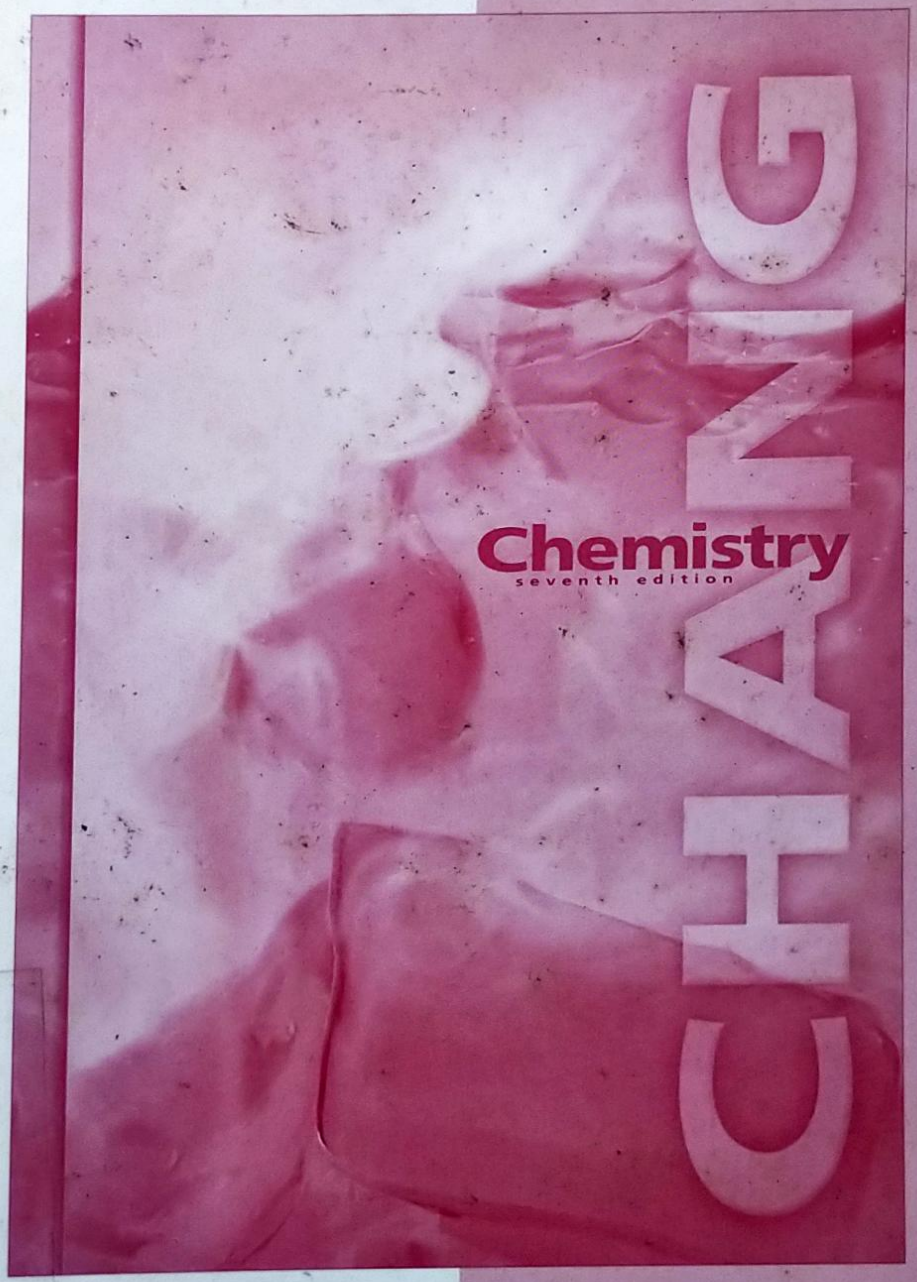
Student Study Guide



Prepared by
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Student Study Guide

Chemistry

Seventh Edition

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CONTENTS

PREFACE

This ***Study Guide*** is intended for use with the seventh edition of Raymond Chang's *Chemistry*. Its purpose is to help you learn chemistry. The ***Study Guide*** contains material to help you organize your studying, practice your problem-solving skills, and test yourself. Each chapter in the guide corresponds to one in the text. The chapters are arranged into four or five sections for easier presentation and comprehension. After the title of each section you will find the number of the corresponding section of the text in parentheses. Each chapter contains the following main features.

Study Objectives. Each chapter section begins with a set of performance objectives. These state in a straightforward manner what you must be able to do with the topics discussed in the section. One problem students frequently experience during a lecture is knowing what is important enough to put in notes. Previewing the objectives on specific topics before attending a lecture will help you focus on important material, listen better, and retain more from your first exposure to the material.

Reviews. The reviews provide a summary of essential material. They are meant to reinforce and enhance your understanding of the material presented in the text and in lectures. The thorough descriptions and explanations provided by the reviews should help you solve the accompanying exercises.

Example Problems. After each summary there are example problems with detailed solutions. These solutions often contain applications of important concepts. They emphasize how to initiate the solution. The steps toward the solution are discussed first and are then worked through. Almost every example contains *Method of Solution* and *Calculation* sections. The method of solution section relates the solution of the problem to the principles involved and suggests equations that are applicable. The calculation section shows how to set up equations and substitute into them to achieve a numerical answer.

Exercises. Exercises appear after each section. These questions provide a quick test of your familiarity with the terminology and principles, and provide drill problems.

Practice Tests. Each chapter contains a practice test to help you to test your knowledge of the material and to prepare for exams. Many of the questions in the practice tests have been taken from old examinations that the author has written. Some questions are more general problems that require integration of concepts from previous material.

If you cannot work a significant number of the problems in the practice test, you should go back and study the material on that subject in the textbook. Work through the practice problems by *writing down* the main steps of the solutions. Don't look at the answers first. Act as if you are taking an exam. Use the answers only to check your own work.

Conceptual Questions. These questions ask you to think through the solution to a question or problem. Understanding and applying concepts is an important part of problem solving.

Answers. Answers to all the exercises and problems are conveniently found at the end of each chapter.

Hints. For this guide to be of maximum assistance, it should be incorporated into a plan for studying general chemstry. The responsibility for organizing your study so that you learn the required material, of course, rests with you. You must organize your study and test yourself in order to be certain that you know the material. A helpful rule is "Don't get behind." Keep in mind that the content of the course builds on concepts and principles developed earlier in the course. General Chemistry will be much more rewarding if you set aside time each day to learn the material as it is presented in class. For most chemistry courses, it is necessary to study 2 to 3 hours outside of class for every hour in class.

Study should include reading the text, working lots of problems, and memorizing facts and vocabulary. Reading in science takes longer than reading in other subject areas. You cannot expect to "speed-read" a

Chapter One
CHEMISTRY: THE STUDY OF CHANGE

- Introduction (1.2 – 1.3)
- Matter and Its Properties (1.4 – 1.6)
- Units of Measurement (1.7)
- Math Review and Significant Figures (1.8)
- Factor-Label Method of Problem Solving (1.9)

INTRODUCTION (1.2 – 1.3)

STUDY OBJECTIVES

1. Describe matter and its physical states.
2. Describe the four main parts of the scientific method.
3. Define chemistry.

About Chemistry. **Chemistry** is the study of matter and the changes it undergoes. **Matter** is defined as anything that has mass and occupies space. The three physical states of matter are solid, liquid, and gas. All matter exists in one or another of these three states, depending on the temperature and pressure of the surrounding environment. Chemists are concerned with developing the tools used to study matter and the concepts useful in describing the properties of matter. They direct their efforts toward the purposeful changing of given forms of matter into new and different substances, and to the discovery of the properties and uses of these new materials. Chemists usually observe matter and the changes it undergoes in the *macroscopic world*. This refers to the objects we can see and touch, and deal with everyday. However, our interpretations of matter involve atoms and molecules and their properties. Because atoms and molecules are so extremely small, we refer to them as belonging to the *microscopic world*.

Chemists, like other scientists, make use of the **scientific method** which can be broken down into four parts: observation and experiment, hypothesis, laws, and theory. The first step is to define the problem clearly. That is you must know what you are trying to find out about. During **experiments** observations are made and information is collected about the system being studied. After a large amount of data related to a certain phenomenon have been collected, sometimes the information can be summarized in a simple verbal or mathematical statement called a **law**. At this point a **hypothesis** may be formulated to provide a tentative explanation of the facts. A hypothesis is only temporary and is meant to be a working model or explanation. It is often adjusted as new information is discovered. As a hypothesis grows and successfully survives many experimental tests, it develops into a theory. A **theory** is a unifying principle that explains a large body of facts and laws. Besides providing explanations for the laws of science, its role is to aid in making predictions that lead to new knowledge. In fact theories are often tested by carefully devised experiments that confirm or disprove their predictions.

MATTER AND ITS PROPERTIES (1.4 – 1.6)

STUDY OBJECTIVES

1. Distinguish between elements, compounds, and solutions.
2. Distinguish between homogeneous and heterogeneous mixtures.
3. Distinguish between physical and chemical properties of a substance.

Elements and Compounds. A **pure substance** is a form of matter that has a definite composition and distinct properties. Examples are water, table salt, and iron. Just as each individual person has a set of characteristics, such as fingerprints and color of eyes and hair, each pure substance has characteristic properties. There are two types of pure substance: elements and compounds. An **element** is a pure substance that cannot be decomposed into simpler substances by ordinary chemical reactions. Elements are the building blocks of which all compounds are composed. Nitrogen, oxygen, and iron are examples of elements. A number of common elements and their symbols are listed in the textbook in Table 1.1.

Compounds are pure substances that are composed of two or more elements combined in definite proportions. Compounds can be broken down into the elements of which they are composed by chemical means. Water and table salt, mentioned earlier, are compounds. The action of an electric current, called *electrolysis*, is one method that can be used to decompose both water and molten table salt into their constituent elements. Pure water consists of 89 percent oxygen and 11 percent hydrogen by mass. Pure salt contains 39 percent sodium and 61 percent chlorine.

Mixtures. Pure substances can be brought together to form mixtures. **Mixtures** are combinations of two or more substances with variable composition. They can be homogeneous or heterogeneous depending on the state of subdivision of the components. Salt water is a uniform mixture of table salt (NaCl) and water. The original crystals of salt have dissolved and are dispersed evenly. On the ordinary scale of observation we cannot detect any chemical or physical differences between adjacent regions of the mixture. The particles of salt are too small to observe. A mixture that has the same composition throughout is said to be a **homogeneous mixture**. The properties of a homogeneous mixture vary since they depend on the percent composition. For example, the hardness of steel, a solid mixture of iron and carbon, depends on the percentage of carbon that is added to iron. Homogeneous mixtures are also called **solutions**.

Heterogeneous mixtures are not uniform in composition. And indeed the individual particles of their components can often be seen by the unaided eye. For example, when preparing home-made ice cream, you use a mixture of ice and rock salt. This is a heterogeneous mixture. The individual chunks (particles) of ice and salt are clearly visible, and the particles are so large, they are not evenly dispersed. The composition of this mixture varies from place to place within the mixture itself. Natural air is actually a heterogeneous mixture. It consists of nitrogen, oxygen, and argon gases, but also contains solid particles of pollen and dust. Any mixture, whether it be homogeneous or heterogeneous, can be separated into its pure components by physical means.

Properties of Matter. **Physical properties** are those properties that can be measured and observed without changing the identity or composition of the substance. Physical properties include color, hardness, solubility, density, specific heat, melting point, and boiling point. **Physical changes** are those that take place with no change in chemical composition. Changes of a substance from one state of matter to another do not change its chemical composition and are examples of physical changes. The three forms of water we call ice, liquid water, and steam are all the same substance, just different physical states.

Chemical properties most often are descriptions of reactions that a substance undergoes when brought in contact with other substances. In a chemical reaction the original substance or substances are changed into new substances. When sodium metal and chlorine gas are heated together, a white solid called sodium chloride is formed. That this is a chemical change is evident by the observation that sodium, a shiny metal, and chlorine, a pale yellow green gas, have disappeared, and in their place is a substance with a completely new set of properties. Sodium chloride is a white solid that melts at very high temperatures.

All properties of matter are either extensive or intensive properties. **Extensive properties** depend on the amount of matter being considered. Volume and mass are examples. In contrast, temperature and density are two properties that do not depend on the amount of mass present. Thus, they are **intensive properties.**

EXAMPLE 1.1 Chemical and Physical Properties

The following are properties of the element silicon; classify them as physical or chemical properties.

a. Melting point, 1410°C
b. Reacts with fluorine to form silicon tetrafluoride
c. Gray color
d. Not affected by most acids

•Method of Solution

Physical properties can be observed without a change in composition, while chemical properties describe reactions with other substances.

a. Melting involves a change in physical state but no chemical change. *Answer:* The melting point is a physical property.
b. This statement describes the change of silicon into another substance on reaction with fluorine. *Answer:* The reaction is a chemical property.
c. *Answer:* The color of a substance is a physical property. No change in composition occurs while observing the color..
d. *Answer:* The lack of reactivity with another substance or class of substances such as acids is a chemical property.

EXAMPLE 1.2 Homogeneous or Heterogeneous Mixture

Classify each of the following as a homogeneous or a heterogeneous mixture.

a. The beverage tea
b. Oil and water
c. Cow's milk
d. Wine

•Method of Solution

Recall that homogeneous mixtures are uniform throughout, while heterogeneous mixtures have components that can be physically observed to be separate.

a. The mixture called tea is uniform throughout and no particles of tea can be observed (if there are no tea leaves). *Answer:* A homogeneous mixture.
b. Since oil floats on water, the oil and water components can be observed to be separate. Samples from the top part of the mixture are different from samples taken from the bottom. *Answer:* A heterogeneous mixture.
c. Cow's milk contains fats and solids suspended in water. On standing, the cream (fat) will rise to the top and the solids will settle. *Answer:* A heterogeneous mixture.
d. Wine contains ethyl alcohol, water, flavor components, dye molecules, and many other substances. The composition is uniform throughout. No solid particles are visible in the liquid. It appears clear. *Answer:* A homogeneous mixture.
