Chapter 10 Problems: Stoichiometry

molar mass 1. An environmental chemist wants to get rid of a 254 .3 gram sample of the illegal pesticide DDT, $CCl_3CH(C_6H_4Cl)_2$. How many moles of DDT does the chemist have to dispose of?

355 g/mol DDT

$$254.3\text{ g DDT}\left|\frac{1\text{ mol DDT}}{355\text{ g DDT}}\right.=\boxed{0.716\text{ mol DDT}}$$

mole → mole 2. Methane and oxygen react to produce carbon dioxide and water. How many moles of methane are required to produce 16.6 moles of water?

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

$$16.6\text{ mol } H_2O\left|\frac{1\text{ mol } CH_4}{2\text{ mol } H_2O}\right.=\boxed{8.3\text{ mol } CH_4}$$

mass → mole 3. In the process of photosynthesis plants convert carbon dioxide and water to glucose ($C_6H_{12}O_6$). How many moles of carbon dioxide are required to produce 5.1 grams of glucose?

$$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$$

$$5.1\text{ g } C_6H_{12}O_6\left|\frac{1\text{ mol Glu}}{180\text{ g Glu}}\right|\frac{6\text{ mol } CO_2}{1\text{ mol Glu}}\left.=\boxed{0.170\text{ mol } CO_2}\right.$$

mass → mass 4. Calculate the mass (g) of silver bromide produced from 22.5 g of silver nitrate in the following reaction:

2 AgNO3 + MgBr2 -> 2 AgBr + Mg(NO3)2

$$22.5\text{ g } AgNO_3\left|\frac{1\text{ mol } AgNO_3}{170\text{ g } AgNO_3}\right|\frac{1\text{ mol AgBr}}{1\text{ mol } AgNO_3}\left|\frac{188\text{ g AgBr}}{1\text{ mol AgBr}}\right.=\boxed{24.9\text{ g AgBr}}$$

mass - mole 5. How many moles of acetylene, C2H2 will be produced from the reaction of 90.0 g of calcium carbide, CaC2, with water in the following reaction?

mass → mole

$$CaC_2 + 2H_2O \longrightarrow C_2H_2 + Ca(OH)_2$$

$$90.0\text{ g } CaC_2\left|\frac{1\text{ mol } CaC_2}{64\text{ g } CaC_2}\right|\frac{1\text{ mol } C_2H_2}{1\text{ mol } CaC_2}\left.=\boxed{1.4\text{ mol } C_2H_2}\right.$$

6. Chlorine gas can be produced in the labrotory by adding concentrated hydrochloric acid, HCl, to manganese(IV) oxide. The other products are water and manganese(II) chloride.

mass → mass a. Calculate the mass of MnO2 needed to produce 25.0 grams of chlorine gas?

mass → mole b. How many moles of manganese chloride is produced when 0.091 g of chlorine gas is generated?

$$MnO_2 + 4HCl \longrightarrow Cl_2 + 2H_2O + MnCl_2$$

a) $$25.0\text{ g } Cl_2\left|\frac{1\text{ mol } Cl_2}{71\text{ g } Cl_2}\right|\frac{1\text{ mol } MnO_2}{1\text{ mol } Cl_2}\left|\frac{87\text{ g } MnO_2}{1\text{ mol } MnO_2}\right.=\boxed{30\text{ g } MnO_2}$$

b) $$0.091\text{ g } Cl_2\left|\frac{1\text{ mol } Cl_2}{71\text{ g } Cl_2}\right|\frac{1\text{ mol } MnCl_2}{1\text{ mol } Cl_2}\left.=\boxed{0.0013\text{ mol } MnCl_2}\right.$$

mass → mass 7. The reaction N2 + 3H2 → 2NH3 is used to produce ammonia commercially. If 1.4 g of N2 is used in the reaction determine the mass of H2 required as well as the mass of NH3 produced?

$$1.4\text{ g } N_2 \left|\frac{1\text{ mol } N_2}{28\text{ g } N_2}\right|\frac{3\text{ mol } H_2}{1\text{ mol } N_2}\left|\frac{2.02\text{ g } H_2}{1\text{ mol } H_2}\right| = \boxed{0.30\text{ g } H_2}$$

$$1.4\text{ g } N_2 \left|\frac{1\text{ mol } N_2}{28\text{ g } N_2}\right|\frac{2\text{ mol } NH_3}{1\text{ mol } N_2}\left|\frac{17\text{ g}}{1\text{ mol } NH_3}\right| =$$

mass → mole 8. What mass and moles of sulfuric acid, H2SO4, is required to react with 1.27 g of potassium hydroxide?
mass → mass The products of this reaction are potassium sulfate and water.

$$H_2SO_4 + 2KOH \longrightarrow K_2SO_4 + 2H_2O$$

$$1.27\text{ g KOH}\left|\frac{1\text{ mol KOH}}{56.1\text{ g KOH}}\right|\frac{1\text{ mol } H_2SO_4}{2\text{ mol KOH}}\left| = \boxed{0.0113\text{ mol } H_2SO_4}\right|\frac{98\text{ g } H_2SO_4}{1\text{ mol } H_2SO_4} = \boxed{1.10\text{ g } H_2SO_4}$$

mass → mole 9. Joseph Priestley is credited with the discovery of oxygen. He produced O2 by heating mercury(II) oxide to decompose into its elements. How many moles of oxygen gas could Priestley have produced if he had decomposed 517.84 g of mercury oxide? $2HgO \longrightarrow O_2 + 2Hg$

$$517.84\text{ g } HgO\left|\frac{1\text{ mol } HgO}{217\text{ g } HgO}\right|\frac{1\text{ mol } O_2}{2\text{ mol } HgO} = \boxed{1.19\text{ mol } O_2}$$

mole → mass 10. In the space shuttle, the carbon dioxide the crew exhales is removed from the air by a reaction within a canister of lithium hydroxide. On average, each astronaut exhales about 20.0 mol carbon dioxide daily. What mass of water will be produced when this amount reacts with LiOH? The other products of the reaction is lithium carbonate. $CO_2 + 2LiOH \longrightarrow H_2O + Li_2CO_3$

$$20.0\text{ mol } CO_2\left|\frac{2\text{ mol } H_2O}{1\text{ mol } CO_2}\right|\frac{18\text{ g } H_2O}{1\text{ mol } H_2O} = \boxed{360\text{ g } H_2O}$$

mass → mass 11. Ethanol, C5H5OH, is considered a clean fuel because it burns in oxygen and produces few trace pollutants. If 95.0 g H2O are produced during the combustion of ethanol, how many grams of ethanol were present at the beginning of the reaction $C_5H_5OH + 6O_2 \longrightarrow 5CO_2 + 3H_2O$

$$95.0\text{ g } H_2O\left|\frac{1\text{ mol } H_2O}{18\text{ g } H_2O}\right|\frac{1\text{ mol } C_5H_5OH}{3\text{ mol } H_2O}\left|\frac{82.1\text{ g } C_5H_5OH}{1\text{ mol } C_5H_5OH}\right| = \boxed{140\text{ g } C_5H_5OH}$$

mass → mass 12. Challenge Question: Rusting or iron occurs in the presence of moisture according to the following reaction: 4Fe(s) + 3O2(g) → 2Fe2O3(s). Suppose that 3.19% of a heap of steel scrap with a mass of 1650 kg rusts in a year. What mass will the heap have after one year of rusting?

$.0319 \times 1650\text{ kg} = 52.7\text{ kg rust/yr.}$

$52.7\text{ kg} = 52700\text{ grams}$

$$52700\text{ g } Fe_2O_3\left|\frac{1\text{ mol } Fe_2O_3}{160\text{ g } Fe_2O_3}\right|\frac{2\text{ mole Fe}}{1\text{ mole } Fe_2O_3}\left|\frac{55.9\text{ g Fe}}{1\text{ mol Fe}}\right| = \boxed{108000\text{ g Fe}}$$