

## Limiting Reactants & Percent Yield

### I. Why Do Reactions Stop?

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

(Circle One): True False

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

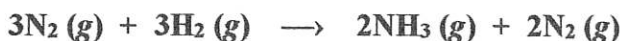
Limiting Reactant -

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

Excess Reactants -

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

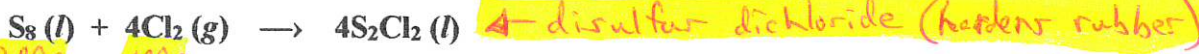
3. Identify the limiting reactant and excess reactants in the following equation.



Limiting Reactant = Hydrogen Excess Reactant = Nitrogen

### II. Calculating Product

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



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.

$$1.410 \text{ mol Cl}_2 \times \frac{4 \text{ mol S}_2\text{Cl}_2}{4 \text{ mol Cl}_2} = \frac{135.0 \text{ g S}_2\text{Cl}_2}{1 \text{ mol S}_2\text{Cl}_2} = 190.4 \text{ g S}_2\text{Cl}_2$$

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.

$$0.3525 \text{ mol S}_8 \times \frac{256.5 \text{ g S}_8}{1 \text{ mol S}_8} = 90.42 \text{ g S}_8$$

Step 5: Determine excess remaining.

$$200 \text{ g S}_8 (\text{available}) - 90.42 \text{ g S}_8 (\text{needed}) = 109.6 \text{ g S}_8 (\text{excess})$$

Tool Sets

10 - Screwdrivers

5 - Pliers

4 - Hammers

4 Sets

2 - Screwdrivers

1 - Pliers

1 - Hammer

1 - Plier

2 - Screwdrivers

(left over)

**III. Percent Yield**

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

- Inherent Errors**
- Liquid reactant or products adhere to surfaces/evaporate
  - Undesired products form
  - Solid product left on filter paper
  - Product "lost" in purification process

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

**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.

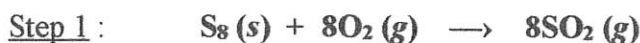
**Percent Yield** - ratio of the actual yield to the theoretical yield as a percent (of the product)

4. Write the equation to determine percent yield.

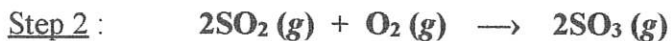
$$\% \text{ Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$$

5. Determine percent yield from the following equation if the **theoretical yield** of silver chromate ( $\text{Ag}_2\text{CrO}_4$ ) is 0.488 g and the **actual yield** is 0.455 g.

$$\frac{0.455 \text{ g } \text{Ag}_2\text{CrO}_4}{0.488 \text{ g } \text{Ag}_2\text{CrO}_4} \times 100 = 93.2\%$$

6. Explain how sulfuric acid ( $\text{H}_2\text{SO}_4$ ) is produced with high yields through a 3-step process.

Combustion of sulfur (100% yield)



Temperature increased (↑ reaction rate; ↓ yield)



Mixture cooled (Yield increase to 98%)

Catalyst used to control temp.

How many free throws can you make out of 100?

$\text{AgNO}_3$  - silver nitrate  
 $\text{K}_2\text{CrO}_4$  - potassium chromate  
 $\text{Ag}_2\text{CrO}_4$  - silver chromate  
 $\text{KNO}_3$  - potassium nitrate