MODULE 6- STOICHIOMETRY

REF: CHAPTER 8 OF TEXTBOOK, SECTION 8.1

TOPICS COVERED :

- ✓STOICHIOMETRY AND CHEMICAL EQUATIONS
- ✓YIELDS: THEORETICAL, ACTUAL AND PERCENT

STOICHIOMETRY AND CHEMICAL EQUATIONS

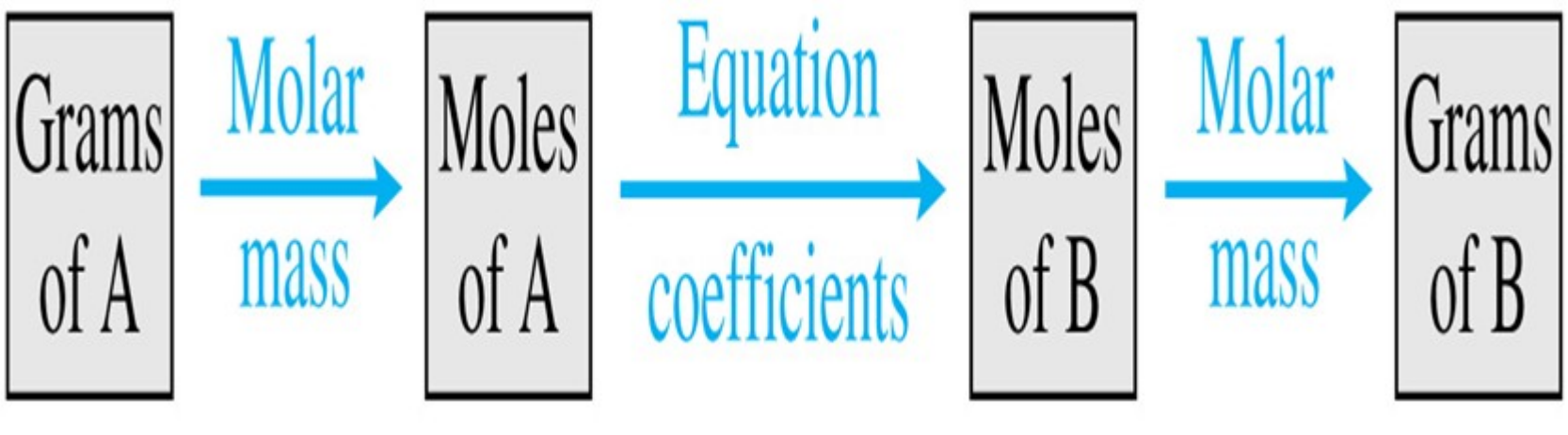
- *CHEMICAL STOICHIOMETRY* IS THE STUDY OF THE QUANTITATIVE RELATIONSHIPS AMONG REACTANTS AND PRODUCTS IN A CHEMICAL REACTION.

- THE WORD STOICHIOMETRY IS DERIVED FROM THE GREEK *STOICHEION* (ELEMENT) AND *METRON* (MEASURE).

- THE STOICHIOMETRY OF A CHEMICAL REACTION INVOLVES THE MOLAR RELATIONSHIPS BETWEEN REACTANTS AND PRODUCTS.

STOICHIOMETRY AND CHEMICAL EQUATIONS

Emphasizing:



STOICHIOMETRY AND CHEMICAL EQUATIONS

THE COEFFICIENTS IN A CHEMICAL EQUATION NOT ONLY DESCRIBE THE NUMBER OF ATOMS/MOLECULES BEING REACTED/PRODUCED, THEY ALSO DESCRIBE THE NUMBER OF MOLES OF ATOMS/MOLECULES BEING REACTED/PRODUCED.

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

Example - 5.46 mol N_2 completely react with how many mol of $\mathbf{H_2}$ and how many moles of $\mathbf{NH_3}$ is produced?

$$5.46 \text{ mol } N_2 \left(\frac{3 \text{ mol } H_2}{1 \text{ mol } N_2} \right)$$

= 16.4 mol H_2 are needed to react

$$5.46 \text{ mol } N_2 \left(\frac{2 \text{ mol } NH_3}{1 \text{ mol } N_2} \right)$$

= 10.9 mol NH_3 must be produced

STOICHIOMETRY PRACTICE

1). Bismuth (III) chloride will react with hydrogen sulfide to form Bismuth(III) sulfide and Hydrochloric acid. write the balanced equation for this reaction, then Calculate how many moles of acid would be formed if 15.0 mol of Hydrogen sulfide react.

$$2\,BiCl_3 + 3H_2S \longrightarrow Bi_2S_3 + 6HCl$$

$$15.0 \text{ mol } H_2S \left(\frac{6 \text{ mol HCl}}{3 \text{ mol } H_2S} \right) = 30.0 \text{ mol HCl}$$

STOICHIOMETRY PRACTICE

2). Sodium nitride can be formed by reacting Sodium metal with Nitrogen gas. Write the balanced equation for this reaction, then calculate how many moles of Sodium nitride can be produced from 25.0 g of Sodium ?

$$6\ Na + N_2 \longrightarrow 2\ Na_3N$$

$$\frac{25.0\ g\ Na}{} \left| \frac{1\ mol\ Na}{22.99\ g\ Na} \right| \frac{2\ mol\ Na_3N}{6\ mol\ Na}$$

$$= 0.362\ mol\ Na_3N$$

STOICHIOMETRY PRACTICE

QUES. 3). Sodium metal will react with gaseous ammonia to produce solid sodium amide, $NaNH_2$.

The unbalanced equation for this reaction is :

$$Na + NH_3 \longrightarrow NaNH_2 + H_2$$

Write the balanced equation for this reaction, then calculate how many moles of Sodium amide can be produced from 60.0 g of Ammonia?

$$2\,Na + 2\,NH_3 \longrightarrow 2\,NaNH_2 + H_2$$

$$\frac{60.0\text{ g } NH_3}{17.04\text{ g } NH_3} \times \frac{1\text{ mol } NH_3}{2\text{ mol } NH_3} \times \frac{2\text{ mol } NaNH_2}{} = \boxed{3.52\text{ mol } NaNH_2}$$

PERCENT YIELD

THEORETICAL YIELD: THE MAXIMUM AMOUNT OF PRODUCT YOU WILL GET IF THE REACTION OCCURS WITH COMPLETE EFFICIENCY.

ACTUAL YIELD: WHAT YOU "ACTUALLY" GET WHEN YOU PERFORM THE REACTION, I.E. THE AMOUNT OF A PRODUCT OBTAINED FROM A CHEMICAL REACTION.

PERCENT YIELD: THE RATIO OF THE ACTUAL YIELD (EXPERIMENTAL) TO THE THEORETICAL YIELD (CALCULATED) MULTIPLIED BY 100.

PERCENT YIELD

measured in lab

$$\%\ yield = \frac{actual\ \ yield}{theoretical\ \ yield} \times 100$$

calculated on paper

Percent Yield Practice

1). WHEN 45.8 g OF K_2CO_3 REACT WITH EXCESS HCl, 46.3 g OF KCl ARE FORMED. CALCULATE THE THEORETICAL AND % YIELDS OF KCl ?

$$K_2CO_3 + 2HCl \rightarrow 2KCl + H_2O + CO_2$$

45.8 g ? g

actual: 46.3 g

$$K_2CO_3 + 2HCl \rightarrow 2KCl + H_2O + CO_2$$

45.8 g ? g

actual: 46.3 g

THEORETICAL YIELD:

$$\frac{45.8\ g\ K_2CO_3}{138.21\ g\ K_2CO_3} \times \frac{1\ mol\ K_2CO_3}{1\ mol\ K_2CO_3} \times \frac{2\ mol\ KCl}{1\ mol\ K_2CO_3} \times \frac{74.55\ g\ KCl}{1\ mol\ KCl} = 49.4\ g\ KCl$$

$$K_2CO_3 + 2HCl \rightarrow 2KCl + H_2O + CO_2$$

45.8 g

49.4 g

actual: 46.3 g

THEORETICAL YIELD = 49.4 g KCl

$$\% \text{ Yield} = \frac{46.3 \text{ g}}{49.4 \text{ g}} = 100 = 93.7\%$$

Percentage yield practice

2). If 130 g is the actual yield of Iron (II) sulfide obtained in a reaction for which the theoretical yield is 142 g. Calculate the percentage yield of it ?

Given:

Actual Yield = 130 g

Theoretical Yield = 270 g

$$\text{Percentage Yield} = \frac{130\ g}{142\ g} \times 100 = 92\ \%$$