TOPIC

18

CHEMISTRY OF THE ENVIRONMENT

Chapter 18 of *Chemistry: The Central Science* is perhaps the most interesting chapter even though very little of its content is found on the Advanced Placement Chemistry exam. Expect no more than one or two general knowledge multiple choice questions from this chapter. In preparation for the exam, do little more than read this summary.

The four major gases that make up the composition of dry air (in mole fraction) are the following:

Nitrogen, N_2, 0.781

Oxygen, O_2, 0.209

Argon, Ar, 0.00934

Carbon dioxide, CO_2, 0.000375

Water and carbon dioxide are the gases principally responsible for the natural greenhouse effect, the trapping of heat in the earth's atmosphere.

The combustion of fossil fuels such as coal and petroleum contributes to the increasing amount of carbon dioxide in the atmosphere.

$$2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(g)$$

Sulfur dioxide, SO_2, is a principal air pollutant resulting from the combustion of various forms of sulfur in coal and oil.

$$S(s) + O_2(g) \rightarrow SO_2(g)$$

Acid rain is formed when sulfur dioxide is oxidized to sulfur trioxide in the atmosphere and then combines with water.

$$SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$$

Powdered limestone ($CaCO_3$) injected into the furnace of a power plant decomposes to lime (CaO) and carbon dioxide.

$$CaCO_3(s) + \text{heat} \rightarrow CaO(s) + CO_2(g)$$

The lime prevents the escape of sulfur dioxide by reacting to form calcium sulfite.

$$CaO(s) + SO_2(g) \rightarrow CaSO_3(s)$$

The high heats generated by internal combustion engines cause the chief components of air to react to form nitrogen monoxide.

$$N_2(g) + O_2(g) + \text{heat} \rightarrow 2NO(g)$$

Nitrogen monoxide oxidizes in air to form nitrogen dioxide.

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

Nitrogen dioxide undergoes photodissociation in sunlight to form atomic oxygen.

$$NO_2(g) + h\nu \rightarrow NO(g) + O(g)$$

Atomic oxygen produces ozone as well as other products, collectively referred to as photochemical smog.

$$O(g) + O_2(g) \rightarrow O_3(g)$$

Municipalities treat water by adding lime, CaO, and alum, $Al_2(SO_4)_3$. Lime in water forms calcium hydroxide.

$$CaO(s) + H_2O(l) \rightarrow Ca^{2+}(aq) + 2OH^-(aq)$$

Aluminum ions react with hydroxide ions to produce a spongy, gelatinous precipitate that absorbs suspended particles and bacteria as it settles, removing them from the water.

$$Al^{3+}(aq) + 3OH^-(aq) \rightarrow Al(OH)_3(s)$$

Chlorine added to water produces hydrochloric acid, a strong acid, and hypochlorous acid, a weak acid, which is deadly to any remaining bacteria.

$$Cl_2(g) + H_2O(l) \rightarrow H^+(aq) + Cl^-(aq) + HClO(aq)$$

Notice that, in the above disproportionation, chlorine atoms are both oxidized and reduced. Also the strong acid is written in ionic form and the weak acid is written in molecular form.