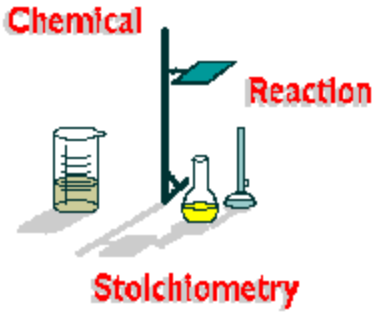
Chapter 9

Stoichiometry!!!



Stoichiometry

- Stoichio metry- “element” “measure”

-the measure of elements

- **Composition Stoichiometry-** mass relationships of elements in compounds
- **Reaction Stoichiometry-** mass relationships between reactants and products in a chemical reaction
  - Use given info to solve for an unknown
  - Use mole ratios to determine relationship between reactants and products

Stoichiometry is Cool !!!

4 Problem Types:

- Moles → Moles
- Moles → Moles → Mass
- Mass → Moles → Moles
- Mass → Moles → Moles → Mass

*** Mole Ratios

- Mole ratio's indicate the relative amount in moles of each substance in a reaction

- Ex: $2\ Al_2O_3 \rightarrow 4\ Al + 3\ O_2$

Ideal Calculations

- Start with a balanced equation
- Assume all reactants are converted to products

- Moles → Moles
- use mole ratio

Ex: **CO_2 + 2 LiOH → Li_2CO_3 + H_2O**

Ideal Calculations

2) Moles → Moles → Mass(g)

- Use mole ratio & multiply by molar mass

Ex: **CO_2 + 2 NaOH → Na_2CO_3 + H_2O**

Ideal Calculations

3) Mass → Moles → Moles

- Divide by molar mass, then use mole ratio

Ex: **$4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$**

Ideal Calculations

4) Mass → Moles → Moles → Mass

- Divide by molar mass, use mole ratio, then multiply by molar mass

Ex: **$4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$**

Mass → Moles → Moles → Mass

Ex:

$$\_\_\ Fe + \_\_\ H_2O \rightarrow \_\_\ Fe_3O_4 + \_\_\ H_2$$

Limiting Reactants:

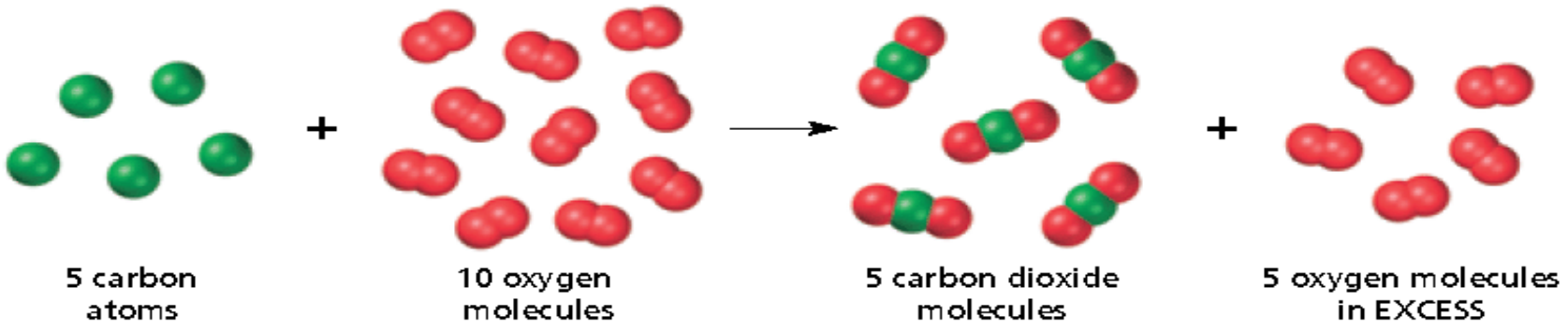
- **Limiting Reactant-** the substance that gets completely used up in a chemical reaction
  - Once the limiting reactant is all used up the reaction stops

- **Excess Reactant-** the substance that is left over after the reaction is complete

Limiting Reactant Example

Ex:

$$5\ C + 10\ O_2 \rightarrow 5\ CO_2 + 5\ O_2$$



Limiting/Excess Reactants

- Ex: $SiO_2 + 4\ HF \rightarrow SiF_4 + 2\ H_2O$

Suggested Steps For Limiting Reactant Problems:

- Find moles of each reactant available
- Determine the limiting reactant by dividing the moles of each reactant by the coefficient of each reactant
- Determine the moles & mass of the products
- Determine the left over mass of the excess reactant

Limiting Reactant Problem

Ex: **$3\ Fe + 4\ H_2O \rightarrow\ Fe_3O_4 + 4\ H_2$**

Percent(%) Yield

- **Theoretical Yield-** the maximum amount of product that can be formed from a given amount of a reactant
- **Actual Yield-** measured amount of a product actually produced in a reaction

% Yield = (Actual Yield / Theoretical Yield) x 100

Suggested Method

- Determine the theoretical yield of products in the given reaction
- Calculate the % Yield based on comparison between the actual and theoretical yields

Ex: $\mathbf{C_6H_6 + Cl_2 \rightarrow C_6H_5Cl + HCl}$

Practice Problem

1. Benzene, C_6H_6, is reacted with bromine, Br_2, to produce bromobenzene, C_6H_5Br, and hydrogen bromide, HBr, as shown below. When 40.0 g of benzene are reacted with 95.0 g of bromine, 65.0 g of bromobenzene is produced.

$$\mathbf{C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr}$$

a. Which compound is the limiting reactant?

b. What is the theoretical yield of bromobenzene?

c. What is the reactant in excess, and how much remains after the reaction is completed?

d. What is the percentage yield?

Extended Response

1. Benzene, C_6H_6, is reacted with bromine, Br_2, to produce bromobenzene, C_6H_5Br, and hydrogen bromide, HBr, as shown below. When 40.0 g of benzene are reacted with 95.0 g of bromine, 65.0 g of bromobenzene is produced.

$$\mathbf{C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr}$$

a. Which compound is the limiting reactant? **benzene**

b. What is the theoretical yield of bromobenzene? **80.4 g**

c. What is the reactant in excess, and how much remains after the reaction is completed? **bromine, 13.2 g**

d. What is the percentage yield? **80.8%**

END OF CHAPTER 9 NOTES!!!