164. You analyze two substances in the laboratory and discover that each has the empirical formula CH_2O. You can easily see that they are different substances because one is a liquid with a sharp, biting odor and the other is an odorless, crystalline solid. How can you account for the fact that both have the same empirical formula?

Stoichiometry: Chap. 9, Sec. 1–2

165. How many moles of sodium will react with water to produce 4.0 mol of hydrogen in the following reaction?

$$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$$

166. How many moles of lithium chloride will be formed by the reaction of chlorine with 0.046 mol of lithium bromide in the following reaction?

$$2LiBr(aq) + Cl_2(g) \rightarrow 2LiCl(aq) + Br_2(l)$$

167. Aluminum will react with sulfuric acid in the following reaction.

$$2Al(s) + 3H_2SO_4(l) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$$

a. How many moles of H_2SO_4 will react with 18 mol Al?
b. How many moles of each product will be produced?

168. Propane burns in excess oxygen according to the following reaction.

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

a. How many moles each of CO_2 and H_2O are formed from 3.85 mol of propane?
b. If 0.647 mol of oxygen are used in the burning of propane, how many moles each of CO_2 and H_2O are produced? How many moles of C_3H_8 are consumed?

169. Phosphorus burns in air to produce a phosphorus oxide in the following reaction:

$$4P(s) + 5O_2(g) \rightarrow P_4O_{10}(s)$$

a. What mass of phosphorus will be needed to produce 3.25 mol of P_4O_{10}?
b. If 0.489 mol of phosphorus burns, what mass of oxygen is used? What mass of P_4O_{10} is produced?

170. Hydrogen peroxide breaks down, releasing oxygen, in the following reaction.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

a. What mass of oxygen is produced when 1.840 mol of H_2O_2 decompose?
b. What mass of water is produced when 5.0 mol O_2 is produced by this reaction?

171. Sodium carbonate reacts with nitric acid according to the following equation:

$$Na_2CO_3(s) + 2HNO_3 \rightarrow 2NaNO_3 + CO_2 + H_2O$$

a. How many moles of Na_2CO_3 are required to produce 100.0 g of $NaNO_3$?
b. If 7.50 g of Na_2CO_3 reacts, how many moles of CO_2 are produced?

172. Hydrogen is generated by passing hot steam over iron, which oxidizes to form Fe_3O_4, in the following equation:

$$3Fe(s) + 4H_2O(g) \rightarrow 4H_2(g) + Fe_3O_4(s)$$

a. If 625 g of Fe_3O_4 is produced in the reaction, how many moles of hydrogen are produced at the same time?
b. How many moles of iron would be needed to generate 27 g of hydrogen?

173. Calculate the mass of silver bromide produced from 22.5 g of silver nitrate in the following reaction:

$$2AgNO_3(aq) + MgBr_2(aq) \rightarrow 2AgBr(s) + Mg(NO_3)_2(aq)$$

174. What mass of acetylene, C_2H_2, will be produced from the reaction of 90. g of calcium carbide, CaC_2, with water in the following reaction?

$$CaC_2(s) + 2H_2O(l) \rightarrow C_2H_2(g) + Ca(OH)_2(s)$$

175. Chlorine gas can be produced in the laboratory by adding concentrated hydrochloric acid to manganese(IV) oxide in the following reaction:

$$MnO_2(s) + 4HCl(aq) \rightarrow MnCl_2(aq) + 2H_2O(l) + Cl_2(g)$$

a. Calculate the mass of MnO_2 needed to produce 25.0 g of Cl_2.
b. What mass of $MnCl_2$ is produced when 0.091 g of Cl_2 is generated?

Mixed Review

176. How many moles of ammonium sulfate can be made from the reaction of 30.0 mol of NH_3 with H_2SO_4 according to the following equation:

$$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

177. In a very violent reaction called a thermite reaction, aluminum metal reacts with iron(III) oxide to form iron metal and aluminum oxide according to the following equation:

$$Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$$

a. What mass of Al will react with 150 g of Fe_2O_3?
b. If 0.905 mol Al_2O_3 is produced in the reaction, what mass of Fe is produced?
c. How many moles of Fe_2O_3 will react with 99.0 g of Al?

178. The reaction $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ is used to produce ammonia commercially. If 1.40 g of N_2 are used in the reaction, how many grams of H_2 will be needed?

179. What mass of sulfuric acid, H_2SO_4, is required to react with 1.27 g of potassium hydroxide, KOH? The products of this reaction are potassium sulfate and water.

180. Ammonium hydrogen phosphate, $(NH_4)_2HPO_4$, a common fertilizer; is made from reacting phosphoric acid, H_3PO_4, with ammonia.
a. Write the equation for this reaction.
b. If 10.00 g of ammonia react, how many moles of fertilizer will be produced?