

Elevation in Boiling Point - It is found that the boiling point of the solution is always higher than that of pure solvent. The increase is called the elevation in boiling point.

$$\Delta T_b = K_b \cdot m$$

K_b → molar elevation constant

ΔT_b → Increase in boiling point

m → molality of solution.

$$M_2 = \frac{1000 \times K_b \times W_2}{\Delta T_b \times W_1}$$

Depression in Freezing Point - Freezing point of a substance is the temperature at which the solid and the liquid forms of substance have the same vapour pressure.

$$\Delta T_f = K_f \cdot m$$

$$M = \frac{1000 \times K_f \times W_2}{\Delta T_f \times W_1}$$

K_f → molar depression constant

m → molality of solution

ΔT_f → Depression in Freezing point.

of the solution is lower than that of pure solvent. It was derived that relative lowering of vapour pressure given by this equation.

$$\frac{p^0 - p_s}{p_A^0} = \frac{n_2}{n_1 + n_2}$$

Osmotic Pressure - The minimum hydro pressure that has to be applied on the solution to prevent the entry of the solvent into the solution through the semi-permeable membrane is called Osmotic Pressure.

$$\pi \propto c$$

$$\pi \propto T$$

$$\pi \propto c \times T$$

$$\text{or } \pi = CRT$$

R - Solution Constant

π - Osmotic Pressure.

c - molar concentration of solution

T - Temperature.

$$\pi = CRT = \frac{n}{V} RT$$

$$\text{or } \boxed{\pi V = nRT}$$

$$\text{or } \pi V = \frac{w}{M} RT \quad \text{or } \boxed{M = \frac{nRT}{\pi V}}$$

- Example (a) Chloroform + Benzene
 (b) Acetone + aniline.
 (c) HCl + water.

Q (3) What is Colligative Properties?
 Discuss different types Colligative Properties.

Ans! - Those Properties of ideal solutions which depend only on the number of particles of the solute dissolved in a definite amount of the solvent and do not depend on the nature of solute are called Colligative Properties.

The important Colligative Properties are:

- (i) Relative lowering of vapour pressure.
- (ii) Osmotic pressure
- (iii) Elevation in boiling point
- (iv) Depression in freezing point

Relative lowering of vapour pressure

When a non-volatile solute is dissolved in a solvent, the vapour pressure

A non-ideal solution is that solution in which solute and solvent molecules interact with one another with a different force than the forces of interaction between the molecules of the pure components.

Types of Non-ideal solution - There are two types

(i) Positive deviation $\Delta V_{mix} > 0$

$$\Delta H_{mix} > 0$$

$$P_A > x_A \cdot P_A^0 \text{ and } P_B > x_B \cdot P_B^0$$

$$F_{A-B} < F_{A-A} \text{ or } F_{B-B}$$

Example (i) Acetone + Carbon disulphide

(ii) Acetone + Ethyl alcohol

(iii) Carbon tetrachloride + Benzene

(iv) Carbon tetrachloride + Toluene

Non-ideal solutions showing negative deviation.

$$(i) P_A < x_A P_A^0, P_B < x_B P_B^0$$

$$P_{Total} < x_A P_A^0 + x_B P_B^0$$

(ii) $\Delta H_{mixing} = -ve$

(iii) $\Delta V_{mixing} = -ve$

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An ideal solution will satisfy the following conditions:

(i) $\Delta V_{\text{mixing}} = 0$, There will be no change in volume on mixing the two components.

(ii) There will be no change in enthalpy
 $\Delta H_{\text{mixing}} = 0$

(iii) $P_A = x_A P_A^0$ and $P_B = x_B P_B^0$

(iv) $f_{A-B} = f_{A-A} = f_{B-B}$
Intermolecular interaction between A-B components are same magnitude as the intermolecular interaction found in the pure A-A and B-B attractions.

Examples (i) Benzene + Toluene

(ii) n-Hexane + n-Heptane

(iii) Ethyl bromide + Ethyl chloride

(iv) Chloro benzene + Bromobenzene

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

For such solution

$$\Delta V_{\text{mixing}} \neq 0$$

$$\Delta H_{\text{mixing}} \neq 0$$

$$P_A \neq x_A \cdot P_A^0 \quad \text{or} \quad P_B \neq x_B \cdot P_B^0$$

$$f_{A-B} \neq f_{A-A} = f_{B-B}$$

(4)

$$\frac{P_s}{P^0} = x_1 = \frac{n_1}{n_1 + n_2}$$

$$1 - \frac{P_s}{P^0} = 1 - \frac{n_1}{n_1 + n_2}$$

$$\Delta \frac{P^0 - P_s}{P^0} = \frac{n_2}{n_1 + n_2}$$

$P^0 - P_s \rightarrow$ lowering of v.p.

$\frac{P^0 - P_s}{P^0} \rightarrow$ Relative lowering of vapour pressure.

$$\frac{n_2}{n_1 + n_2} = x_B = \text{mole fraction of solute}$$

The relative lowering of vapour pressure of a solution containing a non-volatile solute is equal to the mole fraction of the solute in the solution.

2. What are ideal & non-ideal solution discuss with examples. Why it shows positive and negative deviation?

Ans! - An ideal solution is that solution in which each component obeys under all conditions of temperature and concentration.

$$P = (P_B^{\circ} - P_A^{\circ})x_B + P_A^{\circ}$$

(3)

Since P_A° and P_B° are constant at a particular temperature. So that total vapour pressure is a linear function of the mole fraction x_B . Thus a st. line should be obtained when P is plotted against x_A or x_B .

Raoult's law as explained above is applicable only if two components (volatile liquids) form a solution. This law is not applicable if the two liquids are not completely miscible.

Raoult's law for Non volatile solute

For non-volatile solutes quantitatively the effect of adding a solid (non-volatile) on the lowering of vapour pressure can be derived

$$P_s = x_1 \cdot P_A^{\circ}$$

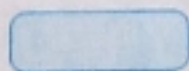
x_1 → mole fraction of solvent

Mole fraction of solute is not dependent, because it is non-volatile solute

P_s → vapour pressure of solvent in the solution

$$\frac{P_s}{P_A^{\circ}} = x_1$$

$$\text{or } P_s \propto x_1 \quad \text{or } x_1 = \frac{n_1}{n_1 + n_2}$$





$x_A \rightarrow$ mole fraction of A component in solution.

$P_A^0 \rightarrow$ v.p of A component in it's pure state.

$P_B^0 \rightarrow$ v.p of B Component in pure state

$P_B \rightarrow$ v.p of B Component in solution

$x_B \rightarrow$ mole fraction of B Component

If P is the total pressure of the system at same temp.

Then, $P = P_A + P_B = x_A P_A^0 + x_B P_B^0$

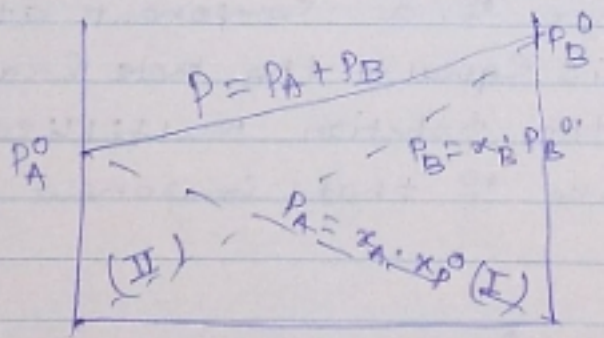
$$P = (1 - x_B) P_A^0 + x_B P_B^0$$
$$= (P_B^0 - P_A^0) x_B + P_A^0$$

When $x_A = 1$ i.e the liquid is pure A

$$P_A = P_A^0$$

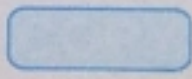
When $x_B = 1$ i.e the liquid is pure B

$$P = P_B^0$$



$x_A = 1$
 $x_B = 0$

$x_A = 0$
 $x_B = 1$



Generic Objective-3

Section 4 - Physical Chemistry

Important questions

(1)

Long Questions & Short questions.

1. Define vapour pressure? State and explain Raoult's law for volatile solutes & non volatile solutes.

Ans:- Vapour pressure of a liquid/solution is the pressure exerted by the vapours in equilibrium (when rate of evaporation is equal to rate of condensation) with the liquid/solution at a particular temperature.

For a solution of liquid-liquid, as both the components of the solution are volatile, each component will form vapour above the solution. When equilibrium is reached each component will exert a vapour pressure called partial pressure whose value depends upon the mole fraction of the component in solution and vapour pressure of that component in pure state.

Raoult's law states that in a solution, the vapour pressure of a component at a given temperature is equal to the mole fraction of that component in the solution multiplied by the vapour pressure of that component in the pure state.

$$P_A = x_A P_A^0 \quad \text{and} \quad P_B = x_B P_B^0$$

$P_A \rightarrow$ V.P of A component in solution

Q (4) Discuss Specific, Equivalent and Molar Conductance.

Ans. - Specific Conductivity - "The reciprocal of resistivity is known as specific conductance or simply conductivity."

$$R \propto \frac{l}{a} \quad \text{or} \quad R = \rho \cdot \frac{l}{a}$$

$R \rightarrow$ Resistance, $l \rightarrow$ Length of Conductor,
 $a \rightarrow$ Area of cross-section
 $\rho \rightarrow$ sp. resistance / resistivity.

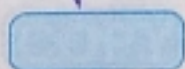
$$\rho = R \times \frac{a}{l} \quad \text{or} \quad \left[\frac{1}{\rho} = \frac{1}{R} \times \frac{l}{a} \right]$$

Reciprocal of ~~sp. resistance~~ resistance is Conductance & $\frac{l}{a}$ is known as Cell Const.

Reciprocal of resistivity / sp. resistance is called conductivity.

Hence Conductivity of a solution is defined as the conductance of a solution 1 cm length and having 1 sq. cm as the area of cross-section.

$$\text{Sp. Conductivity } (k) = \frac{1}{\rho} = \frac{1}{R} \times \frac{l}{a}$$



Equivalent Conductivity:- It is defined as the conductance of all the ions produced from 1 gm. equivalent of the electrolyte dissolved in $v \text{ cm}^3$ of the solution when the distance between the electrodes is one cm and the area of the electrode is so large that whole of the solution is contained between them. It is represented by Λ_{eq} .

$$\Lambda_{eq} = k_c \times v$$

$$\Lambda_{eq} = k_c \times \frac{1000}{c_{eq}} = k_c \times \frac{1000}{\text{Normality}}$$

Molar Conductivity:- Molar Conductivity of a solution at a dilution v is the conductance of all the ions produced from one mole of electrolyte dissolved in $v \text{ cm}^3$ of the solution when the electrodes are one cm apart and the area of the electrodes is so large that the whole of the solution is combined between them. It is usually represented as

$$\Lambda_m = k_v \times v = k_v \times \frac{1000}{\text{Molarity}}$$



Q. (5) State Kohlrausch's law mathematically and its application.

Ans:- Kohlrausch studied the molar conductivity at infinite dilution (Λ_m^0). Each ion makes a definite contribution to the total molar conductivity of an electrolyte at infinite dilution irrespective of the nature of the other ions of the electrolyte.

It is defined as the molar conductivity of an electrolyte is the sum of the limiting ionic conductivities of the cations & the anions each multiplied with the number of ions present in one formula unit of the electrolyte.

$$\Lambda_m^0 = (A_x B_y) = x \lambda_+^0 + y \lambda_-^0$$

Example - $\Lambda_m^0 (\text{NaCl}) = \lambda_{\text{Na}^+}^0 + \lambda_{\text{Cl}^-}^0$

$$\Lambda_m^0 (\text{BaCl}_2) = \lambda_{\text{Ba}^{2+}}^0 + 2 \lambda_{\text{Cl}^-}^0$$

$$\Lambda_m^0 [\text{Al}_2(\text{SO}_4)_3] = 2 \lambda_{\text{Al}^{3+}}^0 + 3 \lambda_{\text{SO}_4^{2-}}^0$$

The equivalent conductivity of an electrolyte at infinite dilution is the sum of two values one depending upon the cation and other upon anions.

$$\Lambda_{eq}^{\circ} = \lambda_c^{\circ} + \lambda_a^{\circ}$$

λ_c° and $\lambda_a^{\circ} \rightarrow$ limiting ionic conductivities for the cation and the anion respectively.

Application of Kohlrausch's Law

1. Calculation of molar conductivity at infinite dilution for weak electrolyte

$$\begin{aligned}\Lambda_m^{\circ}(\text{CH}_3\text{COOH}) &= \Lambda_m^{\circ}(\text{CH}_3\text{COO}^-) + \Lambda_m^{\circ}(\text{H}^+) \\ &= \lambda_{\text{CH}_3\text{COO}^-}^{\circ} + \lambda_{\text{H}^+}^{\circ}\end{aligned}$$

2. Calculation of degree of dissociation

$$\text{Degree of dissociation } (\alpha) = \frac{\Lambda_m^c}{\Lambda_m^{\circ}}$$

$\Lambda_m^c \rightarrow$ molar conductivity at a certain concentration

$\Lambda_m^{\circ} \rightarrow$ molar conductivity at infinite dilution.

Q. (b) Discuss the working of simple "Galvanic cell"

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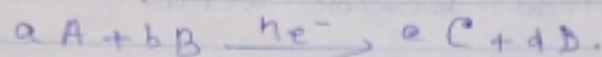
What is Galvanic cell? Describe

Daniell cell. []



Q. (7) Define phase, Component and degree of freedom. Derive Gibbs phase rule.

Q. (8) What is electrode potential? Write Nernst equation for the electrode reaction



How it is applied in the calculation of equilibrium constant.

Q. (9) Write about:

(a) Hell-Vohlard-Zelinsky reaction.

(b) Perkin Condensation.

(c) Hofmann Bromamide reaction

(d) Saytzeff ~~re~~ elimination.

Q. (10) How amino acids is synthesised by Gabriel's phthalimide synthesis explain

Q. (11) Account for the following:

(a) Aliphatic Carboxylic acids are stronger acids than Phenols.

(b) Chloroacetic acid is a stronger acid than Phenol.

Q (12) How will you convert the following into benzoic acid.

(i) Toluene (ii) Benzyl alcohol.

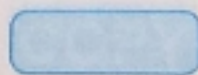
Q (13) What are Carbohydrates? How are they classified? What are their important functions?

MCA GE-3

1. ~~At~~ The Carbohydrate which cannot be hydrolysed by the human digestive system is:

(a) Starch (b) Glycogen (c) Cellulose
(d) All the above.

2. Which one of the following amines gives Carbylamine reaction?

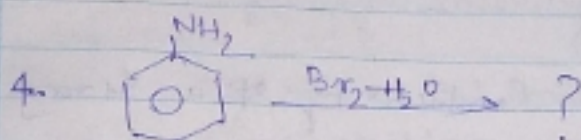
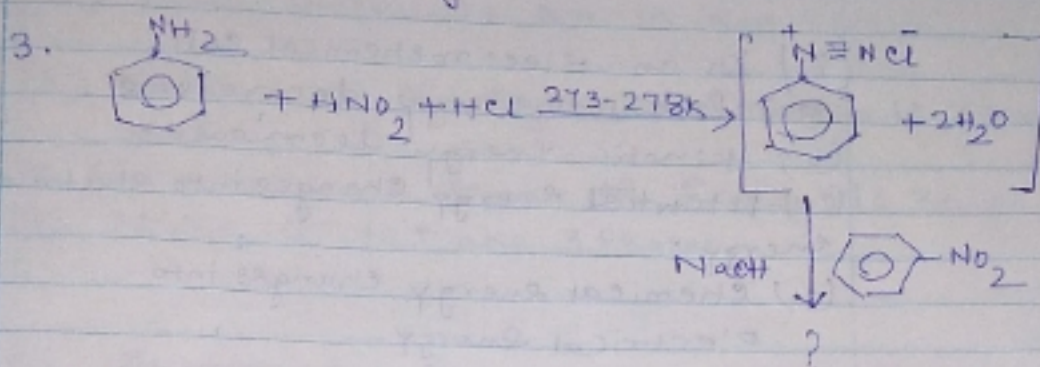


Generic Elective-3



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- (a) Aniline (b) N-Methylaniline (c) N,N-Dimethylaniline (d) Dimethylamine



5. Which of the following acids has the smallest dissociation constant?

- (a) $\text{CH}_3\text{CH}_2\text{COOH}$ (b) $\text{FCH}_2\text{CH}_2\text{COOH}$

- (c) $\text{BrCH}_2\text{CH}_2\text{COOH}$ (d) $\text{CH}_3\text{CH}_2\text{BrCOOH}$

6. If an aqueous solution of glucose is allowed to freeze, then crystals of which will be separated out first?

- (a) Glucose (b) Water (c) both of these
(d) None of these.

7. Ideal solution is formed when its components

- (a) Have zero heat of mixing (b) Have zero vol^m change



- (c) obey Raoult's law
- (d) Can be converted into gases.

- (8) In an electrochemical cell
- (a) potential energy decreases.
 - (b) kinetic energy decreases
 - (c) potential energy changes into electrical energy.
 - (d) Chemical energy changes into electrical energy

- (9) The molar conductivity of a strong electrolyte
- (a) Increases linearly with concentration
 - (b) Increases linearly with square root of concentration
 - (c) Decreases linearly with concentration
 - (d) Decreases with square root of concentration in a linear fashion

(10) The Gibbs phase Rule is

(a) $F = C - P + 1$ (b) $F = P - C + 2$

(c) $F = C - P + 2$ (d) $P = F - C + 1$

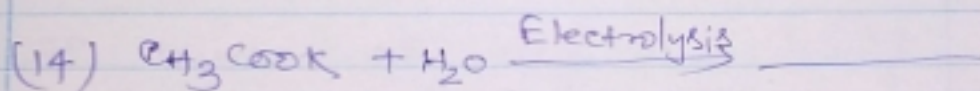
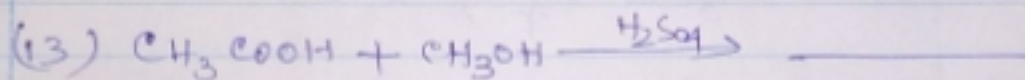


11. Triple point is the point where

- (a) Three components are in equilibrium
- (b) The number of degree of freedom is zero
- (c) The number of degree of freedom is zero
- (d) Three solids make 3 phases.

12. Amongst the following the most basic compound is:

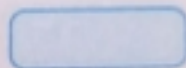
- (a) Benzylamine (b) Aniline (c) Acetanilide.
- (d) p-Nitroaniline.



(15) In Polysaccharides, the linkage connecting monosaccharide is called

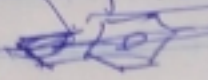
- (a) Glycoside linkage (b) Nucleoside linkage
- (c) Glycogen linkage (d) peptide linkage.

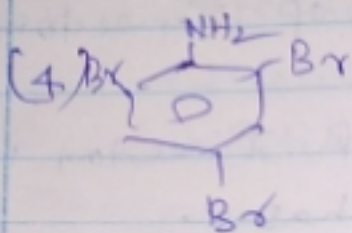
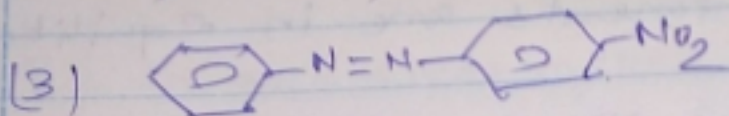
Answer





Answers of MCQ GE-3

1 (c), 2 (a), ~~3~~ 



(5) c, 6 (b), 7, (a), (b), (c)

8. (a), 9. (d), 10 (c), 11. (b)

12. (e), 13. $\text{CH}_3\text{COOCH}_3 + \text{H}_2\text{O}$

14. ~~CH_3~~ CH_4 , 15. (a)