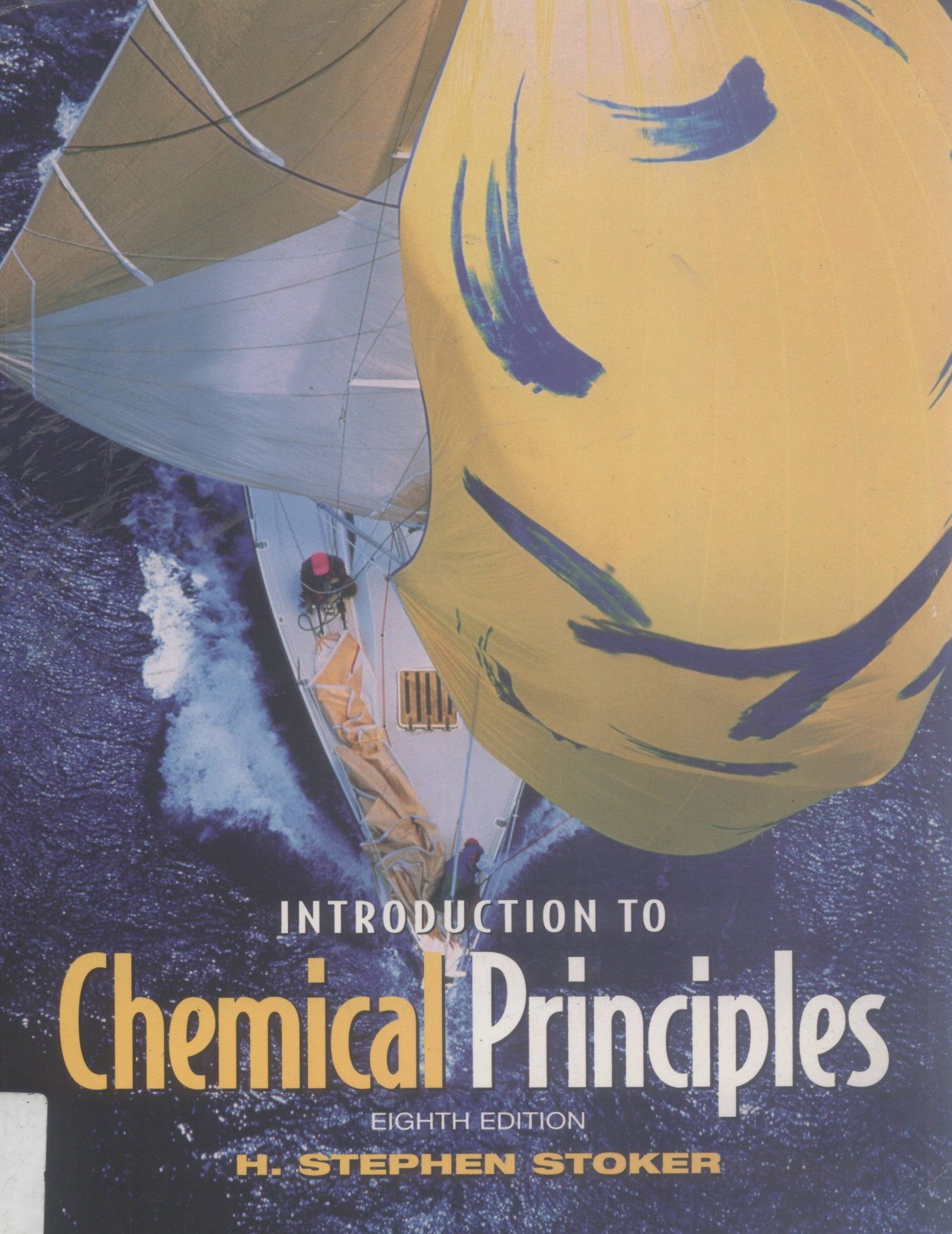

INTRODUCTION TO Chemical Principles

EIGHTH EDITION

H. STEPHEN STOKER

Introduction to Chemical Principles

EIGHTH EDITION

H. Stephen Stoker
Weber State University

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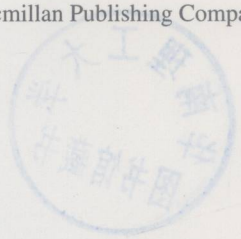

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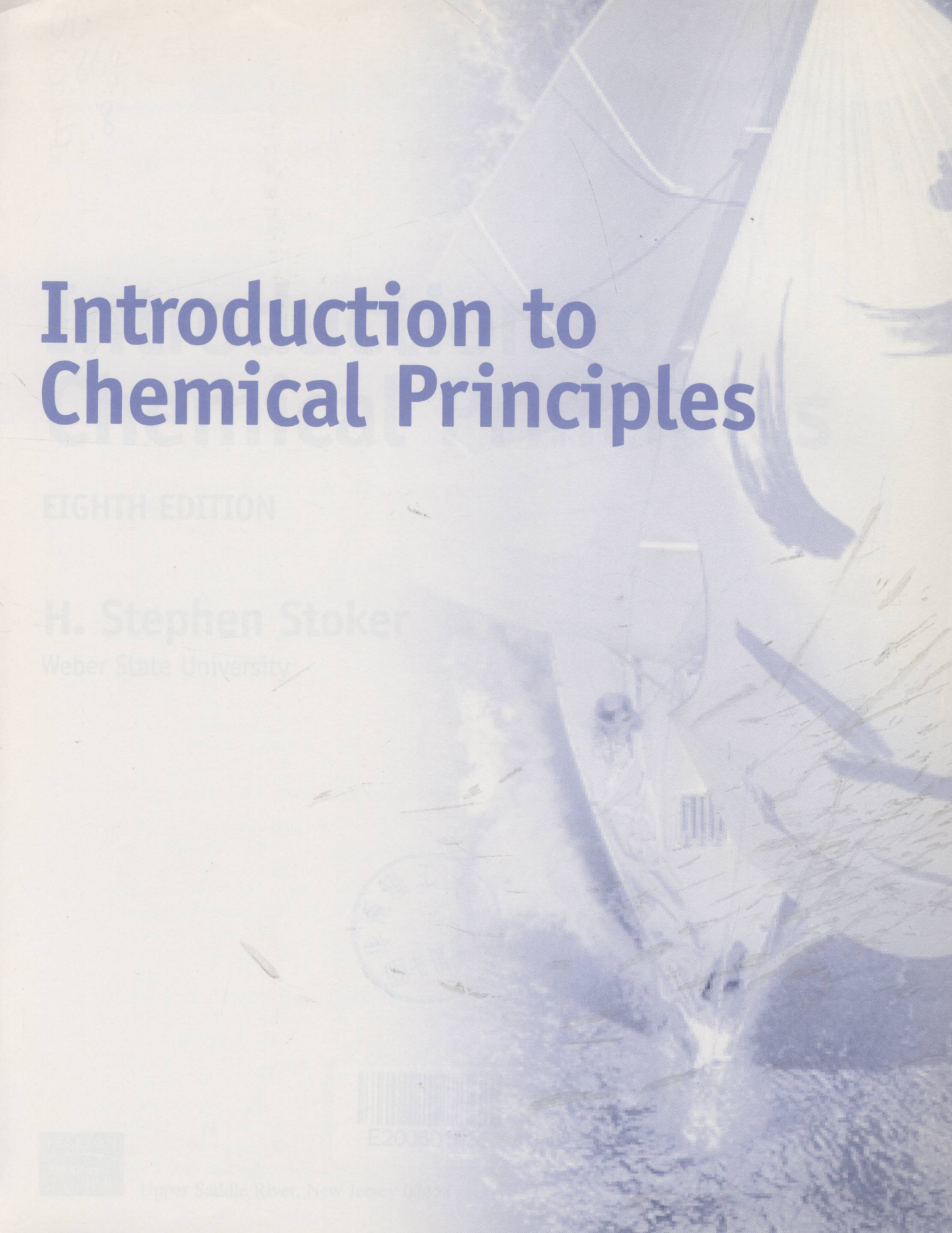

Preface

Introduction to Chemical Principles is a text for students who have had little or no previous instruction in chemistry or who had such instruction long enough ago that a thorough review is needed. The text's purpose is to give students the background (and confidence) needed for a subsequent successful encounter with a main sequence, college-level, general chemistry course.

Many texts written for preparatory chemistry courses are simply "watered down" versions of general chemistry texts: they treat almost all topics found in the general chemistry course, but at a superficial level. *Introduction to Chemical Principles* does not fit this mold. My philosophy is that it is better to treat fewer topics extensively and have the student understand those topics in greater depth. I resisted the very real temptation to include lots of additional concepts in this new edition. Instead, my focus for this edition was on rewriting selected portions to improve the clarity of presentation.

Important Features of the Eighth Edition

1. **Development of each topic starts out at "ground level."** Because of the varied degrees of understanding of chemical principles possessed by students taking a preparatory chemistry course, each topic is developed step by step from "ground level" until the level of sophistication required for a further chemistry course is attained.
2. **Problem-solving pedagogy is based on dimensional analysis.** Thirty-five years of teaching experience suggest to me that student "troubles" in general chemistry courses are almost always centered on the inability to set up and solve problems. Whenever possible, I use dimensional analysis in problem solving. This method, which requires no mathematics beyond arithmetic and elementary algebra, is a powerful and widely applicable problem-solving tool. Most important, it is a method that an average student can master with an average amount of diligence. Mastering dimensional analysis also helps build the confidence that is so valuable for future chemistry courses.
3. **Detailed commentary accompanies all worked-out example problems.** In all chapters, one or more worked-out example problems follow the presentation of key concepts. These examples "walk" students through the thought processes involved in solving the particular type of problem. Detailed commentary accompanies all of the steps involved in solving a problem. In addition, an unworked practice exercise is coupled to each worked-out example. It is intended that students work this exercise immediately after examining the worked-out example. A section at the end of each chapter gives the answers to these unworked practice exercises. In total, the number of worked-out examples is significantly greater than that found in most texts and has increased from that in the previous edition of this work.
4. **Significant-figure concepts are emphasized in all problem-solving situations.** Routinely, electronic calculators display answers that contain more digits than are needed or acceptable. In all worked-out examples, students are reminded about these "unneeded digits" by the appearance of two answers to the example: the calculator answer (which does not take into account significant figures) and, in color, the correct answer (which is the calculator answer adjusted to the correct number of significant figures).
5. **Operation rules for "standardizing" uncertainty in numbers are used.** Students often experience a relatively high degree of frustration when they correctly solve a problem and yet obtain an answer that differs *slightly* from the one given in the answer section at the back of the book. They want to get the "exact" number shown in the answer section. Most often the discrepancy is due to differing degrees of uncertainty in

the input numbers used for the calculation, for example, in molecular mass values. To minimize such frustration, operational rules have been introduced for "standardizing" uncertainty in input numbers. The standard mode of operation is always (1) to round all atomic masses to hundredths before using them in molecular mass calculations, and (2) to specify frequently used numbers, such as Avogadro's number, molar volume, and the ideal gas constant to four significant figures. Using these operational rules for input numbers, student answers will match the back-of-the-book answers *to the last significant digit*.

6. **Defined terms always appear in self-standing complete sentences.** All definitions are highlighted in the text when they are first presented, using boldface and italic type. Each defined term appears as a complete sentence; students are never required to deduce a definition from context. In addition, the definitions of all terms appear in a separate glossary found at the end of the text. A major emphasis in this new edition has been "refinements" in the defined-terms arena. All defined terms have been reexamined to see if they could be stated with greater clarity. The result is a rewording of many defined terms. In addition, the number of defined terms has been increased.
7. **All end-of-chapter exercises occur in matched pairs.** In essence, each chapter has two independent, but similar, problem sets. Counting subparts to problems, there are over 5000 questions and problems available for students to use in their journey to proficient problem solving. Answers to all of the odd-numbered problems are found at the end of the text. Thus, two problem sets exist, one with answers and one without.
8. **Each end-of-chapter problem set,** except for Chapters 1 and 2, **is divided into three sections:** (1) Practice Problems, (2) Additional Problems, and (3) Cumulative Problems. The Practice Problems are categorized by topic and are arranged in the same sequence as the chapter's textual material. These problems, which are always single-concept, are "drill" problems that most students will find routine. The Additional Problem section contains problems that involve more than one concept from the chapter and are usually more difficult than the Practice Problems. The cumulative-skills section draws not only on materials from the current chapter, but also on concepts discussed in previous chapters. The working of problems in this third group allows students to continue to use, rather than forget, problem-solving techniques presented earlier.
9. **Historical vignettes are used to address some of the "people aspects" of chemistry.** These vignettes, entitled "The Human Side of Chemistry," are brief biographies of scientists who helped develop the foundations of modern chemistry. In courses such as the one for which this text is written, it is very easy for students to completely lose any feeling for the people involved in the development of the subject matter they are considering. If it were not for the contributions of these people, many of whom worked under adverse conditions, chemistry would not be the central science that it is today.
10. **"Chemical Extensions" are used to bridge the gap between mathematics and chemistry.** These "extensions," which are appended to most of the worked-out examples in the text, focus on the chemical compound that is the subject of the calculation. They give information on the compound's occurrence, its properties and uses, its relationship to the environment, its relationship to living systems (biochemistry), and so on. It is easy for students to become so involved in the mathematics of problem solving that they completely forget about the "realness" of the compound or compounds that are the subject of their calculation.
11. **Marginal notes are used extensively.** The two main functions of the marginal notes are (1) to summarize key concepts and often give help for remembering concepts or distinguishing between similar concepts, and (2) to provide additional details, links between concepts, or historical information about the concepts under discussion.

Supplements

For the Instructor

Instructor's Solutions Manual **(ISBN 0-13-144942-7)** by Nancy J. Gardner, California State University-Long Beach. Contains full solutions to all of the end-of-chapter problems in the text.

Test Item File **(ISBN 0-13-144992-3)** by Bobby J. Stanton, University of Georgia. Contains approximately 1000 multiple-choice and short-answer questions, all referenced to the text.

TestGen **(ISBN 0-13-144939-7).** This powerful testing and grade management software creates exams from an electronic database version of the Test Item File. Instructors can generate alternate versions of the same test, add their own material, and edit existing tests effortlessly with this program.

PowerPoint™ Images Hundreds of illustrations from the textbook have been digitized and pre-inserted in PowerPoint files for instructor use. Instructors may reformat these slides and add their lecture presentation notes to suit classroom needs.

Annotated Instructor's Manual to Prentice Hall Laboratory Manual for Introductory Chemistry 3e **(ISBN 0-13-096883-8)** by Charles H. Corwin, American River College. Contains a complete listing of chemicals and reagent preparation directions for each experiment. It also provides suggested unknowns and answers to the post-laboratory assignments and a quiz item file with more than 500 class-tested multiple-choice questions.

WebAssign Online Homework. Our partnership with WebAssign gives instructors the opportunity to assign algorithmically generated homework, based on end-of-chapter problems, have it automatically graded, and have the grades entered into a central gradebook. Students get instant feedback and the opportunity for repeated practice.

For the Student

Student Solutions Manual **(ISBN 0-13-144941-9)** by Nancy J. Gardner, California State University-Long Beach. Includes full solutions to all odd-numbered end-of-chapter problems in the text.

Math Review Toolkit **(ISBN 0-13-144993-1)** by Gary Long, Virginia Tech. Designed to provide assistance to students with weaker math skills. This supplement includes a chapter-by-chapter math review keyed to problems in the text as well as a brief self-assessment test.

Introductory ChemIST CD **(ISBN 0-13-033729-3).** This *Interactive Student Tutorial* gives students a media-rich, engaging overview of all of the topics and fundamental skills in an introductory chemistry course, including animations, simulations, video clips, and self-assessment questions.

Prentice Hall Laboratory Manual for Introductory Chemistry 3e **(ISBN 0-13-062333-4)** by Charles H. Corwin, American River College. This comprehensive collection of 25 laboratory experiments with detailed safety information offers an exciting, hands-on introduction to the world of chemistry.

Acknowledgments

I'd like to gratefully acknowledge the valuable contributions of my accuracy reviewers: Boyd Beck of Snow College, David B. Shaw of Madison Area Technical College, and Andreas Lippert of Weber State University.

Every effort has been made to rid this text of any typographical errors. I encourage my readers who notice anything suspicious, or who have other questions or comments, to e-mail me at the address below.

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Mathematical Meanings of Metric System Prefixes

Prefix	Meaning	Prefix	Meaning
Tera (T)	10^{12}	Pico (p)	10^{-12}
Giga (G)	10^{9}	Nano (n)	10^{-9}
Mega (M)	10^{6}	Micro (μ)	10^{-6}
Kilo (k)	10^{3}	Milli (m)	10^{-3}
Hecto (h)	10^{2}	Centi (c)	10^{-2}
Deca (da)	10^{1}	Deci (d)	10^{-1}

Common Fixed-Charge Metallic Cations and Nonmetallic Anions

Cation	Name	Anion	Name
Li^{+}	lithium ion	F^{-}	fluoride ion
Na^{+}	sodium ion	Cl^{-}	chloride ion
K^{+}	potassium ion	Br^{-}	bromide ion
Rb^{+}	rubidium ion	I^{-}	iodide ion
Cs^{+}	cesium ion	O^{2-}	oxide ion
Be^{2+}	beryllium ion	S^{2-}	sulfide ion
Mg^{2+}	magnesium ion	N^{3-}	nitride ion
Ca^{2+}	calcium ion	P^{3-}	phosphide ion
Sr^{2+}	strontium ion	C^{4-}	carbide ion
Ba^{2+}	barium ion		
Ag^{+}	silver ion		
Zn^{2+}	zinc ion		
Cd^{2+}	cadmium ion		
Al^{3+}	aluminum ion		
Ga^{3+}	gallium ion		

Common Variable-Charge Metallic Cations

Cation	IUPAC Name	Older Name
Cu^{+}	copper (I) ion	cuprous ion
Cu^{2+}	copper (II) ion	cupric ion
Fe^{2+}	iron (II) ion	ferrous ion
Fe^{3+}	iron (III) ion	ferric ion
Sn^{2+}	tin (II) ion	stannous ion
Sn^{4+}	tin (IV) ion	stannic ion
Pb^{2+}	lead (II) ion	plumbous ion
Pb^{4+}	lead (IV) ion	plumbic ion
Au^{+}	gold (I) ion	aurous ion
Au^{3+}	gold (III) ion	auric ion

Names of Common Polyatomic Ions

	Ion	Name		Ion	Name
N	NO_3^-	nitrate ion	Cl	ClO_4^-	perchlorate ion
	NO_2^-	nitrite ion		ClO_3^-	chlorate ion
	NH_4^+	ammonium ion		ClO_2^-	chlorite ion
	N_3^-	azide ion		ClO^-	hypochlorite ion
S	SO_4^{2-}	sulfate ion	C	CO_3^{2-}	carbonate ion
	HSO_4^-	hydrogen sulfate ion		HCO_3^-	hydrogen carbonate ion
	$S_2O_3^{2-}$	thiosulfate ion		$C_2O_4^{2-}$	oxalate ion
	SO_3^{2-}	sulfite ion		$C_2H_3O_2^-$	acetate ion
P	PO_4^{3-}	phosphate ion		CN^-	cyanide ion
	HPO_4^{2-}	hydrogen phosphate ion		OCN^-	cyanate ion
	$H_2PO_4^-$	dihydrogen phosphate ion		SCN^-	thiocyanate ion
	PO_3^{3-}	phosphite ion	B	BO_3^{3-}	borate ion
H	H_3O^+	hydronium ion	Mn	MnO_4^-	permanganate ion
	OH^-	hydroxide ion	Cr	CrO_4^{2-}	chromate ion
O	O_2^{2-}	peroxide ion		$Cr_2O_7^{2-}$	dichromate ion

Solubility Guidelines for Ionic Compounds in Water at 25°C

Soluble Compounds	Important Exceptions
Compounds containing the following ions are soluble with exceptions as noted.	
Group IA (Li^+, Na^+, K^+, etc.)	none
Ammonium (NH_4^+)	none
Acetate ($C_2H_3O_2^-$)	none
Nitrate (NO_3^-)	none
Chloride (Cl^-), bromide (Br^-), and iodide (I^-)	Ag^+, Pb^{2+}, Hg_2^{2+}
Sulfate (SO_4^{2-})	Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}

Insoluble Compounds	Important Exceptions
Compounds containing the following ions are insoluble with exceptions as noted.	
Carbonate (CO_3^{2-})	group IA and NH_4^+
Phosphate (PO_4^{3-})	group IA and NH_4^+
Sulfide (S^{2-})	groups IA and IIA and NH_4^+
Hydroxide (OH^-)	group IA, Ba^{2+}, Sr^{2+}, Ca^{2+}

Common Strong Acids

Formula	Name
HNO_3	nitric acid
H_2SO_4	sulfuric acid
$HClO_4$	perchloric acid
$HClO_3$	chloric acid
HCl	hydrochloric acid
HBr	hydrobromic acid
HI	hydroiodic acid

Common Strong Bases

Formula	Name
LiOH	lithium hydroxide
NaOH	sodium hydroxide
KOH	potassium hydroxide
RbOH	rubidium hydroxide
CsOH	cesium hydroxide
$Ca(OH)_2$	calcium hydroxide
$Sr(OH)_2$	strontium hydroxide
$Ba(OH)_2$	barium hydroxide

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