



Chapter 3

Elements of Chemistry

THE MAIN IDEA

Elements combine to form compounds, which blend together to form mixtures

[3.1 Matter Has Physical and Chemical Properties](#)

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3.2 Elements Are Made of Atoms

It may seem that there must be many different kinds of atoms to account for the many different type of substances—from wood to steel to chocolate ice cream. But the number of different kinds of atoms is surprisingly small. **The great variety of substances results from the many ways a few kinds of atoms can be combined.** Just as the three colors red, green, and blue can be combined to form any color on a computer screen or the 26 letters of the alphabet make up all the words in a dictionary, only a relatively few kinds of atoms combine in different ways to produce all substances. To date, we know of 118 different kinds of atoms. Of these, about 90 are found in nature. The remaining atoms have been created in the laboratory.

Any material consisting of only one type of atom is classified as an **element**. A few examples are shown in **Figure 3.9**. Pure gold, for example, is an element—it contains only gold atoms. Similarly, one of the gases in air is nitrogen, an element. Nitrogen gas is an element because it contains only nitrogen atoms. Likewise, the graphite in your pencil is an element—carbon. Graphite is made up solely of carbon atoms. All of the elements are organized in a chart called the **periodic table**, shown in **Figure 3.10**.



READING CHECK

How are there so many types of materials yet so few elements of the periodic table?





▲ Figure 3.11

A plumb bob (inset) is a heavy weight attached to a string and used by carpenters and surveyors to establish a straight vertical line. The name “plumb” comes from the lead (plumbum, Pb) that is still sometimes used as the weight. Plumbers got their name because they once worked with lead pipes. Because of lead’s toxicity, copper or PVC pipes are now used.

nitrogen, as was shown in **Figure 3.9**, consists of molecules containing two nitrogen atoms per molecule. Thus, N_2 is the elemental formula given for atmospheric nitrogen. Similarly, atmospheric oxygen has the elemental formula O_2 , while the elemental formula for sulfur is S_8 . For elements in which the basic units are individual atoms (not molecules), the elemental formula is simply the chemical symbol. This is the case for most elements. To name two examples, Au is the elemental formula for gold, and Li is the elemental formula for lithium.



FOR YOUR INFORMATION

Carbon is the only element that can form bonds with itself indefinitely. Sulfur’s practical limit is S_8 , and nitrogen’s limit is around N_{12} . The elemental formula for a 1-carat diamond, however, is about

$C_{10,000,000,000,000,000,000}$

CONCEPT CHECK

The oxygen we breathe, O_2 , is converted to ozone, O_3 , in the presence of an electric spark. Is this a physical or chemical change?

CHECK YOUR ANSWER When atoms regroup, the result is an entirely new substance, and that is what happens here. The oxygen we breathe, O_2 , is odorless and life-giving. Ozone, O_3 , can be toxic and has a pungent smell commonly associated with electric motors. The conversion of O_2 to O_3 is therefore a chemical change. However, both O_2 and O_3 are elemental forms of oxygen.

