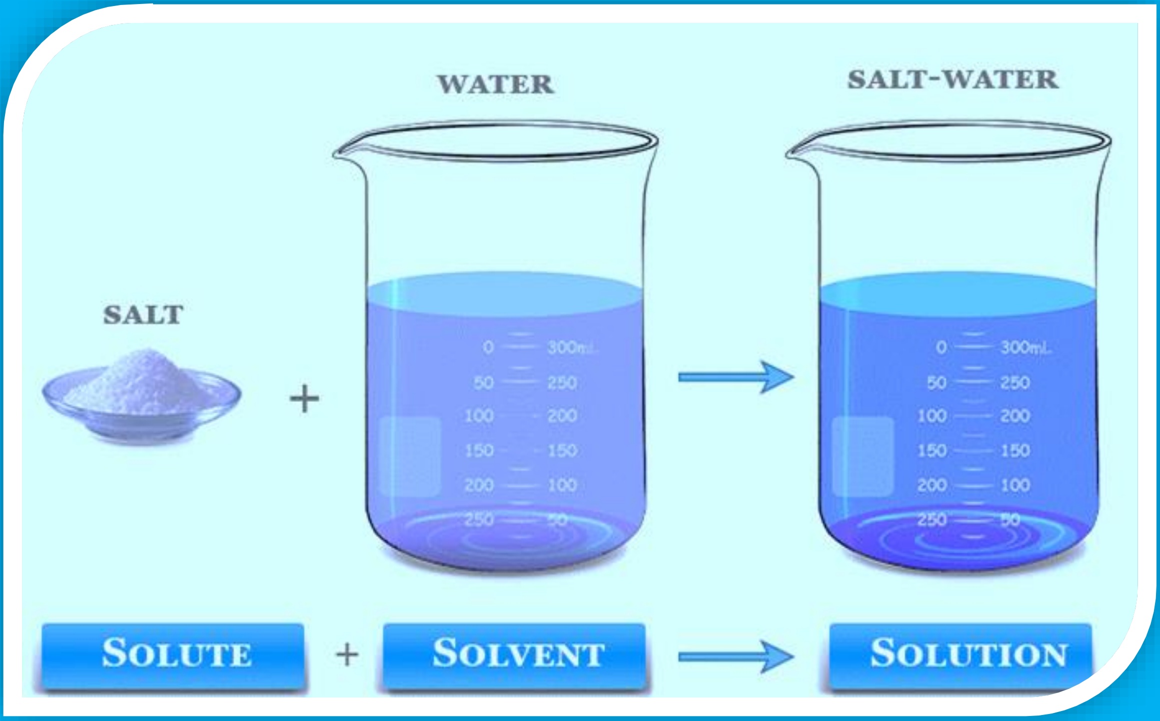
2. SOLUTIONS



Chemistry Smart Booklet

Theory + NCERT MCQs + Topic Wise Practice MCQs + NEET PYQs

Types of Solutions

Based on Physical State

- Gas in Gas (Air)
- Gas in liquid (Soda water)
- Gas in Solid (Hydrogen in Pd)
- Liquid in gas (Fog)
- Liquid in liquid (Alcohol in H_2O)
- Liquid in Solid (Amalgams)
- Solid in gas (Smog)
- Solid in liquid (Sugar in water)
- Solid in Solid (alloys)

Based on Concentration

- Dilate Solution
- Concertated Solution
- Solurated Solution
- Saper Solurated Solution

Concentration terms

Mole fraction (X)

$= \frac{\text{No. of moles of Solute}}{\text{Total moles in Solution}}$

Mass percentage (w/w)

$= \frac{\text{Mass of Solute}}{\text{Total mass of Solution}} \times 100$

Molarity (M)

$= \frac{\text{No. of moles of Solute}}{\text{Volume of Solution (L)}}$

Parts per million (PPM)

$= \frac{\text{No. of Parts of Solute}}{\text{Total No. of Parts of all compounts of Solution}}$

Molatity (M)

$= \frac{\text{No. of moles of Solute}}{\text{weight of the Solvent in Kg}}$

Volume % (V/V)

$\frac{\text{Volume of Solute}}{\text{Total volume of Solution}} \times 100$

Mass by volume %

$= \frac{\text{mass of Solute}}{\text{Total moles in Solution}}$

Normatity (N)

$= \frac{\text{No. of grams equivalent of Solute}}{\text{Volume of Solution (L)}}$

SOLUBILITY

Gas in liquid

Effect of pressure

Solubility increases with increase in pressure

Henry's Law

Partial pressure of gas in vapour Phase

Mole fraction of the gas (x)

P = KHX

Solid in liquid

Effect of nature of Solute of Solvent → Like dissoles Like

Effect of temp →
Exothernic process:- Increase with rise in temp.
Effect → Endothermic process:- Decrease with rise in temp.
Effect of prassure → No effect

Liquid in liquid

Effect of pressure

Raoult's Law

Partial vapour pressure = Parical presssure × Mole fraction

$P_S = P_A^\circ X_A + P_B^\circ X_B$

SOLUTION

Homogenous mixture of two or more pure substance

Colligative property

Osmotic pressure

Pressure applied to stop the flow of salvent through semi permeable memberane

r = CRT

Elevation of Boiling point

$\Delta T_b = \frac{K_b \times 1000 \times w_2}{M_2 \times w_1}$

Depression in freezing point

$\Delta T_f = \frac{K_f \times w_2 \times 1000}{M_2 \times w_1}$

Relating loucing of rapour pressure

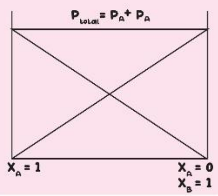
$\frac{w_2 \times M_1}{M_2 \times w_1} = \frac{P_A - P_S}{P_A}$

Ideal & non ideal Solution

Ideal

Raoult's Law

$P_S = P_A^\circ X_A + P_B^\circ X_B$

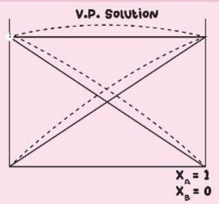


Non Ideal

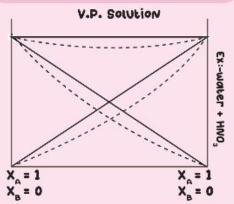
Does not obey Rault's law

$P_S \neq P_A^\circ X_A + P_B^\circ X_B$

Positive deviation



Negative deviation



Azeotropeo

- Constant boiling mixtures

Positive deviation mixture

Minimum boiling azeotropes
Ex. 95% Ethonol in water

Nagative deviation mixture

Maximum boiling azeotropes
Ex. 68% HNO3 in water

Van't hoff factor (i)

Ratio of the normal mass to the observed molecular mass of the Solute:

$i = \frac{\text{Normal molor mass}}{\text{Ab normal molar malar mass}}$

SOLUTIONS

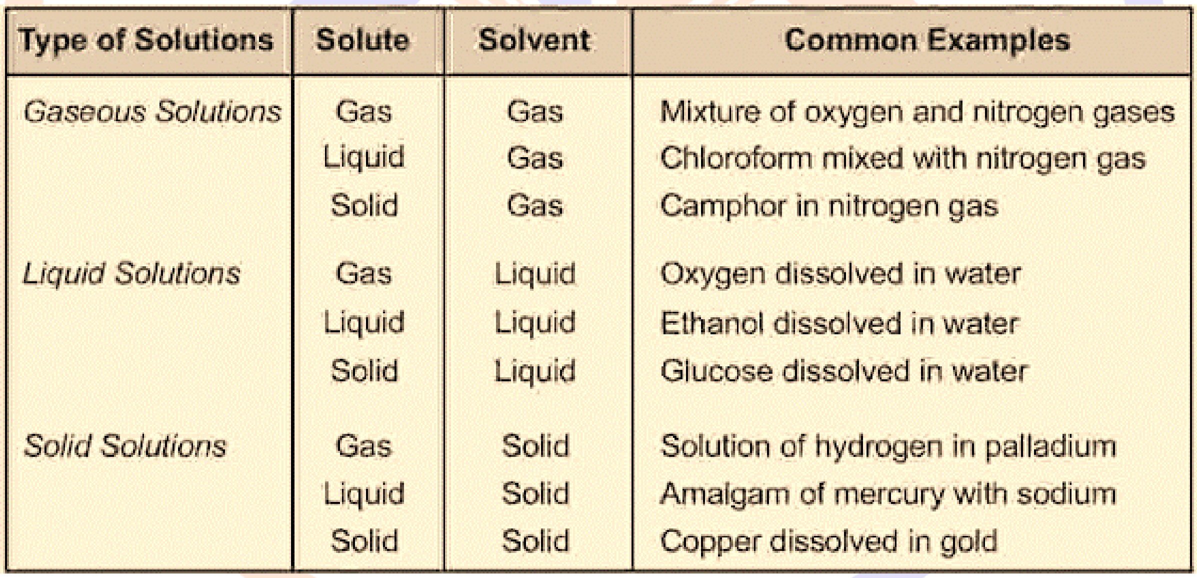
Introduction:

In this chapter, we will discuss about liquid solutions and their formation. This will be followed by studying the properties of solutions, like vapour pressure and colligative properties. We will begin with types of solutions and expressions for concentration of solutions in different units.

Thereafter, we will state and explain Henry's law and Raoult's law, distinguish between ideal and non-ideal solution and deviation of real solutions from Raoult's law. We will also discuss abnormal colligative properties alongwith association and dissociation of solute.

Types of Solutions

All the three states of matter (solid, liquid and gas) may behave either as solvent or solute. When a solution is composed of only two chemical substances, it is termed as binary solution. Depending upon the state of solute or solvent, binary solutions can be classified as



Type of Solutions	Solute	Solvent	Common Examples
Gaseous Solutions	Gas	Gas	Mixture of oxygen and nitrogen gases
	Liquid	Gas	Chloroform mixed with nitrogen gas
	Solid	Gas	Camphor in nitrogen gas
Liquid Solutions	Gas	Liquid	Oxygen dissolved in water
	Liquid	Liquid	Ethanol dissolved in water
	Solid	Liquid	Glucose dissolved in water
Solid Solutions	Gas	Solid	Solution of hydrogen in palladium
	Liquid	Solid	Amalgam of mercury with sodium
	Solid	Solid	Copper dissolved in gold

Some Important Definitions

- **Mixture** - When two or more chemically non-reacting substances are mixed, they form mixture.

- **Heterogeneous Mixture** - It consists of distinct phases, and the observed properties are just the sum of the properties of individual phases.

- **Homogeneous Mixture** - It consists of a single phase which has properties that may differ from one of the individual components.

- **Solution** - The homogeneous mixture of two or more components such that at least one component is a liquid is called solution.

- **Solvent** - It is the constituent of solution which has same physical state as that of solution and generally present in greater amount than all the other components.

- **Solute** - The component of a solution other than solvent is called solute, may or may not have same physical state as that of solution. Generally it is in smaller amount. ***Example*** **-** In a sugar syrup (liquid solution) containing 60% sugar (solid) and 40% water (liquid), water is termed as solvent, due to same physical state as that of solution.

Expressing the Strength of Solution

For a given solution the amount of solute dissolved per unit volume of solution is called concentration of solute. Strength of solution is the amount of solute in grams dissolved in one litre of solution. It is generally expressed in g/litre.

Other methods of expressing the strength of solution are:

1. **Mass percentage –**

$$\text{Mass \% of solute} = \frac{\text{Mass of solute}}{\text{Total mass of solution}} \times 100$$

$$\text{Mass \% of solvent} = \frac{\text{Mass of solvent}}{\text{Total mass of solution}} \times 100$$

2. **Volume percentage –**

$$\text{Volume \% of solute} = \frac{\text{Volume of solute}}{\text{Total volume of solution}} \times 100$$

$$\text{Volume \% of solvent} = \frac{\text{Volume of solvent}}{\text{Total volume of solution}} \times 100$$

3. **Molality (m) -** It is no. of moles of solute dissolved in 1 kg of the solvent.

$$\text{m} = \frac{\text{(Number of moles of solute)}}{\text{(Mass of solvent \{in kg\})}}$$

4. **Molarity (M) -** It is no. of moles of solute dissolved in 1 litre of solution.

$$\text{M} = \frac{\text{(Number of moles of solute)}}{\text{(Mass of soution \{in litre\})}}$$

5. **Normality (N) -** It is no. of gram-equivalents of solute dissolved in 1 litre of solution

$$\text{N} = \frac{\text{(Number of gram equivalents of solute)}}{\text{(Volume of solution \{in litre)}}$$

6. **Formality -** Ionic solutes do not exist in the form of molecules. These molecular mass is expressed as Gram-formula mass. Molarity for ionic compounds is actually called as **formality.**

7. **Mole fraction –**

$$\text{Mole fraction of solute} = \frac{(\text{Number of moles of solute})}{(\text{Total moles of solution})}$$

$$\text{Mole fraction of solvent} = \frac{(\text{Number of moles of solvent})}{(\text{Total moles of solution})}$$

For a binary solution,

mole fraction of solute + mole fraction of solvent = 1.

8. **Parts per million (ppm) –**
   It is defined in two ways

$$\text{ppm} = \text{mass fraction} \times 10^6$$
$$\text{ppm} = \text{mole fraction} \times 10^6$$

Solubility

Solubility of a substance is its maximum amount that can be dissolved in a specified amount of solvent at a specified temperature. It depends upon the nature of solute and solvent as well as temperature and pressure. Let us consider the effect of these factors in solution of a **solid** or a **gas** in a **liquid**.

1. Solubility of Solid in Liquid

A solute dissolves in a solvent if the intermolecular interactions are similar in them, i.e., like dissolves like. Polar solute dissolves in polar solvent and non-polar solute in non-polar solvent. For e.g., sodium chloride and sugar dissolves readily in water and napthalene and anthracene dissolves readily in benzene.

Solute + Solvent ⟶ Solution

i. **Dissolution:** When a solid solute is added to the solvent, some solute dissolves and its concentration increases in solution. This process is called **dissolution**.

ii. **Crystallization**: Some solute particles collide with solute particles in solution and get separated out. This process is called **crystallization**.

iii. **Saturated solution**: Such a solution in which no more solute can be dissolved at the same temperature and pressure is called a **saturated solution.**

iv. **Unsaturated solution:** An unsaturated solution is one in which more solute can be dissolved at the same temperature.

v. **Effect of temperature**: In general, if in a nearly saturated solution, the dissolution process is endothermic, the solubility should increase with rise in temperature, if it is exothermic, the solubility should decrease with rise in temperature.

vi. **Effect of pressure**: Solids and liquids are highly incompressible, so pressure does not have any significant effect on solubility of solids and liquids.

vii. **Supersaturated solution**: When more solute can be dissolved at higher temperature in a saturated solution, then the solution becomes supersaturated.

2. Solubility of Gas in Liquid

All gases are soluble in water as well as in other liquids to a greater or lesser extent. The solubility of a gas in liquid depends upon the following factors Nature of the gas, Nature of solvent, Temperature and Pressure.

Generally, the gases which can be easily liquified are more soluble in common solvents. For e.g., CO2 is more soluble than hydrogen or oxygen in water. The gases which are capable of forming ions in aqueous solutions are much more soluble in water than other solvents. For e.g., HCl and NH3 are highly soluble in water but not in organic solvents (like benzene) in which they do not ionize.

i. **Effect of temperature:** Solubility of most of the gases in liquids decreases with rise in temperature. In dissolution of a gas in liquid, heat is evolved and thus this is an exothermic process. The dissolution process involves dynamic equilibrium and thus follows **Le Chatelier's** principle. As dissolution is exothermic the solubility of gas should decrease with rise in temperature.

ii. **Effect of pressure: Henry's law**: At constant temperature, the solubility of a gas in a liquid is directly proportional to the pressure of the gas.

$$p = KH\ x,$$

KH = Henry's law constant.

Applications of Henry's law

1. In manufacture of soft drinks and soda water, CO_2 is passed at high pressure to increase its solubility.

2. To minimise the painful effects accompanying the decompression of deep sea divers. O_2 diluted with less soluble. He gas is used as breathing gas.

3. At high altitudes, the partial pressure of O_2 is less then that at the ground level. This leads to low concentrations of O_2 in the blood of climbers which causes '**anoxia**'.

Vapour Pressure of Solution

It is the pressure exerted by vapour on the surface layer of liquid at equilibrium between vapour and liquid.

Factors affecting Vapour Pressure

i. **Nature of liquid -** Liquid with higher intermolecular attraction forces form less amount of vapour and hence lower vapour pressure and vice-versa.

ii. **Temperature -** Vapour pressure increases with temperature of liquid. This is because, as temperature increases, kinetic energy of the molecules increases, hence, more molecules leave the surface of the liquid and come into vapour phase.

Raoult's Law

According to Raoult's law, for a solution of volatile liquids, the relative lowering of vapour pressure of solution is directly proportional to its mole fraction of dissolved solvent in solute.

$$\frac{P^\circ - P}{P^\circ} = X_A$$

Ideal Solution

The solution which obeys **Raoult's law** at all compositions of solute and solvent and at all temperature is called an **ideal solution. Ex-** Benzene and Toluene, n-hexane and n-heptane.

Characteristics of an ideal Solution

1. Raoult's law is obeyed by it.

2. $\Delta H_{mixing} = 0$ i.e., no heat should be absorbed or evolved during mixing.

3. $\Delta V_{mixing} = 0$, i.e., no change in volume (expansion or contraction) on mixing.

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Non-ideal Solution

Those solutions which deviate from ideal behaviour are called **non-ideal solutions** or real solutions. Acetone and CS_2, Acetone and C_2H_5OH

Characteristics of an non-ideal Solution

1. Raoult's law is not obeyed by it.
2. $\Delta H_{mixing} \neq 0$ i.e., solution may absorb or release heat.

3. $\Delta V_{mixing} \neq 0$ i.e., solution may expand or contract on mixing of solute and solvent.

Azeotropic Mixture

At the constant boiling temperature, liquid mixture vapouries without change in composition and the condensate contains same composition, i.e., mixture distills like a pure liquid, which has same composition. At this point, solution or mixture is called an **azeotropic mixture.**

Colligative Properties

The properties of dilute solution which depends only on number of particles of solute (molecules or ions) present in the solution and not on their nature, are called colligative properties. The important **colligative properties** are;

1. Relative lowering of vapour pressure
2. Elevation of boiling point
3. Depression in freezing point
4. Osmotic pressure

i. Relative Lowering of Vapour Pressure

When a non-volatile solute is added to a solvent, its vapour pressure gets **lowered**. If this pressure is divided by pressure of pure solvent, this is called **relative lowering of vapour pressure.**

According to **Raoult's law,**

$$\frac{P^\circ - P}{P^\circ} = X_A$$

where, P° = V.P. of pure solvent

P° - P = lwering in vapour pressure

$$\frac{P^\circ - P}{P^\circ} = \frac{n_A}{n_A + n_B} \ldots \left[X_A = \frac{n_A}{n_A + n_B}\right]$$

For dilute solution $n_A + n_A \approx n_A$

$$\frac{P^\circ - P}{P^\circ} = \frac{n_A}{n_B}$$

$$\frac{P^\circ - P}{P^0} = \frac{W_A}{M_A} \times \frac{M_B}{W_B}$$

where, W_A = weight of solute

W_B = weight of solvent

M_A = molecular weight of solute

M_B = molecular weight of solvent

ii. Relative Elevation of boiling point

A liquid boils at the temperature at which its vapour pressure is equal to the atmospheric pressure. The boiling point of a solution of non-volatile solute is always higher than that of the boiling point of pure solvent in which the solution is prepared. Similar to lowering of vapour pressure, the elevation of boiling point also depends on the number of solute particles rather than their nature.

Let T° be the boiling point of pure solvent and T be the boiling point of solution. The increase in boiling point $\Delta Tb = T - T^\circ$ is known as **elevation in boiling point**.

For dilute solutions, the ΔT_b is directly proportional to the molal concentration of the solute in a solution. Thus

$$\Delta T_b \propto m$$

$$\Delta T_b = K_b m$$

K_b is molal **elevation constant** (Ebullioscopic constant). The unit of K_b is K kg mol^{-1}.

Substituting the value of molality in above equation, we get

$$\Delta T_b = \frac{K_b \times 1000 \times w_2}{M_2 \times w_1}$$

$$M_2 = \frac{K_b \times 1000 \times w_2}{\Delta T_b \times w_1}$$

Where, w_1 = mass of solvent, w_2 = mass of solute and M_2 = molar mass of solute

iii. Depression in freezing point

Freezing point is the temperature at which vapour pressure of liquid phase becomes same as that of solid phase. The decrease in freezing point of a solvent on the addition of a non-volatile solute is known as **depression in freezing point**.

Let T° be the freezing point of pure solvent and T be the freezing point of solution. The decrease in freezing point $\Delta T_f = T° - T$ is known as depression in freezing point.

For dilute solutions, the ΔT_f is directly proportional to the molal concentration of the solute in a solution. Thus

$$\Delta T_f \propto m$$

$$\Delta T_f = Kf \cdot m$$

Here K_f is molal depression constant or cryoscopic constant

Substituting the value of molality in above equation, we get

$$\Delta T_f = \frac{K \times w_2 \times 1000}{M_2 \times w_1}$$

$$M_2 = \frac{K \times w_2 \times 1000}{\Delta T_f \times w_1}$$

Where, w_1 = mass of solvent, w_2 = mass of solute and M_2 = molar mass of solute

iv. Osmotic pressure

Osmosis is the spontaneous flow of the solvent molecules from a less concentrated solution (dilute) to a more concentrated solution through a **semi-permeable membrane**. The driving force of osmosis is called **osmotic pressure**. Osmotic pressure may be defined as “the minimum excess pressure that has to be applied on the solution to prevent the osmosis".

Osmotic pressure of a solution ∝ molar concentration of solute in that solution

$$\pi \propto c$$

$$\pi = cRT$$

where, R = Gas constant = 0.0821 lit atm K^{-1} $mole^{-1}$

T = Temperature

c = Molar concentration

$$\pi = \frac{n}{V}RT \;.....[c = \frac{n}{V}]$$

$$\pi = \frac{W_B}{M_B}\frac{RT}{V}$$

W_B = wt. of solute

M_B = Molar mass of solute

van't Hoff Factor

To calculate the extent of association or dissociation, van't Hoff in 1886 introduced a factor 'i' called van't Hoff factor. **van't Hoff factor** 'i' is defined as ratio of the experimental value of colligative property to the calculated value of colligative property.

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$$\text{i. e., i}\frac{\text{Experiment ecolligatival properties}}{\text{Calculated ecolligativ properties}}$$

NCERT LINE BY LINE QUESTIONS

(1.) Which one of the following electrolytes has the same value of Van't Hoff factor (i) as that of $Al_2(SO_4)_3$ (if all are 100% ionized))

(a.) $K_4[Fe(CN)_6]$

(b.) K_2SO_4

(c.) $K_3[Fe(CN)_6]$

(d.) $Al(NO_3)_3$

(2.) Maximum amount of a solid solute that can be dissolved in a specific amount of a given liquid solvent does not depend upon— **[NCERT Exemplar, Page: 40]**

(a.) temperature

(b.) nature of solute

(c.) pressure

(d.) nature of solvent

(3.) If solute and solvent interactions are more than solute-solute and solvent-solvent interaction then

(a.) it is ideal solution.

(b.) it is non-ideal solution with position deviation.

(c.) it is non-ideal solution with negative deviation.

(d.) can't be predicted.

(4.) When 40 g of substance is dissolved in 1000 g of water, its freezing point is depressed by 1.86°C. Kf for water is $1.86^{\circ}\text{C mol}^{-1}$ then find the molar mass of the solute

(a.) 4

(b.) 10

(c.) 40

(d.) 400

(5.) **Assertion:** When a solution is separated from the pure solvent by a semipermeable membrane, the solvent molecules pass through it from pure solvent side to the solution side.

Reason: Diffusion of solvent occurs from a region of high concentration solution to a region of low concentration solution. **[NCERT Exemplar, Page: 57]**

(a.) Both A and R are true and R is the correct explanation of A.

(b.) Both A and R are true but R is not the correct explanation of A.

(c.) A is true but R is false.

(d.) Both A and R are false.

(6.) In water saturated air the mole fraction of water vapour is 0.02. If the total pressure of the saturated air is 1.2 atm, the partial pressure of dry air is **[Odisha NEET-2O19, Page: 37]**

(a.) 1.18 atm

(b.) 1.76 atm

(c.) 1.176 atm

(d.) 0.98 atm

(7.) Matrix match. **[QR Code, NCERT Exemplar, Page: 36]**

Column 1	**Column 2**
(A) Standard	(p) Solution with two solution components
(B) Solid solution	(q) A solution which contains maximum amount of solute that can be dissolved in a given amount of solvent at given temperature
(C) Binary solution	(r) A solution in solid phase

(a.) $A \to P, B \to Q, C \to R$

(b.) $A \to Q, B \to R, C \to P$

(c.) $A \to R, B \to P, C \to Q$

(d.) $A \to R, B \to Q, C \to P$

(8.) According to Henry law, the amount of gas that will dissolve in blood plasma or any other liquid is determined by which of these factors **[Page: 41]**

(a.) Solubility of the gas in the liquid

(b.) The total pressure of the gas mixture

(c.) pH of the liquid

(d.) The osmotic pressure of the gas mixture

(9.) The freezing point depression constant for water is $-1.86^{\circ}\text{cm}^{-1}$. If $5.0\text{ g Na}_2\text{SO}_4$ is dissolved in $45\text{ gH}_2\text{O}$, the freezing point is changed by -3.82°C. Calculate Van't Hoff factor for Na_2SO_4:

[Page: 59]

(a.) 2.05

(b.) 2.63

(c.) 3.11

(d.) 0.381

(10.) vapour phase diagram for a solution is given below if dotted lines represent deviation.
The correct observation for this solution

(a.) ΔH_{mix} :positive

(b.) ΔS_{mix} :positive

(c.) ΔV_{mix} : positive

(d.) All of these

(11.) Osmotic pressure of a solution at a given temperature **[Page: 55]**

(a.) increase with concentration

(b.) decrease with concentration

(c.) remain same

(d.) initially increase and then decrease

(12.) Read statements **[Page: 57]**

I. Semipermeable membrane contains network of submacroscopic holes or pores.
II. Semipermeable membrane appears to be continuous sheets or films.
III. Solvent molecule cannot pass through the holes of semipermeable membrane but solute molecule can pass.

On the basis of the statements given above select correct option

(a.) Only (I)

(b.) Only (II)

(c.) Only (III)

(d.) All of these

(13.) The vapour of a solution having $2.0\ \text{g}$ of solute X (molar atomic mass $= 32\ \text{g mol}^{-1}$) in $100\ \text{g}$ of CS_2(vapour pressure $= 854\text{torr}$) is 848.9 torr . The molecular formula of solute is

(a.) X

(b.) X_2

(c.) X_4

(d.) X_8

(14.) The Van't Hoff factor of $0.1\text{M}Ba(NO_3)_2$ solution is 2.74. The degree of dissociation is **[Page: 59]**

(a.) 91.3%

(b.) 87%

(c.) 100%

(d.) 74%

(15.) The vapour pressure of two liquids P and Q are 80 and 60 torr respectively. The total vapour pressure of solution obtained by mixing 3 mole of P and 2 mole of Q would be **[Page: 54]**

(a.) 72 torr

(b.) 140 torr

(c.) 68 torr

(d.) 20 torr

(16.) The units of ebullioscopic constant is **[NCERT Exemplar, Page: 5l]**

(a.) $\text{K kg}^{-1}\text{mol}^{-1}$ or K(molality)

(b.) mol kg K^{-1} or K^{-1}(molality)

(c.) $\text{kg mol}^{-1}\text{K}^{-1}$ or K^{-1}(molality)

(d.) K mol kg^{-1} or K(molality)

(17.) Of the following 0.10 m aqueous solutions, which one will exhibit the largest freezing point depression? **[QR Code, NCERT Exemplar, Page: 58]**

(a.) KCl

(b.) $C_6H_{12}O_6$

(c.) $Al_2(SO_4)_3$

(d.) K_2SO_4

(18.) An aqueous solution of sugar is taken in a beaker. At freezing point of solution , **Page: 58**

(a.) Crystals of sugar separated

(b.) Crystals of glucose and fructose are separated

(c.) Crystals office separated

(d.) Mixture of ice and some sugar crystals separated

(19.) Which one of the following binary mixtures forms an azeotrope with minimum boiling type **[Page: 47, 48]**

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(a.) acetone— ethanol (b.) H_2O-HNO_3

(c.) benzene— toluene (d.) n-hexane—n-heptane

(20.) How many grams of CH_3OH should be added to water to prepare 150 ml solution of $2MCH_3OH$ **[Page: 38]**

(a.) 9.6×10^3 (b.) 2.4×10^3

(c.) 9.6 (d.) 2.4

(21.) Relationship between partial pressure & mole fraction is **[Page: 47]**

(a.) Graham's law (b.) Raoult's law

(c.) Le-Chatelier (d.) Avogadro's law

(22.) 4L of 0.02M aqueous solution NaCl was diluted by adding one litre of water. The molality of resultant solution is— **[NCERT Exemplar, Page: 38]**

(a.) 0.004 (b.) 0.008

(c.) 0.012 (d.) 0.016

(23.) Iodine and sulphur dissolve in

(a.) H_2O (b.) benzene

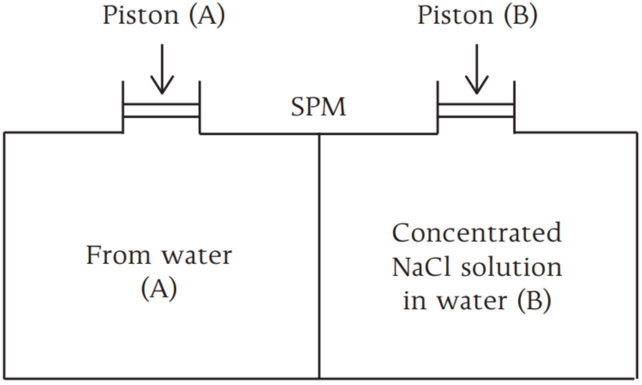
(c.) CS_2 (d.) ethanol

(24.) 19.5 g of CH_2FCOOH is dissolved in 500 g of water. The depression in the freezing point of water observed is $1.0^\circ C$. Calculate Van't Hoff factor.

(a.) 2.97 (b.) 0.79

(c.) 6.28 (d.) 1.0753

(25.) Consider the figure **[NCERT Exemplar, Page: 57]**



Mark the correct statement

(a.) water will move from side (A) to side (B) if a pressure lower than osmotic pressure is applied on piston (B).

(b.) Water will move from side (B) to side (A) if a pressure greater than osmotic pressure is applied on piston (B).

(c.) The value of molal depression constant depends on nature of solvent.

(d.) Relative lowering of vapour pressure is a dimensionless quantity.

(26.) P_A and P_B are the vapour pressure of pure liquid components A and B respectively of an ideal binary solution. If X_A represent the mole fraction of component A, the total pressure of the solution will be — **[Page: 44]**

(a.) $P_A + X_A(P_B - P_A)$ (b.) $P_A + X_A(P_A - P_B)$

(c.) $P_B + X_A(P_B - P_A)$ (d.) $P_B + X_A(P_A - P_B)$

(27.) Nalorphene $(C_{19}H_{21}NO_3)$, similar to morphine, is used to combat withdrawal symptoms in narcotic users. Dose of nalorphene generally given is 1.5 mg. Calculate the mass of 1.5×10^{-3} m aqueous solution required for the above dose **[Page: 63]**

(a.) 9.2 g (b.) 4.2 g

(c.) 3.2 g (d.) 6.2 g

(28.) **Assertion:** Azeotropic mixture are formed only by non-ideal solution.
Reason: Boiling point of an azeotropic mixture is either higher or lower than both the components of solution. **[Page: 47, 48]**

(a.) Both A and R are correct and R is correct explanation of A. (b.) Both A and R are correct but R is not correct explanation of A.

(c.) A is true but R is false. (d.) Both A and R are false.

(29.) If molality of a dilute solution is double, the value of molal depression constant (K_f) will be? **[NEET-2017, Page: 52]**

(a.) Halved (b.) tripled

(c.) unchanged (d.) doubled

(30.) Solid solution in which the solute is gas

(a.) copper dissolved in gold (b.) camphor in nitrogen gas

(c.) solution of hydrogen in palladium (d.) all of the above

(31.) Which of the following 0.10m aqueous solutions will have the lowest freezing point? **[NEET-2O14, Page: 59]**

(a.) $A1_2(SO_4)_3$ (b.) $C_6H_{12}O_6$

(c.) KC1 (d.) $C_{12}H_{22}O_{11}$

(32.) Which one is a colligative property? **[Page: 49]**

(a.) Boiling point (b.) Vapour pressure

(c.) Osmotic pressure (d.) Freezing point

(33.) H_2S, a toxic gas with rotten egg like smel1, is used for the qualitative analysis. If the solubility of H_2S in water at STP is $0.195m$. Calculate Henry law constant?

(a.) 282 bar (b.) 386 bar

(c.) 192 bar (d.) 465 bar

(34.) If liquids A and B form an ideal solution. **[Page: 47, 48]**

(a.) the free energy of mixing is zero (b.) the free energy as well as entropy of mixing are zero

(c.) enthalpy of mixing is zero (d.) the entropy of mixing is zero

(35.) 200cm^3 of an aqueous solution of a protein contains 1.26 g of the protein. The osmotic pressure of such solution at 300 K is found to be 2.57×10^{-3}bar . Calculate the molar mass of protein . **[Page: 56]**

(a.)	$21200\ \text{g mol}^{-1}$	(b.)	$61022\ \text{g mol}^{-1}$
(c.)	$19200\ \text{g mol}^{-1}$	(d.)	none of these

(36.) Low concentration of oxygen in the blood and tissues of people living at high altitude is due to **[NCERT Exemplar, Page: 41]**

(a.)	Low temperature	(b.)	Low atmospheric pressure
(c.)	High atmospheric pressure	(d.)	Both low temperature and high atmospheric pressure

(37.) Which of the following statement(s) is/are true **[Page: 37]**

I. In a binary mixture, mole fraction of A is

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

II. For solution containing i number of components, $X_i=\frac{n_i}{\sum n_i}$

III. Sum of all mole fraction is one.

Select option with true statements.

(a.)	I and II	(b.)	II and III
(c.)	III and I	(d.)	All of the above

(38.) When a solute is present in trace quantities which of the following expression is used? **[Page: 36]**

(a.)	Gram per million	(b.)	Milligram percent
(c.)	Microgram percent	(d.)	Parts per millions

(39.) Which of the following physical property is used to determine the molecular mass of a polymer Solution? **[Page: 55]**

(a.)	Relative lowering of vapour pressure	(b.)	Elevation in boiling point
(c.)	Depression in freezing point	(d.)	Osmotic pressure

(40.) The freezing point of 1% solution of lead nitrate in water will be **[Page: 52]**

(a.)	2°C	(b.)	1°C
(c.)	0°C	(d.)	below $0\,\text{C}$

(41.) If 0.15 g of solute, dissolved in 15 g of solvent, is boiled at a temperature higher by 0.216°C than that of pure solvent, the molecular weight of substance (molal elevation constant for the solvent is 2.16°C) is **[Page: 51]**

(a.)	10. 1	(b.)	100
(c.)	1.01	(d.)	1000

(42.) Which condition is not satisfied by an ideal solution . **[Page: 47]**

(a.)	$\Delta_{\text{mix}}V=0$	(b.)	$\Delta_{\text{mix}}S=0$
(c.)	obeyance to Raoult's law	(d.)	$\Delta_{\text{mix}}H=0$

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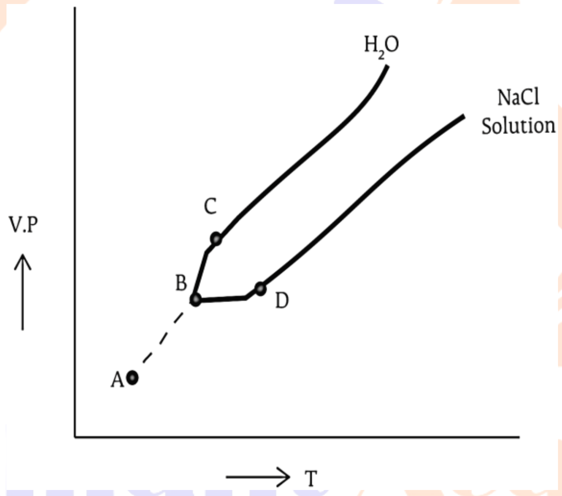
(43.) How many grams of Conc.HNO_3 solution should be used to prepare 250 ml of 2.0MHNO_3? The conc.acid is 70 % HNO_3? **[Page: 37]**

(a.) 70 g conc.HNO_3
(b.) 54 g conc.HNO_3
(c.) 45 g conc.HNO_3
(d.) 90 g conc.HNO_3

(44.) 0.5 molal aqueous solution of a weak acid (HX) is 20% ionised. If κ_f for water is $1.86\ \text{K kg mol}^{-1}$. The lowering freezing point of the solution is **[Page: 53]**

(a.) 0.56 K
(b.) 1.12 K
(c.) –0.56K
(d.) –1.12K

(45.) The freezing point of solution is marked as:



(a.) A
(b.) B
(c.) C
(d.) D

(46.) Which condition is not satisfied by an ideal solution? **[Page: 47, HOTS]**

(a.) $\Delta_{mix}H = 0$
(b.) $\Delta_{mix}V = 0$
(c.) $\Delta_{mix}S = 0$
(d.) obeyance to Raoult's law

(47.) The relative lowering of the vapour pressure is equal to the ratio between number of **[Page: 50]**

(a.) solute molecules to the solvent molecules
(b.) solute molecules to the total molecules in the solution
(c.) solvent molecules to the total molecules in the solution
(d.) solvent molecules to the total number of ions of the solute

(48.) If solubility of any gas in the liquid at 1 bar pressure is 0.05 mol / litre, what will be its solubility at 3 bar pressure, keeping the temperature constant?

(a.) $\frac{0.05}{3}$ mol / L
(b.) 0.15 mol / L
(c.) 0.05mol / L
(d.) 1.0mol / L

(49.) **Assertion:** Camphor is used as a solvent in the experimental determination of molecular masses of naphthalene and anthracene.
Reason: Camphor has high molal elevation constant. **[Page: 55]**

(a.) Both A and R are correct and R is the correct explanation of A. (b.) Both A and R are correct and R is not correct explanation of A.
(c.) A is correct but R is incorrect statement. (d.) Both A and R are false.

(50.) At equilibrium, the rate of dissolution of a solid solute in a volatile liquid solvent is —
[NCERT Exemplar, Page: 40]
(a.) less than rate of crystallization (b.) greater than rate of crystallization
(c.) equal to the rate of crystallization (d.) zero

TOPIC WISE PRACTICE QUESTIONS

TOPIC 1: Solubility and Concentration of Solutions

1. When the solute is present in trace quantities the following expression is used
1) gram per million 2) milligram percent
3) microgram percent 4) parts per million

2. Which one of the following gases has the lowest value of Henry's law constant?
1) N_2 2) He 3) H_2 4) CO_2

3. Equal moles of water and urea are taken in a flask. What is mass percentage of urea in the solution ?
1) 7.692% 2) 9.2% 3) 76.92% 4) 0.7692%

4. What is the normality of a 1 M solution of H_3PO_4 ?
1) 0.5 N 2) 1.0 N 3) 2.0 N 4) 3.0 N

5. Molarity of liquid HCl will be, if density of solution is 1.17 gm/cc
1) 36.5 M 2) 32.05 M 3) 18.25 M 4) 42.10 M

6. An X molal solution of a compound in benzene has mole fraction of solute equal to 0.2. The value of X is
1) 14 2) 3.2 3) 1.4 4) 2

7. 1 M, 2.5 litre NaOH solution is mixed with another 0.5 M, 3 litre NaOH solution. Then find out the molarity of resultant solution
1) 0.80 M 2) 1.0 M 3) 0.73 M 4) 0.50 M

8. In acidic medium, the equivalent weight of $K_2Cr_2O_7$
(Mol. wt. = M) is
1) M 2) M/2 3) M/3 4) M/6

9. The mole fraction of the solute in one molal aqueous solution is:
1) 0.009 2) 0.018 3) 0.027 4) 0.036

10. 10 g of NaCl is dissolved in 106g of the solution. Its concentration is
1) 100 ppm 2) 0.1 ppm 3) 1 ppm 4) 10 ppm

11. Which of the following substances will lose its solubility with increase in temperature?
1) NaOH 2) Na_2CO_3 3) Na_2SO_4 4) All

12. 2.5 litres of NaCl solution contain 5 moles of the solute. What is the molarity?
1) 5 molar 2) 2 molar 3) 2.5 molar 4) 12.5 molar

13. Which of the following factor do not affect solubility of solid solute in liquid?
1) Temperature 2) Pressure 3) Nature of solute 4) All of these

TOPIC 2: Vapour Pressure, Laws of Solutions and Ideal, Non-Ideal Solutions

14. For a dilute solution, Raoult's law states that
1) the lowering of vapour pressure is equal to the mole fraction of solute.
2) the relative lowering of vapour pressure is equal to the mole fraction of solute.
3) the relative lowering of vapour pressure is proportional to the amount of solute in solution.
4) the vapour pressure of the solution is equal to the mole fraction of solvent.

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15. If p° and p_s are vapour pressures of solvent and its solution, respectively, χ_1 and χ_2 are mole fractions of solvent and solute, respectively, then

1) $p_s = p^0/\chi_2$ 2) $p^0 - p_s = p^0\chi_2$ 3) $p_s = p^0\chi_2$ 4) $\frac{p^0 - p_s}{p_s} = \frac{\chi_1}{\chi_1+\chi_2}$

16. The normal boiling point of water is 373 K. Vapour pressure of water at temperature T is 19 mm Hg. If enthalpy of vaporisation is 40.67 kJ/mol, then temperature T would be
(Use : log 2 = 0.3, R : 8.3 JK–1 mol–1):

1) 250 K 2) 291.4 K 3) 230 K 4) 290 K

17. For a binary ideal liquid solution, the total vapour pressure of the solution is given as:

1) $P_{total} = P_A^0 + \left(P_A^0 - P_B^0\right)x_B$ 2) $P_{total} = P_B^0 + \left(P_A^0 - P_B^0\right)x_A$

3) $P_{total} = P_B^0 + \left(P_B^0 - P_A^0\right)x_A$ 4) $P_{total} = P_B^0 + \left(P_B^0 - P_A^0\right)x_B$

18. Moles of Na_2SO_4 to be dissolved in 12 mole water to lower its vapour pressure by 10 mm Hg at a temperature at which vapour pressure of pure water is 50 mm is:

1) 1.5 mole 2) 2 mole 3) 1 mole 4) 3 mole

19. Equimolar solutions in the same solvent have

1) different boiling and different freezing points. 2) same boiling and same freezing points.
3) same freezing point but different boiling points. 4) same boiling point but different freezing points.

20. The solubility of common salt is 36.0 g in 100 g of water at 20 °C. If systems *I*, *II* and *III* contain 40.0, 36.0 and 20.0 g of the salt added to 100.0 g of water in each case, the vapour pressures would be in the order:

1) I < II < III 2) I > II > III 3) I = II > III 4) I = II < III

21. The vapour pressure of two liquids P and Q are 80 and 60 torr, respectively. The total vapour pressure of solution obtained by mixing 3 mole of P and 2 mole of Q would be

1) 72 torr 2) 140 torr 3) 68 torr 4) 20 torr

22. A mixture of components *A* and *B* will show –ve deviation when

1) $\Delta V_{mix} > 0$ 2) $\Delta H_{mix} > 0$
3) *A–B* interaction is weaker than *A–A* and *B– B* interactions.
4) *A–B* interaction is stronger than *A–A* and *B–B* interactions.

23. At the state of dynamic equilibrium, for solute + solvent ⇌ solution.

1) Rate of dissolution = Rate of unsaturation. 2) Rate of dissolution = Rate of unsaturation.
3) Rate of dissolution = Rate of saturation 4) Rate of crystallization = Rate of saturation.

24. The value of P° for benzene is 640 mm of Hg. The vapour pressure of solution containing 2.5g substance in 39g benzene is 600mm of Hg the molecular mass of *X* is –

1) 65.25 2) 130 3) 40 4) 80

25. An ideal solution is formed when its components

1) have no volume change on mixing 2) have no enthalpy change on mixing
3) both (1) and (2) are correct 4) neither (1) nor (2) is correct

26. For which of the following parameters the structural isomers C_2H_5OH and CH_3OCH_3 would be expected to have the same values?(Assume ideal behaviour)

1) Boiling points 2) Vapour pressure at the same temperature
3) Heat of vaporization 4) Gaseous densities at the same temperature and pressure

27. Which one of the following is non-ideal solution

1) Benzene + toluene 2) *n*-hexane + *n*-heptane
3) Ethyl bromide + ethyl iodide 4) CCl_4 + $CHCl_3$

TOPIC 3:Colligative Properties and Abnormal Molecular Masses

28. When common salt is dissolved in water

1) the melting point of the solution increases. 2) the boiling point of solution decreases.
3) both melting point and boiling point decrease. 4) the boiling point of the solution increases.

29. Camphor is often used in molecular mass determination because

1) it is readily available. 2) it has a very high cryoscopic constant.

3) it is volatile. 4) it is solvent for organic substances.

30. The normal boiling point of the solution is the temperature at which the vapour pressure of the solution is –

1) equal to 1 torr 2) equal to 76 mm Hg 3) equal to 2.0 atm 4) equal to 1 atm

31. When solid SnO_2 is added to an aqueous solution of NaOH, the

1) vapour pressure is lowered. 2) vapour pressure is raised.
3) osmotic pressure is increased. 4) boiling point is raised.

32. The vapour pressure of a dilute solution of non-volatile solute is *P* and the VP of a pure solvent is *P*°. The lowering of the VP is

1) + ve 2) – ve 3) $P/P°$ 4) $P°/P$

33. 12 g of a nonvolatile solute dissolved in 108 g of water produces the relative lowering of vapour pressure of 0.1. The molecular mass of the solute is

1) 80 2) 60 3) 20 4) 40

34. If a thin slice of sugar beet is placed in concentrated solution of NaCl, then

1) sugar beet will lose water from its cells. 2) sugar beet will absorb water from solution.
3) sugar beet will neither absorb nor lose water. 4) sugar beet will dissolve in solution.

35. Which salt shows maximum osmotic pressure in its 1 M solution.

1) $AgNO_3$ 2) Na_2SO_4 3) $(NH_4)_3PO_4$ 4) $MgCl_2$

36. The osmotic pressure of a sugar solution at 24 °C is 2.5 atm. The concentration of the solution in mole per litre is

1) 10.25 2) 1.025 3) 1025 4) 0.1025

37. Which has the maximum osmotic pressure at temperature T ?

1) 100 mL of 1 M urea solution.
2) 300 mL of 1 M glucose solution.
3) Mixture of 100 mL of 1 M urea solution and 300 mL of 1 M glucose solution.
4) All are isotonic.

38. Which one of the following is a colligative property ?

1) Boiling point 2) Vapour pressure
3) Osmotic pressure 4) Freezing point

39. Which one of the following aqueous solutions will exhibit highest boiling point?

1) 0.015 M urea 2) 0.01 M KNO_3 3) 0.10 M Na_2SO_4 4) 0.015 M glucose

40. When a solution containing non-volatile solute freezes, which equilibrium would exist?

1) solid solvent ⇌ liquid solvent 2) solid solute ⇌ liquid solution
3) solid solute ⇌ liquid solvent 4) solid solvent ⇌ liquid solution

41. Which of the following aqueous solution has minimum freezing point ?

1) 0.01 m NaCl 2) 0.005 m C_2H_5OH 3) 0.005 m MgI_2 4) 0.005 m $MgSO_4$.

42. A solution containing 1.8 g of a compound (empirical formula CH_2O) in 40 g of water is observed to freeze at – 0.465 °C. The molecular formula of the compound is (Kf of water =1.86 kg K mol^{-1}):

1) $C_2H_4O_2$ 2) C_3H_6 3) $C_4H_8O_4$ 4) $C_6H_{12}O_6$

43. Freezing point of the following equilibrium,
liquid solvent ⇌ solid solvent is:

1) $\frac{\Delta H - \Delta G}{T\Delta S}$ 2) $\frac{\Delta H}{\Delta S}$ 3) $\frac{\Delta G}{\Delta S}$ 4) $\frac{\Delta S}{\Delta H}$

44. The freezing point of equimolal aqueous solutions will be highest for:

1) $C_6H_5NH_3Cl$ 2) $Ca(NO_3)_2$ 3) La $(NO_3)_2$ 4) $C_6H_{12}O_6$

45. In a 0.5 molal solution of KCl, KCl is 50% dissociated. The freezing point of solution will be (K_f = 1.86 k kg mol^{-1}):

1) 274.674 K 2) 271.60 K 3) 273 K 4) None of these

46. In a 0.2 molal aqueous solution of a weak acid HX the degree of dissociation is 0.25. The freezing point of the solution will be nearest to: (K_f = 1.86 K kg mol^{-1})

1) – 0.26 °C 2) 0.465 °C 3) – 0.48 °C 4) – 0.465 °C

47. Which one of the following statements is false ?

1) The correct order of osmotic pressure for 0.01 M aqueous solution of each compound is $BaCl_2$ > KCl >CH_3COOH > sucrose.

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2) Isotonic solutions are those solutions which have the same osmotic pressure.
3) Raoult's law states that the vapour pressure of a component over a solution is proportional to its mole fraction in liquid state.
4) Two sucrose solutions of same molality prepared in different solvents will have the same freezing point depression.

48. 0.1 molal aqueous solution of an electrolyte AB_3 is 90% ionised. The boiling point of the solution at 1 atm is : $\left(K_{b(H_2O)} = 0.52K\ \ kg\ mol^{-1}\right)$
1) 273.19 K 2) 374.92 K 3) 376.4 K 4) 373.19 K

49. In the case of osmosis, solvent molecules move from :
1) higher vapour pressure to lower vapour pressure.
2) higher concentration to lower concentration.
3) lower vapour pressure to higher vapour pressure.
4) higher osmotic pressure to lower osmotic pressure.

50. Which of the following solutions will have maximum osmotic pressure? (Assume 90% dissociation of each salt):
1) Decinormal aluminium sulphate 2) Decinormal barium chloride solution
3) Decinormal sodium sulphate solution
4) Solution of equal volumes of decinormal barium chloride and decinormal sodium sulphate solutions

51. At 25°C, the highest osmotic pressure is exhibited by 0.1 M solution of
1) $CaCl_2$ 2) KCl 3) glucose 4) urea

52. Osmotic pressure of blood is 7.40 atm, at 27 °C. Number of moles of glucose to be used per litre for an intravenous injection that is to have same osmotic pressure of blood is:
1) 0.3 2) 0.2 3) 0.1 4) 0.4

53. The freezing point of 1% solution of lead nitrate in water will be
1) 2°C 2) 1°C 3) 0°C 4) below 0°C

54. If the elevation in boiling point of a solution of 10 g of solute (mol. wt. = 100) in 100 g of water is ΔT_b, the ebullioscopic constant of water is
1) 10 2) 10 ΔT_b 3) ΔT_b 4) $\frac{\Delta T_b}{10}$

55. The boiling point of a solution of 0.11 g of a substance in 15 g of ether was found to be 0.1 °C higher than that of pure ether. The molecular weight of the substance will be
(K_b = 2.16 °K kg mol^{-1})
1) 148 2) 158 3) 168 4) 178

56. The rise in the boiling point of a solution containing 1.8 g of glucose in 100 g of solvent is 0.1°C. The molal elevation constant of the liquid is
1) 0.01 K/m 2) 0.1 K/m 3) 1 K/m 4) 10 K/m

57. An aqueous solution freezes at –0.186 °C (K_f = 1.86, K_b = 0.512) what is the elevation in boiling point?
1) 0.186 °C 2) 0.512 °C 3) 0.86 °C 4) 0.0512 °C

58. At temperature 327 °C and concentration C, osmotic pressure of a solution is P, the same solution at concentration C/2 and at temperature 427 °C shows osmotic pressure of 2 atm, value of P will be
1)12/7 2) 24/7 3)6/5 4)5/6

59. The relationship between osmotic pressure at 273 K when 10g glucose (P_1), 10 g urea (P_2), and 10g sucrose (P_3) are dissolved in 250 ml of water is
1) $P_1 > P_2 > P_3$ 2) $P_3 > P_1 > P_2$ 3) $P_2 > P_1 > P_3$ 4) $P_2 > P_3 > P_1$

60. Consider the following statements
I : Osmosis takes place with increase of entropy.
II : Osmosis is a non-spontaneous process.
III : Free energy decreases during osmosis.
Which of the above is/are correct?
1) I only 2) I and II 3) II and III 4) I and III

61. For an electrolyte, elevation of B.P. is directly proportional to
1) molarity 2) molality 3) mole fraction 4) All of these

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62. The molecular weight of benzoic acid in benzene as determined by depression in freezing point method corresponds to

1) ionization of benzoic acid. 2) dimerization of benzoic acid.
3) trimerization of benzoic acid. 4) solvation of benzoic acid.

63. Blood cells retain their normal shape in solution which are

1) hypotonic to blood 2) isotonic to blood 3) hypertonic to blood 4) equinormal to blood.

64. Which of the following pairs of solution are isotonic at the same temperature ?

1) 0.1 M $Ca(NO_3)_2$ and 0.1 M Na_2SO_4 2) 0.1 M NaCl and 0.1 M Na_2SO_4
3) 0.1 M urea and 0.1 M $MgCl_2$ 4) 0.2 M urea and 0.1 M NaCl

65. The van't Hoff factor *i* for a compound which undergoes dissociation in one solvent and association in other solvent is respectively

1) less than one and greater than one. 2) less than one and less than one.
3) greater than one and less than one. 4) greater than one and greater than one.

66. Van't Hoff factor is given by the expression ________.

1) $i = \dfrac{\text{Normal molar mass}}{\text{Abnoral molar mass}}$ 2) $i = \dfrac{\text{Abnoral molar mass}}{\text{Normal molar mass}}$

3) $i = \dfrac{\text{Observed Colligative property}}{\text{Calculated colligative property}}$ 4) both 1) and 3)

67. If α is the degree of dissociation of Na_2SO_4, the Vant Hoff's factor (*i*) used for calculating the molecular mass is

1) $1 + \alpha$ 2) $1 - \alpha$ 3) $1 + 2\alpha$ 4) $1 - 2\alpha$

68. The correct order of osmotic pressure of 0.01M aqueous solution of the following is

1) Sucrose > CH_3COOH > KC1 2) CH_3COOH > Sucrose > KC1
3) Sucrose > KC1 > CH_3COOH 4) KC1 > CH_3COOH > Sucrose

69. Which one of the following salts will have the same value of van't Hoff factor (*i*) as that of $K_4[Fe(CN)_6]$.

1) $Al_2(SO_4)_3$ 2) NaCl 3) $Al(NO_3)_3$ 4) Na_2SO_4.

70. Consider the following statements

1. Isotonic solutions have the same molar concentration at a given temperature
2. The molal elevation constant K_b is a characteristic of a solvent, and is independent of the solute added
3. The freezing point of a 0.1 M aqueous KCl solution is more than that of a 0.1 M aqueous $AlCl_3$ solution.

Which of these statements is correct?

1) 1 and 2 2) 2 and 3 3) 1 and 3 4) 1, 2 and 3

NEET PREVIOUS YEARS QUESTIONS

1. If molality of the dilute solutions is doubled, the value of molal depression constant (K_f) will be : **[2017]**

1) halved 2) tripled 3) unchanged 4) doubled

2. Which of the following statement about the composition of the vapour over an ideal 1 : 1 molar mixture of benzene and toluene is correct? Assume that the temperature is constant at 25°C. (**given :** Vapour Pressure Data at 25°C, benzene = 12.8 kPa, toluene = 3.85 kPa) **[2016]**

1) The vapour will contain a higher percentage of benzene
2) The vapour will contain a higher percentage of toluene
3) The vapour will contain equal amounts of benezene and toluene
4) Not enough information is given to make a predication

3. At 100 °C the vapour pressure of a solution of 6.5g of a solute in 100 g water is 732 mm. If K_b = 0.52, the boiling point of this solution will be **[2016]**

1) 101 °C 2) 100 °C 3) 102 °C 4) 103 °C

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4. Which one of the following electrolytes has the same value of van't Hoff's factor (i) as that of the $Al_2(SO_4)_3$ (if all are 100% ionised)? **[2015]**

1) $K_3[Fe(CN)_6]$ 2) $Al(NO_3)_3$ 3) $K_4[Fe(CN)_6]$ 4) K_2SO_4

5. The boiling point of 0.2 mol kg^{-1} solution of X in water is greater than equimolal solution of Y in water. Which one of the following statements is true in this case? **[2015]**

1) Molecular mass of X is greater than the molecular mass of Y.
2) Molecular mass of X is less than the molecular mass of Y.
3) Y is undergoing dissociation in water while X undergoes no change.
4) X is undergoing dissociation in water.

6. Which one is not equal to zero for an ideal solution: **[2015]**

1) ΔS_{mix} 2) ΔV_{mix} 3) $\Delta P = P_{observed} - P_{Raoult}$ 4) ΔH_{mix}

7. Of the following 0.10 m aqueous solutions, which one will exhibit the largest freezing point depression? **[2014]**

1) KCl 2) $C_6H_{12}O_6$ 3) $Al_2(SO_4)_3$ 4) K_2SO_4

8. For an ideal solution, the correct option is :- **[2019]**

(1) $\Delta_{mix} S = 0$ at constant T and P (2) $\Delta_{mix} V \neq 0$ at constant T and P
(3) $\Delta_{mix} H = 0$ at constant T and P (4) $\Delta_{mix} G = 0$ at constant T and P

9. The mixture that forms maximum boiling azeotrope is : **[2019]**

(1) Water + Nitric acid (2) Ethanol + Water (3) Acetone + Carbon disulphide
(4) Heptane + Octane

10. Which of the following statements is correct regarding a solution of two compounds A and B exhibiting positive deviation from ideal behaviour? **[2019 ODISSA]**

(1) Intermolecular attractive forces between A-A and B-B are stronger than those between A-B.
(2) $\Delta_{mix} H = 0$ at constant T and P (3) $\Delta_{mix} V = 0$ at constant T and P
(4) Intermolecular attractive forces between A-A and B-B are equal to those between A-B.

11. In water saturated air the mole fraction of water vapour is 0.02. If the total pressure of the saturated air is 1.2 atm, the partial pressure of dry air is : ? **[2019 ODISSA]**

(1) 1.18 atm (2) 1.76 atm (3) 1.176 atm (4) 0.98 atm

12. The density of 2 M aqueous solution of NaOH is 1.28 g/cm^3. The molality of the solution is [Given that molecular mass of NaOH = 40 g mol^{-1}] **[2019 ODISSA]**

(1) 1.20 m (2) 1.56 m (3) 1.67 m (4) 1.32 m

13. If 8g of a non-electrolyte solute is dissolved in114 g of n-octane to reduce its vapour pressure to 80%, the molar mass (in g mol^{-1}) of the solute is [Given that molar mass of n-octane is 114 g mol^{-1}]. **[2020 COVID-19]**

(1) 40 (2) 60 (3) 80 (4) 20

14. Isotonic solutions have same **[2020 COVID-19]**

(1) vapour pressure (2) freezing temperature (3) osmotic pressure (4) boiling temperature

15. The mixture which shows positive deviation from Raoult's law is : **[2020]**

1. Chloroethane + Bromoethane 2. Ethanol + Acetone
3. Benzene + Toluene 4. Acetone + Chloroform

16. The freezing point depression constant (K_f) of benzene is $5.12\, K\, kg\, mol^{-1}$. The freezing point depression for the solution of molality 0.078 m containing a non-electrolyte solute in benzene is (rounded off upto two decimal places) **[2020]**

1) 0.60 K 2) 0.20 K 3) 0.80 K 4) 0.40 K

17. The following solutions were prepared by dissolving 10 g of glucose $\left(C_6H_{12}O_6\right)$ in 250 ml of water $\left(P_1\right)$, 10 g urea $\left(CH_4N_2O\right)$ in 250 ml of water $\left(P_2\right)$ and 10 g of sucrose $\left(C_{12}H_{22}O_{11}\right)$ in 250 ml of water $\left(P_3\right)$. The right option for the decreasing order of osmotic pressure of these solutions is : **[NEET-2021]**

1. $P_1 > P_2 > P_3$ **2.** $P_2 > P_3 > P_1$ **3.** $P_3 > P_1 > P_2$ **4.** $P_2 > P_1 > P_3$

18. The correct option for the value of vapour pressure of a solution at $45°C$ with benzene to octane in molar ratio 3 : 2 is: **[NEET-2021]**

[At $45°C$ vapour pressure of benzene is 280 mm Hg and that of octane is 420 mm Hg. Assume Ideal gas]

1) 168 mm of Hg 2) 336 mm of Hg 3) 350 mm of Hg 4) 160 mm of Hg

19. In one molal solution that contains 0.5 mole of a solute, there is **[NEET-2022]**

1) 500 mL of solvent 2) 500 g of solvent
3) 100 mL of solvent 4) 100 g of solvent

NCERT LINE BY LINE QUESTIONS – ANSWERS

(1.)	a	**(2.)**	c	**(3.)**	c	**(4.)**	c	**(5.)**	b
(6.)	c	**(7.)**	b	**(8.)**	a	**(9.)**	b	**(10.)**	d
(11.)	a	**(12.)**	b	**(13.)**	d	**(14.)**	b	**(15.)**	a
(16.)	a	**(17.)**	c	**(18.)**	c	**(19.)**	a	**(20.)**	c
(21.)	b	**(22.)**	d	**(23.)**	c	**(24.)**	d	**(25.)**	b
(26.)	d	**(27.)**	c	**(28.)**	b	**(29.)**	c	**(30.)**	c
(31.)	a	**(32.)**	c	**(33.)**	a	**(34.)**	c	**(35.)**	b
(36.)	b	**(37.)**	d	**(38.)**	d	**(39.)**	d	**(40.)**	d
(41.)	b	**(42.)**	b	**(43.)**	c	**(44.)**	b	**(45.)**	b
(46.)	c	**(47.)**	a	**(48.)**	b	**(49.)**	c	**(50.)**	c

TOPIC WISE PRACTICE QUESTIONS - ANSWERS

1) 4	2) 4	3) 3	4) 4	5) 2	6) 2	7) 3	8) 4	9) 2	10) 4
11) 4	12) 2	13) 2	14) 2	15) 2	16) 2	17) 2	18) 4	19) 2	20) 4
21) 1	22) 4	23) 2	24) 4	25) 3	26) 4	27) 4	28) 4	29) 2	30) 4
31) 2	32) 1	33) 3	34) 1	35) 3	36) 4	37) 4	38) 3	39) 3	40) 4
41) 1	42) 4	43) 2	44) 4	45) 2	46) 4	47) 4	48) 4	49) 1	50) 1
51) 1	52) 1	53) 4	54) 3	55) 2	56) 3	57) 4	58) 2	59) 3	60) 4
61) 2	62) 2	63) 2	64) 1	65) 3	66) 4	67) 3	68) 4	69) 1	70) 4

NEET PREVIOUS YEARS QUESTIONS-ANSWERS

1) 3	2) 1	3) 1	4) 3	5) 4	6) 1	7) 3	8) 3	9) 1	10) 1
11) 3	12) 3	13) 1	14) 3	15) 2	16) 4	17) 4	18) 2	19) 2	

NCERT LINE BY LINE QUESTIONS – SOLUTIONS

(1.) (a)

(2.) (c) Pressure.
Solubility of a solid in liquid does not depends upon pressure since solids and liquids are almost incompressible.

(3.) (c) Solute – *solvent* Interactions > Solute – *solute* or solvent-solvent interactions
Interactions are high.
So, bonds cannot easily break so that's why vapour decreases so, V.P. decrease negative deviation.

(5.) (b)

(6.) (c) $X_{H_2O} = 0.02, X_{gas} = 0.98, P_T = 1.2 \text{atm}$
Partial Pressure of dry air $= P_T \times$ M.P of dry air $= 1.2 \times 0.98 = 1.176 \text{atm}$

(7.) (b) $A \to Q, B \to R, C \to P$

(8.) (a) According to Henrys law at constant temperature, the solubility of a gas in a liquid is directly proportional to the pressure of the gas.

(9.) (b)

$$\Delta T_f = i \times K_f \times \frac{W_B \times 1000}{M_B \times w_A}$$

$$\Delta T_f = 3.82, K_f = 1.86$$

$$w_B = 5, M_B = 142, w_A = 45$$

$$i = \frac{\Delta T \times M_B \times w_A}{K_f \times W_B \times 1000} = \frac{3.82 \times 142 \times 45}{1.86 \times 5 \times 1000} = 2.63$$

(11.) (a) According to Boyle Van't Hoff factor $\pi \propto C$ (at constant temperature)

(12.) (b)

(14.) (b) $\alpha = \frac{i-1}{n-1} = \frac{2.74-1}{3-1} = \frac{1.74}{2} = 0.87$

(15.) (a) By Raoult's law

$P_T = P_P^o X_P^o + P_Q^o X_Q$

where, $P_P^o = 80\,\text{torr}$

$P_Q^O = 60\,\text{torr}$

$X_P = \frac{3}{5}, X_Q = \frac{2}{5}$

$P_T = 80 \times \frac{3}{5} + 60 \times \frac{2}{5} = 72\,\text{torr}$

(16.) (a) $K_b = \frac{\Delta T_b}{m} = \frac{K}{\text{mol kg}^{-1}} \text{ or } = K($ molality)

(17.) (c) $\Delta T_f = K_f \times i \times m$

$\Delta T_f \propto i$ (Van't Hoff factor)

Salt	i
KCl	2
$C_6H_{12}O_6$	1
$Al_2(SO_4)_3$	5
K_2SO_4	3

i.e., i is maximum for 5 for $Al_2(SO_4)_3$.

(19.) (a) Minimum boiling azeotrope is formed by solution showing positive deviation, e.g. ethanol + acetone.

(20.) (c) Since the molecular mass of CH_3OH is 32, so, quantity of CH_3OH to prepare 150 ml solution of $2MCH_3OH$

$= \frac{2}{1000} \times 150 \times 32 = 9.6g$

(21.) (b) According to Raoult's law, the partial pressure of a volatile component of a solution is directly proportional to its mole fraction in solution at any temperature.

(22.) (d) $M_1V_1 = M_2V_2$

$M_1 = 0.02M, V_1 = 4L$

$M_2 = ?, V_2 = 5L$

$0.02 \times 4L = M_2 \times 5L$

$M_2 = 0.016M$

(25.) (b) Water will move from side (B) to side (A) if pressure greater than osmotic pressure is applied on piston (B) due to reverse osmosis.

(26.) (d) $P = P_A X_A + P_B X_B$

$= P_A X_A + P_B (1 - X_A)$

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$=P_AX_A+P_B-P_BX_A$

$=P_B+X_A\left(P_A-P_B\right)$

(27.) (c) 3.2g

$1.5\times10^3\text{m}$ Aqueous solution of nalorphene, means thar 1.5×10^3 mole of Nalorphene is dissolved in 1 kg of water.

Molar mass of Nalorphene $=311\ \text{gmol}^{-1}$

1.5×10^3 mole of Nalorphene $=1.5\times10^3\times311\text{ g}=0.467\text{g}$

Mass of solution $=0.467+1000=1000.467\text{gF}$ or, 0.467 g of nalorphene, mass of solution required $=1000.467\text{g}$

For $1.5\text{mg}\left(1.5\times10^3\text{g}\right)$ of nalorphene, mass of solution required $=\dfrac{1000.467}{0.467}\times1.5\times10^{-3}=3.2\text{lg}$

(28.) (b)

(29.) (c) The value of molal depression constant K_f is constant for a particular solvent, thus, it will be unchanged when molality of the dilute solution is doubled.

(31.) (a) Depression in freezing point $\propto$ no . of particles $Al_2\left(SO_4\right)_3$ provides five ions on the ionisation

$Al_2\left(SO_4\right)_3\rightarrow2Al^{3+}+3SO_4^{2-}$

So, $Al_2\left(SO_4\right)_3$ have maximum value of depression in freezing point or lowest freezing point.

(32.) (c) The properties which depend only upon the number of solute particles present in the solution irrespective of their nature are called colligative properties. Osmotic pressure is a colligative property.

(34.) (d) Entropy of mixing is zero.

(35.) (b) $\pi=2.57\times10^{-3}\text{bar}$

$V=200\text{ cm}^3=0.200\text{ litre}$

$T=300\text{ K}$

$R=0.083\text{L bar K}^{-1}\text{mo1}^{-1}$

use $M_2=\dfrac{W_2RT}{\pi V}$

$$M_2=\frac{1.26\text{ g}\times0.083\text{ L bar K}^{-1}\text{mo1}^{-1}\times300\text{ K}}{2.57\times10^{-3}\text{bar}\times0.200\text{ L}}$$

$M_2=61022\text{gmo1}^{-1}$.

(36.) (b) Low atmospheric pressure

At high altitude, the atmospheric pressure is decreased and due to low atmospheric pressure the solubility of oxygen in blood and tissues is reduced. Or Body temperature of human beings remains constant.

(37.) (d) All of the above.

(38.) (d) ppm (parts per million.)

(39.) (d) In relative lowering of vapour pressure, elevation in B.P., depression in freezing point get minimum for high molecular masses but osmotic pressure cannot be lowered as much for high molecular masses.

(40.) (d) Addition of solute to water decrease the freezing point of water (pure solvent).

$\therefore$ when 1% lead nitrate (solute) is added to water, the freezing point of water will be below 0°C.

(41.) (b) $\Delta T_b=i\times K_b\times m$

$$0.216=1\left[\frac{2.16\times0.15\times1000}{MW\times15}\right]$$

$MW=100\text{g}$

(42.) (b) An ideal solution is as follows:

Volume change $\left(\Delta V\right)$ of mixing should be zero. Heat change $\left(\Delta H\right)$ on mixing should be zero. Obey Raoult's law at every range of concentration.

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(43.) (c) Molarity $= \frac{w\times1000}{M_w\times V_{sol}(vol)} = 2$

$$2 = \frac{w}{63}\times\frac{1000}{250}$$

$$W = \frac{63}{2}g \text{, mass of acid } \times\frac{70}{100} = \frac{63}{2} \text{ Mass of acid } = 45g$$

(44.) (b)

$$\begin{array}{ccccc} HX & \rightleftharpoons & H^+ & + & X^- \\ 1-\alpha & & \alpha & & \alpha \end{array}$$

Total $= 1+\lambda$

$i = 1+\alpha = 1+0.2 = 1.2$

$\Delta T_f = i\times k_f\times m$

$= 1.2\times1.86\times0.5 = 1.116k \approx 1.2k$

(46.) (c) For ideal solution

$\Delta H_{mix} > 0, \Delta H_{mix} = +ve$

$\Delta V_{mix} > 0, \Delta V_{mix} = +ve$

$\Delta S_{mix} > 0$

(47.) (a) $\frac{P^o_{solvent} - P_{solution}}{P^o_{Solvent}} = X_{solute}$

$P_A^O - P_A$ (difference in V.P. of pure solvent and solution) $\Rightarrow$ lowering in V.P. (1)

Now, P_A^O = V.P . of pure solvent (2)

By dividing (1) and (2) we ger,

$\frac{P_A^\circ - P_A}{P_A}$ = which is relative lowering in V.P.

(49.) (c)

(50.) (c) Equal to the rate of crystallization.

Rate of forward reaction (dissolution) = rate of backward reaction (crystallization)

TOPIC WISE PRACTICE QUESTIONS – SOLUTIONS

1. (4) For very dil. solution the concentration is expressed in ppm.
2. (4) According to Henry's law the mass of a gas dissolved per unit volume of solvent is proportional to the pressure of the gas at constant temperature m = K p i.e. as the solubility increases, value of Henry's law constant decreases. Since CO_2 is most soluble in water among the given set of gases.
3. (3) From molarity equation

$$M_1V_1 + M_2V_2 = M_3(V_1+V_2)$$

$$1\times2.5 + 0.5\times3 = M_3\times5.5$$

$$M_3 = \frac{4}{5.5} = 0.73M$$

4. 4) H_3PO_4 is tribasic so $N = 3M = 3\times1N = 3N$
5. 2) Density = 1.17 gm/cc (given) as $d = \frac{Mass}{Volume}$

Volume = 1cc ∴ Mass = *d* = 1.17g

Molarity = $\frac{\text{No.of moles}}{\text{Volume in litre}} = \frac{1.17\times1000}{36.5\times1} = \frac{1170}{36.5} = 32.05M$

6. 2) Relation between molality and mole fraction is

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$$m=\frac{1000\times x_2}{x_1M_1}=\frac{1000\times 0.2}{0.8\times 78}=3.2$$

Thus, X(m) = 3.2

7. 3) From molarity equation

$$M_1V_1+M_2V_2=M_3\left(V_1+V_2\right)$$

$$1\times 2.5+0.5\times 3=M_3\times 5.5$$

$$M_3=\frac{4}{5.5}=0.73M$$

8. 4) In acidic medium, $K_2Cr_2O_7$ undergo reduction as follows:

$$K_2\overset{+6}{Cr_2}O_7+14HCl\rightarrow 2KCl+2\overset{+3}{Cr}Cl_3+7H_2O+3Cl_2$$

Change in oxidation states = 6 –3 = 3

$\therefore$ Net change = $2\times 3=6$ [Two Cr atoms are involved]

$\therefore$ Eq wt. per unit of $K_2Cr_2O_7=M/6$

9. 2) One molal solution means one mole of solute is present in 1 kg (1000 g) solvent i.e., mole of solute = 1

$$\text{Mole of solvent}\left(H_2O\right)=\frac{1000g}{18g}=\frac{1000}{18}$$

$$\text{Mole fraction of solute}=\frac{1}{\left(1+\frac{1000}{18}\right)}=\frac{18}{1008}=0.018$$

10. 4) $ppm=\frac{\text{Mass of solute}}{\text{Mass of solution}}\times 10^6$

$$\therefore ppm=\frac{10}{10^6}\times 10^6=10\text{ ppm}$$

11. 4) All get dissolved with the evolution of heat.

12. 2) $\text{Molarity}=\frac{\text{No.of moles of solute}}{\text{Volume in litres}}=\frac{5}{2.5}=2M$

13. 2) An increase in temperature of the solution increases the solubility of a solid solute. The amount of solute that dissolve depends on what type of solute it is. For solids and liquid solutes, changes in pressure have practically no effect on solubility.

14. 2) $P_{solution}=P^0_{solution}x_{solvent}$; $\frac{P^0-P}{P^0}=x_{solute}$

15. 2) $\frac{p^0-P_s}{P^0}$ = Mole fraction of solute = λ_2

16. 2)

Given $P_1=19$ mm Hg, $P_2=760$ mm Hg;

$\Delta H_{vap.}=40670$ J/mol

Applying Clausius-Clapeyron's equation

$$\log\frac{P_2}{P_1}=\frac{\Delta H_{vap}}{2.303\times R}\left(\frac{T_2-T_1}{T_1T_2}\right)$$

$$\text{or }\log\frac{760}{19}=\frac{40670}{2.303\times 8.3}\left(\frac{373-T_1}{T_1\times 373}\right)$$

on solving, we get $T_1=291.4$ K

17. 2) $P=P^0_Ax_A+P^0_Bx_B=P^0_B+x_A\left(P^0_A-P^0_B\right)\left[\because x_B=1-x_A\right]$

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18. 4) $\frac{P^0 - P}{P^0} = \frac{10}{50} = \frac{n}{n+12} \therefore n = 3$

19. 2) Equimolar solutions of normal solutes in the same solvent will have the same b. p and same f. p.

20. 4) Solutions in cases *I* and *II* are saturated and that in *III* is unsaturated.

21. 1) Given V. P_P = 80 torr

V. P_P = 80 torr

$$P_{total} = V.P_P \times x_p + V.P_Q \times x_Q = \left[80 \times \frac{3}{5} + 60 \times \frac{2}{5}\right] = 16 \times 3 + 12 \times 2$$

$$P_{total} = 48 + 24 = 72 torr$$

22. 4) A solution containing A and B components shows negative deviation when A–A and B–B interactions are weaker than that of A–B interactions. For such solutions.

$\Delta H = -ve$ and $\Delta V = -ve$

23. 2) Number of solute particles going into solution will be equal to the solute particles separating out and a state of dynamic equilibrium is reached.

$\text{solute} + \text{solvent} \rightleftharpoons \text{solution}$

i.e., rate of dissolution = rate of crystallization

24. 4) $\frac{P^0 - P}{P^0} = \frac{n_2}{n_1 + n_2}$

$$\frac{640 - 600}{640} = \frac{25.5/m}{39/78}$$

$$m = \frac{640 \times 78 \times 2.5}{39 \times 40} = 80$$

25. 3) For ideal solution, $\Delta V_{mixing} = 0$ and $\Delta H_{mixing} = 0$

26. 4) Gaseous densities of ethanol and dimethyl ether would be same at same temperature and pressure. The heat of vaporisation, V.P. and b.pts will differ due to H-bonding in ethanol.

27. 4)

28. 4) Addition of a solute increases the boiling point of solution.

29. 2) Solvent having high cryoscopic constant (camphor) can be used in determination of molecular masses of organic compounds like naphthalene, anthracene etc., by cryoscopic method.

30. 4) Boiling temperature is a temperature at which vapour pressure is equal to the atmospheric pressure when external pressure is equal to 1 atm.

31. 2) $2Na^+(aq) + 2OH^-(aq) + SnO_2(s) \rightarrow 2Na^+(aq) + SnO_3^{2-}(aq) + H_2O$

The number of ions decreases in the ratio of 4 to 3, and so also the colligative property.

32. 1) Lowering is always positive

33. 3) $\frac{P^o - P_s}{P^o} = \frac{n}{N} = \frac{w}{m} \times \frac{M}{W}; 0.1 = \frac{12}{m} \times \frac{18}{108}$; $m = \frac{12 \times 18}{0.1 \times 108} = 20$

34. 1) Osmosis occurs from dilute solution to concentrated solution, i.e., exosmosis.

35. 3) Osmotic pressure $\propto$ no. of ions

$(NH_4)_3PO_4$ gives maximum ions. Hence its osmotic pressure is maximum

36. 4) $\pi = CRT \Rightarrow 2.5 = C \times 0.0821 \times 297$

$\therefore C = 0.1025 mol\ L^{-1}$

37. 4) $\pi = MRT$

i) $\pi = RT$; ii) $\pi = RT$; iii) $\pi = RT$ (mix has concentration = 1M)

38. 3) Osmotic pressure is a colligative property

39. 3) B.P. $\propto$ moles of non-volatile solute.

40. 4) Liquid solution ⇌ solid solvent

41. 1) $\Delta T_f = i \times K_f \times m$

Van't Hoff factor, i = 2 for NaCl, m = 0.01 hence $\Delta T_f = 0.02K_f$ which is maximum in the present case. Hence ΔT_f is maximum or freezing point is minimum.

42. 4) $0.465 = 1.86 \times \left[\frac{1.8/x}{40} \times 10^3\right]$

$x = 180 g/mol \therefore C_6H_{12}O_6$

43. 2) $T_f = \frac{\Delta H}{\Delta S}$

44. 4) Depression in freezing point, $\Delta T_f = iK_f m$. The value of van't Hoff factor (i) is minimum for the glucose, which is a non-electrolyte. Hence, aqueous solution of glucose has highest freezing point.

45. 2) $\begin{matrix} KCl \rightleftharpoons & K^+ + Cl^- \\ 1-\alpha & \alpha \quad\quad \alpha \end{matrix}$

Total number of particles at e.g.

$1-\alpha+\alpha+\alpha = 1+\alpha = 1+0.5 \quad \Delta T_f = ikfm$

$\Delta T_f = (1+0.5) \times 1.86 \times 0.5 = 1.395$

$\therefore T_f = 273 - 1.395 = 271.60$

46. 4) $i = 1+\alpha \Rightarrow 1.25$

$\Delta T_f = K_f.m.i \Rightarrow 1.86 \times 0.2 \times 1.25$ or $\Delta T_f = 0.465$ or $T_f = -0.465^0C$

47. 4) Depression in freezing point = $K_f m (as\, K_f \uparrow, \Delta T_f \uparrow)$

K_f depends upon the solvent

48. 4)

$$\begin{array}{lllll} t=0 & AB_3 & \rightleftharpoons & A^{3+} & + \ 3B^- \\ & 1 & & 0 & \ \ 0 \\ t=t_{eq} & 1-\alpha & & \alpha & \ \ \alpha \end{array}$$

Total $1+\alpha+\alpha+3\alpha = 1+3\alpha$

$\therefore T - 100 = 0.1\,(1+3\times 0.9)\times 0.52$

$T = 373.19\,K$

49. 1) In osmosis, solvent molecules move from lower concentration (higher vapour pressure) to higher

concentration (Lower vapour pressure)

50. 1) $\pi \propto i$ [Equal concentration]

Aluminium sulphate $Al_2(SO_4)_3$ (i = 5),

Barium chloride $BaCl_2$(i = 3),

51. (1) Concentration of particles in $CaCl_2$ solution will be maximum as *i* = 3 for $CaCl_2$ and *i* = 2 for KCl.

Glucose and Urea do not dissociate into ions, as they are nonelectrolytes.

52. 1) $7.4 = n \times 0.0821 \times 300$

$\therefore n = 0.3$

53. 4) Addition of solute to water decreases the freezing point of water (pure solvent).

$\therefore$ When 1% lead nitrate (solute) is added to water, the freezing point of water will be below 0°C.

54. 3) $\Delta T_b = \frac{K_b \times 100 \times 100}{10 \times 1000} = \Delta T_b$

55. 2) $M = \frac{K_b \times w \times 1000}{\Delta T_b \times W} = \frac{2.16 \times 0.11 \times 1000}{0.1 \times 15} = 158.4$

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56. 3) $K_b = \frac{0.1 \times 180 \times 100}{1.8 \times 1000} = 1K/m$

57. 4) $0.186 = 1.86 \times m; \therefore m = 0.1;$

$\therefore \Delta T_b = 0.512 \times 0.1 = 0.0512^0 C$

58. 2) $\pi V = CRT$

$\frac{\pi_1}{\pi_2} = \frac{C_1 T_1}{C_2 T_2}$

$\pi_1 = P, \pi_2 = 2atm. C_1 = C, C_2 = \frac{C}{2}$

$T_1 = 600K, T_2 = 700K$

$\frac{P}{2} = \frac{2 \times C \times 600}{C \times 700}; P = \frac{24}{7}$

59. 3)

60. 4) Osmosis is a spontaneous process $(\Delta G < 0)$ which takes place with $(\Delta S < 0)$ (due to transfer of solvent in 70 solution)

61. 2) $\Delta T_b = K_b \times i \times m$

Where $\Delta T_b =$ Elevation in boiling point

$K_b =$ molal elevation constant

$i =$ vant Hoff factor

$\therefore \Delta T_b \propto$ molality

62. 2) Benzoic acid exists as dimer in benzene.

63. 2) Blood cells neither swell nor shrink in isotonic solution. As isotonic solutions have equal concentration therefore there is no flow of solvent occurs and hence solvent neither enters nor flow out of the blood cells.

64. 1) The solution which provide same number of ions are isotonic.

$Ca(NO_3)_2 \rightarrow Ca^{2+} + 2NO_3^-$

Total ions produced = 3

$Na_2SO_4 \rightarrow 2Na^+ + SO_4^{2-}$

Total ions produced = 3

$\therefore 0.1M \quad Ca(NO_3)_2$ and 0.1 M Na_2SO_4 are isotonic

65. 3) If compound dissociates in solvent $i > 1$ and on association $i < 1$.

66. 4)

67. 3)

$Na_2SO_4 \longrightarrow 2Na^+ + SO_4^{2-}$

	Na_2SO_4	$2Na^+$	SO_4^{2-}
Mol. before dissociation	1	0	0
Mol. after dissociation	$1-\alpha$	2α	1α

$i = 1 - \alpha + 2\alpha + \alpha = 1 + 2\alpha$

68. 4) Osmotic pressure is directly proportional to the number of particles in the solution. KCl will dissociate completely in the solution, while CH_3COOH and sucrose are weak electrolyte. Hence correct order will be :

$KCl > CH_3COOH > Sucrose$

69. 1)

$K_4[Fe(CN)_6]$ and $Al_2(SO_4)_3$ both dissociates to give 5 ions or $i = 5$

$K_4[Fe(CN)_6] \rightleftharpoons 4K^+ + [Fe(CN)_6]^{4-}$

and $Al_2(SO_4)_3 \rightleftharpoons 2Al^{3+} + 3SO_4^{2-}$

70. 4) All the statements are correct

NEET PREVIOUS YEARS QUESTIONS-EXPLANATIONS

1. 3) K_f (molal depression constant) only depends on the nature of the solvent and is independent of the concentration of the solution.

2. 1) Let us consider that A is benzene and B is toluene 1 : 1 molar mixture of A and B

$\therefore x_A = \frac{1}{2}$ and $x_B = \frac{1}{2}$

Total pressure of solution (P) = $P_A^0 x_A + P_B^0 x_B$

$$P = 12.8 \times \frac{1}{2} + 3.85 \times \frac{1}{2} = 8.325\text{kPa} \;;\quad Y_A = \frac{P_A^0 x_A}{P} = \frac{12.8 \times \frac{1}{2}}{8.325} = 0.768$$

$\therefore y_B = 1 - y_A = 1 - 0.768 = 0.232$

so, the vapour will contain higher percentage of benzene.

3. 1)

$$\left(\frac{P^\circ - P_s}{P^\circ}\right) = \frac{n}{N} = \frac{W_1}{M_1} \times \frac{M_2}{W_2}$$

Where, W_1 = wt of solute

W_2 = wt of solvent

M_1 = Mass of solute

M_2 = Mass of solvent

at 100°C, $P^\circ = 760\,\text{mm}$

$$\frac{760 - 732}{760} = \frac{6.5 \times 18}{M_1 \times 100}$$

$M_1 = 31.75\ \text{g mol}^{-1}$

$$\Delta T_b = m \times K_b = \frac{W_1 \times 1000}{M_1 \times W_2} \times K_b$$

$$\Delta T_b = \frac{0.52 \times 6.5 \times 1000}{31.75 \times 100} = 1.06^\circ\text{C}$$

boiling point of solution

$= 100^\circ\text{C} + 1.06^\circ\text{C} = 101\,^\circ\text{C}$

4. 3) $K_4\left[Fe(CN)_6\right] \rightleftharpoons 4K^+ + \left[Fe(CN)_6\right]^-$

And $Al_2(SO_4)_3 \rightarrow 2Al^{3+} + 3SO_4^{2-}$

$\therefore$ van't Hoff factor is 5 for both

$Al_2(SO_4)_3$ and $K_4\left[Fe(CN)_6\right]$

5. 4) $\Delta T_b = iK_b m$

Given $(\Delta T_b)_x > (\Delta T_b)_y$

$\therefore i_x K_b m > i_y K_b m$ (K_b is same for same solvent)

$i_x > i_y$ So, x is undergoing dissociation in water

6. 1) For an ideal solution $\Delta S_{mix} > 0$

7. 3) Colligative properties $\propto$ no. of particles since $Al_2(SO_4)_3$ contains maximum number of particles, hence will have the largest value of freezing point depression.

8. 3)For an ideal solution, $\Delta H_{mix} = 0$

9. 1)Maximum boiling azeotrope are formed by solutions which show negative deviation from ideal behaviour. Water + Nitric acid shows negative deviation.

10. 1)

If, intermolecular attractive forces between **A – A** **and B – B** are **stronger** than those **A – B** then it show positive deviation from ideal behaviour.

11. 3)

$X_{H_2O} = 0.02$

$\therefore X_{gas} = 0.98$

$P_{total} = 1.2$ atm

partial pressure of dry-air=P_T xmole fraction of dry-air

Partial pressure of dry-air = $1.2 \text{ atm} \times 0.98$

$= \mathbf{1.176\ atm.}$

12. 3)

13. 1) Assuming dilute solution,

$$\frac{P_0 - P_s}{P_s} \approx \frac{P_0 - P_s}{P_0} = \frac{n_{solute}}{n_{solvent}}$$

Let $P_0 = 100$, V.P reduced to 80%, $\therefore P_s = 80$

$$\frac{100-80}{100} = \frac{8/m}{114/114}$$

m = 40

14. 3) Isotonic solutions have same osmotic pressure.

15. 2)Ethanol + Acetone mixture shows positive deviation from Raoult's law

16. 4) $\Delta_F^t = K_f \times m = 5.12 \times 0.078$; Depression in = 0.4K ; Freezing point

17. **4) π = i.C.R.T**

$$\pi \ \alpha \ \frac{1}{molecular \ weight} \ ; \qquad P_2 > P_1 > P_3$$

18. 2) $\frac{C_6H_6}{n_1 = 3}$ $\frac{C_8H_{18}}{n_2 = 2}$

$P_1 = 280\,mm$ $P_2 = 420\,mm$

$$P = P_1X_1 + P_2X_2 = 280 \times \frac{3}{5} + 420 \times \frac{2}{5} = 168 + 168 = 336 \text{ mm of Hg}$$

19. Molality = $n \times \frac{1000}{weight \ of \ solvent}$

$$1 = 0.5 \times \frac{1000}{w} \Rightarrow w = 500g$$

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