Stoich Warm-Up: Answer the following to check your understanding of stoich problems.

1) What is meant by theoretical yield? Define it in your own words.

Amount of product you predict can be made with a certain amount of reactant. Found with stoichiometry conversions.

2) What is the difference between experimental yield and theoretical yield? Discuss percent yield & percent error in your answer.

Experimental Yield is the amount of product you actually collect in lab.

% Yield : How much of the theoretical collected

$$\%\text{Yield} = \frac{\text{Exp}}{\text{Theor}}(100)$$

% Error : How far off you were from theoretical

$$\%\text{Error} = \frac{|\text{Exp} - \text{Theor}|}{\text{Theor}}(100)$$

3) 3.41 g of ammonia (NH_3) reacts with excess water to produce ammonium hydroxide. What would be the theoretical yield of ammonium hydroxide in grams?

$$NH_3\,(g) + H_2O\,(l) \longrightarrow NH_4OH\,(aq)$$

$$3.41\text{ g } NH_3\left(\frac{1\text{ mol } NH_3}{17.02\text{ g}}\right)\left(\frac{1\text{ mol } NH_4OH}{1\text{ mol } NH_3}\right)\left(\frac{35.05\text{ g}}{1\text{ mol } NH_4OH}\right) = \boxed{7.02\text{ g } NH_4OH}$$

4) Excess calcium nitrate reacts with 114.9 g of ammonium phosphate. What would be the theoretical yield of the precipitate?

$$3Ca(NO_3)_2\,(aq) + 2(NH_4)_3PO_4\,(aq) \longrightarrow Ca_3(PO_4)_2\,(s) + 6NH_4NO_3\,(aq)$$

$$114.9\text{ g } (NH_4)_3PO_4\left(\frac{1\text{ mol } (NH_4)_3PO_4}{149.09\text{ g}}\right)\left(\frac{1\text{ mol } Ca_3(PO_4)_2}{2\text{ mol } (NH_4)_3PO_4}\right)\left(\frac{310.18\text{ g}}{1\text{ mol } Ca_3(PO_4)_2}\right) = 119.5\text{ g } Ca_3(PO_4)_2$$

Key

Theoretical Yield Exit Slip

1) How do you know if a problem is a regular stoich conversion or a limiting reagent problem?

- If one reactant is present in excess & only one value is given it is a regular stoich conversion. (Ex: 12.5 g of NaCl is added to excess $CaBr_2$)
- If two amounts of reactants are given, you have to figure out which one is limiting. (Ex: 12.5 g of NaCl is added to 7.9 g of $CaBr_2$)

2) Determine the theoretical yield of iron in the following example:

Excess potassium is placed into a solution containing 33.0 g of dissolved iron (III) chloride.

$$3K(s) + FeCl_3(aq) \longrightarrow 3KCl(aq) + Fe(s)$$

$$33.0\text{ g } FeCl_3\left(\frac{1\text{ mol } FeCl_3}{162.20\text{ g}}\right)\left(\frac{1\text{ mol Fe}}{1\text{ mol } FeCl_3}\right)\left(\frac{55.85\text{ g}}{1\text{ mol Fe}}\right) = \boxed{11.4\text{ g Fe}}$$

3) Determine the theoretical yield of iron in the following example:

14.1 g of potassium are placed into a solution containing 33.0 g of dissolved iron (III) chloride.

$$3K(s) + FeCl_3(aq) \longrightarrow 3KCl(aq) + Fe(s)$$

① Who is limiting?

$$14.1\text{ g K}\left(\frac{1\text{ mol K}}{39.10\text{ g}}\right) = \boxed{0.361\text{ mol K}}$$

$$33.0\text{ g } FeCl_3\left(\frac{1\text{ mol } FeCl_3}{162.20\text{ g}}\right) = \boxed{0.203\text{ mol } FeCl_3}$$

How much you have

$$0.361\text{ mol K}\left(\frac{1\text{ mol } FeCl_3}{3\text{ mol K}}\right) = \boxed{0.120\text{ mol } FeCl_3}$$

needed to use up all of the K we have

- We have more than enough $FeCl_3$ to react all of the K (have 0.203 mol, only need 0.120 mol)
- Therefore $FeCl_3$ is the excess reagent & K is the limiting reagent

② Calc the theor. yield using amount of limiting

$$0.361\text{ mol K}\left(\frac{1\text{ mol Fe}}{3\text{ mol K}}\right)\left(\frac{55.85\text{ g}}{1\text{ mol Fe}}\right) = \boxed{6.72\text{ g Fe}}$$