Date _____

STOICHIOMETRY

CHAPTER ONE DETAILED NOTES

STOTCHIOMETRY

DEFINITION

* "The study of relative amounts of substances involved in a chemical reaction is called Stoichiometry" **OR**
* "The quantitative measure of reactants and products" → (from Balochistan Board)

ORIGIN

* Greek word "Stoicheion" means "element" and "metry" means "measurement"

STOICHMETRIC AMOUNTS

→ The amount of reactants and products in a balanced chemical equation are called "Stoichiometric Amounts"

IMPORTANCE [from KPK Board]

→ It is essential when quantitative information about a chemical reaction is required

→ It tells how much of the matter is required to form a specific amount of another "matter"

→ It tells how much of the "product" could be

Date _____

formed under "given conditions" if a particular amount of "matter" is present.

→ It also plays an important role when calculating the amount of products such as "masses, moles, volumes and percentage yield etc"

ANALYTICAL CHEMISTRY → [KPK Side info]

→ It deals with the study of analysis of "obtaining, processing, characterizing" the "composition & structure of matter" both "qualitatively & quantitavily".

BALANCED CHEMICAL EQUATION → Bal Board

→ Balanced chemical equations have definite ratios of "reactants & products"

→ It has same number of "atoms" of each type on both sides of equation.

MOLE

DEFINITION

→ "One mole is the amount of substance that has as many particles (atoms, molecules, ions or formula units) as the number of atoms in exactly "12 g of carbon-12" → [Bal Board]

OR

→ "The atomic mass, formula mass and molecular mass of a substance expressed in "grams"

Date _____

IMP POINTS [Balochistan Board]

* Mole is a latin word ; it means a "huge mass"
* It's symbol is "mol"
* It is represented by "n"

OTHER DEF [KPK Board]

→ The amount of (mass) of substance , which contains Avogadro's number "(6.023×10^{23})" of particles (atoms , ions , molecules , formula units).

→ It establishes a link between mass of a substance & "number" of particles.

AVOGADROS NUMBER

DEFINITION

"The number of atoms , ions or molecules present in one mole of substance is called Avogadro's number"

VIP Points [Bal Board]

→ It's numerical value is "6.023×10^{23}"

→ It is represented by "N_A"

→ Scientists call this Avogdro's number in the honour of Italian scientist "Amedo Avogadro" (1776 - 1856)

→ The unit of Avogadro's number is read as "per mole" or "inverse of mole"

Date _____

QUALITATIVE ANALYSIS (KPK Board)

- It tells us "what" is in the sample

QUANTITATIVE ANALYSIS (KPK Board)

- It tells us "how much" is in the sample
- It's very important in medical science

MOLE RATIOS

- Mole ratio means the ratio of no of moles of "reactants" taking part and the number of moles of "products" formed.

MOLAR MASS

- The mass of mole of a substance "in grams" is called molar mass
- Its unit is "g/mol"

MOLAR VOLUME

- One mole of any gas at STP (standard temperature and pressure occupies volume of "22.414 dm^3."
- This volume is called "Molar volume"
- It is denoted by "Vm"

Date _____

STOICHIOMETRIC CALCULATIONS [BAL Board]

MOLE CALCULATIONS

- **MASS TO MOLES** → No of moles of a substance = $\frac{\text{Given mass}}{\text{Molar mass}}$
- **MOLES TO MASS** → Mass = Moles × Molar mass
- **PARTICLES TO MOLES** → Moles = $\frac{\text{Particles}}{\text{Avogadro's No}}$

PARTICLE CALCULATIONS

- **MOLES TO PARTICES** → Particles = Moles × NA
- **MASS TO PARTICLES** → Particles = $\frac{\text{Given mass}}{\text{Molar mass}}$ × NA

VOLUME CALCULATIONS

- **MOLES TO VOLUME** → Volume of gas = Moles × Molar volume
- **MASS TO VOLUME** → Volume = $\frac{\text{Mass}}{\text{Molar mass}}$ × Molar volume

PRINCIPLES [BAL board]

Stoichiometric Calculations are based on following principles

- Reactants are completely converted into products
- No side reaction occurs
- While doing calculations "law of conservation of mass" and "law of definite proportions" is obeyed

Date _____

LAW OF CONSERVATION OF MASS [Bal board]

→ According to this law "mass (matter)" can neither be "created or destroyed"

→ It states that "total mass of reactants" is equal to "total mass of products" in a chemical equation

LAW OF DEFINITE PROPORTIONS [Bal Board]

→ According to this law "a pure compound always contains the same element combined in the same ratio by mass"

PERCENTAGE COMPOSITION

DEFINITION

"The percentage composition is the number of parts by mass of an element" in to 100 parts by mass of a compound" → (Bal board)

OR

"The relative amount of each element in a compound are expressed as the "percentage composition" "

FORMULA

$$\text{Percentage composition of an element} = \frac{\text{Molar mass of Element}}{\text{Molar mass of Compound}} \times 100$$

Date _____

LIMITING REACTANT OR REAGENT

The reactant that is consumed completely in a chemical reaction is called limiting reactant or reagent.

→ It can also be defined as the reagent which produces "least number" of moles of "products" in a chemical reaction.

→ It "limits" or determines the amount of products formed in the reaction

→ "Na khaon ga, Na khelne dunga" (Sir MAK)

→ It stops the reaction

NON-LIMITING REACTANT OR REACTANT IN EXCESS

→ The reactant left "unused" or "un-reacted" after the completion of reaction

→ The reactant which is in "large amount"

THEORETICAL YIELD

→ The quantity of "product" calculated from a balanced chemical equation is called theoretical yield.

→ It is also called "Expected yield".

→ It is the ideal yield and calculated by "paper & pen".

ACTUAL YIELD

The quantity of product that is actually

Date _____

produced in a chemical reaction.

→ It is also called "practical yield"

→ It is determined by "experiment" thus also called "experimental yield"

→ The actual yield is always less than theoratical yield due to following reasons

1) Side reactions may produce "by-products"
2) Some reactions are reversible
3) "Mechanical loss" takes place due to filtration, distillation & separation by separating funnel, washing & crystallization etc.
4) Reaction "conditions" like temperature, pressure
5) "pH" etc might have been disturbed

→ If actual yield is very low, final cost can be high.

YIELD

"The yield of a chemical reaction is the amount of product that is produced from given amount of reactants"

PERCENT YIELD

→ The "efficiency" of a chemical reaction is determined with the help of percent yield, which is actually a comparism of actual yield & theoratical yield

FORMULA

→ $$\text{Percent yield} = \frac{\text{Actual yield}}{\text{Theoratical yield}} \times 100$$

Date _____

SIGNIFICANCE OF %age yield [Bal board]

- It shows efficiency of reaction
- Greater the %age yield, higher will be the efficiency of reaction & vice versa

TIDBITS [KPK Board]

- In the Chemical industry, you need to know the limiting reactant in order to get the maximum yield of product at "minimum cost"
- AMU (atomic mass unit) is defined as one-twelfth the mass of an atom of Carbon-12. Also known as "dalton (Da)" or "unified atomic mass unit (u)"
  - → 1 litre = $1\,dm^3$
  - → 1 litre = 1000 ml
  - → $1\,dm^3 = 1000\,cm^3$
- Equal volumes of different gases contain the "same" number of "particles", but
  - Equal mass of different gases "dont" contain the same number of particles