PROPERTIES OF THE GROUP 16 ELEMENTS

	O	S	Se	Te	Po
Melting point (°C)	–218.4	119.0	217	449.8	254
Boiling point (°C)	–182.962	444.674	685	989.9	962
Density (g/cm^3)	1.429×10^{-3}	1.96	4.82	6.24	9.4
Ionization energy (kJ/mol)	1314	1000	941	869	812
Atomic radius (pm)	73	103	119	142	168
Ionic radius (pm)	140	184	198	221	—
Common oxidation number in compounds	–2	–2, +4, +6	–2, +2, +4, +6	–2, +2, +4, +6	–2, +2, +4, +6
Crystal structure*	orthorhombic, rhombohedral, cubic (when solid)	orthorhombic, monoclinic	hexagonal	hexagonal	cubic, rhombohedral
Hardness (Mohs' scale)	none (gas)	2.0	2.0	2.3	—

* Most elements of this family can have more than one crystal structure.

APPLICATION *Chemical Industry*

Oxides

Oxides of the reactive metals are ionic compounds. The oxide ion from any soluble oxide reacts immediately with water to form hydroxide ions as represented by the following equation.

$$O^{2-}(aq) + H_2O(l) \longrightarrow 2OH^-(aq)$$

The reactive metal oxides of Groups 1 and 2 react vigorously with water and release a large amount of energy as heat. The product of the reaction is a metal hydroxide. The following equation is an example of this reaction.

$$Na_2O(s) + H_2O(l) \longrightarrow 2NaOH(aq)$$

A basic oxide can be thought of as the dehydrated form of a hydroxide base. Oxides of the less reactive metals, such as magnesium, can be prepared by using thermal decomposition to drive off the water.

$$Mg(OH)_2(s) \xrightarrow{\text{heat}} MgO(s) + H_2O(g)$$

Hydroxides of the reactive metals of Group 1 are too stable to decompose in this manner.

If a hydroxide formed by a metal oxide is water-soluble, it dissolves to form a basic solution. An oxide that reacts with water to form a basic solution is called a basic oxide or a basic anhydride. Table 7A on the next page lists oxides that form basic solutions with water.

Molecular Oxides

Nonmetals, located on the right side of the periodic table, form molecular oxides. For example, sulfur forms two gaseous oxides: sulfur dioxide, SO_2, and sulfur trioxide, SO_3. In reactions typical of nonmetal oxides, each of the sulfur oxides reacts with water to form an oxyacid.

An oxide that reacts with water to form an acid is called an acidic oxide or an acid anhydride. As with the basic anhydrides, each acid anhydride can be thought of as the dehydrated form of the appropriate oxyacid. For example, when sulfuric acid decomposes, the loss of H_2O leaves the oxide SO_3, which is an anhydride.

$$H_2SO_4(aq) \xrightarrow{\text{heat}} H_2O(g) + SO_3(g)$$