gather information about the needs and challenges of instructors teaching these courses. This information helped to create the book plan for *Chemistry.* They also offer a forum for the attendees to exchange ideas and experiences with colleagues they might have not otherwise met.

Focus Groups In addition to the symposia, we held two specific focus groups for this book—on the overall project and on the art. These selected chemistry professors provided ideas on improvements and suggestions for fine-tuning the content, pedagogy, and art.

Online Focus Groups Online focus groups were held with selected reviewers on specific topics, including the coverage of hybridization and orbitals, organic chemistry, and the art program. The author and editorial team used the information gathered to make improvements to the content and art, and to provide accurate user-friendly material.

Manuscript Review Panels Over 100 teachers and academics from across the country and internationally reviewed the various drafts of the manuscript to give feedback on content, design, pedagogy, and organization. This feedback was summarized by the book team and used to guide the direction of the text.

Accuracy Panel A select group of chemistry experts served as the chief advisors for the accuracy and clarity of the text and solutions manual. These individuals reviewed manuscripts and art in the draft and final forms, reviewed page proofs in the first and revised rounds, and oversaw the writing and accuracy check of the instructor's solutions manuals, test bank, and other ancillary materials.

Student Focus Groups on Content and Design Six student class tests and three student focus groups provided the editorial team with an understanding of how content and the design of a textbook impacts students' homework and study habits in the general chemistry course area.

Developmental Editing In addition to being influenced by a distinguished chemistry author, the development of this manuscript was impacted by two developmental editors. One with a Ph.D. in Chemistry, John Murdzek, helped to ensure clarity and consistency and to develop the conversational and casual narrative style. His expertise also helped to maximize the positive visual impact of the art and photo placement.

Art Development Julia Burdge, along with our designer and editors, worked closely with Precision Graphics, an art development company, to create the visual program within this text. Several personal visits to the Precision offices in Champaign, Illinois, allowed the author and art team to work together and develop the individual art pieces, art-photo combinations, process boxes, and new animations of chemical processes. Out of these dynamics came the author's entirely unique art pieces, the **Visualizing Chemistry** two-page spreads. The end result is a distinctive and innovative visual program that ensures accuracy in relation to textual information, and a style that is uniquely Burdge.

Board of Advisors

Deborah Beard *Mississippi State University*
Steve Davis *University of Mississippi*
Nick Flynn *San Angelo State University*
Cheryl Frech *University of Central Oklahoma*
Gerald Korenowski *Rensselaer Polytechnic University*
Diana Mason *University of North Texas*
Mark Rockley *Oklahoma State University*
Steven Watkins *Louisiana State University*

Symposia Participants

Chris Bauer *University of New Hampshire*
Stephen Cabaniss *University of New Mexico*
Jon Carnahan *Northern Illinois University*
Chris Cheatum *University of Iowa*
John DiVincenzo *Middle Tennessee State University*
William Donovan *University of Akron*
Mark Freilich *University of Memphis*
John Hagen *California Polytechnic State University*
James Hovick *University of North Carolina at Charlotte*
Wendy Innis-Whitehouse *University of Texas–Pan American*
Michael Jones *Texas Tech University*
David Laude *University of Texas at Austin*
Pippa Lock *McMaster University*
Diana Mason *University of North Texas*
Maryann McDermott-Jones *University of Maryland*
Lauren McMills *Ohio University*
Cortland Pierpont *University of Colorado*
Jerry Reed-Mundell *Cleveland State University*
Phil Reid *University of Washington*
Jimmy Rogers *University of Texas–Arlington*
Joe Thrasher *University of Alabama*
Ellen Verdel *University of South Florida*
Steve Watkins *Louisiana State University*

Art Focus Group

William Cleaver *University of Vermont*
Nick Flynn *San Angelo State University*
Karen Glover *Clarke College*
Robert McIntyre *East Carolina University*
David Oostendorp *Loras College*

Reviewers of Various Drafts of the Manuscript

William E. Acree *University of North Texas*
Jeffrey R. Appling *Clemson University*
Benny Ervin Arney, Jr. *Sam Houston State University*
Anamitro Banerjee *University of North Dakota*
Leo A. Bares *University of North Carolina at Asheville*
Debbie J. Beard *Mississippi State University*
Vladimir Benin *University of Dayton*
Paul H. Benoit *University of Arkansas*
Mary Jo Bojan *Pennsylvania State University*
Nancy J. Boldt *Colorado State University*
Londa Borer-Skov *California State Sacramento*
Wayne Bosma *Bradley University*
Simon Bott *University of Houston*
David A. Boyajian *Palomar College*
Timothy Robert Brewer *Eastern Michigan University*
Phillip J. Brucat *University of Florida*
Steven W. Buckner *Saint Louis University*
Brian Buffin *University of Michigan–Flint*
Tara S. Carpenter *University of Maryland, Baltimore County*
Joe A. Casalnuovo *California Polytechnic State University–Pomona*
David L. Cedeno *Illinois State University*
Dana Chatellier *University of Delaware*
Michelle Chatellier *University of Delaware*
Chris Cheatum *University of Iowa*
William Cleaver *University of Vermont*
Elzbieta Cook *Louisiana State University*
Karen Creager *Clemson University*
Curtis J. Czerwinski *University of Wisconsin–LaCrosse*
Steven R. Davis *University of Mississippi*
Dru L. DeLaet *Southern Utah University*
Patrick Desrochers *University of Central Arkansas*
Kenneth L. Dorris *Lamar University*
Ronald Drucker *City College of San Francisco*
Bill Durham *University of Arkansas*
Amina K. El-Ashmawy *Collin Community College*
Nick E. Flynn *Angelo State University*
Stephan C. Foster *Mississippi State University*
David L. Frank *California State University, Fresno*
Cheryl B. Frech *University of Central Oklahoma*
Mark Freilich *University of Memphis*
John Goodwin *Coastal Carolina University*
Scott W. Gordon-Wylie *University of Vermont*
Gary M. Gray *University of Alabama–Birmingham*
Thomas J. Greenbowe *Iowa State University*