Name _____

Limiting Reactants & Percent Yield

I. Why Do Reactions Stop?

1. **In most reactions, one or more reactants are in excess.**

(Circle One) : (True) False

Tool Sets
10 - Screwdrivers
5 - Pliers
4 - Hammers
4 Sets
2 - Screwdrivers
1 - Pliers
1 - Hammer
1 - Plier
2 - Screwdrivers
(left over)

2. **Differentiate between the terms limiting reactant and excess reactants.**

Limiting Reactant - limits the extent of a reaction (determines amount of product formed)

Excess Reactants - leftover when a reaction stops (ideally a common, inexpensive substance)

3. **Identify the limiting reactant and excess reactants in the following equation.**

$3N_2\,(g) + 3H_2\,(g) \longrightarrow 2NH_3\,(g) + 2N_2\,(g)$

Limiting Reactant = Hydrogen Excess Reactant = Nitrogen

II. Calculating Product

1. **Determine the amount of product formed and excess reactant from the following equation.**

$S_8\,(l) + 4Cl_2\,(g) \longrightarrow 4S_2Cl_2\,(l)$ ← disulfur dichloride (hardens rubber)

200 g 100 g

Step 1 : Convert molar masses to moles.

$$100\text{ g } Cl_2 \times \frac{1\text{ mol } Cl_2}{70.91\text{ g } Cl_2} = 1.410\text{ mol } Cl_2$$

$$200\text{ g } S_8 \times \frac{1\text{ mol } S_8}{256.5\text{ g } S_8} = 0.7797\text{ mol } S_8$$

Step 2 : Using the limiting reactant, calculate the product formed.

$$1.410\text{ mol } Cl_2 \times \frac{4\text{ mol } S_2Cl_2}{4\text{ mol } Cl_2} = \frac{135.0\text{ g } S_2Cl_2}{1\text{ mol } S_2Cl_2} = 190.4\text{ g } S_2Cl_2$$

Step 3 : Determine moles reacted.

$$1.410\text{ mol } Cl_2 \times \frac{1\text{ mol } S_8}{4\text{ mol } Cl_2} = 0.3525\text{ mol } S_8$$

Step 4 : Determine mass reacted.

$$0.3525\text{ mol } S_8 \times \frac{265.5\text{ g } S_8}{1\text{ mol } S_8} = 90.42\text{ g } S_8$$

Step 5 : Determine excess remaining.

$200\text{ g } S_8\text{ (available)} - 90.42\text{ g } S_8\text{ (needed)} = 109.6\text{ g } S_8\text{ (excess)}$

Name _____

III. Percent Yield

1. **List four reasons why chemical reactions may not go to completion.**

Inherent Errors

1. Liquid reactant or products adhere to surfaces/evaporate
2. Undesired products form
3. Solid product left on filter paper
4. Product "lost" in purification process

2. **Differentiate between the terms theoretical yield and actual yield.**

How many free throws can you make out of 100?

Theoretical Yield - maximum amount of product that can be produced from a given amount of reactant

Actual Yield - amount of product produced when the chemical reaction is carried out

3. **Define the term percent yield.**

Percent Yield - ratio of the actual yield to the theoretical yield as a percent (of the product)

4. **Write the equation to determine percent yield.**

$$\% \text{ Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$$

5. **Determine percent yield from the following equation if the theoretical yield of silver chromate (Ag_2CrO_4) is 0.488 g and the actual yield is 0.455 g.**

$AgNO_3$ - silver nitrate
K_2CrO_4 - potassium chromate
Ag_2CrO_4 - silver chromate
KNO_3 - potassium nitrate

$$2AgNO_3\,(aq) + K_2CrO_4\,(aq) \longrightarrow Ag_2CrO_4\,(s) + 2KNO_3\,(aq)$$

$$\frac{0.455\text{ g } Ag_2CrO_4}{0.488\text{ g } Ag_2CrO_4} \times 100 = 93.2\ \%$$

6. **Explain how sulfuric acid (H_2SO_4) is produced with high yields through a 3-step process.**

Step 1 : $S_8\,(s) + 8O_2\,(g) \longrightarrow 8SO_2\,(g)$

Combustion of sulfur (100 % yield)

Catalyst used to control temps.

Step 2 : $2SO_2\,(g) + O_2\,(g) \longrightarrow 2SO_3\,(g)$

Temperature increased (↑ reaction rate, ↓ yield)

Step 3 : $SO_3\,(g) + H_2O\,(l) \longrightarrow H_2SO_4\,(aq)$

Mixture cooled (Yields increase to 98 %)