CHM 1010 **Problem Set for Moles II** **Gage**

1. A compound has a molar mass of approximately 117-120 g/mole and the following composition: 61.0% carbon, 11.9% hydrogen, and 27.1 % oxygen. What are the simplest and molecular formulas for the compound?

$$61.0 \text{ g C} \times \frac{1 \text{ mol C}}{12.0 \text{ g C}} = 5.08 \text{ mol C} \qquad \frac{5.08}{1.69} \sim 3$$

$$11.9 \text{ g H} \times \frac{1 \text{ mol H}}{1.0 \text{ g H}} = 11.9 \text{ mol H} \qquad \frac{11.9}{1.69} \sim 7$$

$$27.1 \text{ g O} \times \frac{1 \text{ mol O}}{16.0 \text{ g O}} = 1.69 \text{ mol O} \qquad \frac{1.69}{1.69} = 1$$

The simplest formula is $C_3H_7O_1$.

Divide the approximate molar mass by the mass for the simplest formula to determine how many times larger the actual compound is compared to the simplest.

117/59 ~ 2 …so molecular formula is $C_6H_{14}O_2$

2. How many atoms of sodium are required to form 16.5 grams of sodium phosphate? Na_3PO_4

$$16.5 \text{ g } Na_3PO_4 \times \frac{1 \text{ mol } Na_3PO_4}{164.0 \text{ g } Na_3PO_4} \times \frac{3 \text{ mol Na}}{1 \text{ mol } Na_3PO_4} \times \frac{6.02 \times 10^{23} \text{Na atoms}}{1\text{mol Na}} = 1.82 \times 10^{23} \text{ Na atoms}$$

3. Potassium nitrate reacts with barium chloride in a double replacement reaction. How many grams of potassium nitrate are required to completely react with 3.22 grams of barium chloride?

$$2\ KNO_3 + BaCl_2 \text{ ----------> } 2\ KCl + Ba(NO_3)_2$$

$$3.22 \text{ g } BaCl_2 \times \frac{1 \text{ mol } BaCl_2}{208.3 \text{ g } BaCl_2} \times \frac{2 \text{ mol } KNO_3}{1 \text{ mol } BaCl_2} \times \frac{101.1 \text{ g } KNO_3}{1 \text{ mol } KNO_3} = 3.13 \text{ g } KNO_3$$

4. A person making magnesium chloride by the reaction of magnesium metal with hydrochloric acid end up with 4.5 grams of magnesium chloride. He determines that he had a 76% yield. How much magnesium did he start with?

$$\%\text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100 \quad \text{so theoretical} = \frac{\text{actual}}{\%} \times 100$$

$$\text{theoretical} = \frac{4.5 \text{ g } MgCl_2}{76} \times 100 = 5.9 \text{ g } MgCl_2$$

$$5.9 \text{ g } MgCl_2 \times \frac{1 \text{ mole } MgCl_2}{95.3 \text{ g } MgCl_2} \times \frac{1 \text{ mol Mg}}{1 \text{ mole } MgCl_2} \times \frac{24.3 \text{ g Mg}}{1 \text{ mol Mg}} = 1.5 \text{ g Mg}$$

5. phosphoric acid and calcium hydroxide ----------> calcium phosphate and water

$2\ H_3PO_4 + 3\ Ca(OH)_2 \text{ ----------> } Ca_3(PO_4)_2 + 6\ H_2O$

How many grams of calcium phosphate can be produced when you start the reaction with 0.669 moles of phosphoric acid and 54.0 grams of calcium hydroxide? How many grams of which reactant is left over?

$$0.669 \text{ mol } H_3PO_4 \times \frac{1 \text{ mol } Ca_3(PO_4)_2}{2 \text{ mol } H_3PO_4} \times \frac{310.3 \text{ g } Ca_3(PO_4)_2}{1 \text{ mol } Ca_3(PO_4)_2} = 104 \text{ g } Ca_3(PO_4)_2$$

$$54.0 \text{ g } Ca(OH)_2 \times \frac{1 \text{ mole } Ca(OH)_2}{74.1 \text{ g } Ca(OH)_2} \times \frac{1 \text{ mol } Ca_3(PO_4)_2}{3 \text{ mol } Ca(OH)_2} \times \frac{310.3 \text{ g } Ca_3(PO_4)_2}{1 \text{ mol } Ca_3(PO_4)_2} = 75.4 \text{ g } Ca_3(PO_4)_2$$

104 g $Ca_3(PO_4)_2$ possible - 75.4 g made = 29 g not made

$$29 \text{ g } Ca_3(PO_4)_2 \times \frac{1 \text{ mol } Ca_3(PO_4)_2}{310.3 \text{ g } Ca_3(PO_4)_2} \times \frac{2 \text{ mol } H_3PO_4}{1 \text{ mol } Ca_3(PO_4)_2} \times \frac{98.0 \text{ g } H_3PO_4}{1 \text{ mol } H_3PO_4} = 18 \text{ g } H_3PO_4$$