

-
- (v) The **liquid** is the intermediate state between solid and gas. (vi) **Evaporation** is the escape of molecules from the surface of liquid.

(vi)

SOLUTION AND SUSPENSION

SOLUTION:

"Homogenous mixture of two or more substance is called a Solution."

Examples:

- Salt and water uniformly mixed to form a solution.
- Sugar and water uniformly mixed to form a solution.
- Zinc and copper are mixed by melting them together uniformly to form solution called brass.

SOLUTE:

"The substance which is to be dissolved in other substance to form a solution and present in lesser amount is called a solute."

Example:

Sugar and salt are used as solute in their respective.

SOLVENT:

"The substance which dissolves other substance in it and present in generally greater amount is called a solvent."

Example:

Water is used as a solvent in the aqueous solutions of all the substances.

Types of solution with respect to the quantity of solute:

Saturated solution:

"The solution which contains maximum amount of solute and can't hold more solute in it at a particular temperature and pressure is called saturated solution."

Super saturated solution:

"The solution which contains more amount of solute than its holding capacity at particular temperature and pressure is called super saturated solution."

Unsaturated solution:

"The solution which contains lesser amount of solute than its holding capacity at particular temperature and pressure is called unsaturated solution."

Preparation of an unsaturated solution:

Take few crystals of sugar and dissolve them in water. This results in an unsaturated solution, because the solution has a capacity to dissolve more crystals of sugar (solute) at a given temperature.

Preparation of saturated solution:

Take some sugar and dissolve in a beaker containing 100 ml of water. After dissolving those crystals, add more sugar until the added crystals start to settle down at room temperature. This solution is called saturated solution.

Preparation of super saturated solution:

To prepare super saturated solution take a saturated solution and dissolve more solute by increasing temperature or pressure (where it effect) and a solution forms which contain more solute than its holding capacity at room temperature. Types of solutions:

Solute	Solvent	Examples
Solid	Solid	Alloys such as brass (copper and zinc). Bronze (copper and tin). Steel (carbon and iron). Glass.
Solid	Liquid	Sugar in water. Salt in water. Sea water.
Solid	Gas	Smoke (carbon particles in air).
Liquid	Solid	Amalgam (e.g. mercury in sodium). Water in jelly powder.
Liquid	Liquid	Water in milk. Milk in tea. Alcohol in water. Vinegar (acetic acid in water).
Liquid	Gas	Cloud (water vapor in air). Steam.
Gas	Solid	Hydrogen gas absorbed over palladium. Platinum metal surface.
Gas	Solid	Carbonated soft drinks such as Pepsi etc. Ammonia gas in water. Air dissolved in water.
Gas		Air is the homogenous mixture of 78% N ₂ , 21% O ₂ and 1 % other gases.

SOLUBILITY:

“Maximum amount of solute which is required to saturate 100g of solvent (water) at particular temperature or pressure is called solubility.”

FACTORS AFFECTING SOLUBILITY:

Following factors affect solubility.

- i. Temperature.
 - ii. Pressure.
 - iii. Nature of solute or solvent.
- i. AFFECT OF TEMPERATURE ON SOLUBILITY:**
- a. Affect of temperature on the solubility of solid and liquids in liquid:**
The solubility of solid in liquid or solubility of partially miscible liquids increases with increase in temperature.
For example: The solubility of sugar on water at 0°C is 179 g/100ml whereas at 100°C it is 487 g/100ml.
- b. Affect of temperature on the solubility of gases in liquids:**
The solubility of gases in a liquid decreases with the increase in temperature. For this reason when a glass of cold water is warmed, bubbles of air are seen on the inside of the glass.
- ii. AFFECT OF PRESSURE ON SOLUBILITY:**

Henry's law:

“Solubility of a gas in a liquid is directly proportional to the pressure of gas.”

$$m \propto P$$
$$m = K P$$

Where m = amount of gas dissolved.

K = Constant.

P = Pressure.

- a. Affect of pressure on the solubility of solids and liquids in liquids:**
There is no effect of pressure on the solubility of solids and liquids in liquids.
- b. Affect of pressure on the solubility of gases in liquid:**
The solubility of gases in liquid increase by the increase in pressure like carbonated drinks (soft drinks i.e. 7up, sprite etc.). CO₂ is filled with slightly greater than One atmospheric pressure because at one atmosphere it is not good soluble. When the bottles are opened pressure decreases, so solubility of CO₂ also decreases, hence bubble of CO₂ come out from solution.
- iii. AFFECT OF NATURE OF SOLUTE ON SOLUBILITY:**
Solubility of a substance works with a proverb “LIKE DISSOLVE LIKE.”
Therefore

-
- Ionic solids are only soluble in polar solvent being similar in charge like common salt and many other ionic substances are soluble in water because water is polar.
 - Polar substances are soluble in polar solvents like sugar; HCL etc. are soluble in water because water is a polar compound.
 - Non-polar substances are soluble in non-polar solvents like oil, grease, nail polish are soluble in solvent like alcohol, benzene, thinner, petrol etc.

CRYSTALLIZATION:

"The process of formation of geometrical shaped solid substances is called Crystallization."

PROPERTIES OF CRYSTALLIZATION SUBSTANCES:

- They have sharp melting points.
- They have regular and definite shapes.
- They contain water molecules called water of crystallization.
- They are homogenous solids.

PROCESS OF CRYSTALLIZATION:

To prepare crystals of any material first a super saturated solution of that solid is prepared at high temperature and allowed to cool down, then at lower temperature it can't hold more solute in dissolve state, some of the dissolved solute particles come out of solution in solid form having regular and definite geometrical shape which are called Crystals.

PREPARATION OF CRYSTALS OF COPPER SULPHATE $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ (BLUE VITRIOL):

To prepare the crystals of copper sulphate first its saturated solution is prepared in a beaker at room temperature and then more quantity of copper sulphate is added to make super saturated solution by heating and stirring the solution continuously with a glass rod. Now allow this super saturated solution to cool down at room temperature. Upon cooling and standing, Blue vitriol crystals of copper sulphate formed. The shape of these crystals can be observed under light microscope.

PREPARATION OF CRYSTALS OF POTASSIUM NITRATE (KNO_3):

To prepare the crystals of potassium nitrate first its 100 ml saturated solution is prepared in beaker at room temperature by dissolving 37g of solute and then add 20g more to make super saturated solution by heating up to 50°C and stir the solution continuously with a glass rod. Filter the hot super saturated solution and collect filtrate in another beaker and then allow it to cool down at room temperature. Upon cooling crystals of potassium nitrate are formed. Filter the crystals and then their shape can be observed ~~under~~ under light microscope.

PURIFICATION OF SOLIDS BY CRYSTALLIZATION:

Following are the steps with the help of which solid can be purified through crystallization:

- Preparation of super saturated solution.
- Filtrate of hot super saturated solution.
- Formation of crystals.
- Filtration of crystals.

v. Filtration and drying of crystals.

i. Preparation of super saturated solution:

Take 50 ml of water in a beaker and add the impure sample (40g) of KNO_3 to it while stirring with glass rod. Supply heat gently till the temperature of the solution is above 50°C stir the solution at this temperature till most of the solid is dissolved.

ii. Filtration of hot super saturated solution:

Filter the hot solution and collect residue on the filter paper and collect the filtrate in another beaker.

iii. Formation of crystals:

On cooling, the crystals of potassium nitrate will start appearing.

iv. Filtration and drying of crystals:

When no more crystals are formed, filter it again and collect filtrate in a beaker. Purified crystals of KNO_3 are obtained on the filter paper and then dry the crystals by keeping them in between dry filter paper to observe.

Note:

The filtrate contains some quantity of the dissolved KNO_3 along with the NaCl , being a soluble impurity.

CONCENTRATION OF A SOLUTION:

"The amount of solute dissolve in a definite amount of solvent or solution is called concentration."

It can be expressed in following ways:

- i. Molarity.
- ii. Molality.
- iii. Mole fraction.
- iv. Percentage concentration.
- v. Normality.

i. MOLARITY:

"Number of moles of solute dissolved in a litre or dm^3 of a solution is called molarity."

Formulae:

$$M = (\text{Number of moles of solute}) / (\text{volume of solution in litre or } \text{dm}^3)$$
$$M = (\text{Mass of solution in gram}) / (\text{gram formula mass or grammolecular mass} \times \text{volume of solution in litre or } \text{dm}^3)$$

$$M = (\text{Mass of solute in gram} \times 1000) / (\text{Gram formula mass or gram molecular mass} \times (\text{volume of solution in ml or } \text{cm}^3))$$

UNIT:

Molarity is measure in moles per litre or cubic decimeter.

$$\text{Molarity} = \text{mol/litre or dm}^3$$

NAMES OF SOLUTIONS ACCORDING TO THEIR MOLARITIES:

MOLAR SOLUTION	= 1 mol/dm ³ .
SEMI MOLAR SOLUTION	= 0.5 mol/dm ³ .
BIMOLAR SOLUTION	= 2 mol/dm ³ .
TRIMOLAR SOLUTION	= 3 mol/dm ³ .
DECIMOLAR SOLUTION	= 0.1 mol/dm ³ .

ii. MOLALITY:

"Number of moles of solute dissolve in a kilogram of solvent is called molality." **Formulae:**

$$M = (\text{Number of moles of solute}) / (\text{Mass of solvent in kilogram}).$$

$$M = (\text{Mass of solute in gram}) / (\text{Gram formula mass or gram molecular mass of solvent in Kg}). \quad M = (\text{Mass of solute in gram} \times 1000) / (\text{Gram formula mass or gram molecular mass} \times \text{mass of solvent in Kg}).$$

UNIT:

Molality is measured in moles per kilogram.

$$\text{Molality} = \text{mol/kg}.$$

NAMES OF SOLUTION ACCORDING TO THEIR MOLALITIES:

MOLAL SOLUTION	= 1 mol/Kg.
SEMI MOLAL SOLUTION	= 0.5 mol/Kg.
BIMOLAL SOLUTION	= 2 mol/Kg.
TRIMOLAL SOLUTION	= 3 mol/Kg.

iii. MOLE FRACTION:

"The relation between the number of moles of either solute or solvent and the sum of moles of solute and solvent is called Mole fraction."

$$\text{Mole fraction} = (\text{number of moles of solute or solvent}) / (\text{sum of moles of solute and solvent})$$

If

$$\text{Number of moles of solute} = n_1.$$

$$\text{Number of moles of solvent} = n_2.$$

Then

$$\text{Mole fraction of solute} = n_1 / (n_1 + n_2)$$

iv. PERCENTAGE CONCENTRATION:

"The amount of solute dissolved in 100 parts of solvent is called percentage solvent."

It is expressed in following ways:

- Mass by mass percentage concentration (m/m %).
- Mass by volume percentage concentration (m/v %).
-

Volume by mass percentage concentration (v/m %). iv.
Volume by volume percentage concentration (v/v %).

i. Mass by Mass percentage concentration:

If both solute and solvent are taken on the basis of their masses is called mass by mass percentage concentration.

$$m/m \% \text{ age conc.} = (\text{mass of solute} / \text{mass of solution}) \times 100\%$$

Example:

25 % m/m conc. Of NaOH solution means 25 g of NaOH dissolved in 75g of water to make 100 g of solution.

ii. Mass by volume percentage concentration:

If a particular mass of solute is dissolved in a definite volume of solution, the percentage concentration is called mass by volume percentage concentration.

$$m/v \% \text{ age conc.} = (\text{mass of solute} / \text{volume of solvent or solution}) \times 100\%$$

Example:

15% m/v conc. Of NaCl solution means 15g of NaCl dissolved in 100 cm³ of solution.

iii. Volume by mass percentage concentration:

If a particular volume of solute is dissolved in a particular mass of solution, the percentage concentration is called volume by mass percentage concentration.

$$v/m \% \text{ age conc.} = (\text{volume of solute} / \text{mass of solvent or solution}) \times 100\%$$

Example:

20 % v/m conc. Of HCl solution means 20 cm³ of HCl dissolved in 100g of solution.

iv. Volume by volume percentage concentration:

If both solute and solvent are taken on the basis of their volumes is called volume by volume percentage concentration.

$$v/v \% \text{ age conc.} = (\text{volume of solute} / \text{volume of solvent or solution}) \times 100\%$$

Example:

30 % v/v conc. Of acetic acid solution means 30 cm³ of acetic acid dissolved in 70 cm³ of water to make 100 cm³ of solution.

SUSPENSION:

A heterogeneous mixture consists of visible particles, each of which contains millions of molecules surrounded by molecules of liquid is called suspension.

Properties of Suspension:

- i. The size of their particles is 1000 nm.
- ii. Particles of suspension can be seen through low power microscope.
- iii. They are heterogeneous mixtures.
- iv. Their particles settle down.
- v. They are not transparent.
- vi. Their components can be separated by filtration.

Example:

- i. Smoke: A suspension of the particles of carbon in a gas or air.
- ii. Mud (slime): A suspension of fine particles of soil in small amount of liquid.
- iii. Foam (froth): A suspension of fine particles of gas in liquid.
- iv. Emulsion: A suspension of droplets of one liquid into another in which it is not soluble:

DIFFERENCE BETWEEN SUSPENSION AND SOLUTION:

S/NO	SOLUTION	SUSPENSION
1	The size of their particles is 0.1 nm to 1 nm.	The size of their particles is 1000 nm.
2	Particles of solution can't be seen through low power microscope.	Particles of suspension can be seen through low power microscope.
3	They are homogeneous mixture.	They are heterogeneous mixture.
4	Their particles don't settle down.	Their particles settle down.
5	They are generally transparent.	They are not transparent.
6	Their components can't be separated by filtration	Their components can be separated by filtration.

EXERCISES

1. Fill in the blanks:
 - i. The most common solvent in nature is **water**.
 - ii. An **aqueous** is the solution when the liquid solvent is water.
 - iii. 10 % solution contain 10gm solute, dissolved in **90** g solvent.
 - iv. **M** is the symbol for the concentration unit of molarity.
2. Calculate molarity of solution containing 16 gm glucose per 300 ml solution.

DATA:

Given:

- Mass of solute = 16 g.
- Volume of solution = 300 ml.
- Gram formula mass of glucose = 180 g.

Required:

Molarity =?

Formula:
$$M = \frac{\text{Mass of solute in gram} \times 1000}{(\text{Gram formula mass or gram molecular mass} \times (\text{volume of solution in ml or cm}^3))}$$
Solution:

$$M = (16 \times 1000) / (180 \times 300)$$

Answer: Molarity = 0.296 mol. /dm³

Find the mass of sucrose (Molecular Mass = 342) required to be dissolved per 60 cm³ solution to prepare a semi molar solution.

Given:

Molarity	= semi molar = 0.5 mol. /dm ³ .
Volume of solution	= 600 cm ³ .
Gram molecular mass of sucrose	= 342 g.

Required:

Mass of solute =?

x (volume of

3.

3

DATA:

3

Formula:
$$\text{Mass of solute} = \frac{\text{Molarity} \times \text{gram formula mass of solute} \times \text{volume of solution in cm}^3}{1000}$$
Solution:

$$\text{Mass of solute} = (0.5 \times 342 \times 600) / 1000$$

$$\text{Mass of solute} = 102.6 \text{ g}$$

Answer:

Mass of sucrose = 102.6 g.

4. 5.3 gm Na_2CO_3 was dissolved in 800g water, calculate the molality of solution.

DATA:

Given:

Mass of solute = 5.3 g.

Mass of solvent = 800 g.

Gram formula mass of Na_2CO_3 = 106 g.

Required:

Molality =?

Formula:

$$M = \frac{\text{Mass of solute in gram} \times 1000}{\text{Gram formula mass or gram molecular mass} \times \text{Mass of solvent in kg}}$$

Solution:

$$\text{Molality} = \frac{5.3 \times 1000}{106 \times 800}$$

Answer: