

# MOLE CONCEPT SHORT NOTES

## Mole - Just a number

1 mole =  $N_A$  particles

Avagadro's number  
 $= 6.02 \times 10^{23}$   
 $= 6 \times 10^{23}$

Atoms  
 Molecules  
 Ions  
 Electrons  
 Protons

## Fundamental particles:

	Mass	Charge
Electron	$9.1 \times 10^{-31}$ kg	$-1.6 \times 10^{-19}$ C
Proton	$1.672 \times 10^{-27}$ kg	$+1.6 \times 10^{-19}$ C
Neutron	$1.674 \times 10^{-27}$ kg	Zero

Mass -  $m_e < m_p < m_n$

Charge on  $e^-$  = charge on p

Charge is always quantized

$$q = \pm ne$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$n = 1, 2, 3, 4, \dots$$

$$1 \text{ Faraday} = 96500 \text{ C} = 1.6 \times 10^{-19} \times 6.02 \times 10^{23} \text{ C}$$

## Gram atomic mass [Unit = grams]

Mass of 1 mole atom of an element

$N_A$  atoms

H = 1g      Li = 7g  
 He = 4g      Be = 9g

## Average atomic mass (AAM)

$$\text{Cl}^{35} = 75\%$$

$$\text{Cl}^{37} = 25\%$$

$$\text{AAM} = \frac{(35 \times 75) + (37 \times 25)}{75 + 25} = 35.5$$

- Lowest AM < AAM < Highest AM

- AAM is closer to that isotopes where % is more.

$$1 \text{ amu} = \frac{1}{12} \times \text{mass of one } \text{C}^{12} \text{ atom}$$

$$1 \text{ amu} = \frac{1}{N_A} \text{ g} = 1.67 \times 10^{-24} \text{ g}$$

## Calculation of moles:

$$n = \frac{\text{Given wt}}{\text{Molar mass}}$$

Weight

Particles

$$n = \frac{\text{Given particles}}{N_A}$$

$$\text{wt} = \text{moles} \times \text{molar mass}$$

Always Valid.

Volume

$$n = \frac{\text{Given volume of gas at STP}}{22.4 \text{ L or } 22400 \text{ ml}}$$

22.4 L or 22400 ml

Valid only - 1) For gases.

2) At STP or NTP

## Vapour Density:

Relative Density

Relative to  $\text{H}_2$

$$V.D = \frac{\text{Molecular mass}}{2}$$

## Molecular mass [Unit = amu or u]

Mass of 1 molecule of a substance

$\text{H}_2\text{O} = 18 \text{ amu}$       Glucose = 180 amu

$\text{NH}_3 = 17 \text{ amu}$

## Atomic mass [Unit - atomic mass unit (amu) or unified mass (u)]

Mass of 1 atom of an element.

H = 1 amu

Li = 7 amu

He = 4 amu

Be = 9 amu

## Gram molecular mass [Unit = gram]

Mass of 1 mole molecule

$N_A$  molecule

$\text{H}_2\text{O} = 18 \text{ g}$

$\text{NH}_2\text{CONH}_2 = 60 \text{ g}$

## Molar mass:

Mass of 1 mole of a substance.

$\text{H}_2\text{O} = 18 \text{ g}$

Na = 23 g

$\text{NH}_3 = 17 \text{ g}$

Mg = 24 g

## Molar Volume

Volume of 1 mole of any gas at STP

22.4 l or 22400 ml

STP - Standard temp and pressure.

T = 0°C or 273 K

P = 1 atm.

## Formula mass:

Defined for ionic compounds

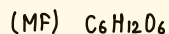
NaCl = 58.5 g of amu

## % Composition

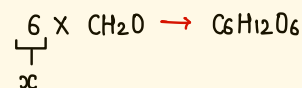
$$\% \text{ of any element} = \frac{\text{weight of element}}{\text{Molecular wt}} \times 100$$

# MOLE CONCEPT SHORT NOTES

**Molecular Formula** - Represents actual number of atoms in molecule.



**Empirical Formula** - Represents ratio in which atoms combine.



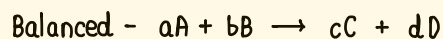
$$x = \frac{\text{Molecular Formula mass}}{\text{Empirical Formula mass}}$$

**Stoichiometry** - Balance the reaction

**Case:** When **information** about only one reactant and product is given.

→ Moles  
→ Particles  
→ Volumes

**General equation**



Mass  
Volume  
Particles } → Moles

**Magical equation**

$$\frac{n_A}{a} = \frac{n_B}{b} = \frac{n_C}{c} = \frac{n_D}{d}$$

**Case-2:** When information about 2 or more than 2 reactant is given.

**Limiting reagent** - that reagent which is consumed first in the reaction.

Q. How to Find Limiting Reagent LR?

→ That reagent is LR whose **Moles SC** is minimum.

→ Per stoichiometric.

[If value is same then there is no LR]

Element	%	%/AM	Relative Ratio	Simplest Ratio
C	80	$80/12 = 20/3$	$\frac{20/3}{20/3} = 1$	1
H	20	$20/1 = 20$	$\frac{20}{20/3} = 3$	3

(CH<sub>3</sub>)

**% V/V**

Volume of solute in ml present in 100 ml of solution.

$$\% V/V = \frac{\text{Volume of solute in ml} \times 100}{\text{Volume of solution in ml}} \rightarrow 30\% V/V$$

30 ml of solute in 100 ml of solution

$$\therefore V_{\text{solvent}} = 70 \text{ ml}$$

**% w/v**

Weight of solute in gm present in 100 ml of solution.

$$\% w/v = \frac{\text{Weight of solute in gm} \times 100}{\text{Volume of solution in ml}} \rightarrow 30\% w/v$$

30 gm solute in 100 ml of solution

**Solution**

**Solute (B)**

$n_B$

$$x_B = \frac{n_B}{n_A + n_B}$$

**Solvent (A)**

$n_A$

$$x_A = \frac{n_A}{n_A + n_B}$$

$$x_A + x_B = 1$$

**Molarity:**

$$M = \frac{n_{\text{solute}}}{\text{Vol. of solution in L}}$$

Vol. of solution in L

**Molar - 1M**

**Semi-molar -  $\frac{1}{2}$  M**

**Deci molar -  $\frac{1}{10}$  M**

$$M = \frac{n_{\text{solute}} \times 1000}{\text{Vol. of solution in ml}}$$

Vol. of solution in ml

**Molality**

$$m = \frac{n_{\text{solute}}}{\text{weight of solvent in kg.}}$$

weight of solvent in kg.

**Molal - 1m**

**Semi-molal -  $\frac{1}{2}$  m**

**Deci-molal -  $\frac{1}{10}$  m**

$$m = \frac{n_{\text{solute}} \times 1000}{\text{weight of solvent in g}}$$

weight of solvent in g

**Parts per million (PPM)**

$$PPM = \frac{\text{Weight of solute} \times 10^6}{\text{Weight of solution}}$$

**Mole Fraction (x)**

$$x_{\text{substance}} = \frac{n_{\text{substance}}}{n_{\text{total}}}$$

# MOLE CONCEPT SHORT NOTES

% w/w

Weight of solute in gm present in 100 gm of solution.

$$\% w/w = \frac{\text{Weight of solute in gm} \times 100}{\text{Weight of solution in gm}} \quad \rightarrow 30\% w/w$$

30 gm of solute present in 100 gm of solution

W solvent = 70 gm.

Solute + Solvent = Solution

W solute + W solvent = W solution

V solute + V solvent = V solution

Homogenous solution

Concentration terms

Temperature dependent

→ % v/v

→ % w/v

→ Molarity

→ Normality

Temperature independent

→ % w/w

→ Mole Fraction

→ Molality

→ PPM

## Mixing of Solutions

Case I : When two non-reacting substances are mixed.

→ Acid + Acid

→ Base + Base

Case II : When reacting species are mixed.

→ Acid + Base

## Some important terms :

a)  $\% w/v = \% w/w \times d$

b)  $M = \frac{10 \times \% w/w \times d}{\text{MM solute}}$

c)  $m = \frac{1000 M}{1000 d - M \times \text{MM solute}}$

d)  $m = \frac{\% \text{ solute} \times 1000}{\% \text{ solvent} \times \text{MM solvent}}$

d = density

M = Molarity

MM solute = Molar mass solute

m = molality.

## Dilution :

On Dilution — a) Moles solute remains same.

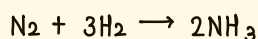
b) Concentration decreases.

(  $M_1 V_1 = M_2 V_2$  )

c) Volume increases.

## % Yield

Q. 5 moles of  $N_2$  reacts with  $H_2$  to form 8 moles of  $NH_3$ .



5 moles                      10 moles

$$\% \text{ yield} = \frac{8}{10} \times 100 = 80\%$$