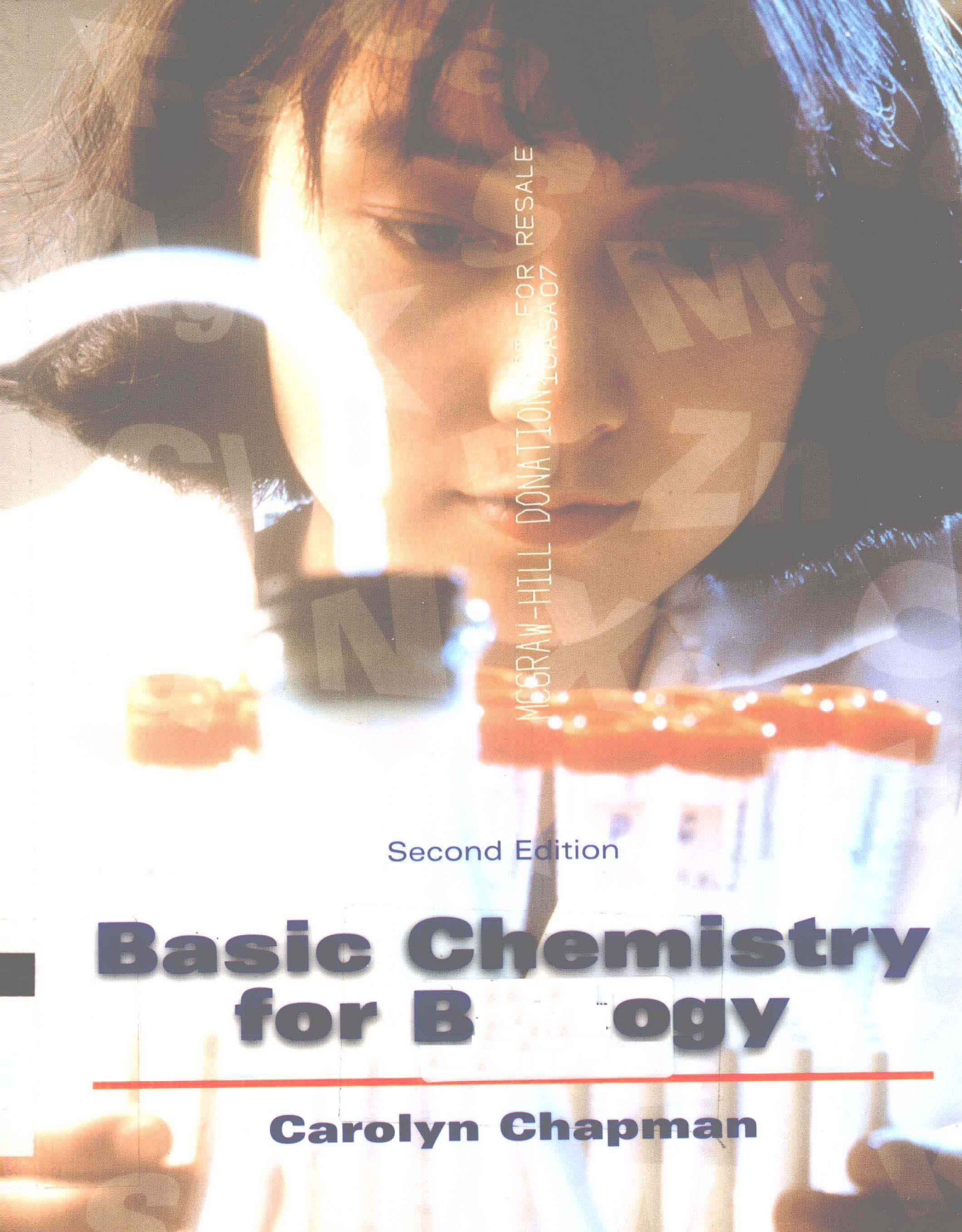

MCGRAW-HILL DONATION NOT FOR RESALE

Second Edition

Basic Chemistry for Biology

Carolyn Chapman

Second Edition

Basic Chemistry for Biology

Carolyn Chapman
Suffolk County Community College

WCB McGraw-Hill

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

WCB/McGraw-Hill

*A Division of The **McGraw-Hill** Companies*

BASIC CHEMISTRY FOR BIOLOGY, SECOND EDITION

Copyright © 1999 by The McGraw-Hill Companies, Inc. All rights reserved. Previous edition © 1996 by Wm. C. Brown Communications, Inc. All rights reserved. Printed in the United States of America. Except as permitted under the United States Copyright Act of 1976, no part of this publication may be reproduced or distributed in any form or by any means, or stored in a data base or retrieval system, without the prior written permission of the publisher.

This book is printed on acid-free paper.

8 9 10 QPF/QPF 0 5

ISBN 0–697–36087–3

Vice president and editorial director: *Kevin T. Kane*
Publisher: *Michael D. Lange*
Sponsoring editor: *Patrick Reidy*
Senior developmental editor: *Suzanne M. Guinn*
Marketing manager: *Lisa Gottschalk*
Project manager: *Jill R. Peter*
Senior production supervisor: *Sandra Hahn*
Designer: *K. Wayne Harms*
Compositor: *Shepherd, Inc.*
Typeface: *10/12 Times Roman*
Printer: *Quebecor Printing Book Group/Fairfield, PA*

Cover/interior design: *Kristyn Kalnes*
Cover photograph: *Stephen Simpson/FPG International*

Figures on pages 239, 260, 269, and 271 adapted from Sylvia S. Mader, *Biology,* 6th edition. Copyright © 1998 McGraw-Hill Company, Inc., Dubuque, Iowa. All rights reserved.

Introduction

Welcome to the second edition of *Basic Chemistry for Biology*. Chemistry is a subject that is important in many other areas of science. Students of biology, medicine, geology, and astronomy need a working knowledge of chemistry to succeed in their fields. The goal of this book is to provide you with an introduction or review of the basic principles of chemistry that are most useful in other areas of science.

As a beginning science student, you may wonder why you need to know about chemistry if your direct goal is to learn a field such as anatomy and physiology or geology. Some examples will illustrate why chemistry is so fundamental. The human body, like that of all living organisms, is composed of chemicals. The composition of the body will not make sense unless a basic knowledge of chemistry is available to help you understand the body's structure. Living organisms are based on chemical activity. When the liver responds to hormones and regulates blood sugar levels, chemical reactions are responsible. When you think and learn, chemical interactions in the neurons of the brain play an essential role. These examples show that physiology is the study of how the body regulates its internal chemistry. Clearly, a knowledge of chemistry will greatly increase your chances of success in physiology. Similar examples from other areas of science would lead to the same conclusion.

This book can be used as an introduction to chemistry or as a review of the subject. Those topics from high school chemistry (or an entry-level college course) that are most essential to an understanding of other science areas are included here. The second edition includes new chapters on organic chemistry and biomolecules. Although these topics are not usually covered in high school chemistry, they are essential to your success in biology. This book is not intended to replace an entire chemistry course. If you master the subject matter of this book, you will learn (or relearn) the principles of chemistry used in introductory science courses. If you decide to pursue the study of science seriously, however, you will need to take several chemistry courses as you progress.

All fields of science are based on experimentation. The goal of this book is to help you acquire a basic knowledge of the concepts of chemistry as quickly as possible. Therefore, the concepts of chemistry are presented without their experimental basis. It is important to remember that these concepts are not arbitrary but were developed to explain and be compatible with experimental findings. A full chemistry course will include the experimental basis of the field.

A scientific model is a description and explanation of experimental observations. Models can vary in complexity. In general, simpler models are utilized in this book. The octet rule, used to predict chemical reactions, is an example. Such models are compatible with many experimental findings and can be used to predict a wide array of chemical reactions. Typically, they do not explain everything, and exceptions are known. This does not mean that such models are incorrect, but rather that they represent incomplete and simplified descriptions of the natural world. As your knowledge of chemistry increases, more complex models can be added to those presented here.

How To Use This Book

Objectives

Each chapter in this book covers the major topic stated in its title. The first page of each chapter gives a list of learning objectives for the chapter. These objectives list the things you should be able to do when you have mastered the material in the chapter.

Some of these objectives are basic and must be mastered before you can continue on to more advanced topics. This is because much of the subject matter of chemistry is cumulative, and later topics build on what has gone before. Other objectives are intermediate or advanced. These objectives are indicated with an asterisk. Frequently, these topics can be omitted without impeding your progress through future chapters. You should customize your chemistry study by choosing which of these to include. Your prior knowledge of chemistry and the requirements of your current academic program are prime factors to consider. One effective strategy is to work through the book two or more times. Cover the basic objectives the first time. This provides a good start to the beginning student without introducing difficult subject matter. Then, during subsequent readings, add intermediate and advanced topics.

Study and Self-Testing

Each section of text includes a short paragraph about a new topic. Read the paragraph carefully. The paragraph will be followed by a series of questions that test your understanding of the material and ask you to apply it. Answer the questions as completely as you can.

The answers to the questions are at the end of the chapter. When you have completed the questions on a page, check your responses against the answers. Explanations are often included with the answers. If you did not answer the question correctly, the explanation may be sufficient to help you get back on track.

If you understood the paragraph and answered all the questions correctly, you are ready to continue to the next section. If you are uncertain that you understand or if you missed questions, repeat the section. Read the paragraph again. When you understand it, try the questions again.

Repetition is essential to the learning process. Working through this book more than once provides such repetition and is strongly recommended. A longer and more complete test is included at the end of each chapter. This test enables you to evaluate your mastery of the entire chapter. The chapter test is also a learning experience, because it provides more repetition of the subjects that have been covered.

此为试读，需要完整PDF请访问：www.ertongbook.com

Table of Contents

Chapter 1

The Atom

How to Use the Objectives

The objectives for Chapter 1 are stated below. All are tasks you should be able to complete successfully once the material in this chapter has been mastered. These are general objectives. The questions in Chapter 1 specifically apply to these objectives. Correct answers to the questions in Chapter 1 provide good evidence that the objectives have been achieved. A full chapter test at the end of this unit is available for you to take when you are ready. It includes questions designed to evaluate all of the objectives. Your score on the chapter test provides you with an overall assessment of your mastery of the chapter objectives.

Objectives that cover more advanced material are indicated with an asterisk (*). Include the optional objectives appropriate for your academic program. Progress through the remaining chapters of this book does not require mastery of the optional topics.

Objectives

1. Define the following terms and apply the definitions correctly: matter, element, atom, atomic number, mass number, atomic mass (weight), and isotope.
2. List the elementary particles, their properties, and their locations in an atom.
3. State the interactions of like and unlike electrical charges.
4. Given the atomic number and mass number, calculate the number of protons, neutrons, and electrons in an atom.
5. Use the periodic table of the elements to find information such as an element's name, atomic number, atomic mass (weight), and symbol.
6. List the symbols for the elements that are significant in living things.
7. Know and use the appropriate formula to calculate the number of electrons in an electron shell.
8. Sketch the structure of any atom up to an atomic number of 18, showing the correct number of electrons in each electron shell.
9. Represent the isotopic variants of an element with standard chemical notation.
10. *Sketch the electronic structure of any atom up to atomic number 38, showing the correct number of electrons in each electron shell.
11. *Accurately describe the size of an atom and the spatial relations within it.

Matter, Elements, and Atoms

All physical objects are made of matter. Your body, all the objects you see, and even the air that fills the space between visible objects are composed of matter. (Matter in a solid or liquid state is usually visible, whereas matter in the gaseous state often is not.) Matter is defined as anything that occupies space and has mass. The space an object occupies can be measured and is the volume of that object. Under the circumstances we usually encounter (on earth in a gravitational field), having mass is detected as the weight of an object.

Questions

1. Is your body composed of matter? How would you demonstrate the validity of your answer?

   Yes _____ No _____

2. Is the chair or couch you are sitting on composed of matter? How can you tell?

   Yes _____ No _____

3. A tank appears to be empty. It is weighed. Then it is connected to a vacuum pump, which is operated for ten minutes. The tank is weighed again and now weighs less. Did it contain matter? How did the information provided permit you to answer the question?

   Yes _____ No _____

How could you determine whether the tank still contains some matter after being pumped?

Chemists have analyzed matter carefully. Their experimental work shows that matter is made up of simple substances called elements. The elements are the basic building blocks of more complex forms of matter. Elements cannot be converted to less complex substances by chemical reactions.

Questions

4. Samples of four pure gases are put through testing procedures that attempt to decompose them into simpler substances using chemical reactions. The following results are obtained: oxygen, nitrogen, and neon cannot be decomposed into simpler substances. Carbon dioxide does decompose, releasing carbon and oxygen. Based on these results, which gases are elements? Explain.

5. It is possible to use an electrical current to decompose a sample of water, a process called electrolysis. As the electrolysis procedure progresses, both hydrogen gas and oxygen gas are released. Is water an element? What evidence supports your answer?

   Yes _____ No _____

6. A pure sample of sugar is burned in oxygen. The products of combustion are carbon dioxide and water. Is sugar an element? Explain your reasons for answering as you did.

   Yes _____ No _____

Experimental investigation demonstrates that matter is particulate. An atom is the smallest particle of an element that still retains the properties of that element. Atoms are extremely tiny. Between one million and two million atoms could line up side by side across the diameter of one of the printed periods on this page.

Questions

7. Carbon is an element that is very important in organic molecules. (Organic molecules are synthesized by living cells and are always based on carbon. Organic molecules are central to the structure and function of all forms of life.) An atom of carbon is one _____ of carbon.

8. Experimentation shows that atoms can be broken up, though not by chemical means. Atoms have internal structure and contain still smaller particles. Would the smaller particles within the carbon atom have the properties of carbon? Explain.

   Yes _____ No _____

9. Would one particle of sugar be an atom? Explain your answer.

   Yes _____ No _____

10. The smallest particle of nitrogen that still has the properties of nitrogen is one _____ of nitrogen. Would this single particle of nitrogen be visible to the unaided eye? Explain your answer.

    Yes _____ No _____

Elementary Particles

The simplified model of atomic structure presented here considers the atom to be composed of three types of elementary particles (subatomic particles): the proton, the neutron, and the electron. Each particle is characterized by a weight (or mass) and an electrical charge.

Particle	Symbol	Mass*	Charge
Proton	p	1	+1
Neutron	n	1	0
Electron	e^-	0**	−1

*The units of mass are atomic mass units (amu) or daltons.
**The mass of the electron is not exactly zero, but is so small that it is negligible for most purposes.

Questions

11. Which elementary particles have a charge?

12. Which elementary particle is not charged?

13. Which elementary particles account for nearly all the weight of the atom?

14. Which elementary particle has a charge that is equal in magnitude, but opposite in sign, to the proton?

15. Which elementary particle contributes very little to the weight of the atom?

此为试读，需要完整PDF请访问：www.ertongbook.com

Electrical charges that are opposite in sign attract each other. Electrical charges that have the same sign repel each other. Uncharged matter neither repels nor attracts other matter.

Questions

For the pairs of particles listed, state whether the particles attract each other, repel each other, or do not interact.

16. Proton and neutron.

17. Proton and electron.

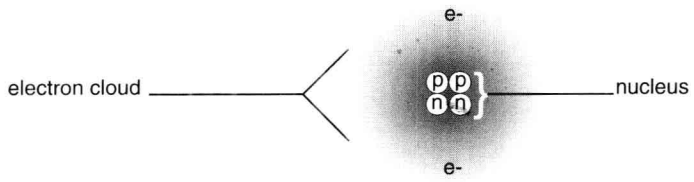
18. Electron and neutron.

19. Neutron and neutron.

20. Electron and electron.

21. Proton and proton.

The Atom



An Atom of Helium

This diagram of an atom* shows the locations of the elementary particles. The nucleus of the atom contains the protons (p) and neutrons (n). The nucleus is extremely small and therefore very dense. The electrons (e-) are located at a distance from the nucleus. The electron cloud represents the regions where the electrons are most likely to be found. The electrons in the cloud may be pictured as moving very rapidly in the area of the cloud, or as a smear of negative charge.

*This diagram represents an atom of helium. The helium atom has two protons, two electrons, and two neutrons. The numbers of elementary particles would be different in atoms of other elements.

Questions

22. The atom is mostly empty space. Explain your answer.

    True _____ False _____

23. Which part of the atom is positively charged?

24. Most of the mass of the atom is contained in the _____.

25. Sketch an atom that contains three protons, three electrons, and four neutrons.

The atomic number of an element is equal to the number of protons the element contains. The atomic number of an element establishes its identity. For example, hydrogen is atomic number 1, carbon is atomic number 6, and nitrogen is atomic number 7.

Questions

26. How many protons does carbon contain?

27. Where are the protons located in the carbon atom?

28. Could an atom with an atomic number of 8 be a variant of nitrogen? Explain.

    Yes _____ No _____

29. How many protons do hydrogen atoms contain?

30. How many protons do nitrogen atoms contain?

Unreacted atoms are electrically neutral. Because they contain charged elementary particles, the number of positive and negative charges must be the same.

Questions

31. Which elementary particle is positively charged?

32. Which elementary particle is negatively charged?

33. In a neutral atom, the number of protons must be equal to the number of _____. Explain.

34. An atom of carbon contains _____ protons and _____ electrons. Explain how you determined the answer to this question.

35. An atom of nitrogen contains _____ protons and _____ electrons.

36. How many electrons does a hydrogen atom contain? Explain.

The Periodic Table of the Elements

The elements are arranged in a sequence by increasing atomic number in a chart called the periodic table of the elements. The periodic table organizes a great deal of information about the elements in a very compact form. You will learn to use some of that information now. A copy of the periodic table (or chart) is located at the back of this book. The key at the top of the periodic table explains the information that is available about each element. Use the key and periodic table to answer the following questions.

Questions

37. Where is the atomic number for an element found?

38. Where is the name of the element found?

39. The atomic number of calcium is _____.

40. The atomic number of sodium is _____.

41. Which element has an atomic number of 26?

42. Which element has an atomic number of 12?

Each element is represented by a chemical symbol. The symbol is often the first letter or two of the element's name in English. Occasionally, the symbol is derived from the name of the element in Latin. Use the periodic table to answer the following questions.

Questions

43. Carbon, hydrogen, oxygen, and nitrogen are four elements that are present in substantial amounts in all living organisms. What are the symbols for these four elements?

44. Look up the atomic numbers and chemical symbols for phosphorus and potassium.

45. What are the chemical symbols for sodium, sulfur, and iron?

46. Which element has an atomic number of 17? What is the chemical symbol for this element? How many protons does an atom of this element contain? How many electrons?

此为试读,需要完整PDF请访问: www.ertongbook.com