Reaction Stoichiometry II
Extra Stoichiometry Study Questions

1. a. What quantity, in moles, of water are formed by the reaction of 0.112 mol of oxygen gas with excess hydrogen gas?

$$2\ H_2(g)\ +\ O_2(g)\ \rightarrow\ 2\ H_2O(g)$$

$$n_{H_2O} = 0.112\text{ mol }O_2 \times \frac{2\text{ mol }H_2O}{1\text{ mol }O_2} = 0.224\text{ mol }H_2O$$

b. In the same reaction as above, what quantity in moles of hydrogen gas are consumed? (Just for fun... how many molecules of hydrogen gas were consumed?)

$$n_{H_2\text{ consumed}} = 0.112\text{ mol }O_2 \times \frac{2\text{ mol }H_2}{1\text{ mol }O_2} = 0.224\text{ mol }H_2$$

$$N_{H_2\text{ consumed}} = 0.224\text{ mol }H_2 \times 6.022\times10^{23}\ \tfrac{\text{molecules}}{\text{mol}} = 1.35\times10^{23}\text{ molecules }H_2$$

c. If 1.000 mol of hydrogen gas was available, how much remains?

$$n_{H_2\text{ remaining}} = 1.000\text{ mol} - 0.224\text{ mol} = 0.776\text{ mol }H_2\text{ remaining}$$

2. The reaction of silver nitrate with potassium chloride yields silver chloride as one of the products. What mass, in grams, of silver chloride will be produced by the reaction of 1.00 g of silver nitrate with 0.439 g of potassium chloride?

$$AgNO_3\ +\ KCl\ \rightarrow\ AgCl\ +\ KNO_3$$

$$M_{AgNO_3} = 169.9\ {}^{g}\!/_{mol} \quad M_{AgCl} = 143.32\ {}^{g}\!/_{mol} \quad M_{KCl} = 74.55\ {}^{g}\!/_{mol}$$

$$n_{AgCl\text{ from }AgNO_3} = \left(1.00\text{ g }AgNO_3 \Big/ 169.9\ {}^{g\ AgNO_3}\!/_{mol\ AgNO_3}\right) \times \frac{1\text{ mol AgCl}}{1\text{ mol }AgNO_3} = 5.886\times10^{-3}\text{ mol AgCl}$$

$$n_{AgCl\text{ from KCl}} = \left(0.439\text{ g KCl} \Big/ 74.55\ {}^{g\ KCl}\!/_{mol\ KCl}\right) \times \frac{1\text{ mol AgCl}}{1\text{ mol KCl}} = 5.889\times10^{-3}\text{ mol AgCl}$$

$AgNO_3$ is limiting reactant (but just barely)...

$$m_{AgCl} = 5.886\times10^{-3}\text{ mol AgCl} \times 143.32\ \tfrac{\text{g AgCl}}{\text{mol AgCl}} = 0.844\text{ g AgCl}$$

3. Assume that gasoline is entirely C_7H_8 (toluene). What mass of CO_2 will be produced by burning 1 tank (48.0 L) of gasoline in your car? The density of toluene is 0.866 g/mL. (FYI, gasoline is an enormously complex mixture of aliphatic and aromatic hydrocarbons with the toluene being a major component.)

$$C_7H_8 + 9\,O_2 \rightarrow 7\,CO_2 + 4\,H_2O$$

$$M_{C_7H_8} = 92.141\,{}^{g}\!/\!_{mol}$$

$$m_{\text{toluene}} = 48{,}000 \text{ mL} \times 0.866\,{}^{g}\!/\!_{mL} = 41{,}568 \text{ g toluene}$$

$$m_{CO_2} = 41{,}568 \text{ g } C_7H_8 \times \frac{1 \text{ mol } C_7H_8}{92.141 \text{ g } C_7H_8} \times \frac{7 \text{ mol } CO_2}{1 \text{ mol } C_7H_8} \times 40.01\,{}^{g\,CO_2}\!/\!_{mol\,CO_2}$$

$$m_{CO_2} = 126{,}349 \text{ g } CO_2 = \boxed{126{,}000 \text{ g } CO_2 = 1.26 \times 10^5 \text{ g } CO_2}$$