

# Chemical Symbols and Formulas

In the first half of this unit, you learned that an element is a pure substance that is made up of identical atoms and has definite properties. Scientists needed a way to represent these elements that people all over the world would understand.

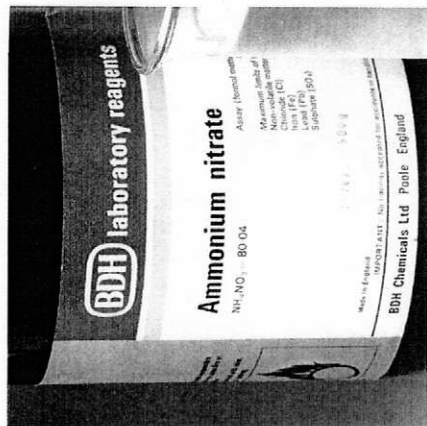
In 1817, a Swedish scientist named Jakob Berzelius developed a system of representing elements with symbols that was soon accepted and used around the world. All countries now use the same chemical symbols to represent elements and compounds, even when their language makes the names different. For example, the symbol Fe represents the element that people call *iron* in Canada, *fer* in France, and *fier* in Romania. A scientist in any country can identify the contents of a bottle by reading the symbols in the formula on the label (Figure 1).

Berzelius's system worked because it provided symbols for all the known elements of the time. It also set up a system for naming any new elements that had not yet been discovered:

## Chemical Symbols

Today, each **chemical symbol**, an abbreviation of the name of the element, consists of one or two letters. For example, the symbol for oxygen is O, and the symbol for carbon is C. When the first letter has already been used as the symbol for another element, the first two letters are used. For example, the symbol for calcium is Ca, and the symbol for cobalt is Co. Notice that when two letters are used, the first is always a capital letter while the second is not.

The names for symbols and their elements come from many sources. The symbol for silver is Ag because it comes from the Latin name for silver, *argentum*. Hydrogen (H) comes from the Greek term *hydro gene*, which means water producer. Mercury's symbol (Hg) comes from the Latin word *hydrargyrum*, which means liquid silver. Some elements and the origin of their symbols are listed in Table 1.



**Figure 1**  
Scientists rely on symbols and formulas to help them keep track of chemicals.

## Chemical Formulas

Just as single symbols are used to represent elements, chemical symbols can be put together to represent chemical substances. Combinations of chemical symbols are called **chemical formulas** (Table 2). The chemical formula indicates which elements are present and how many atoms of each element are found in that substance (Figure 2). For example, table salt is a compound made up of the elements sodium (Na) and chlorine (Cl). The chemical formula for table salt (sodium chloride) is NaCl.

If only one atom of an element is present in a compound, no number is included. NaCl is made up of one atom of sodium and one atom of chlorine.

If more than one atom of an element is in a compound, the symbol is followed by a small number written below the line. This number, called a **subscript**, tells us how many atoms of that element are present. Water, H<sub>2</sub>O, is a compound made up of two atoms of hydrogen and one atom of oxygen. The chemical formula for ammonia is NH<sub>3</sub>. What elements make up this compound? How many atoms of each element are found in ammonia? If you answered one atom of nitrogen and three atoms of hydrogen, you are correct.

Some formulas contain more than two elements. The formula for baking soda (sodium hydrogen carbonate) is NaHCO<sub>3</sub>. It contains one atom of sodium, one atom of hydrogen, one atom of carbon, and three atoms of oxygen. The formula for acetic acid (vinegar) is C<sub>2</sub>H<sub>4</sub>O<sub>2</sub>. Can you list the elements and how many atoms of each element are found in each of these formulas?

## Challenge

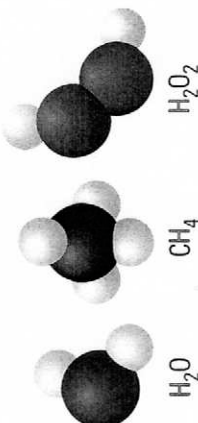
1 What chemical symbols and formulas will you need to identify the elements and compounds found in your substance or material?

## Work the Web

Learn about the elements and their symbols the interactive way. Visit [www.science.nelson.com](http://www.science.nelson.com) and follow the links from *Science 9: Concepts and Connections*, 1.14.

**Table 2** Some Examples of Chemical Formulas

Name of Substance	Formula
sodium bicarbonate (baking soda)	NaHCO <sub>3</sub>
calcium carbonate (chalk)	CaCO <sub>3</sub>
sodium nitrate (fertilizer)	NaNO <sub>3</sub>
calcium phosphate (fertilizer)	Ca <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>
sodium chloride (salt)	NaCl
acetylsalicylic acid (ASA or aspirin)	C <sub>9</sub> H <sub>8</sub> O <sub>4</sub>
acetic acid (vinegar)	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>



**Figure 2**

## Understanding Concepts

- Why are symbols useful in describing chemicals?
- Use the periodic table at the back of this text to find the symbols for the following elements: lithium, silicon, argon, copper, phosphorus, and gold.
- What two things does a chemical formula tell us about a compound?

4. Write a chemical formula for the following:

- a molecule of carbon dioxide that is made up of one atom of carbon and two atoms of oxygen.
- a molecule of aspirin that is made up of nine atoms of carbon, eight atoms of hydrogen, and four atoms of oxygen.
- a molecule of sugar (glucose) that is made up of 6 atoms of carbon, 12 atoms of hydrogen, and 6 atoms of oxygen.

## Making Connections

- Research a common use for each of the following pure substances:
  - helium gas
  - acetone
  - tartaric acid