4.9: What Are Chemical Compounds Called?

The naming of chemical compounds can get a little complicated. This is particularly true of organic compounds, the names of which are discussed in Chapter 9. Some of the simpler aspects of naming inorganic compounds are discussed here.

In naming compounds, prefixes are used to represent the relative numbers of atoms in the formula unit of the compound. These prefixes through number 10 are given below:

1-mono 3-tri 5-penta 7-hepta 9-nona

2-di 4-tetra 6-hexa 8-octa 10-deca

The first class of inorganic compounds to be addressed here are **binary molecular compounds**. Binary molecular compounds are composed of only 2 kinds of elements and do not contain ions. For these compounds, the first part of the name is simply the name of the first element in the compound formula. The second part of the name is that of the second element in the compound formula modified to have the ending *-ide*. Prefixes are added to indicate how many of each kind of atom are present in the molecule. Consider as an example the name of N_2O_5. The name of the compound is dinitrogen pentoxide where *di* indicates 2 N atoms, *pent* indicates 5 oxygen atoms, and the second element has the *ide* ending. Other examples of this system of naming are $SiCl_4$, silicon tetrachloride; S_2F_6, disilicon hexafluoride; PCl_5, phosphorus pentachloride; and SCl_2, sulfur dichloride.

A number of compounds, including binary molecular compounds, have **common names** that have been used for so long that they are part of the chemical vocabulary. An especially common example is the name of water for H_2O; its official name is dihydrogen monoxide. Another example is dinitrogen monoxide, N_2O, usually called nitrous oxide. Aluminum oxide, Al_2O_3, is commonly called alumina and silicon oxide, SiO_2, is called silica, specific mineral forms of which are sand and quartz.

Recall that *ionic compounds* are those composed of ions that are held together by ionic bonds, rather than covalent bonds. As noted in the discussion of ionic sodium chloride in Section 4.3, ionic compounds do not consist of discrete molecules, but rather of aggregates of ions whose relative numbers make the compound electrically neutral overall. Therefore, it is not correct to refer to molecules of ionic compounds but rather to *formula units* equal to the smallest aggregate of ions that can compose the compound. Consider, for example, the ionic compound composed of Na^+ and SO_4^{2-} ions. Every ionic compound must be electrically neutral with the same number of positive as negative charges. For the compound in question this requires 2 Na^+ ions for each SO_4^{2-} ion. Therefore, the formula of the compound is Na_2SO_4 and a formula unit contains 2 Na^+ ions and 1 SO_4^{2-} ion. Furthermore, a mole of Na_2SO_4 composed of 6.02×10^{23} formula units of Na_2SO_4 contains $2\times6.02\times10^{23}$ Na^+ ions and 6.02×10^{23} SO_4^{2-} ions. Since the ionic charges determine the relative numbers of ions, prefixes need not be used in naming the compound and it is called simply sodium sulfate.

Exercise: Give the formulas and names of compounds formed from each cation on the top row with each anion on the bottom row, below:

1. NH_4^+ 2. Ca^{2+} 3. Al^{3+}

(A) Cl^- (B) SO_4^{2-} (C) PO_4^{3-}

Answers: 1(A) NH_4Cl, ammonium chloride; 1(B) $(NH_4)_2SO_4$, ammonium sulfate; 1(C), $(NH_4)_3PO_4$, ammonium phosphate; 2(A) $CaCl_2$, calcium chloride; 2(B) $CaSO_4$, calcium sulfate; 2(C), $Ca_3(PO_4)_2$, calcium phosphate; 3(A) $AlCl_3$, aluminum chloride; 3(B) $Al_2(SO_4)_3$, aluminum sulfate; 3(C), $AlPO_4$, aluminum phosphate.

Prefixes are used in naming ionic compounds where more than 1 cation or more than 1 anion are present in the formula unit. For example, Na_2HPO_4 in which each formula unit is composed of 2 Na^+ ions, 1 H^+ ion, and 1 PO_4^{3-} ion is called disodium monohydrogen phosphate. And KH_2PO_4 is called monopotassium dihydrogen phosphate.