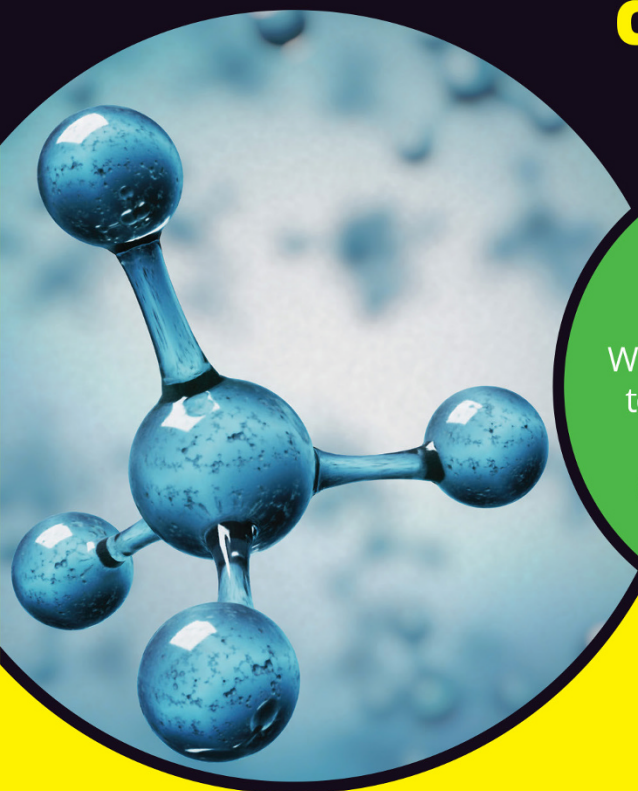


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John T. Moore, EdD

Regents Professor of Chemistry,
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Contents at a Glance

Introduction	1
CHAPTER 1: Matter and Energy: Exploring the Stuff of Chemistry	5
CHAPTER 2: What's in an Atom?	17
CHAPTER 3: The Periodic Table	35
CHAPTER 4: Nuclear Chemistry	43
CHAPTER 5: Ionic Bonding	55
CHAPTER 6: Covalent Bonding	69
CHAPTER 7: Chemical Reactions	87
CHAPTER 8: Electrochemistry: Using Electrons	111
CHAPTER 9: Measuring Substances with the Mole	125
CHAPTER 10: A Salute to Solutions	135
CHAPTER 11: Acids and Bases	145
CHAPTER 12: Clearing the Air on Gases	159
CHAPTER 13: Ten Serendipitous Discoveries in Chemistry	171
Index	175

Table of Contents

INTRODUCTION	1
About This Book	1
Conventions Used in This Book	2
Foolish Assumptions	2
Icons Used in This Book	3
Where to Go from Here	3
CHAPTER 1: Matter and Energy: Exploring the Stuff of Chemistry	5
Knowing the States of Matter and Their Changes	6
Solids, liquids, and gases	6
Condensing and freezing	7
Melting and boiling	8
Skipping liquids: Sublimation	9
Pure Substances and Mixtures	9
Pure substances	10
Throwing mixtures into the mix	11
Measuring Matter	12
Nice Properties You've Got There	13
Energy Types	14
Kinetic energy	14
Potential energy	15
Temperature and Heat	15
CHAPTER 2: What's in an Atom?	17
Subatomic Particles	17
Centering on the Nucleus	19
Locating Those Electrons	21
The quantum mechanical model	21
Energy level diagrams	26
Isotopes and Ions	30
Isotopes: Varying neutrons	31
Ions: Varying electrons	32

CHAPTER 3:	The Periodic Table	35
	Repeating Patterns: The Modern Periodic Table.....	35
	Arranging Elements in the Periodic Table.....	38
	Grouping metals, nonmetals, and metalloids.....	38
	Arranging elements by families and periods.....	41
CHAPTER 4:	Nuclear Chemistry	43
	Seeing How the Atom's Put Together.....	43
	Dealing with a Nuclear Breakup: Balancing Reactions.....	44
	Understanding Types of Natural Radioactive Decay.....	46
	Alpha emission.....	47
	Beta emission.....	48
	Gamma emission.....	48
	Positron emission.....	48
	Electron capture.....	49
	Half-Lives and Radioactive Dating.....	49
	Calculating remaining radioactivity.....	50
	Radioactive dating.....	51
	Breaking Elements Apart with Nuclear Fission.....	51
	Mass defect: Where does all that energy come from?.....	52
	Chain reactions and critical mass.....	52
	Coming Together with Nuclear Fusion.....	53
CHAPTER 5:	Ionic Bonding	55
	Forming Ions: Making Satisfying Electron Trades.....	55
	Gaining and losing electrons.....	56
	Looking at charges on single-atom ions.....	58
	Grouping atoms to form polyatomic ions.....	61
	Creating Ionic Compounds.....	63
	Making the bond: Sodium metal + chlorine gas = sodium chloride.....	63
	Figuring out the formulas of ionic compounds.....	64
	Naming ionic compounds.....	66
	Bonding Clues: Electrolytes and Nonelectrolytes.....	68
CHAPTER 6:	Covalent Bonding	69
	Covalent Bond Basics.....	69
	Sharing electrons: A hydrogen example.....	69
	Comparing covalent bonds with other bonds.....	71
	Dealing with multiple bonds.....	72

Naming Covalent Compounds Made of Two Elements.....	73
Writing Covalent Compound Formulas	74
Empirical formulas.....	74
Molecular or true formulas	75
Structural formulas: Dots and dashes.....	75
Electronegativities: Which Atoms Have More Pull?.....	81
Predicting the type of bond	81
Polar covalent bonding: Creating partial charges.....	83
Attracting other molecules: Intermolecular forces.....	84
CHAPTER 7: Chemical Reactions.....	87
Reactants and Products: Reading Chemical Equations	87
Collision Theory: How Reactions Occur	88
Hitting the right spot	89
Adding, releasing, and absorbing energy	90
Types of Reactions	92
Combination reactions: Coming together	92
Decomposition reactions: Breaking down.....	93
Single displacement reactions: Kicking out another element	93
Double displacement reactions: Trading places	95
Combustion reactions: Burning	97
Redox reactions: Exchanging electrons	97
Balancing Chemical Equations.....	97
Balancing the Haber process.....	98
Balancing the burning of butane	99
Knowing Chemical Equilibrium Backward and Forward	100
Matching rates of change in the Haber process	101
Constants: Comparing amounts of products and reactants.....	102
Le Chatelier's Principle: Getting More (or Less) Product	103
Changing the concentration	103
Changing the temperature	104
Changing the pressure.....	104
Chemical Kinetics: Changing Reaction Speeds	105
Seeing How Catalysts Speed Up Reactions	107
Heterogeneous catalysis: Giving reactants a better target	108
Homogeneous catalysis: Offering an easier path.....	108

CHAPTER 8: Electrochemistry: Using Electrons	111
Transferring Electrons with Redox Reactions.....	111
Oxidation	112
Reduction.....	113
One's loss is the other's gain	114
Oxidation numbers.....	115
Balancing Redox Equations.....	116
Exploring Electrochemical Cells.....	120
Galvanic cells: Getting electricity from chemical reactions.....	121
Electrolytic cells: Getting chemical reactions from electricity	122
Having it both ways with rechargeable batteries	123
CHAPTER 9: Measuring Substances with the Mole	125
Counting by Weighing.....	125
Moles: Putting Avogadro's Number to Good Use	127
Defining the mole	127
Calculating weight, particles, and moles.....	128
Finding formulas of compounds.....	129
Chemical Reactions and Moles.....	130
Reaction stoichiometry	131
Percent yield.....	132
Limiting reactants	133
CHAPTER 10: A Salute to Solutions	135
Mixing Things Up with Solutes, Solvents, and Solutions	135
How dissolving happens	136
Concentration limits	136
Saturated facts	137
Understanding Solution Concentration Units	138
Percent composition	138
Molarity: Comparing solute to solution	140
Molality: Comparing solute to solvent	143
Parts per million.....	143
CHAPTER 11: Acids and Bases	145
Observing Properties of Acids and Bases	145
The Brønsted-Lowry Acid-Base Theory	146
Understanding Strong and Weak Acids and Bases.....	147
Strong: Ionizing all the way.....	147
Weak: Ionizing partially	149

Acid-Base Reactions: Using the Brønsted-Lowry System	151
Acting as either an acid or base: Amphoteric water.....	152
Showing True Colors with Acid-Base Indicators	153
Doing a quick color test with litmus paper	153
Phenolphthalein: Finding concentration with titration	154
Phun with the pH Scale.....	155
CHAPTER 12: Clearing the Air on Gases.....	159
The Kinetic Molecular Theory: Assuming	
Things about Gases.....	159
Relating Physical Properties with Gas Laws	162
Boyle's Law: Pressure and volume	163
Charles's Law: Volume and temperature.....	164
Gay-Lussac's Law: Pressure and temperature	165
The combined gas law: Pressure, volume, and temp.....	166
Avogadro's Law: The amount of gas.....	167
The ideal gas equation: Putting it all together	168
CHAPTER 13: Ten Serendipitous Discoveries in Chemistry	171
Archimedes: Streaking Around.....	171
Vulcanization of Rubber	172
Molecular Geometry	172
Mauve Dye.....	172
Kekulé: The Beautiful Dreamer	173
Discovering Radioactivity.....	173
Finding Really Slick Stuff: Teflon	173
Stick 'Em Up! Sticky Notes	174
Growing Hair	174
Sweeter than Sugar.....	174
INDEX.....	175

Introduction

Congratulations on making a step toward discovering more about what I consider a fascinating subject: chemistry. For more than 40 years, I've been a student of chemistry. This includes the time I've been teaching chemistry, but I still consider myself a student because I'm constantly finding out new facts and concepts about this important and far-reaching subject.

Hardly any human endeavor doesn't involve chemistry in some fashion. People use chemical products in their homes — cleaners, medicines, cosmetics, and so on. And they use chemistry in school, from the little girl mixing vinegar and baking soda in her volcano to the Ivy League grad student working on chemical research.

Chemistry has brought people new products and processes. Many times this has been for the good of humankind, but sometimes it's been for the detriment. Even in those cases, people used chemistry to correct the situations. Chemistry is, as has been said many times, the central science.

About This Book

My goal with this book is to give you the really essential information and concepts that you would face in a first semester chemistry class in high school or college. I've omitted a lot of topics found in a typical chemistry textbook. This book is designed to give you the bare essentials.

Remember, this is a light treatment. If you want more, many other books are available. My favorite, naturally, is *Chemistry For Dummies*. I understand the author is really a great guy.

Conventions Used in This Book

Here are a couple of conventions you find in *For Dummies* books:

- » I use *italics* to emphasize new words and technical terms, which I follow with easy-to-understand definitions.
- » **Bold** text marks keywords in bulleted lists and highlights the general steps to follow in a numbered list.

In addition, I've tried to organize this book in approximately the same order of topics found in a one-semester general chemistry course. I've included some figures for you to look at; refer to them as you read along. Also, pay particular attention to the reactions that I use. I've attempted to use reactions that you may be familiar with or ones that are extremely important industrially.

Foolish Assumptions

I don't know your exact reasons for picking up this guide, but I assume you want to know something about chemistry. Here are some reasons for reading:

- » You may be taking (or retaking) a chemistry class. This book offers a nice, quick review for your final exam. It can also give you a refresher before you plunge into a new course, such as biochemistry or organic chemistry.
- » You may be preparing for some type of professional exam in which a little chemistry appears. This book gives you the essentials, not the fluff.
- » You may be a parent trying to help a student with his or her homework or assignment. Pay attention to what your child is currently studying and try to stay a little ahead.
- » Finally, you may be what people call a "nontraditional student." You knew most of this material once upon a time, but now you need a quick review.

Whatever the reason, I hope that I'm able to give you what you need in order to succeed. Good luck!

Icons Used in This Book

If you've read any other *For Dummies* books (such as the great *Chemistry For Dummies*), you'll recognize the two icons used in this book. Here are their meanings:



REMEMBER

This icon alerts you to those really important things you shouldn't forget. These are ideas that you most probably need to memorize for an exam.



TIP

This icon points out the easiest or quickest way to understand a particular concept. These are the tricks of the trade that I've picked up in my 40+ years learning chemistry.

Where to Go from Here

Where you go next really depends on you and your reason for using this book. If you're having difficulty with a particular topic, go right to that chapter and section. If you're a real novice, start at Chapter 1 and go from there. If you're using the book for review, skim quickly starting at the beginning and read in more depth those topics that seem a little fuzzy to you. You can even use this book as a fat bookmark in your regular chemistry textbook.

Whatever way you use this book, I hope that it helps and you grow to appreciate the wonderful world of chemistry.

IN THIS CHAPTER

- » Understanding the states of matter
- » Differentiating between pure substances and mixtures
- » Measuring matter with the metric system
- » Examining the properties of chemical substances
- » Discovering the different types of energy

Chapter 1

Matter and Energy: Exploring the Stuff of Chemistry

Simply put, chemistry is a whole branch of science about matter, which is anything that has mass and occupies space. Chemistry is the study of the composition and properties of matter and the changes it undergoes.

Matter and energy are the two basic components of the universe. Scientists used to believe that these two things were separate and distinct, but now they realize that matter and energy are linked. In an atomic bomb or nuclear reactor, for instance, matter is converted into energy. (Perhaps someday science fiction will become a reality and converting the human body into energy and back in a transporter will be commonplace.)

In this chapter, you examine the different states of matter and what happens when matter goes from one state to another. I show you how to use the SI (metric) system to make matter and energy measurements, and I describe types of energy and how energy is measured.

Knowing the States of Matter and Their Changes

Matter is anything that has mass and occupies space. It can exist in one of three classic states: solid, liquid, and gas. When a substance goes from one state of matter to another, the process is called a *change of state*, or *phase change*. Some rather interesting things occur during this process, which I explain in this section.

Solids, liquids, and gases

Particles of matter behave differently depending on whether they're part of a solid, liquid, or gas. As Figure 1-1 shows, the particles may be organized or clumped, close or spread out. In this section, you look at the solid, liquid, and gaseous states of matter.

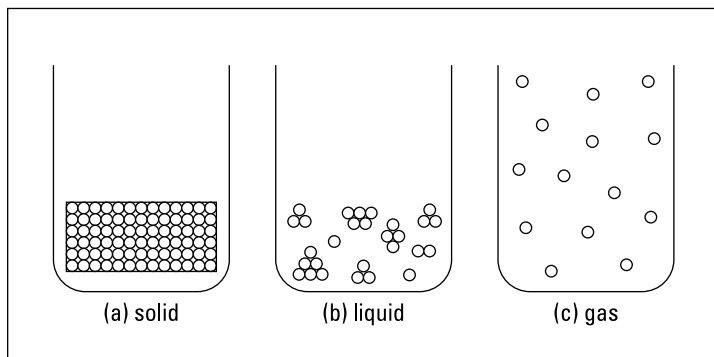


FIGURE 1-1: Solid, liquid, and gaseous states of matter.

Solids

At the *macroscopic level*, the level at which you directly observe with your senses, a solid has a definite shape and occupies a definite volume. Think of an ice cube in a glass — it's a solid. You can easily weigh the ice cube and measure its volume.

At the *microscopic level* (where items are so small that people can't directly observe them), the particles that make up the solid are very close together and aren't moving around very much (see Figure 1-1a). That's because in many solids, the particles are pulled into a rigid, organized structure of repeating patterns

called a *crystal lattice*. The particles in the crystal lattice are still moving but barely — it's more of a slight vibration. Depending on the particles, this crystal lattice may be of different shapes.

Liquids

Unlike solids, liquids have no definite shape; however, they do have a definite volume, just like solids do. The particles in liquids are much farther apart than the particles in solids, and they're also moving around much more (see Figure 1-1b).

Even though the particles are farther apart, some particles in liquids may still be near each other, clumped together in small groups. The attractive forces among the particles aren't as strong as they are in solids, which is why liquids don't have a definite shape. However, these attractive forces are strong enough to keep the substance confined in one large mass — a liquid — instead of going all over the place.

Gases

A gas has no definite shape and no definite volume. In a gas, particles are much farther apart than they are in solids or liquids (see Figure 1-1c), and they're moving relatively independent of each other. Because of the distance between the particles and the independent motion of each of them, the gas expands to fill the area that contains it (and thus it has no definite shape).

Condensing and freezing

If you cool a gaseous or liquid substance, you can watch the changes of state, or *phase changes*, that occur. Here are the phase changes that happen as substances lose energy:

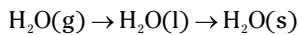
» **Condensation:** When a substance *condenses*, it goes from a gas to a liquid state. Gas particles have a high amount of energy, but as they're cooled, that energy decreases. The attractive forces now have a chance to draw the particles closer together, forming a liquid. The particles are now in clumps, as is characteristic of particles in a liquid state.

» **Freezing:** A substance *freezes* when it goes from a liquid to a solid. As energy is removed by cooling, the particles in a liquid start to align themselves, and a solid forms. The temperature at which this occurs is called the *freezing point (fp)* of the substance.



TIP

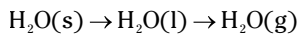
You can summarize the process of water changing from a gas to a solid in this way:



Here, the *(l)* stands for liquid, the *(g)* stands for gas, and *(s)* stands for solid.

Melting and boiling

As a substance heats, it can change from a solid to a liquid to a gas. For water, you represent the change like this:



This section explains melting and boiling, the changes of state that occur as a substance gains energy.

From solid to liquid

When a substance melts, it goes from a solid to a liquid state. Here's what happens: If you start with a solid, such as ice, and take temperature readings while heating it, you find that the temperature of the solid begins to rise as the heat causes the particles to vibrate faster and faster in the crystal lattice.

After a while, some of the particles move so fast that they break free of the lattice, and the crystal lattice (which keeps a solid *solid*) eventually breaks apart. The solid begins to go from a solid state to a liquid state — a process called *melting*. The temperature at which melting occurs is called the *melting point (mp)* of the substance. The melting point for ice is 32°F, or 0°C.



REMEMBER

During changes of state, such as melting, the temperature remains constant — even though a liquid contains more energy than a solid. So if you watch the temperature of ice as it melts, you see that the temperature remains steady at 0°C until all the ice has melted.



TIP

The melting point (solid to a liquid) is the same as the freezing point (liquid to a solid).

From liquid to gas

The process by which a substance moves from the liquid state to the gaseous state is called *boiling*.