CH6 Fact Sheet
ELEMENTS, MOLECULES, AND COMPOUNDS

The early Greeks believed there were four basic particles that made up all matter. According to the Greeks, these four basic **elements** were made of **earth** particles, **air** particles, **water** particles, and **fire** particles. They thought that every substance they could see, smell, taste, or feel was made of these four types of particles. A Greek philosopher named **Democritus** (b. 460 B.C.; d. 370 B.C.) called the smallest particle of an element an **atom**. Today we know there are a lot more than four elements (i.e., four kinds of atoms). We also know that atoms are not the most basic or simplest units of matter.

The definition of an element is much the same today as it was long ago. An **element** is any substance that cannot be split into simpler substances by ordinary chemical means. Twelve grams of pure carbon, for example, is composed of about six hundred billion trillion (i.e., 6×10^{23}) separate atoms of carbon; and, every atom of carbon in that sample behaves exactly like every other atom of carbon when mixed with other substances in a chemical reaction. So, an **atom** is defined as the smallest part of a chemical element.

The chart that shows all of the known chemical elements is called **The Periodic Table of the Elements**. There are more than 100 elements on that chart. Each element is represented by one or two letters called a **chemical symbol**. The English or Latin name of a chemical element is used to decide which letters will represent that element. For example, the element **hydrogen**—which makes up about 90 percent of the universe—is represented by the capital letter "**H**". **Iron** is represented by the letters "**Fe**" from the Latin word for iron: ferrum. The letter "**I**" is used to represent the element **iodine**. If an element is represented by one letter, then that letter is always capitalized. If the element is represented by two letters, then the first letter is always capitalized and the second letter is always lowercase. Chemists obey these simple rules for writing chemical symbols to avoid mistakes when mixing chemicals together during experimentation.

A **molecule** is a particle that has two or more atoms bonded together. The air we breathe contains molecules of oxygen atoms bonded together in pairs. A chemist will write the chemical symbol for oxygen as "**O**". However the **chemical formula** for the oxygen molecules that we breathe is written "$\mathbf{O_2}$". The little "2" at the lower right corner of the symbol for oxygen tells us that there are *two oxygen atoms in one molecule of oxygen gas*. The nitrogen gas we breathe is also made of molecules. Nitrogen gas contains the substance N_2: two atoms of nitrogen bonded together to form one molecule of nitrogen gas.

A **compound** is a molecule that has more than one kind of atom bonded together. It is a substance composed of two or more chemically combined elements. *Water is made of two hydrogen atoms bonded to one oxygen atom.* A chemist writes the formula for water as "$\mathbf{H_2O}$." It is not neces-

sary to write a small number "1" next to the symbol for oxygen because the symbol itself stands for one atom of oxygen. The chemical formula for a simple sugar called **glucose** is $\mathbf{C_6H_{12}O_6}$. Every glucose molecule contains 6 atoms of carbon, 12 atoms of hydrogen, and 6 atoms of oxygen bonded together: 24 atoms in all to make one glucose molecule.

Scientists believe that no new matter or energy is ever created anew or destroyed completely. This principle is called the **Law of Conservation of Matter and Energy**. All chemical reactions obey this law. This means that in any chemical reaction, no new atoms are ever added or taken away from the reaction. The atoms are merely rearranged to form new substances. Plants carry on **photosynthesis** which uses the energy of the sun to make glucose and oxygen out of carbon dioxide and water. A chemist writes the chemical equation to describe this process as follows:

$6CO_2$	+	$6H_2O$	$\rightarrow$	$C_6H_{12}O_6$	+	$6O_2$
"carbon dioxide gas"	and	"water"	form	"glucose"	and	"oxygen gas"

The large number "6" in front of the chemical formulas for "carbon dioxide gas," "water," and "oxygen gas" are called **coefficients**. These coefficients tell us that *six* molecules of each of these substances was involved in the production of *one* molecule of "glucose." Note: There is no coefficient in front of the chemical formula for glucose because the formula itself represents one molecule of glucose. Coefficients are used to "balance" chemical equations in order to satisfy the Law of Conservation of Matter and Energy.