MIND MAP

Mole Concept

Laws of Chemical Combination

- Atoms combine to form a molecule.
- An atom has different affinities with different atoms to combine.
- This is the reason molecules react with each other.
- There are some basic laws of chemical combination based upon factors mentioned above.

Law of Conservation of Mass/Energy

- Atoms can neither be created nor destroyed during the course of a chemical reaction.
- Mass of all the reactants is equal to the mass of all the products if no reactant is in excess.

Total mass of reactants = Total mass of products + Unreacted substance

Law of Constant Proportions[Proust]

A molecule will always have fixed proportion of its constituent atoms.

Law of Multiple Proportions

When two elements combine with each other to form more than one compound, the weights of one element that combine with a fixed weight of the other are in a simple ratio.

Gay-Lussac's Law of Gaseous Volume

For the reactions where reactants and products are all moles.
The reactants and the products are in the simple ratio of their volumes.

Avogadro Hypothesis

Under similar conditions of T and P, Equal volume of all gases contain equal number of MOLECULE

Atomicity

Atomicity means number of atoms presents in a molecule of an elementary gas.

Atomic Mass Unit (amu)

The quantity $1/12^{th}$ mass of an atom of C^{12} is known as one atomic mass unit.

$1/12^{th}$ part of mass of 1 C^{12} atom = 1 amu= 1.66056×10^{-24} g

$$1\ g = N_A\ amu$$

Mole

1 Mole is the amount of any substance that contains N_A particles
Avogadro Number, N_A, is exactly equal to the number of atoms in 12 grams of C-12 isotope.
Number of moles

$$n = \frac{\text{Number of particles}}{N_A}$$

Mass of Element And Number Of Atoms

$$\text{Number of atoms} = \frac{\text{mass (in g)}}{\text{gram} - \text{atomic mass}} x N_A$$

Average Atomic Mass

The atomic weight of most of the elements is fractional due to the presence of isotopes.

Average Atomic weight =

$$\frac{\sum(\%\ \text{abundance x atomic weight})}{100}$$

Gram Atomic Mass

Mass of 1 mole atoms, expressed in gram

gram atomic mass (GAM)

= mass of 1 gram atom

= mass of 1 mole atoms

= mass of N_A atoms

= mass of 6.022×10^{23} atoms.

MIND MAP

Mole Concept

Molecular Mass

The molecular mass of a substance is the sum of atomic masses of the elements present in a molecule

Formula Mass

- Substances like Sodium Chloride (Ionic Compounds) does not contain discrete molecules as their constituent units.
- The chemical formula of such substances are the simplest ratio of their constituent ions called formula units.
- Formula mass is calculated similar to molecular mass.

Gram Molecular Mass

When numerical value of molecular mass of the substance is expressed in grams then it is called gram molecular mass or GMM of the substance.

gram molecular mass (GMM)

= mass of 1 gram molecule
= mass of 1 mole molecules
= mass of N_A molecules
= mass of 6.022×10^{23} molecules

Molar Mass The mass of one mole(N_A entities)of the substance, in gram.

Gram Molecular Volume (GMV)

1 mole of any gas occupies 22.4 litre of volume at STP.

Vapour Density

It is the ratio of density of gas or vapours of any solid or liquid substance relative to the density of hydrogen gas under identical conditions.

$$\text{Vapour Density (V.D.)} = \frac{\text{density of gas}}{d_{H_2}}$$

Empirical Formula

Formula depicting constituent atoms in their simplest ratio.

Molecular Formula

Formula depicting actual number of atoms in one molecule of the compound.

Parts Per Million (ppm)

Units of parts per million (ppm) or per billion (ppb) are often used to describe the concentrations of solutes in very dilute solutions. The units are defined as the number of grams of solute per million or per billion grams of solvent.

Determination of Empirical Formula

(i) First of all find the % by weight of each element present in 1 molecule of the compound.

(ii) The % by wt of each element is divided by its atomic weight. It gives atomic ratio of elements present in the compounds.

(iii) Atomic ratio of each element is divided by the minimum value of atomic ratio so as to get simplest ratio of atoms.

Empirical Formula to Molecular Formula

Divide the molecular mass (determined experimentally by some suitable method) by the empirical formula mass and find out the value of n.

molecular formula = empirical formula × n

Solution

Homogeneous Mixture of two or more pure substances.

Solution= Solute + Solvent(2 Components)

MIND MAP

Mole Concept

Concentration

Concentration is the amount of solute dissolved in the unit amount of the solvent.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} \text{ gm/cc}$$

$$\text{Relative Density} = \frac{\text{Denisty of any substance}}{\text{Denisty of reference substance}}$$

$$\text{Specific gravity} = \frac{\text{Denisty of any substance}}{\text{Density of water at } 4^0\text{C}}$$

$$\%\ \text{by mass}\ \frac{w}{W} = \frac{\text{wt. of solute}}{\text{wt. of solution}} \text{ x } 100$$

X % by mass means 100 gm solution contains X gm solute (100 – X) gm solvent

Mass-Volume %

The mass of solute present in 100 cm^3 of solution.

For example, If 100 cm^3 of solution contains 5 g of sodium hydroxide, than the mass-volume percentage will be 5% solution.

$$\%\ \frac{w}{V} = \frac{\text{wt. of solute}}{\text{volume of solution}} \times 100$$

Volume %

Both components are in liquid state. It is the number of parts of by volume of solute per hundred parts by volume of solution.

$$\%\ \frac{v}{V} = \frac{\text{Volume of solute} \times 100}{\text{Volume of solution}}$$

$$\text{Mole } \% = \frac{\text{Moles of solute}}{\text{Total Moles}} \text{ x } 100$$

For gases % by volume is same as mole %

Mixing of Solutions

It is Based upon Law of conservation of moles

Case 1. Two solutions having same solute

$$\text{Final Molarity} = \frac{\text{Total moles}}{\text{Total volume}} = \frac{M_1V_1 + M_2V_2}{V_1 + V_2}$$

Case 2. Extra Solvent is added (Dilution)

The moles of solute do not change but molarity changes

$$\text{Final Molarity} = \frac{M_1V_1}{V_1+V_2}$$

Mole Fraction

The ratio of number of moles of one component to the total number of moles of all the components (solute and solvent) present in solution.

$$\text{Mole fraction} = \frac{\text{Moles of solute}}{\text{Total Moles}}$$

Molarity (M)

The number of moles of solute present in one litre or one dm^3 of the solution or millimol of solute present in one mL of solution.

$$\text{Molarity (M)} = \frac{\text{Mole of solute}}{\text{volume of solution in litre}}$$

Molality (m)

The number of gram mole of the solute present in 1000 g of the solvent is known as molality of solution.

$$\text{Molality (m)} = \frac{\text{Mole of solute}}{\text{Mass of solvent (in Kg)}}$$

MIND MAP

Mole Concept

Stoichiometry

Stoichiometry is the calculation of amounts of reactants and products involved in a chemical reaction.

Stoichiometric calculations require a balanced chemical equation of the reaction.

Stoichiometric Coefficients

Stoichiometric coefficients of chemical equation tells us about the ratio in which moles of reactants react and moles of products form.

Ex.

$3H_2$ +	N_2	$2NH_3$ (g)
3 moles	1 mole	2 moles
$3N_A$ molecules	N_a molecule	$2N_A$ molecules
3 molecules	1 molecule	2 molecules

Limiting Reagent

The reactant which is consumed completely during the course of reaction, is called limiting reagent.

The amount of product formed will be according to the limiting reagent because as the limiting reagent will be consumed completely, the reaction will stop.

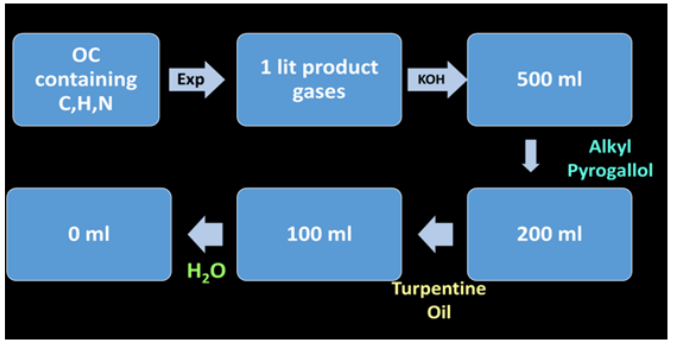
Percent Yield

The amount of the product that is actually obtained is called the actual yield.

$$\% \text{ yield} = \frac{\text{Actual yield}}{\text{Theoretical yield}} \ 100$$

Eudiometry (Gas Analysis)

Eudiometry or gas analysis involves the calculations based on gaseous reactions or the reactions in which at least two components are gaseous, in which the amounts of gases are represented by their volumes, measured at the same pressure and temperature.



% Labelling of Oleum

Oleum, or fuming sulfuric acid, is a solution of various compositions of sulphur trioxide in sulphuric acid (mix of H_2SO_4 and SO_3).

'% oleum' means the maximum amount of H_2SO_4 that can be obtained from 100 gm of such oleum by adding sufficient water.

% labelling of oleum sample = (100 + x)%

x = mass of H_2O required for the complete conversion of SO_3 in H_2SO_4

Volume Strength of H_2O_2 Solution

Labelled as 'volume H_2O_2' means volume of O_2 (in litre) at 1 atm & 273 K that can be obtained from 1 litre of such a sample when it decomposes according to

$$H_2O_2 \longrightarrow H_2O + 1/2O_2$$

Volume Strength of H_2O_2 Solution = 11.2 ×molarity (At 273K & 1 atm)