REVIEW QUESTIONS
Chapter 3

1. What mass of chlorine is present in 12.2 g of $PbCl_2$?

$$12.2\ \cancel{g}\ \cancel{PbCl_2}\ \times\ \frac{1\ \cancel{mol}}{278.1\ \cancel{g}}\ \times\ \frac{2\ Cl}{1\ \cancel{PbCl_2}}\ \times\ \frac{35.45\ g}{1\ \cancel{mol}} = 3.11\ g$$

2. How many atoms of oxygen are present in 2.15 g of $Ca_3(PO_4)_2$?

$$2.15\ \cancel{g}\ \cancel{Ca_3(PO_4)_2}\ \times\ \frac{1\ \cancel{mol}}{310.2\ \cancel{g}}\ \times\ \frac{8\ O}{1\ \cancel{Ca_3(PO_4)_2}}\ \times\ \frac{6.02\times10^{23}\ atoms}{1\ \cancel{mol}} = 3.34\times10^{22}\ O\ atoms$$

3. What is the percent composition of caffeine ($C_8H_{10}N_4O_2$)?

$$\text{molar mass} = 194.2\ g/mol$$

$$\%\ C = \frac{8 \times 12.0}{194.2} \times 100 = 49.4\%$$

$$\%\ H = \frac{10 \times 1.01}{194.2} \times 100 = 5.20\%$$

$$\%\ N = \frac{4 \times 14.0}{194.2} \times 100 = 28.8\%$$

$$\%\ O = \frac{2 \times 16.0}{194.2} \times 100 = 16.5\%$$

$$\text{Total} = 99.9\% \cong 100\ \%$$

4. Determine the empirical formula for a compound with the following composition:

62.1% C 5.21% H 12.1% N 20.7% O

$$\text{mol C} = 62.1\ \cancel{g} \times \frac{1\ mol}{12.0\ \cancel{g}} = 5.175 \quad (6) \xrightarrow{\times 2} (12)$$

$$\text{mol H} = 5.21\ \cancel{g} \times \frac{1\ mol}{1.01\ \cancel{g}} = 5.158 \quad (6) \xrightarrow{\times 2} (12)$$

$$\text{mol N} = 12.1\ \cancel{g} \times \frac{1\ mol}{14.0\ \cancel{g}} = 0.8643 \quad (1) \xrightarrow{\times 2} (2)$$

$$\text{mol O} = 20.7\ \cancel{g} \times \frac{1\ mol}{16.0\ \cancel{g}} = 1.294 \quad (1.5) \xrightarrow{\times 2} (3)$$

$$\text{Empirical formula} = C_{12}H_{12}N_2O_3$$

5. The alcohol in "gasohol" burns according to the equation shown below:

$$C_2H_5OH\ (l) + 3\ O_2\ (g) \rightarrow 2\ CO_2\ (g) + 3\ H_2O\ l)$$

How many grams of CO_2 are produced when 3.00 g of C_2H_5OH burns according to this reaction? (Assume excess oxygen)

$$3.00\ \cancel{g}\ \cancel{C_2H_5OH} \times \frac{1\ \cancel{mol}}{46.0\ \cancel{g}} \times \frac{2\ CO_2}{1\ \cancel{C_2H_5OH}} \times \frac{44.0\ g}{1\ \cancel{mol}} = 5.74\ g\ CO_2$$

6. How many grams of NO form when 1.50 g NH_3 react with 1.85 g of O_2 as shown below:

$$4\ NH_3\ (g) + 5\ O_2\ (g) \rightarrow 4\ NO\ (g) + 6\ H_2O\ (l)$$

$$1.50\ \cancel{g}\ NH_3 \times \frac{1\ mol}{17.0\ \cancel{g}} = 0.08824\ mol$$

$$1.85\ \cancel{g}\ O_2 \times \frac{1\ mol}{32.0\ \cancel{g}} = 0.05781\ mol$$

$$0.08824\ mol\ \cancel{NH_3} \times \frac{5\ O_2}{4\ \cancel{NH_3}} = 0.1103\ mol\ O_2\ \text{needed to completely react with}\ NH_3$$

$0.05781\ mol\ actual < 0.1103\ mol\ needed$, therefore O_2 is the Limiting Reactant

$$0.05781\ \cancel{mol}\ \cancel{O_2} \times \frac{4\ NO}{5\ \cancel{O_2}} \times \frac{30.0\ g}{1\ \cancel{mol}} = 1.34\ g\ NO$$

Alternate Solution:

$$1.50\ \cancel{g}\ \cancel{NH_3} \times \frac{1\ \cancel{mol}}{17.0\ \cancel{g}} \times \frac{4\ NO}{4\ \cancel{NH_3}} \times \frac{30.0\ g}{1\ \cancel{mol}} = 2.65\ g\ NO$$

$$1.85\ \cancel{g}\ \cancel{O_2} \times \frac{1\ \cancel{mol}}{32.0\ \cancel{g}} \times \frac{4\ NO}{5\ \cancel{O_2}} \times \frac{30.0\ g}{1\ \cancel{mol}} = 1.34\ g\ NO \leftarrow \text{LR (correct answer)}$$

7. When 30.0 g of benzene (C_6H_6) and 65.0 g of bromine are reacted together as shown below, 56.7 g of bromobenzene (C_6H_5Br) is formed. What is the percent yield of this reaction?

$$C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr$$

$30.0 \text{ g } C_6H_6 \times \frac{1 \text{ mol}}{78.1 \text{ g}} = 0.3841 \text{ mol}$

$65.0 \text{ g } Br_2 \times \frac{1 \text{ mol}}{159.8 \text{ g}} = 0.4068 \text{ mol}$

$0.3841 \text{ mol } C_6H_6 \times \frac{1 \text{ } Br_2}{1 \text{ } C_6H_6} = 0.3841 \text{ mol } Br_2$ needed to completely react with C_6H_6

0.4068 mol actual > 0.3841 mol needed, therefore C_6H_6 is the Limiting Reactant

$0.3841 \text{ mol } C_6H_6 \times \frac{1 \text{ } C_6H_5Br}{1 \text{ } C_6H_6} \times \frac{156.95 \text{ g}}{1 \text{ mol}} = 60.3 \text{ g } C_6H_5Br$ ← Theoretical Yield

$\% \text{ Yield} = \frac{56.7}{60.3 \text{ g}} \times 100 = 94.0\%$