9.3 Naming and Writing Formulas for Molecular Compounds

Guide for Reading

Key Concepts

- What does a prefix in the name of a binary molecular compound tell you about the compound's composition?
- How do you write the formula for a binary molecular compound?

Reading Strategy

Monitoring Your Understanding
Before you read, preview the Key Concepts, the headings, the boldfaced sentences, and the visuals. List two things you expect to learn. After reading, state what you learned about each item you listed.

Connecting to Your World

Gold was one of the first metals to attract human attention. When gold was discovered in California in the late 1840s, people from all over the world came to find it and make their fortune. Today, gold is still greatly prized and valued. Whereas one milligram of gold is worth only about one cent, one kilogram of gold is worth approximately $12,500. In this case, using the correct prefix (*milli-* or *kilo-*) makes quite a difference! Prefixes are important in chemistry, too. In this section, you will learn how prefixes in the name of a binary molecular compound tell you its composition.

Naming Binary Molecular Compounds

Recall that binary ionic compounds are composed of the ions of two elements, a metal and a nonmetal. Binary molecular compounds are also composed of two elements, but both elements are nonmetals and they are not ions. These differences affect the naming of these compounds and their formulas. Binary molecular compounds are composed of molecules, not ions, so ionic charges cannot be used to write formulas or to name them. In addition, when two nonmetallic elements combine, they often do so in more than one way. For example, the elements carbon and oxygen combine to form two invisible gaseous compounds, CO and CO_2. CO is illustrated in Figure 9.12. How would you name a binary compound formed by the combination of carbon and oxygen atoms? It might seem satisfactory to call it carbon oxide. However, the two carbon oxides, CO and CO_2, are very different compounds. Sitting in a room with small amounts of the carbon oxide CO_2 in the air would not present any problems. You exhale CO_2 as a product of your body chemistry. Thus it is normally present in the air you breathe. On the other hand, if the same amount of the other carbon oxide, CO, were in the room, you could die of asphyxiation. The binary compound CO is a poisonous gas that interferes with your blood's ability to carry oxygen to body cells. Obviously, a naming system that distinguishes between these two compounds is needed.

Table 9.4

Prefixes Used in Naming Binary Molecular Compounds

Prefix	Mono-	Di-	Tri-	Tetra-	Penta-	Hexa-	Hepta-	Octa-	Nona-	Deca-
Number	1	2	3	4	5	6	7	8	9	10

Prefixes in the masses of gold samples distinguish between large and small samples. Prefixes in the names of binary molecular compounds help distinguish compounds containing different numbers of atoms. **A prefix in the name of a binary molecular compound tells how many atoms of an element are present in each molecule of the compound.** Table 9.4 lists the prefixes used to name binary molecular compounds. According to the table, the prefix *mono-* indicates the presence of one oxygen atom in CO. The prefix *di-* indicates the presence of the two oxygen atoms in CO_2. The two compounds of carbon and oxygen, CO and CO_2, are thus named carbon monoxide and carbon dioxide, respectively. *Laughing gas* is the common name for the gaseous compound dinitrogen monoxide (N_2O), which is used as an anesthetic. When inhaled, N_2O tends to make people laugh. Notice that the second element in the name ends with *-ide*. The names of all binary molecular compounds end in *-ide*. Also note that the vowel at the end of a prefix is sometimes dropped when the name of the element begins with a vowel. For CO, you would write carbon *mon*oxide, not carbon *mono*oxide. If just one atom of the first element is in the formula, omit the prefix *mono-* for that element.

Here are some guidelines for naming binary molecular compounds. First, confirm that the compound is a binary molecular compound—that is, a compound composed of two nonmetals. The name must identify the elements in the molecule and indicate the number of each atom of each element. Name the elements in the order listed in the formula. Use prefixes to indicate the number of each kind of atom. Omit the prefix *mono-* when the formula contains only one atom of the first element in the name. The suffix of the name of the second element is *-ide*. Now, apply these guidelines to naming N_2O. The formula shows that the compound consists of two nonmetals, so it is a binary molecular compound. Two atoms of nitrogen are combined with one atom of oxygen. Thus the prefix of nitrogen is *di-* and the prefix of oxygen is *mono-*. The name of the compound is dinitrogen monoxide. Using the same guidelines, the name of SF_6 is sulfur hexafluoride. Notice that it is not necessary to use the prefix *mono-* before sulfur. What about the compound Cl_2O_8? This binary molecular compound consists of two chlorine atoms (prefix *di-*) and eight oxygen atoms (prefix *octa-*). The name is dichlorine octoxide.

Checkpoint ***What suffix ends the names of all binary molecular compounds?***

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Figure 9.12 Carbon monoxide is an invisible, gaseous compound of carbon and oxygen. It is a toxic product of incomplete burning, such as occurs in automobile engines and faulty furnaces.

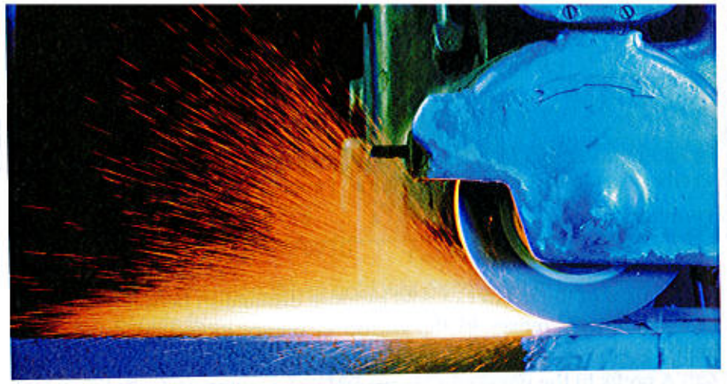

Figure 9.13 A grinding wheel made of silicon carbide (SiC) can shape even the toughest materials. **Inferring** ***What causes the sparks?***

Writing Formulas for Binary Molecular Compounds

Suppose you know the name of a molecular compound and want to write the formula. **Use the prefixes in the name to tell you the subscript of each element in the formula. Then write the correct symbols for the two elements with the appropriate subscripts.** A simple example is silicon carbide. Silicon carbide is a hard material like diamond. It is used as an abrasive and for cutting and grinding, as shown in Figure 9.13. The name *silicon carbide* has no prefixes, so the subscripts of silicon and carbon must be one. Thus the formula for silicon carbide is SiC. The name of another binary molecular compound is dinitrogen tetroxide. The prefix *di-* before nitrogen tells you that the compound contains two nitrogen atoms; the prefix *tetra-* tells you that the molecule also contains four oxygen atoms. Thus the formula for dinitrogen tetroxide is N_2O_4.

9.3 Section Assessment

20. **Key Concept** What information do prefixes in the name of a binary molecular compound tell you about the composition of the compound?
21. **Key Concept** Describe how to write the formula of a binary molecular compound.
22. Write the names for these molecular compounds.
    a. NCl_3 b. BCl_3 c. NI_3
    d. SO_3 e. N_2H_4 f. N_2O_3
23. Write the formulas or names for these molecular compounds.
    a. CS_2 b. carbon tetrabromide
    c. Cl_2O_7 d. diphosphorus trioxide
24. Write the formulas for these binary molecular compounds.
    a. phosphorus pentachloride
    b. iodine heptafluoride
    c. chlorine trifluoride
    d. iodine dioxide
25. The name a student gives for the molecular compound $SiCl_4$ is monosilicon trichloride. Is this name correct? Explain.

Connecting Concepts

Covalent Bonds In Section 8.1, you learned about covalent bonds. Are the bonds between silicon and chlorine in silicon tetrachloride ($SiCl_4$) single bonds? Justify your answer by drawing an electron dot structure of silicon tetrachloride.

Interactive Textbook

Assessment 9.3 Test yourself on the concepts in Section 9.3.

with **ChemASAP**

9.4 Naming and Writing Formulas for Acids and Bases

Connecting to Your

...dipped
...fluoric acid (HF), the acid etches (eats away) the glass wherever the wax has been removed.