CONCEPT 5

Names and formulas of covalent compounds reflect their molecular structure.

Activity

Chemical Formulas of Covalent Compounds

Your teacher will provide models of each of the following compounds:

water, H_2O

hydrogen peroxide, H_2O_2

carbon dioxide, CO_2

carbon monoxide, CO

propane, C_3H_8

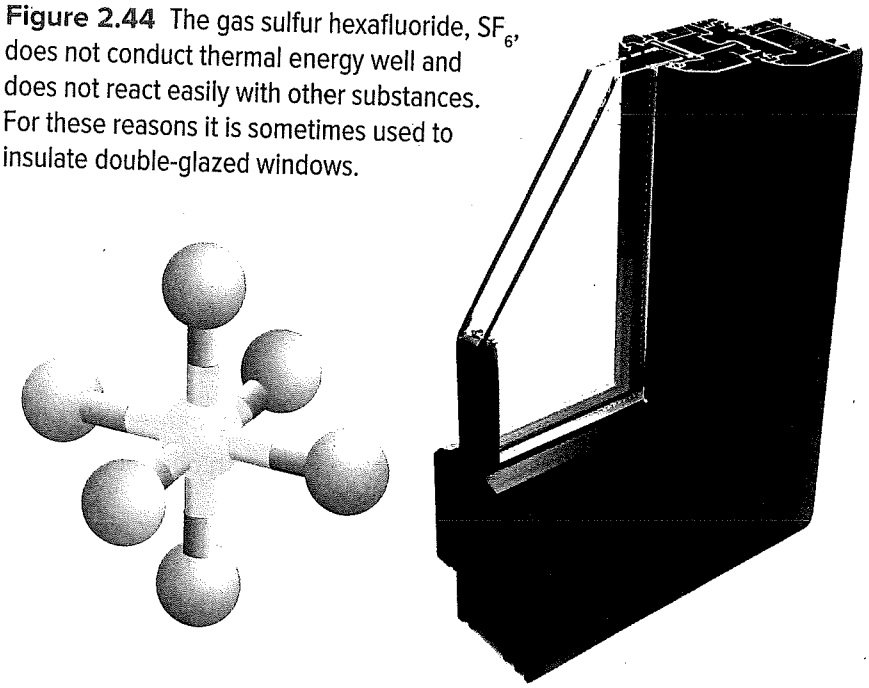
glucose, $C_6H_{12}O_6$

Sketch the models in your notebook. For each compound, compare the molecular model with the formula. What do chemical formulas of covalent compounds represent? How do they differ from ionic compounds? Why is the chemical formula of hydrogen peroxide not simplified to HO?

binary covalent compound a compound made up of the atoms of two elements joined by covalent bonds

Like binary ionic compounds, **binary covalent compounds** are made up of two elements only. Chemical formulas of binary covalent compounds indicate how many atoms of each element are present in a single molecule of the compound, as shown for sulfur hexafluoride, SF_6, in **Figure 2.44**. Like names for ionic compounds, names for binary covalent compounds have two parts—one part for each element in the compound. The following three rules will help you write names and formulas of binary covalent compounds.

Figure 2.44 The gas sulfur hexafluoride, SF_6, does not conduct thermal energy well and does not react easily with other substances. For these reasons it is sometimes used to insulate double-glazed windows.



Writing Names and Formulas of Binary Covalent Compounds

Follow these steps to write the name of a binary covalent compound.

1. The first element in the name and formula of a binary covalent compound is usually the one that is farther to the left on the periodic table.

   Example: In carbon monoxide, CO, carbon comes first because carbon is to the left of oxygen on the periodic table.

2. When naming, the suffix *-ide* is attached to the name of the second element.

   Example: Oxygen is changed to oxide in the name carbon monoxide.

3. When naming, prefixes are used to indicate how many atoms of each type are present in one molecule of the compound. **Table 2.8** lists the first 10 prefixes. The prefix *mono-* is used only for the second element in the name. When there is no prefix, *mono-* is implied, as in carbon monoxide. Also, when *mono-* comes before *-oxide*, an "o" is dropped. Thus, you write *monoxide*, not *monooxide.*

   Example: Using prefixes correctly, the name of CO is carbon monoxide.

   Note that when the addition of a prefix results in two vowels appearing together, the vowel at the end of the prefix is usually dropped. The "i" at the end of the prefixes *di-* and *tri-* are never dropped, however.

   Example: the correct name for PI_3 is phosphorus triiodide.

To write the formula for a binary covalent compound, write the element symbols in the order they appear in the name. Add subscripts based on the prefixes used in the name. Examples are provided in the Sample Problem on the next page.

Table 2.8 Prefixes Used to Name Binary Covalent compounds

Prefix	Number	Prefix	Number
mono-	1	hexa-	6
di-	2	hepta-	7
tri-	3	octa-	8
tetra-	4	nona-	9
penta-	5	deca-	10

Sample Problem

Names and Formulas of Binary Covalent Compounds

Nitrogen and oxygen form a wide variety of different covalent compounds with different properties. Two examples are described below. A third is shown in **Figure 2.45**.

a) Dinitrogen tetroxide is used in rocket fuels. What is its formula?

b) The toxic brown gas NO_2 is found in smog in urban areas. What is its name?

Figure 2.45 The compound NO acts to widen blood vessels, which can lessen chest pain in heart patients. The patient takes nitroglycerin pills, which react in the body to form NO. **What is the name of the compound NO?**

Solution

a) Nitrogen comes first in the formula, as in the name, because it is to the left of oxygen in the periodic table. The prefix *di* tells you that there are 2 nitrogen atoms and the prefix *tetr-* tells you that there are 4 oxygen atoms. (The *a* in *tetra* was dropped.)

The formula of dinitrogen tetroxide is N_2O_4.

b) Follow these steps to name a binary covalent compound.

1. Name the leftmost element in the formula first.	The first element is N (nitrogen).
2. Name the second element, making sure the name ends with the suffix *-ide*.	The second element is O (oxygen), which becomes *oxide*.
3. Add a prefix to each element's name to indicate the number of atoms of each element in a molecule of the compound. If the first element would get the prefix *mono*, do not include that prefix.	The compound's name is nitrogen dioxide.

The name of NO_2 is nitrogen dioxide.

Practice Problems

1. Write formulas for each of the following covalent compounds.

a) sulfur tetrafluoride

b) disulfur difluoride

c) dinitrogen trioxide

d) oxygen difluoride

e) nitrogen tribromide

f) diiodine hexachloride

2. Write the names of the following covalent compounds.

a) PI_3

b) SO_2

c) SO_3

d) S_2F_{10}

e) CCl_4

f) N_2O_5

g) N_2O

h) NI_3

i) P_2O_5

j) PBr_5

k) As_2S_3

l) ICl_3

Exceptions to the Rules

One important group of compounds breaks the naming rules given in this section. These are the compounds that contain hydrogen. You might think that HCl, for example, would be ionic. It contains hydrogen, found in the same group as the alkali metals, and a halogen. In fact, hydrogen is a non-metal, and HCl is known to be molecular. In its pure form, it is a gas at room temperature.

Although it is a covalent compound, HCl is not named in the same way as other covalent compounds you have encountered so far. Like other binary hydrogen-containing compounds, it is named as though it is an ionic compound. The correct name for HCl is thus hydrogen chloride, not hydrogen monochloride. Similarly, the name of H_2S is hydrogen sulfide, not dihydrogen monosulfide. When these types of compounds are added to water they form acidic solutions. You are probably already familiar with the name "hydrochloric acid," which is what HCl is called when it is dissolved in water.

Compounds containing hydrogen and carbon, such as ethane, C_2H_6, or ethanol, C_2H_5OH, are called *organic compounds*, and these have yet another set of naming rules, which you will encounter if you continue your studies in chemistry.

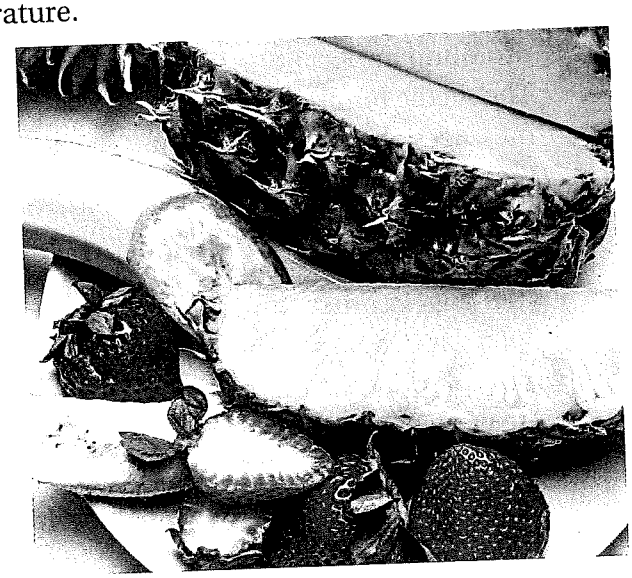


Figure 2.46 The characteristic smells of strawberries, pineapples, and bananas are due to organic compounds: methyl hexanoate, ethyl butanoate, and isoamyl acetate respectively. These compounds are named according to detailed rules based on their composition and structure.

Extending the Connections

Organic Compounds

Why are organic compounds so called? Are all organic compounds found in living things, like the ones in **Figure 2.46**? Find out the origin of the term *organic* in this context, and give some examples to demonstrate the diversity of organic compounds.

Before you leave this page . . .

1. What does the formula for a covalent compound tell you about the compound?
2. Identify two problems with the name mononitrogen monooxide for the compound NO and correct them.
3. Sketch a model of a molecule of carbon dioxide, CO_2, and carbon monoxide, CO. How do the names and formulas communicate the difference between these compounds?