

# GENERAL CHEMISTRY

RAYMOND CHANG

	1A																	8A	
1	H	2A																	He
2	Li	Be																	Ne
3	Na	Mg	3B	4B	5B	6B	7B	8B	1B	2B	Al	Si	P	S	Cl			Ar	
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
6	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
7	Fr	Ra	Ac	Unq	Unp	Unh	Uns	Uno	Une										

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

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WILLIAMS COLLEGE



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# PREFACE

*General Chemistry* is written for students taking a full-year introductory chemistry course. In recent years, a growing number of instructors have felt the need to introduce more descriptive chemistry in such a beginning course. However, teaching the chemistry of the elements early in the course before the fundamental principles have been presented or arbitrarily inserting a chapter on the chemistry of hydrogen and oxygen between the properties of solutions and chemical equilibrium, say, seems inappropriate. In writing this book, I have tried to strike a balance between theory and application, and I have attempted to solve the problem of "what to do with descriptive chemistry in a general chemistry course" by emphasizing the use of the periodic table. In many ways the periodic table is the single most important and useful source of information regarding the elements. It correlates the chemical behavior of the elements in a systematic manner and helps us to remember and understand many facts. Most of the topics presented in an introductory course can be expanded upon by reference to the periodic table, which allows descriptive chemistry to be taught and learned in a more natural way.

No ideal single organizational scheme exists for a general chemistry course. The chapters in this text have been arranged to follow the mainstream sequence, but the organization also allows for flexibility. Chapter 1 presents the basic vocabulary and tools needed for chemistry and Chapter 2 introduces the basic concepts of atoms and molecules and the nomenclature of inorganic compounds. As a group, Chapters 3 through 5 are devoted to the nature and types of chemical reactions and the mass and energy relationships accompanying chemical changes. That a fair amount of descriptive chemistry is presented in Chapter 3 through the discussion of chemical reactions enables students to gain an early appreciation of the reactivity of some common substances. After a chapter on the physical properties of gases (Chapter 6), the structure and quantum mechanical treatment of atoms are presented in Chapters 7 and 8. The general properties of elements and periodic trends are the topic of Chapter 9.

A very important topic, chemical bonding, is the subject of four chapters (Chapters 10–13). Chapters 14 and 15 deal with the physical properties of

liquids and solids and solutions, and Chapter 16 discusses one important type of chemical reaction, oxidation–reduction reactions. As a group, Chapters 17 through 24 deal with the more quantitative aspects of chemistry. Acid-base reactions, which are among the most common and important of chemical processes, are discussed in three chapters (Chapters 18–20). After Chapter 25, which studies nuclear reactions, are four chapters that deal with descriptive chemistry in a systematic manner. The last chapter is on the chemistry of organic compounds.

Several features of the text deserve special mention.

- At the end of a number of chapters are box features called **An Aside on the Periodic Table**. These are short, elementary discussions related to the chapter materials and they serve to illustrate the periodic relationships among the elements. These box features enable students to appreciate descriptive chemistry in a more meaningful way.
- The text has two **Color Plate** sections. The first group of Color Plates (1–10) shows the appearance of many of the elements, their minerals, and the mining processes and methods used for their extraction. The second group of Color Plates (11–24) illustrates various physical and chemical processes and the properties of a number of substances. These Color Plates serve to bring the living color of chemistry to beginning students and enhance their appreciation for descriptive chemistry.
- Every **important term** appears in boldface when it is introduced and defined. For quick reference, these key words are also listed alphabetically at the end of each chapter and defined in a glossary at the end of the book.
- There is a **summary at the end of each chapter** to serve as a review of the important concepts introduced in the chapter.
- Numerous **marginal notes** that serve as reminder of facts already presented and additional comments are provided throughout the text.

The best way to test one's understanding of chemical concepts is by solving problems. The many **worked examples** within each chapter demonstrate problem-solving techniques. In addition, there are over 1,500 **end-of-chapter problems**. These problems are grouped according to specific topics in the chapters. **Answers to selected problems** are given at the end of the book.

Most of the units used in this book are SI units. For practical laboratory reasons, I have retained the use of atmosphere and mmHg for pressure and liter and milliliter for volume.

Supplements available for use with this text are:

Philip C. Keller and Jill L. Keller, *Study Guide*  
Raymond Chang, *Solutions Manual*

These supplements contain many ideas and insights that are helpful to understanding chemical concepts, as well as problem-solving techniques. An *Instructor's Manual*, written by the author, and a *Test Bank*, written by Kenneth W. Watkins, are available to instructors upon request to the publisher.

Your comments and suggestions on the text and its ancillaries will be greatly appreciated.

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## MINING AND PRODUCTION



Magnesium bromide and magnesium chloride are obtained by solar evaporation of salt water.



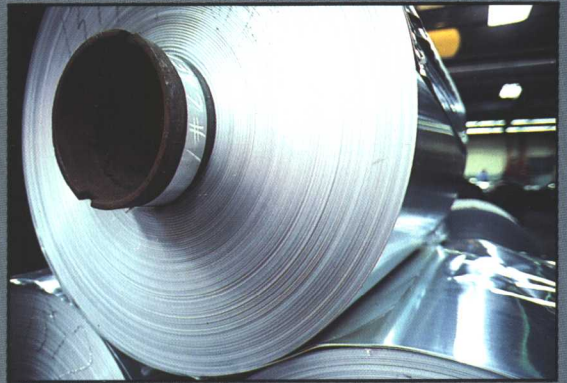
"Pigs" of magnesium ready for use.



## PRODUCTION



Aluminum ingots at production site.



Sheets of aluminum.



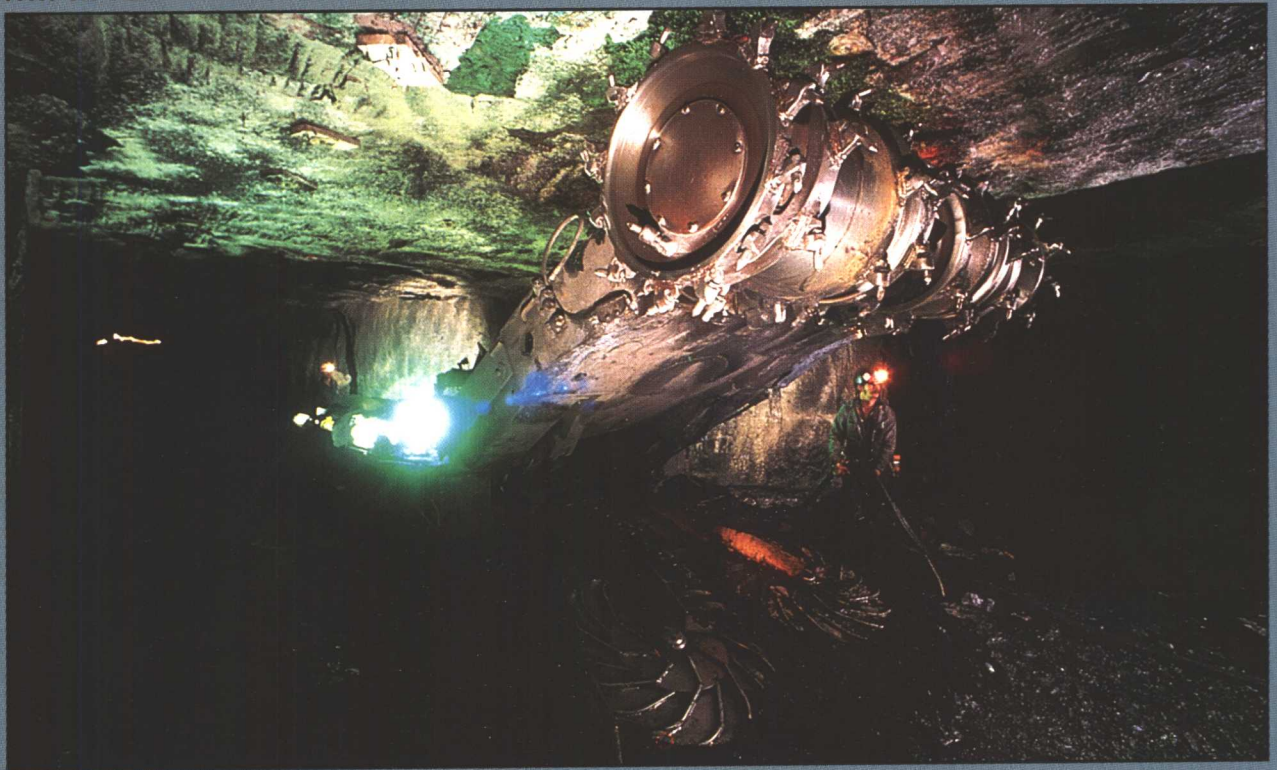
Used aluminum cans for recycling.



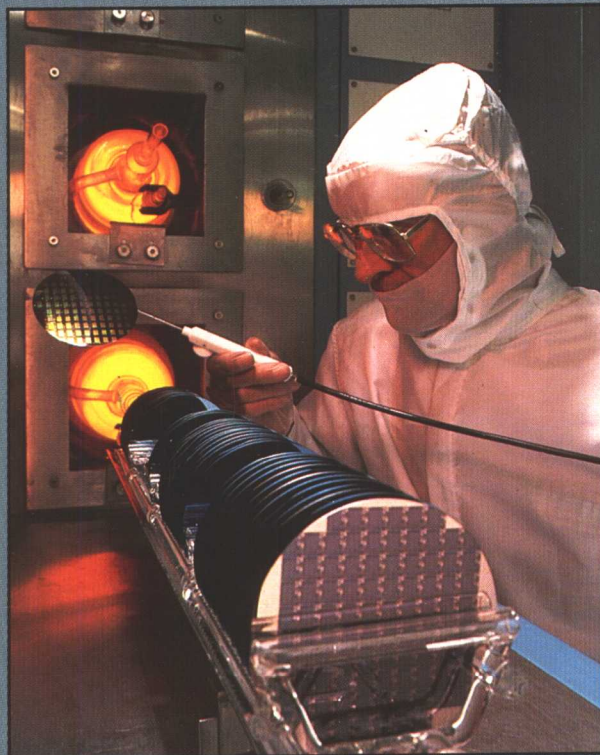
Melted aluminum cans.



## MINING AND PRODUCTION

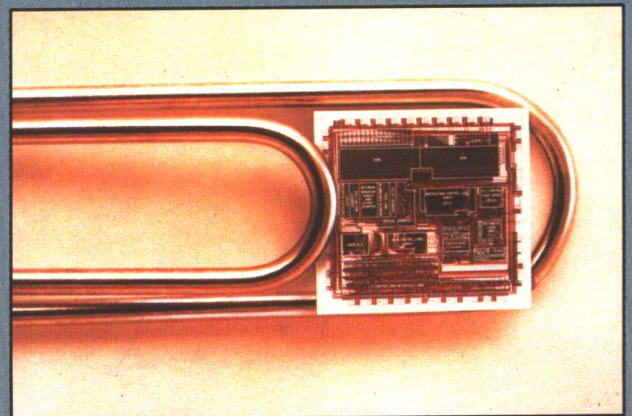


Coal mining.



Production of ultrapure silicon wafers.

Silicon in solid-state electronics—the one-chip computer.





# MINING



Phosphate mining.



Testing the purity of phosphate rock.





