Part I: Review of Limiting Reactants

1. Aqueous sodium hydroxide reacts with aqueous phosphoric acid in a typical acid-base neutralization reaction.

a. Write the balanced chemical equation for the above reaction.

b. Determine how many grams of sodium phosphate can be made from 18.0 grams of sodium hydroxide. Assume you have an excess of phosphoric acid.

c. Now, assume you have 18.0 grams of phosphoric acid and an excess of lithium hydroxide. How many grams of sodium phosphate can be made now?

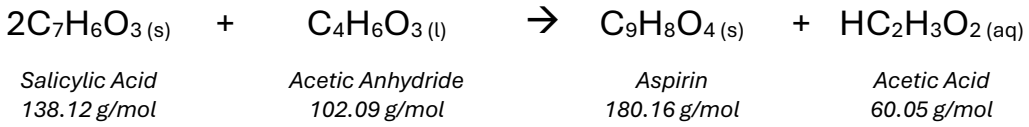
d. Given your answers from **1b** and **1c**, which is the actual limiting reactant, and what is the theoretical yield, in g, of sodium phosphate? Briefly explain your choice.

e. What is the percent yield if the actual yield is 22.8 g?

Part II: Calculating Remaining Excess Reactant

We can calculate how much of the excess reactant remains from a chemical reaction based on the amount of limiting reactant present.

2. The synthesis of aspirin is a common experiment done by many undergraduate chemistry student. The lab performed by students follows the following chemical reaction:



a. How many grams of aspirin can be made from 20.00 g of salicylic acid and an excess of acetic anhydride?

b. How many grams of aspirin can be made from 20.00 g of acetic anhydride and an excess of acetic acid?

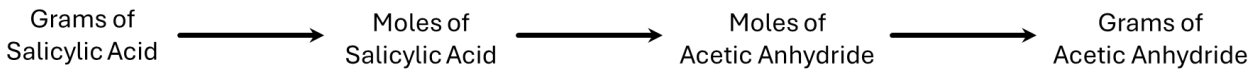
c. Based on your answers from questions **2a** and **2b**, what is the limiting reactant and theoretical yield of aspirin?

Theoretical Yield _____

Limiting Reactant _____

Now that we know our limiting reactant (which you should have found to be salicylic acid) we can determine how much of the excess reactant is left. A flow chart similar to that used in the previous worksheet will be provided to guide you in this first example. Fill in the conversion factors above the arrows if necessary.

d. How many grams of acetic anhydride will react with 20.00 grams salicylic acid? Once you have determined the amount of acetic anhydride will be used up in grams, subtract this amount from the initial 20.00 grams of acetic anhydride.



Part III: Extra Practice Problems

You now have the necessary tools to calculate limiting reactant, theoretical yield, percent yield, and remaining excess reactant! Use the following problems to practice these new skills.

3. Acrylonitrile, C_3H_3N is an important chemical used in making different plastics. Over 1.4 billion kg of acrylonitrile are produced each year in the United States alone.

a. Balance chemical reaction below which shows the synthesis of acrylonitrile liquid propylene (C_4H_6), ammonia gas, and oxygen gas.

$$\_\_\_\_\_\ C_3H_{6\,(l)} + \_\_\_\_\_\ NH_{3\,(g)}\ \_\_\_\_\_\ O_{2\,(g)} \rightarrow \_\_\_\_\_\ C_3H_3N_{\,(l)} + \_\_\_\_\_\ H_2O_{\,(l)}$$

b. Determine the limiting reactant, theoretical yield, and remaining mass of each excess reactant. The amounts of each reactant are provided below. Provide the theoretical yield and remaining excess reactants in units of kg.

1.5×10^3 kg of propylene 6.8×10^2 kg of ammonia 1.9×10^3 kg of oxygen

Limiting Reactant _____

Theoretical Yield _____

Excess Limiting Reactant 1 _____ **Excess Limiting Reactant 2** _____

c. What is the percent yield if 1.8×10^3 kg of acrylonitrile was produced?

4. Carborundum (silicon carbide, SiC) is an important industrial abrasive made by the high temperature reaction of SiO_2 with carbon according to the following unbalanced reaction:

$$\_\_\_\_\_\ SiO_{2\,(s)} + \_\_\_\_\_\ C_{(s)} \rightarrow \_\_\_\_\_\ SiC_{(s)} + \_\_\_\_\_\ CO_{(g)}$$

a. Balance the above chemical reaction.

b. Determine the limiting reactant, theoretical yield, and remaining mass of excess reactant if a manufacturer uses 500.0 grams each of SiO_2 C. Provide the theoretical yield and remaining excess reactants in units of g.

Limiting Reactant _____

Theoretical Yield _____

Excess Limiting Reactant _____

c. How much carborundum was made if the percent yield was 93.5%?

The next problem is not a limiting reactant problem but requires the same concepts.

5. The ceramic silicon nitride (Si_3N_4) is used in automobile engines and as an insulator in manufacturing integrated circuits. It is made by heating solid silicon with nitrogen gas at temperatures between 1300 – 1400°C.

a. Write a balanced chemical equation for the synthesis of silicon nitride.

b. How many kg of silicon are needed to produce 1.00 kg of silicon nitride if the process is 89.0% efficient?