Inorganic Chemistry

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Chapter One INTRODUCTION

1.1 Chemistry and Its Uses

Chemistry is one of the most practical of the sciences. The products of chemistry are so common in the home that users rarely wonder how they are made. The ink in your pen, the gasoline in your tank, the drugs in your medicine chest, the dyes that give your clothes their many hues—all of these were invented in chemical laboratories and manufactured in chemical processing plants.

Chemistry is a very large discipline, with many branches and specialties. In this book we shall give only a brief introduction to the subject. You should, after completing this text, be able to go on to the more detailed and advanced books. You will learn the basic language of chemistry—the language by which the chemist identifies and discusses processes and materials. This language is not a secret jargon designed merely to be difficult. It is a logical terminology designed to help chemists communicate.

For this reason, the study of chemistry requires learning the names of many substances (chemical compounds) and learning how the compounds are assembled from simpler substances (elements). In addition, it is important to learn the properties of these substances—what they look like, how they behave, how they react with other substances, and so on.

When we want to manufacture a particular material, we must know how much of each ingredient to use, both to avoid waste and to make sure that we end up with a satisfactory product. The process is not unlike baking a cake. To determine these quantities, we must know how to calculate the amount of each ingredient that should go into the reaction. Therefore, a large part of chemistry is devoted to the mathematics of such calculations.

Almost important part of chemistry is the theoretical foundation of the subject—the understanding of the structure of matter and the relationship between matter and energy. Much of this book will deal with one very fundamental concept: the idea that all matter is made up of extremely tiny particles (atoms), which, in turn, are made up of even smaller particles determine the behavior of all the different substances in the world. Even the processes inside living organisms are determined by the behavior of the materials out of which we are all made. These processes make up the subject matter of biochemistry and molecular biology.

As you learn the theory of chemistry and learn to write down the chemical equations describing the reactions that take place between a variety of substances, you will encounter some of the ways in which chemistry is related to your own life experiences and to the development of society as a whole.

1.2 **History of Chemistry**

Chemistry is the study of matter and the changes that matter undergoes. In changing matter, chemist attempt to unlock nature’s secrets by seeking answers to such questions as: Can a dark-colored rock be made to yield copper or iron? Can sand be converted into clear glass? Can a black lump of coal be used to produce a new drug or brilliant dye?

From our study of ancient documents and civilizations, it seems that people have always sought new knowledge about the natural world. Prehistoric cave paintings indicate an attempt to visualize and perhaps control events in the world. Ancient temples represent efforts to intervene with the forces that control our world.

From their writings, we know that early Greeks systematically studied nature. Democritus(400 B.C.) espoused an atomic theory of matter more than 2000 years ago. Aristotle(384-332 B.C.), the teacher of Alexander the Great, made and recorded numerous observations on the many plants, animals, and rock which the young conqueror sent him from many different lands. Based on his observations, Aristotle argued that the material world was made of for elements: earth, water, air, and fire.

During the Middle Ages, numerous technological advances were made. Roger Bacon (1214-1292) foresaw the day when machines would drive ships, cars, and airplanes; he predicted that glass lenses would be used to correct vision and that some day people would sail around the world. (He died 200 years before Columbus discovered America.)

The development of gunpowder and the invention of a printing press with movable type marked a new era of exploration and discovery. New attitudes and discoveries occurred in science. Paracelsus (1493-1541) pioneered in the application of chemistry to medicine, and he urged other doctors to try new drugs and medicines made from salts and minerals. Many of his cures were successful where herbal remedies had failed. Notable among Paracelsus' achievements was a treatment for syphilis.

Copernicus (1473-1543) argued that the sun and the earth might very well be the center of the solar universe. When Galileo (1564- 1642) pointed his newly invented telescope at Jupiter and saw several moons circling that giant planet, he helped confirm Copernicus' concept. Robert Boyle (1627- 1691) helped overthrow the concept of four elements (fire, earth, air, water) with his book *The Sceptical Chymist*, and he paved the way for the new atomic theory. At Boyle's urging, chemists began to rely less on ancient beliefs and more and more on experimentation.

Modern chemistry can be said to have started at the end of the 1700s. During that time the nature of air and various gases was being investigated. Henry Cavendish discovered hydrogen, and Joseph Priestley discovered oxygen. Antoine Lavoisier used those discoveries and others to explain the nature of water, air, and combustion. Lavoisier has been called by some the father of modern chemistry. It is interesting to note that Priestley had to flee from England to America because of his liberal religious views and that Lavoisier lost his head in the French Revolution for being a member of the conservative upper class.

In 1803 John Dalton proposed that all matter consists of tiny invisible and indestructible particles called *atoms*. He was able to assign relative weights to atoms of various elements. Although many people in the 1800s doubted the existence of atoms, the theory was very useful in laboratory work. As time passed, more and more evidence supported the atomic theory; by 1900, few doubters were left.

The discoveries and accomplishments of modern chemistry since 1900 are indeed numerous. Some people agree that our vast knowledge has been abused in such a way as to cause pollution, violence, destruction, and death. Others argue that science has saved millions of men, women, and children from untimely deaths from horrendous diseases, infections, malnutrition, and starvation. Through ignorance or evil, science has been abused and misused. However, we think a better world will come about from more knowledgeable citizens, not from less knowledgeable ones.

1.3 Scientific Laws

A scientific law is a general description of the behavior of matter. For example, in the 1600s Robert Boyle found that if he applied pressure to a gas, the gas contracted. The more pressure he applied, the more the gas contracted. Since that time, scientists have found Boyle’s discovery to be true for many different gases. Boyle’s law describes the behavior of gases as pressure and volume vary.

Similar to scientific laws are scientific principles. A principle usually describes a more specific behavior of matter than a law.

1.4 Matter and Energy

Chemists study matter and energy and the changes that matter undergoes. *Matter* is the “stuff” of which the universe and everything in it is made. Matter has mass and occupies space. A silver coin, a glass of tea, the air we breathe, and the blood in our veins are examples of matter.

When matter undergoes change, energy is usually absorbed or released. The amount and form of energy involved in a change are of interest to chemical, thermal, sound, nuclear, and radiant energy.

1.5 Some Hints for Successful Study

A great many students approach the study of chemistry with fear and trepidation, yet there in no need to fear this subject. Any student with average intelligence and a well-organized set of study habits can learn the material in this text. These study habits are essential:

1. Read the text carefully.
2. Outline the highlights. Note words encountered for the first time, and make sure that you understand them. Also note definitions and special information required for complete understanding.
3. Carefully study sample problems found throughout the text. If necessary, write down the steps of a problem to make sure you understand the reasoning.
4. Do the problems, and answer the questions at the end of each section.
5. Test yourself with the questions and problems at the end of the chapter.
6. Consult your instructor on any area or specific point that confuses you.

Be sure to allow enough time for the information to "percolate". Cramming at the last minute before an exam usually results in failure. When the solution to a problem is not immediately apparent, you need more time to think the matter through. Often it helps to let a particularly sticky problem sit until the next day.

It is amazing what thoughts will come to mind if you give them the chance.

1.6 References