I) DEFINITIONS:

1)Solution: A homogenous mixture of two or more non-reacting chemical substances whose composition can be varied within certain limits is called a solution.

2) Solvent: The component of the solution which constitutes larger part of the solution is called solvent.

3)Solute: The component of the solution which constitutes smaller part of the solution is called solute.

4) Binary solution: A solution that is composed of two components is called a binary solution.

5)Ideal solution:A solution which obeys Raoult's law is called ideal solution.

6) Non-ideal solution: A solution which does not obey Raoult's law is called a non-ideal solution.

7)Dilute solution: The solution in which the solute is present in small quantity as compare to that of the solvent is called a dilute solution.

8)Aqueous solution:A solution prepare by dissolving solute in water as a solvent is called aqueous solution.

9)Percentage by mass: It is defined as the mass of the solute in grams dissolved in solvent to form 100 grams of the solution is called mass percentage.

10)Percentage by Volume : It is defined as the number of parts by volume of the solute to one 100 parts by volume of the solution

11)Normality: It is defined as the number of gram equivalents of the solute dissolved in one dm^3 of the solution.

12)Normal solution:A solution is said to be **one normal** when **one gram equivalent** of the solute is dissolved in **one dm^3** of the solution.

13)Decinormal solution (0.1N or N/10): A solution is said to be decinormal when 0.1 gm equivalent of the solute is dissolved in one dm^3 of the solution.

14)**Seminormal solution (0.5 N or N/2):** A solution is said to be seminormal when half gm equivalent of the solute is dissolved in one dm^3 of the solution.

15)**Centinormal solution(0.01N or N/100):** A solution is said to be centinormal when 0.001 gm equivalent of the solute is dissolved in one dm^3 of the solution.

16)**Millinormal solution:** A solution is said to be millinormal when 0.001 gram equivalent mole of the solute is dissolved in **one dm^3** of the solution.

17) **Molarity:** It is defined as the ratio of number of moles of the solute to the volume of the solution in dm^3.

18)**Molar solution:**A solution is said to be **one molar** when one mole of the solute is dissolved in one dm^3 of the solution.

19)**Decimolar solution (0.1M or M/10)**: A solution is said to be decimolar when 0.1 mole of the solute is dissolved in one dm^3 of the solution.

20)**Semimolar solution (0.5 M or M/2):** A solution is said to be semimolar when half mole of the solute is dissolved in one dm^3 of the solution.

21)**Centimolar solution(0.01M or M/100):** A solution is said to be decimolar when **0.01mole** of the solute is dissolved in **one dm^3** of the solution.

22)**Millimolar solution:** A solution is said to be semi-molar when 0.001 mole of the solute is dissolved in **one dm^3** of the solution.

23)**Molality:** It is defined as the number of moles of the solute dissolved in 1 kg of the solvent.

24)**Molal solution:** A solution is said to be one molal when **one mole** of the solute is dissolved in **one kg** of the solvent.

25) **Mole fraction:** The mole fraction of a component in a solution is defined as the ratio of number of moles of that component to the total number of moles of all the components present in the solution.

26) <u>**Concentration of the solution:**</u>It may be defined as the amount of the solute present in a specific amount of the solvent**.**

27) <u>**Formality :**</u> It is defined as the number of gram formula weight of the solute to the volume of the solution in dm^3.

28) <u>**Formal solution**</u>: A solution is said to be **one formal** when **one gram formula weight** of the solute is dissolved in one dm^3 of the solution.

29) <u>**Parts per million:**</u> It may be defined as the mass or volume of the solute (in grams) or cm^3 per 10^6 g or 10^6 cm^3 **o**f the solution

30) <u>**Saturated solution**</u>**:** It is defined as the solution that contains just the amount of dissolved solute necessary for establishing equilibrium between dissolved solute and undissolved solute.

31) <u>**Unsaturated solution**</u>: It is defined as the solution that contains less amount of solute than required for formation of saturated solution.

32) <u>**Supersaturated solution:**</u> It is defined as the solution that contains excess amount of solute than required for formation of saturated solution

33) <u>**Solubility**</u>**:** The maximum amount of the solute that dissolves in the given volume of the solvent at constant temperature is called solubility of the solute in the given solvent.

34)Solid solutions or Alloy: Solutions consisting of two or more metals or metals with one or more nonmetals are called solid solutions or alloys**.**

II) <u>SHORT ANSWER QUESTIONS</u>:

1) Give the types of solutions with suitable examples.

Ans: The various types of solutions are as follows:

Sr.No.	Type	Solute	Solvent	Examples
1	Gas in gas	Gas	Gas	Air, mixture of gases
2	Gas in liquid	Gas	Liquid	Aerated drinks, CO_2 in water
3	Gas in solid	Gas	Solid	H_2 gas on Pd catalyst.
4	Liquid in solid.	Liquid	Solid	Zn amalgam, Na amalgam
5	Liquid in liquid	Liquid	Liquid	Alcohol in water, acetone in water.
6	Liquid in gas	Liquid	Gas	Water vapour in air, acetone in N_2 gas
7	Solid in solid	Solid	Solid	Alloys(Cu in Au, Zn in Cu)
8	Solid in liquid	Solid	Liquid	Sugar in water, NaCl in water.
9	Solid in gas	Solid	Gas	Camphor in Nitrogen, Napthalene in air.

2) Explain the following terms:

i) Normality ii) Molarity iii) Molality iv) Mole fraction

Ans:

i) <u>Normality:</u> It is defined s the number of gram equivalents of the solute dissolved in one dm^3 of the solution.

a)It is represented by the symbol **N**

b)A solution is said to be **one normal** when **one gram equivalent** of the solute is dissolved in **one dm^3** of the solution.

c)Number of gram equivalents = $\frac{\text{weight of the solute}}{\text{Equivalent weight of the solute}}$

d) $N = \frac{W_2 \times 1}{E_2 \quad V} = \frac{W_2 \times 1000}{E_2 \times V}$

e)Normality X equivalent weight = $\frac{w}{V}$ = Strength of the solution in gms/dm^3

f) Unit : gm.eqv dm^{-3}

g) <u>Decinormal solution</u> (0.1N): A solution is said to be decinormal when 0.1 gm equivalent of the solute is dissolved in one dm^3 of the solution.

h) <u>Seminormal solution</u> (0.5 N): A solution is said to be seminormal when half gm equivalent of the solute is dissolved in one dm^3 of the solution.

i) Normality of a solution changes with the temperature.

ii<u>) Molarity</u>: It is defined as the ratio of number of moles of the solute to the volume of the solution in dm^3 .

a) It is represented by the symbol **M.**

b)A solution is said to be **one molar** when one mole of the solute is dissolved in one dm^3 of the solution.

c) Number of moles of the solute = $\frac{\text{weight of the solute}}{\text{Molecular weight}}$

d) Molarity = $\frac{\text{weight of the solute}}{\text{Molecular weight}} \times \frac{1}{\text{Volume in dm}^3}$

e) Molarity = $\frac{W_2 \times 1}{M_2 \times V} = \frac{W_2 \times 1000}{M_2 \times V_1}$

f) Unit: moles dm^{-3}.

g) **<u>Decimolar solution(0.1M):</u>** A solution is said to be decimolar when **0.1 mole** of the solute is dissolved in **one dm^3** of the solution.

h) **<u>Semi-molar solution(0.5M):</u>** A solution is said to be semi-molar when **half mole** of the solute is dissolved in **one dm^3** of the solution.

iii) **<u>Molality:</u>** It may be defined as the number of moles of the solute dissolved in 1000 grams (1 kg) of the solvent.

a) It is represented by the symbol **'m'.**

b) Molality = $\frac{\text{number of moles of the solute}}{\text{Weight of the solvent in kg}}$

c) Molality = $\frac{\text{weight of the solute} \times 1000}{\text{Molecular weight of the solvent in grams}}$

d) m = $\frac{W_2 \times 1000}{M_2 \times W_1}$ where W_1 = weight of the solvent.

e) **<u>Molal solution</u>**: A solution is said to be one molal when **one mole** of the solute is dissolved in **one kg** of the solvent.

f) Unit **: moles kg^{-1}.**

g) The molality of the solution does not change with the temperature.

iv) <u>Mole fraction</u>: The mole fraction of a component in a solution is defined as the ratio of number of moles of that component to the total number of moles of all the components present in the solution.

a)It is denoted by **'x'.**

b)If a solution contains n_1 number of moles of the solute dissolved in n_2 number of moles of the solvent, then the mole fraction x_1 of the solvent is given by

$$x_1 = \frac{n_1}{n_1 + n_2}$$

Similarly, the mole fraction x_2 of the solute is given by

$$x_2 = \frac{n_2}{n_1 + n_2}$$

c)The mole fraction of the component is independent of temperature.

d)The sum of the mole fractions of all the components in the solution is unity.

e)Eg if a solution is prepared by dissolving 4 moles of alcohol in 16 moles of water, then

Mole fraction of alcohol = 4/ 20 = 0.2 and

Mole fraction of water is = 16/20 = 0.8

3) Define the term concentration of the solution. Name the various ways in which the concentration of the solution is expressed.

Ans:Concentration of the solution: It may be defined as the amount of the solute dissolved in a specific amount of the solvent.

The different ways of expressing the concentration of the solution are:
a) Percentage b) Normality c) Molarity
d) Molality e) mole fraction

4) Explain the percentage method of expressing the concentration of the solution.
Ans: The percentage of a solution is expressed in the following two ways:

a)<u>Mass percentage:</u> It is defined as the mass of the solute present in 100 grams of the solution. If m_1 and m_2 are the masses of the solute A and solvent B in grams respectively, then

$$\textbf{Mass percentage of A} = m_1 = \frac{m_1}{m_1 + m_2} \times 100$$

eg: A 5 % of solution of NaCl means 5 grams of NaCl is present in 100 grams of the solution.

ii) Volume percentage: It is defined as the number of parts by volume of the solute per 100 parts by volume of the solution.

If V_A is the volume of the solute and V_B is the volume of the solvent in the solution, then

$$\textbf{Volume percentage of A} = \frac{V_A}{V_A + V_B} \times 100$$

The volume percentage method is convenient when the solute and the solvents are liquids.

5) Explain the following terms;
i) Formality of a solution **ii) ppm**

Ans:i) Formality:

i) It is a unit used to express the concentration of a solution and is denoted by F.

ii)It is defined as the number of gram formula weight of the solute to the volume of the solution in dm^3.

iii)Formality = $\frac{\text{Number of gram formula weight of the solute}}{\text{Volume of the solution in } dm^3}$

iv)No. of gram formula weight of the solute = $\frac{\text{Weight of the solute}}{\text{Formula weight of the solute}}$

v) **Formality** = $\frac{W}{M} \times \frac{1}{V}$

vi)**Formal solution:** A solution is said to be **one formal** when **one gram formula weight** of the solute is dissolved in one dm^3 of the solution.

vii) Formality is a function of temperature and it changes with the change in temperature.

viii) Formality is used when the solute is an ionic compound that exist in the form of aggregates formed by the ions of the solution.

II) Parts per million(ppm): It is a unit of concentration used when the solution is very dilute.

ii)It may be defined as the mass of the solute (in grams) present in one million grams of the solution.

iii) **Parts per million** $= \frac{\textbf{Mass of the solute}}{\textbf{Total mass of the solution}} \times 10^6$

Eg. 2 ppm solution of $CuSO_4$ means 2 gms of copper sulphate present in 10^6 grams of the solution.

iv) 1 ppm = 1mg/dm^3

6) Give the relation between the following:

i) Normality and Molarity **ii) Molarity and molality**

Ans:

$$\text{Normality} = \text{Molarity} \times \frac{\text{Molecular weight}}{\text{Equivalent weight}}$$

$$\text{Hence Normality} = n \times \text{Molarity}$$

$$\text{where } n = \frac{\text{Molecular weight}}{\text{Equivalent weight}}$$

ii) Relation between Molarity and molality;

$$\text{Molality} = \frac{1000 \times M}{1000 \times d - M \times \text{gram molecular weight}}$$

Q.7) What is a standard solution? Give its characteristics.

Ans: A solution whose concentration is accurately known is called a standard solution.It contains definie number of gram equivalents or moles per dm^3 of the solution.

Characteristics:

a) The concentrationof the solution should remain constant for a long period of time.

b) It should react rapidly with the test substance(analyte).

c) The reaction with the analyte should be complete so as to obtain a sharp end point.

d)The reaction with the analyte should be such that it should be described by a balanced chemical equation to permit necessary calculations.

Q.8) What is a primary standard? What are its characteristics?

Ans. A substance which is available in pure form and with definite chemical composition is called a primary standard.These ar the substances whose standard solutions can be prepared directly by weighing a known amount of the substance in a suitable solvent , usually water and then diluting the solution to a definite volume in a standard flask.Such a solution can be directly used as a titrant.

Primary standards should have the following characteristics:

1) It should be highly pure.

2) It should be highly stable towards atmosphere.

3) It should be free from water of crstallisation.

4) It should have low hygroscopicity and efflorescence.

5) it should have high equivalent weight so as to minimize weighing errors.

6)It should be readily available at reasonable cost.

Examples of primary standard:

1) Acidic standards:Succinic acid, Adipic acid, Potassium hydrogen phthalate

2) Alkaline primary standards: Anhydrous sodium carbonate, Thallous carbonate

3) Redox primary standard: KIO_3, $K_2Cr_2O_7$, $KBrO_3$, Sodium oxalate

4) Precipitation primary standards: $AgNO_3$, NaCl, KCl etc.

Q.9) What are secondary standards? Give suitable examples

Ans:A secondary standard is a compound or a solution whose purity or concentration has been determined to a very high degree of accuracy by a certain experimental comparison with a primary standard.

The comparison is made by titrating this solution against a primary standard.

A secondary standard should satisfy the following requirements:

1) Its solution must be able to retain its strength for a long period of time.

2) The reaction between between the secondary standard and the solution to be standardized should be stoichiometric , rapid and should to completion.

Q.10)Obtain the relations between the following

i) Normality and molarity

ii) Mole fraction and molality

iii) Molality and molariity

Ans:

i) Relation between normality and molarity

By def, Normality $= \frac{\text{Number of gram eqiuivalents of solute}}{\text{Volume of solution in dm}^3}$

$$= \frac{W_2 \times 1}{E_2 \times V} \qquad \text{-----------------------------I}$$

Where W_2 = weight of the solute

E_2 = Equivalent weight of the solute

V= Volume of the solution in dm^3

Molarity = $\frac{\text{Number of moles of the solute}}{\text{Volume of solution in } dm^3}$

$$= \frac{W_2 \times 1}{M_2 \times V} \quad \text{-----------------------------II}$$

Where W_2 = weight of the solute

M_2 = Molecular weight of the solute

V= Volume of the solution in dm^3

Divide I by II

$$\text{Normality} = \frac{W_2 \times 1}{E_2 \times V}$$

$$\text{Molarity} = \frac{W_2 \times 1}{M_2 \times V}$$

i.e $\frac{\text{Normality}}{\text{Molarity}} = \frac{M_2}{E_2} = n$ where n = $\frac{\text{Molecular weight}}{\text{Equivalent weight}}$

Therefore**, Normality = n X Molarity**

ii) <u>Relation between mole fraction and molality:</u>

By def., Mole fraction of a solute $X_2 = \frac{n_2}{n_1 + n_2}$ --------------------------I

where n_1 = number of moles of the solvent.
n_2 = number of moles of the solute.

Let **m** be the molality of the solution.

The solution contains **m** moles of the solute in **1000 g** of the solvent.

Therefore number of moles of solvent = $\frac{\text{weight of solvent}}{\text{Molecular weight of the solvent}}$

$$= \frac{1000}{M_1}$$

Therefore , mole fraction of the solute X_2 is now given by the expression

$$X_2 = \frac{m}{\quad}$$

$$1000 / M_1 + m$$

Because n_2 = m= no.of moles of the solute

iii) Relation between molarity and molality

Consider a solution of molarity M.

This solution contains M moles of solute in one dm^3 of the solution.($1000 cm^3$ of solution)

no. of moles of solute = $\frac{\text{weight of solute}}{\text{Molecular weight}}$

Therefore weight of solute = no. of moles of solute X Molecular weight

$$= M \times M_2 \qquad \text{------------------I}$$

Let **d** be the density of the solution in **g/cc**.

Weight of the solution= weight of solute + weight of solvent

Therefore weight of solvent = weight of solution – weight of solute

= volume X density - $M \times M_2$ (**from equn I**)

= $1000 \times d - M \times M_2$ grams of solvent

= $d - 0.001 \times M \times M_2$ kg of solvent

$d - 0.001 \times M \times M_2$ kg of solvent contains M moles of solute

Hence 1 kg of solvent will contain $\frac{M}{d - 0.001 \times M \times M_2}$

= molality of the solution(m)

$$\mathbf{m = \frac{M}{d - 0.001 \times M \times M_2}}$$

OR

$$\textbf{Molality} = \frac{\mathbf{1000 \times M}}{\textbf{1000 X d – M x gram molecular weight}}$$

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