CLASS : CC -AD

Revision Work-sheet Liquid Solution

Single correct

Q.1 Which of the following options regarding order of ebullioscopic constant, K_b is correct?

(A) $K_{bC_6H_6} > K_{bC_2H_5-O-C_2H_5} > K_{bCS_2} > K_{bCCl_4}$

(B) $K_{bCCl_4} > K_{bC_6H_6} > K_{bCS_2} > K_{bC_2H_5-O-C_2H_5}$

(C) $K_{bCS_2} > K_{bC_2H_5-O-C_2H_5} > K_{bC_6H_6} > K_{bCCl_4}$

(D) $K_{bC_2H_5-O-C_2H_5} > K_{bC_6H_6} > K_{bCS_2} > K_{bCCl_4}$

Q.2 For a dilute solution containing 2.5 g of a non-volatile non-electrolyte solute in 100 g of water, the elevation in boiling point at 1 atm pressure is 2ºC. Assuming concentration of solute is much lower than the concentration of solvent, the vapour pressure (mm of Hg) of the solution is (take $K_b = 0.76$ K kg mol^{-1})

(A) 724 (B) 710 (C) 736 (D) 718

Q.3 The freezing point depression of a 0.1 M aq. solution of weak acid (HX) is –0.20°C. What is the value of equilibrium constant for the reaction:

$$HX\,(aq) \rightleftharpoons H^+(aq) + X^-\,(aq)$$

[Given : K_f for water = 1.8 kg mol^{-1} K. & Molality = Molarity]

(A) 1.46×10^{-4} (B) 1.35×10^{-3} (C) 1.21×10^{-2} (D) 1.35×10^{-4}

Q.4 The vapour pressure of an aqueous solution is found to be 750 torr at certain temperature 'T'. If 'T' is the temperature at which pure water boils under atmospheric pressure and same solution show elevation in boiling point $\Delta T_b = 1.04$ K, find the atmospheric pressure ($K_b = 0.52$ K kg mol^{-1})

(A) 777 (B) 779 (C) 782 (D) 746

Q.5 The vapour pressure of a saturated solution of sparingly soluble salt (XCl_3) was 17.20 mm Hg at 27°C. If the vapour pressure of pure H_2O is 17.25 mm Hg at 300 K, what is the solubility of sparingly soluble salt XCl_3 in mole/Litre.

(A) 4.04×10^{-2} (B) 8.08×10^{-2} (C) 2.02×10^{-2} (D) 4.04×10^{-3}

Q.6 A 0.001 molal solution of a complex $[MA_8]$ in water has the freezing point of –0.0054°C. Assuming 100% ionization of the complex salt and K_f for H_2O = 1.86 k.m^{-1}, write the correct representation for the complex.

(A) $[MA_8]$ (B) $[MA_7]A$ (C) $[MA_6]A_2$ (D) $[MA_5]A_3$

Q.7 Which of the following aqueous solution will show maximum vapour pressure at 300 K?

(A) 1 M NaCl (B) 1 M $CaCl_2$ (C) 1 M $AlCl_3$ (D) 1 M $C_{12}H_{22}O_{11}$

Q.8 When 20 g of naphtholic acid ($C_{11}H_8O_2$) is dissolved in 50 g of benzene ($K_f = 1.72$ K kg mol^{-1}), a freezing point depression of 2 K is observed. The van't Hoff factor (*i*) is

(A) 0.5 (B) 1 (C) 2 (D) 3

Q.9 A mixture contains 1 mole of volatile liquid A (P_A° =100 mm Hg) and 3 moles of volatille liquid B (P_B° = 80 mm Hg). If solution behaves ideally, the total vapour pressure of the distillate is

(A) 85 mm Hg (B) 85.88 mm Hg (C) 90 mm Hg (D) 92 mm Hg

SMART ACHIEVERS
smartachievers.online

Q.10 The Henry's law constant for the solubility of N_2 gas in water at 298 K is 1.0×10^5 atm. The mole fraction of N_2 in air is 0.8. The number of moles of N_2 from air dissolved in 10 moles of water at 298 K and 5 atm pressure is

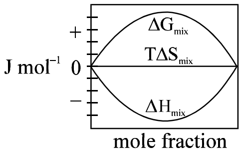
(A) 4.0×10^{-4} (B) 4.0×10^{-5} (C) 5.0×10^{-4} (D) 4.0×10^{-6}

Q.11 At 300 K, the vapour pressure of an ideal solution containing 3 mole of A and 2 mole of B is 600 torr. At the same temperature, if 1.5 mole of A & 0.5 mole of C (non-volatile) are added to this solution the vapour pressure of solution increases by 30 torr. What is the value of P_B^o?

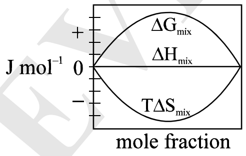
(A) 940 (B) 405 (C) 90 (D) none of these

Q.12 Which of the following represents correctly the changes in thermodynamic properties during the formation of 1 mol of an ideal binary solution.

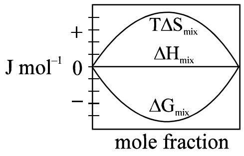
(A)



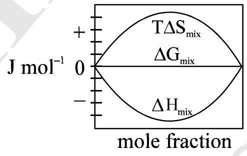
(B)



(C)



(D)



Q.13 Which of the following plots represents an ideal binary mixture?

(A) Plot of P_{total} v/s $1/X_B$ is linear (X_B = mole fraction of 'B' in liquid phase).

(B) Plot of P_{total} v/s Y_A is linear (Y_B = mole fraction of 'A' in vapour phase)

(C) Plot of $\frac{1}{P_{total}}$ v/s Y_A is linear

(D) Plot of $\frac{1}{P_{total}}$ v/s Y_B is non linear

Q.14 Pressure over ideal binary liquid mixture containing 10 moles each of liquid A and B is gradually decreased isothermally. If P_A^o =200 mm Hg and P_B^o =100 mm Hg, find the pressure at which half of the liquid is converted into vapour.

(A) 150 mm Hg (B) 166.5 mm Hg (C) 133 mm Hg (D) 141.4 mm Hg

Q.15 During depression of freezing point in a solution, the following are in equilibrium

(A) liquid solvent-solid solvent (B) liquid solvent-solid solute

(C) liquid solute-solid solute (D) liquid solute-solid solvent

Q.16 A 0.004 M solution of Na_2SO_4 is isotonic with a 0.010 M solution of glucose at same temperature. The apparent degree of dissociation of Na_2SO_4 is

(A) 25% (B) 50% (C) 75% (D) 85%

SMART ACHIEVERS
smartachievers.online

Assertion Reason

Q.17 **Statement-1** : Additon of ethylene glycol (non-volatile) to water lowers the freezing point of water hence used as antifreeze.

Statement-2 : Addition of any substance to water lowers its freezings point.

(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.

(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.

(C) Statement-1 is true, statement-2 is false.

(D) Statement-1 is false, statement-2 is true.

Comprehension

Paragraph for Question no. 18 & 19

Two liquids A and B mix to form an ideal binary liquid solution. On adding solid solute C to the solution A starts polymerising into a hexamer soluble solid 'A_6' following zero order kinetics with a rate constant = 10^{-1} moles/ min. If initially 10 moles of A and 20 moles of B were taken to form liquid solution and 5 moles of C were added then answer the following questions based on above information and data given below: **[Data :** vapour pressure of pure A = 100 torr, vapour pressure of pure B = 90 torr**]**

Q.18 The vapour pressure of the solution 1 hrs. after solid **C** is added will be given by :

(A) $\frac{220}{3}$ torr (B) 98 torr (C) $\frac{2200}{29}$ torr (D) $\frac{2200}{24}$ torr

Q.19 Which of the following statements is **incorrect** regarding the above process?

(A) The vapour pressure will keep on decreasing initially.

(B) The vapour pressure will become constant 100 min. after addition of C.

(C) Two hours after addition of C, the vapour pressure will become 72 torr.

(D) Four hours after addition of C, the vapour pressure will become 67.5 torr.

Paragraph for Question No. Q.20 to Q.22

Properties such as boiling point, freezing point and vapour pressure of a pure solvent change when solute molecules are added to get homogeneous solution. These are called colligative properties. Applications of colligative properties are very useful in day-to-day life. One of its examples is the use of ethylene glycol and water mixture as anti-freezing liquid in the radiator of automobiles.

A solution **M** is prepared by mixing ethanol and water. The mole fraction of ethanol in the mixture is 0.9.

Given : Freezing point depression constant of water $\left(K_f^{water}\right) = 1.86$ K kg mol^{-1}

Freezing point depression constant of ethanol $\left(K_f^{ethanol}\right) = 2.0$ K kg mol^{-1}

Boiling point elevation constant of water $\left(K_b^{water}\right) = 0.52$ K kg mol^{-1}

Boiling point elevation constant of ethanol $\left(K_b^{ethanol}\right) = 1.2$ K kg mol^{-1}

Standard freezing point of water = 273 K
Standard freezing point of ethanol = 155.7 K
Standard boiling point of water = 373 K
Standard boiling point of ethanol = 351.5 K
Vapour pressure of pure water = 32.8 mm Hg
Vapour pressure of pure ethanol = 40 mm Hg
Molecular weight of water = 18 g mol^{-1}
Molecular weight of ethanol = 46 g mol^{-1}

SMART ACHIEVERS
smartachievers.online

In answering the following questions, consider the solutions to be ideal dilute solutions and solutes to be non-volatile and non-dissociative.

Q.20 The freezing point of the solution **M** is
(A) 268.7 K (B) 268.5 K (C) 234.2 K (D) 150.9 K

Q.21 The vapour pressure of the solution **M** is
(A) 39.3 mm Hg (B) 36.0 mm Hg (C) 29.5 mm Hg (D) 28.8 mm Hg

Q.22 Water is added to the solution **M** such that the mole fraction of water in the solution becomes 0.9. The boiling point of this solution is
(A) 380.4 K (B) 376.2 K (C) 375.5 K (D) 354.7 K

More than one correct :

Q.23 Identify the option(s) which are **not correct** w.r.t. solubility of a gas in water.
(A) Value of K_H (Henry's constant) will decrease as the temperature increases.
(B) Value of K_H (Henry's constant) at same temperature for O_2 gas will be less as compared to H_2 gas
(C) Soft drinks will have greater **"fizz"** if sealed under low pressure.
(D) **Scuba** divers when they move underwater will have increased solubility of gases in their blood.

Subjective

Q.24 Calculate the number of binary liquid solutions which are expected to follow Raoult's law.
(1) Solution of benzene & toluene
(2) Solution of hexane & heptane
(3) Solution of chloroform & methanol
(4) Solution of methanol & acetone
(5) Solution of chloroform & acetone
(6) Solution of HNO_3 & water
(7) Solution of Aniline & phenol
(8) Solution of two volatile liquids which can give maximum boiling azeotrope.
(9) Very dilute aqueous solution of glucose
(10) Solution of two volatile liquids which on mixing do not show contraction / expansion of volume.

Q.25 A sample of water contains 12% w/w $MgSO_4$ and 9.5% w/w $MgCl_2$. If the sulphate dissociates to 80% extent and chloride to 60% extent then calculate the boiling point of the solution.
Given : $K_b[H_2O]$ = 0.785 K-Kg/mole^{-1} .
[Express your answers in Kelvin scale.]

Q.26 Dry air was drawn thorugh bulbs containing a solution of 40 grams of urea in 300 grams of water, then through bulbs containing pure water at the same temperature and finally through a tube in which pumice moistened with strong H_2SO_4 was kept. The water bulbs lost 0.0870 grams and the sulphuric acid tube gained 2.036 grams. Calculate the molecular weight of urea.

Q.27 A 10% (w/w) solution of an optical active compound A (M = 100gm / mol^{-1}) has undergone partial inversion according to the reaction:
$A(aq) \longrightarrow B(aq) + C(aq)$. If the boiling point of solution is 100.8533°C.
(a) What is the average mass of the dissolved materials?
(b) What fraction of the A has inverted? $K_b(H_2O) = 0.512$ K mol^{-1} kg; (Molar mass of B = 60)

SMART ACHIEVERS smartachievers.online

Q.28 Phenol associates in benzene to a certain extent to form a dimer. A solution containing 20×10^{-3} kg phenol in 1 kg of benzene has its freezing point depressed by 0.69 K. Calculate the fraction of phenol that has dimerised. K_f for benzene = 5.12 kg $mol^{-1}K$.

Q.29 A solution of crab hemocyanin, a pigmented protein extracted from crabs, was prepared by dissolving 0.750 g in 125 cm^3 of an aqueous medium. At 4°C an osmotic pressure rise of 2.6 mm of the solution was observed. The solution had a density of 1.00 g/cm^3. Determine the molecular weight of the protein.

Q.30 A storage battery contains a solution of H_2SO_4 38% by weight. What will be the Van't Hoff factor if the $\Delta T_{f(experiment)}$ in 29.08. [Given K_f = 1.86 mol^{-1} Kg]

Q.31 The elements X and Y form compounds having molecular formula XY_2 and XY_4. When dissolved in 20 gm of benzene, 1 gm XY_2 lowers the freezing point by 2.3°, whereas 1 gm of XY_4 lowers the freezing point by 1.3°C. The molal depression constant for benzene is 5.1. Calculate the atomic masses of X and Y.

Q.32 Calculate the amount of ice that will separate out of cooling a solution containing 50g of ethylene glycol in 200 g water to –9.3°C. (K_f for water = 1.86 K mol^{-1} kg)

Q.33 The vapour pressure of two miscible liquids (A) and (B) are 300 and 500 mm of Hg respectively. In a flask 10 mole of (A) is mixed with 12 mole of (B). However, as soon as (B) is added, (A) starts polymerising into a completely insoluble solid. The polymerisation follows first-order kinetics. After 100 minute, 0.525 mole of a solute is dissolved which arrests the polymerisation completely. The final vapour pressure of the solution is 400 mm of Hg. Estimate the rate constant of the polymerisation reaction. Assume negligible volume change on mixing and polymerisation and ideal behaviour for the final solution.

Q.34 The molar volume of liquid benzene (density = 0.877 g ml^{-1}) increases by a factor of 2750 as it vaporizes at 20°C and that of liquid toluene (density = 0.867gml^{-1}) increases by a factor of 7720 at 20°C. Solution of benzene & toluene has a vapour pressure of 46.0 torr. Find the mole fraction of benzene in the vapour above the solution.

Q.35 The vapour pressure of two pure liquids, A and B that form an ideal solution are 300 and 800 torr respectively, at temperature T. A mixture of the vapour of A and B for which the mole fraction of A is 0.25 is slowly compressed at temperature T. Calculate

(a) the composition of the first drop of the condensate,
(b) the total pressure when this drop is formed,
(c) the composition of the solution whose normal boiling point is T,
(d) the pressure when only the last bubble of vapour remains, and
(e) the composition of the last bubble.

Q.36 At 90°C, the vapour pressure of toluene is 400 torr and that of σ-xylene is 150 torr. What is the composition of the liquid mixture that boils at 90°C, when the pressure is 0.50 atm? What is the composition of vapour produced?

SMART ACHIEVERS smartachievers.online

REVISION FLOW CHART

Liquid Solutions

Solubility of gases

(i) Effect of temperature (T)

(ii) Effect of pressure (T+N)

1. Vapour Pressure(T)

2. Raoult's law (T+N+G)

(i) When volatile solute is added

(a) When solute and solvent; both are miscible

(b) When both are immiscible

(ii) When non-volatile solute is added.

3. Condensation of vapours of solution (T + N)

4. Ideal and non-ideal solutions (T)

5. Azeotropic mixtures (T)

Colligative properties (C.P.)

1. Introduction (T)

2. The various C.P. (T+N)

(i) Lowering of V.P.

(a) Determination of molar masses

(b) It's measurement

(ii) Boiling point elevation

(iii) Depression in freezing point

(iv) Osmotic pressure

(a) Osmosis
(b) Reverse osmosis
(c) Isotonic solution

3.Van't Haff factor; Where the solute associates or dissociates in solution. (N)

(G) → represents topic of graphical importance

(T) → represents topic of theoretical importance

(N) → represents topic of numerical importance

SMART ACHIEVERS
smartachievers.online

LIST OF IMPORTANT FORMULAS

Henary's Law : $P = K_H X$

* K_H increase with increase in temperature for a particular gas,

* K_H depends on nature of gas

Clausius Clapeyron Equaiton : $\ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_{vap}}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$

Raoult's Law : For Ideal solution of 2 volatile solute's

$$P_A = P_A^\circ X_A$$

$$P_B = P_B^\circ X_B$$

$$P_{Solution} = P_A^\circ X_A + P_B^\circ X_B$$

(X_A and X_B are mole fraction in liquid phase (Solution),

$$\frac{1}{P} = \frac{Y_A}{P_A^\circ} + \frac{Y_B}{P_B^\circ}$$

Y_A and Y_B are mole fraction in vapour phase)

COLLIGATIVE PROPERTIES :

(a) Relative lowering in Vapour pressure

$$\frac{P^\circ - P_S}{P^\circ} = \frac{n}{n+N} \text{ or } \frac{P^\circ - P_S}{P^\circ} = \frac{n}{N}$$

If $n << N$

$$\frac{P^\circ - P_S}{P^\circ} \cong \frac{n}{N} \qquad \frac{P^\circ - P_S}{P^\circ} = \frac{m \times M_{solvent}}{1000}$$

$M_{Solvent} \Rightarrow$ Molar mass of solvent

$m \Rightarrow$ Molality

Elevation in Boiling Poing (ΔT_b) :

$$\Delta T_b = K_b \times \text{molality}$$

$$K_b = \frac{RT_b}{1000\ell_{vap}} = \frac{RT_b \times M_{solvent}}{1000 \times \Delta H_{vap}}$$

$T_b \Rightarrow$ Boiling point of pure solvent in Kelvin

$\ell_{vap} \Rightarrow$ Latent heat of vaporisation of solvent (per gm)

$\Delta H_{vap} \Rightarrow$ Enthalpy of vaporisation of solvent (per mole)

$M_{solvent} \Rightarrow$ Molar mass of solvent (in gm)

(c) Depression in freezing point (ΔT_f):

$$\Delta T_f = K_f \times \text{molality}$$

$$K_f = \frac{RT_f}{1000\ell_f} = \frac{RT_f \times M_{solvent}}{1000 \times \Delta H_{fusion}}$$

T_f = freezing point of pure solvent in Kelvin

ℓ_f = Latent heat of fusion (per gram)

ΔH_{fusion} = Enthalpy of fusion (Per mole)

$M_{solvent}$ = Molar mass of solvent (in gram)

(d) Osmotic pressure : $\pi = CRT = h\rho g$

Vant Hoff factor : $i = \frac{n_{observed}}{n_{calculated}} = \frac{\text{Observed colligative property}}{\text{Theoretical colligative property}}$

For $A_X B_y$ (Degree of dissociation α)

$$i = \frac{1 + (x + y - 1)\alpha}{1}$$

SMART ACHIEVERS
smartachievers.online

LAST MOMENT REVIEW

LIQUID SOLUTION

Theory : ....

....

....

....

Exercise - 1 : Question ....

Exercise - 2 : Question ....

Exercise - 3 : Question ....

Exercise - 4 : Question ....

DPPs : ....

....

....

....

Other Sources : ....

....

....

SMART ACHIEVERS
smartachievers.online

CLASS : CC -AD

Revision Work-sheet Liquid Solution

Single correct

Q.1 Which of the following options regarding order of ebullioscopic constant, K_b is correct?

(A) $K_{b\,C_6H_6} > K_{b\,C_2H_5-O-C_2H_5} > K_{b\,CS_2} > K_{b\,CCl_4}$

(B*) $K_{b\,CCl_4} > K_{b\,C_6H_6} > K_{b\,CS_2} > K_{b\,C_2H_5-O-C_2H_5}$

(C) $K_{b\,CS_2} > K_{b\,C_2H_5-O-C_2H_5} > K_{b\,C_6H_6} > K_{b\,CCl_4}$

(D) $K_{b\,C_2H_5-O-C_2H_5} > K_{b\,C_6H_6} > K_{b\,CS_2} > K_{b\,CCl_4}$

Q.2 For a dilute solution containing 2.5 g of a non-volatile non-electrolyte solute in 100 g of water, the elevation in boiling point at 1 atm pressure is 2ºC. Assuming concentration of solute is much lower than the concentration of solvent, the vapour pressure (mm of Hg) of the solution is (take $K_b = 0.76$ K kg mol^{-1})

(A*) 724 (B) 710 (C) 736 (D) 718

Q.3 The freezing point depression of a 0.1 M aq. solution of weak acid (HX) is –0.20°C. What is the value of equilibrium constant for the reaction:

$$HX\,(aq) \rightleftharpoons H^+(aq) + X^-\,(aq)$$

[Given : K_f for water = 1.8 kg mol^{-1} K. & Molality = Molarity]

(A) 1.46×10^{-4} (B*) 1.35×10^{-3} (C) 1.21×10^{-2} (D) 1.35×10^{-4}

Q.4 The vapour pressure of an aqueous solution is found to be 750 torr at certain temperature 'T'. If 'T' is the temperature at which pure water boils under atmospheric pressure and same solution show elevation in boiling point $\Delta T_b = 1.04$ K, find the atmospheric pressure ($K_b = 0.52$ K kg mol^{-1})

(A*) 777 (B) 779 (C) 782 (D) 746

Q.5 The vapour pressure of a saturated solution of sparingly soluble salt (XCl_3) was 17.20 mm Hg at 27°C. If the vapour pressure of pure H_2O is 17.25 mm Hg at 300 K, what is the solubility of sparingly soluble salt XCl_3 in mole/Litre.

(A*) 4.04×10^{-2} (B) 8.08×10^{-2} (C) 2.02×10^{-2} (D) 4.04×10^{-3}

Q.6 A 0.001 molal solution of a complex $[MA_8]$ in water has the freezing point of –0.0054°C. Assuming 100% ionization of the complex salt and K_f for H_2O = 1.86 k.m^{-1}, write the correct representation for the complex.

(A) $[MA_8]$ (B) $[MA_7]A$ (C*) $[MA_6]A_2$ (D) $[MA_5]A_3$

Q.7 Which of the following aqueous solution will show maximum vapour pressure at 300 K?

(A) 1 M NaCl (B) 1 M $CaCl_2$ (C) 1 M $AlCl_3$ (D*) 1 M $C_{12}H_{22}O_{11}$

Q.8 When 20 g of naphtholic acid ($C_{11}H_8O_2$) is dissolved in 50 g of benzene ($K_f = 1.72$ K kg mol^{-1}), a freezing point depression of 2 K is observed. The van't Hoff factor (i) is

(A*) 0.5 (B) 1 (C) 2 (D) 3

Q.9 A mixture contains 1 mole of volatile liquid A (P_A° =100 mm Hg) and 3 moles of volatille liquid B (P_B° = 80 mm Hg). If solution behaves ideally, the total vapour pressure of the distillate is

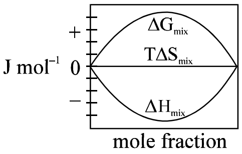
(A) 85 mm Hg (B*) 85.88 mm Hg (C) 90 mm Hg (D) 92 mm Hg

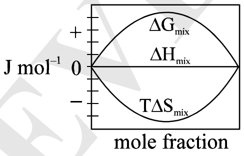
SMART ACHIEVERS
smartachievers.online

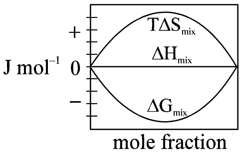
Q.10 The Henry's law constant for the solubility of N_2 gas in water at 298 K is 1.0×10^5 atm. The mole fraction of N_2 in air is 0.8. The number of moles of N_2 from air dissolved in 10 moles of water at 298 K and 5 atm pressure is
(A*) 4.0×10^{-4} (B) 4.0×10^{-5} (C) 5.0×10^{-4} (D) 4.0×10^{-6}

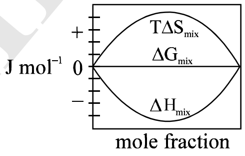
Q.11 At 300 K, the vapour pressure of an ideal solution containing 3 mole of A and 2 mole of B is 600 torr. At the same temperature, if 1.5 mole of A & 0.5 mole of C (non-volatile) are added to this solution the vapour pressure of solution increases by 30 torr. What is the value of P_B^o?
(A) 940 (B) 405 (C*) 90 (D) none of these

Q.12 Which of the following represents correctly the changes in thermodynamic properties during the formation of 1 mol of an ideal binary solution.

(A)


(B)


(C*)


(D)


Q.13 Which of the following plots represents an ideal binary mixture?
(A) Plot of P_{total} v/s $1/X_B$ is linear (X_B = mole fraction of 'B' in liquid phase).
(B) Plot of P_{total} v/s Y_A is linear (Y_B = mole fraction of 'A' in vapour phase)
(C*) Plot of $\frac{1}{P_{total}}$ v/s Y_A is linear
(D) Plot of $\frac{1}{P_{total}}$ v/s Y_B is non linear

Q.14 Pressure over ideal binary liquid mixture containing 10 moles each of liquid A and B is gradually decreased isothermally. If P_A^o =200 mm Hg and P_B^o =100 mm Hg, find the pressure at which half of the liquid is converted into vapour.
(A) 150 mm Hg (B) 166.5 mm Hg (C) 133 mm Hg (D*) 141.4 mm Hg

Q.15 During depression of freezing point in a solution, the following are in equilibrium
(A*) liquid solvent-solid solvent (B) liquid solvent-solid solute
(C) liquid solute-solid solute (D) liquid solute-solid solvent

Q.16 A 0.004 M solution of Na_2SO_4 is isotonic with a 0.010 M solution of glucose at same temperature. The apparent degree of dissociation of Na_2SO_4 is
(A) 25% (B) 50% (C*) 75% (D) 85%

SMART ACHIEVERS
smartachievers.online

Assertion Reason

Q.17 **Statement-1** : Additon of ethylene glycol (non-volatile) to water lowers the freezing point of water hence used as antifreeze.

Statement-2 : Addition of any substance to water lowers its freezings point.

(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.

(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.

(C*) Statement-1 is true, statement-2 is false.

(D) Statement-1 is false, statement-2 is true.

Comprehension

Paragraph for Question no. 18 & 19

Two liquids A and B mix to form an ideal binary liquid solution. On adding solid solute C to the solution A starts polymerising into a hexamer soluble solid 'A_6' following zero order kinetics with a rate constant = 10^{-1} moles/ min. If initially 10 moles of A and 20 moles of B were taken to form liquid solution and 5 moles of C were added then answer the following questions based on above information and data given below: **[Data :** vapour pressure of pure A = 100 torr, vapour pressure of pure B = 90 torr**]**

Q.18 The vapour pressure of the solution 1 hrs. after solid **C** is added will be given by :

(A*) $\frac{220}{3}$ torr (B) 98 torr (C) $\frac{2200}{29}$ torr (D) $\frac{2200}{24}$ torr

Q.19 Which of the following statements is **incorrect** regarding the above process?

(A) The vapour pressure will keep on decreasing initially.

(B) The vapour pressure will become constant 100 min. after addition of C.

(C*) Two hours after addition of C, the vapour pressure will become 72 torr.

(D) Four hours after addition of C, the vapour pressure will become 67.5 torr.

Paragraph for Question No. Q.20 to Q.22

Properties such as boiling point, freezing point and vapour pressure of a pure solvent change when solute molecules are added to get homogeneous solution. These are called colligative properties. Applications of colligative properties are very useful in day-to-day life. One of its examples is the use of ethylene glycol and water mixture as anti-freezing liquid in the radiator of automobiles.

A solution **M** is prepared by mixing ethanol and water. The mole fraction of ethanol in the mixture is 0.9.

Given : Freezing point depression constant of water $\left(K_f^{water}\right) = 1.86$ K kg mol^{-1}

Freezing point depression constant of ethanol $\left(K_f^{ethanol}\right) = 2.0$ K kg mol^{-1}

Boiling point elevation constant of water $\left(K_b^{water}\right) = 0.52$ K kg mol^{-1}

Boiling point elevation constant of ethanol $\left(K_b^{ethanol}\right) = 1.2$ K kg mol^{-1}

Standard freezing point of water = 273 K
Standard freezing point of ethanol = 155.7 K
Standard boiling point of water = 373 K
Standard boiling point of ethanol = 351.5 K
Vapour pressure of pure water = 32.8 mm Hg
Vapour pressure of pure ethanol = 40 mm Hg
Molecular weight of water = 18 g mol^{-1}
Molecular weight of ethanol = 46 g mol^{-1}

SMART ACHIEVERS
smartachievers.online

In answering the following questions, consider the solutions to be ideal dilute solutions and solutes to be non-volatile and non-dissociative.

Q.20 The freezing point of the solution **M** is

(A) 268.7 K (B) 268.5 K (C) 234.2 K (D*) 150.9 K

Q.21 The vapour pressure of the solution **M** is

(A) 39.3 mm Hg (B*) 36.0 mm Hg (C) 29.5 mm Hg (D) 28.8 mm Hg

Q.22 Water is added to the solution **M** such that the mole fraction of water in the solution becomes 0.9. The boiling point of this solution is

(A) 380.4 K (B*) 376.2 K (C) 375.5 K (D) 354.7 K

More than one correct :

Q.23 Identify the option(s) which are **not correct** w.r.t. solubility of a gas in water.

(A*) Value of K_H (Henry's constant) will decrease as the temperature increases.

(B) Value of K_H (Henry's constant) at same temperature for O_2 gas will be less as compared to H_2 gas

(C*) Soft drinks will have greater **"fizz"** if sealed under low pressure.

(D) **Scuba** divers when they move underwater will have increased solubility of gases in their blood.

Subjective

Q.24 Calculate the number of binary liquid solutions which are expected to follow Raoult's law.

(1) Solution of benzene & toluene
(2) Solution of hexane & heptane
(3) Solution of chloroform & methanol
(4) Solution of methanol & acetone
(5) Solution of chloroform & acetone
(6) Solution of HNO_3 & water
(7) Solution of Aniline & phenol
(8) Solution of two volatile liquids which can give maximum boiling azeotrope.
(9) Very dilute aqueous solution of glucose
(10) Solution of two volatile liquids which on mixing do not show contraction / expansion of volume.

[Ans. 4]

Q.25 A sample of water contains 12% w/w $MgSO_4$ and 9.5% w/w $MgCl_2$. If the sulphate dissociates to 80% extent and chloride to 60% extent then calculate the boiling point of the solution.

Given : K_b[H_2O] = 0.785 K-Kg/mole^{-1} .

[Express your answers in Kelvin scale.] [Ans. 0377]

Q.26 Dry air was drawn thorugh bulbs containing a solution of 40 grams of urea in 300 grams of water, then through bulbs containing pure water at the same temperature and finally through a tube in which pumice moistened with strong H_2SO_4 was kept. The water bulbs lost 0.0870 grams and the sulphuric acid tube gained 2.036 grams. Calculate the molecular weight of urea.

Ans. M = 53.8

Q.27 A 10% (w/w) solution of an optical active compound A (M = 100gm / mol^{-1}) has undergone partial inversion according to the reaction:

$A(aq) \longrightarrow B(aq) + C(aq)$. If the boiling point of solution is 100.8533°C.

(a) What is the average mass of the dissolved materials?

SMART ACHIEVERS smartachievers.online

(b) What fraction of the A has inverted? $K_b(H_2O) = 0.512\ K\ mol^{-1}\ kg$; (Molar mass of B = 60)

[Ans. (a) 66.66 (b) 50%]

Q.28 Phenol associates in benzene to a certain extent to form a dimer. A solution containing 20×10^{-3} kg phenol in 1 kg of benzene has its freezing point depressed by 0.69 K. Calculate the fraction of phenol that has dimerised. K_f for benzene = 5.12 kg mol^{-1}K.

Ans. a = 0.7333

Q.29 A solution of crab hemocyanin, a pigmented protein extracted from crabs, was prepared by dissolving 0.750 g in 125 cm^3 of an aqueous medium. At 4°C an osmotic pressure rise of 2.6 mm of the solution was observed. The solution had a density of 1.00 g/cm^3. Determine the molecular weight of the protein.

Ans. 5.4×10^5 g/mol

Q.30 A storage battery contains a solution of H_2SO_4 38% by weight. What will be the Van't Hoff factor if the $\Delta T_{f(experiment)}$ in 29.08. [Given $K_f = 1.86\ mol^{-1}$ Kg]

Ans. i = 2.5

Q.31 The elements X and Y form compounds having molecular formula XY_2 and XY_4. When dissolved in 20 gm of benzene, 1 gm XY_2 lowers the freezing point by 2.3°, whereas 1 gm of XY_4 lowers the freezing point by 1.3°C. The molal depression constant for benzene is 5.1. Calculate the atomic masses of X and Y.

Ans. x = 25.6, y = 42.6

Q.32 Calculate the amount of ice that will separate out of cooling a solution containing 50g of ethylene glycol in 200 g water to –9.3°C. (K_f for water = 1.86 K mol^{-1} kg)

Ans. 38.71 g

Q.33 The vapour pressure of two miscible liquids (A) and (B) are 300 and 500 mm of Hg respectively. In a flask 10 mole of (A) is mixed with 12 mole of (B). However, as soon as (B) is added, (A) starts polymerising into a completely insoluble solid. The polymerisation follows first-order kinetics. After 100 minute, 0.525 mole of a solute is dissolved which arrests the polymerisation completely. The final vapour pressure of the solution is 400 mm of Hg. Estimate the rate constant of the polymerisation reaction. Assume negligible volume change on mixing and polymerisation and ideal behaviour for the final solution.

Ans. 1.0×10^{-4}

Q.34 The molar volume of liquid benzene (density = 0.877 g ml^{-1}) increases by a factor of 2750 as it vaporizes at 20°C and that of liquid toluene (density = 0.867gml^{-1}) increases by a factor of 7720 at 20°C. Solution of benzene & toluene has a vapour pressure of 46.0 torr. Find the mole fraction of benzene in the vapour above the solution.

Ans. 0.73

Q.35 The vapour pressure of two pure liquids, A and B that form an ideal solution are 300 and 800 torr respectively, at temperature T. A mixture of the vapour of A and B for which the mole fraction of A is 0.25 is slowly compressed at temperature T. Calculate

(a) the composition of the first drop of the condensate,
(b) the total pressure when this drop is formed,
(c) the composition of the solution whose normal boiling point is T,
(d) the pressure when only the last bubble of vapour remains, and
(e) the composition of the last bubble.

Ans. (a)0.47, (b) 565 torr, (c) x_A=0.08, x_B= 0.92, (d) 675 torr, (e) x'_A= 0.11, x'_B= 0.89

SMART ACHIEVERS smartachievers.online

REVISION FLOW CHART

Liquid Solutions

Solubility of gases

(i) Effect of temperature (T)

(ii) Effect of pressure (T+N)

1. Vapour Pressure(T)

2. Raoult's law (T+N+G)

(i) When volatile solute is added

(a) When solute and solvent; both are miscible

(b) When both are immiscible

(ii) When non-volatile solute is added.

3. Condensation of vapours of solution (T + N)

4. Ideal and non-ideal solutions (T)

5. Azeotropic mixtures (T)

Colligative properties (C.P.)

1. Introduction (T)

2. The various C.P. (T+N)

(i) Lowering of V.P.

(a) Determination of molar masses

(b) It's measurement

(ii) Boiling point elevation

(iii) Depression in freezing point

(iv) Osmotic pressure

(a) Osmosis
(b) Reverse osmosis
(c) Isotonic solution

3. Van't Haff factor; Where the solute associates or dissociates in solution. (N)

(G) → represents topic of graphical importance

(T) → represents topic of theoretical importance

(N) → represents topic of numerical importance

SMART ACHIEVERS
smartachievers.online

LIST OF IMPORTANT FORMULAS

Henary's Law : $P = K_H X$

* K_H increase with increase in temperature for a particular gas,

* K_H depends on nature of gas

Clausius Clapeyron Equaiton : $\ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_{vap}}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$

Raoult's Law : For Ideal solution of 2 volatile solute's

$P_A = P_A^\circ X_A$

$P_B = P_B^\circ X_B$

$P_{Solution} = P_A^\circ X_A + P_B^\circ X_B$ (X_A and X_B are mole fraction in liquid phase (Solution),

$\frac{1}{P} = \frac{Y_A}{P_A^\circ} + \frac{Y_B}{P_B^\circ}$ Y_A and Y_B are mole fraction in vapour phase)

COLLIGATIVE PROPERTIES :

(a) Relative lowering in Vapour pressure

$$\frac{P^\circ - P_S}{P^\circ} = \frac{n}{n+N} \text{ or } \frac{P^\circ - P_S}{P^\circ} = \frac{n}{N}$$

If $n << N$

$\frac{P^\circ - P_S}{P^\circ} \cong \frac{n}{N}$ $\frac{P^\circ - P_S}{P^\circ} = \frac{m \times M_{solvent}}{1000}$

$M_{Solvent} \Rightarrow$ Molar mass of solvent

$m \Rightarrow$ Molality

Elevation in Boiling Poing (ΔT_b) :

$\Delta T_b = K_b \times$ molality

$K_b = \frac{RT_b}{1000\ell_{vap}} = \frac{RT_b \times M_{solvent}}{1000 \times \Delta H_{vap}}$

$T_b \Rightarrow$ Boiling point of pure solvent in Kelvin

$\ell_{vap} \Rightarrow$ Latent heat of vaporisation of solvent (per gm)

$\Delta H_{vap} \Rightarrow$ Enthalpy of vaporisation of solvent (per mole)

$M_{solvent} \Rightarrow$ Molar mass of solvent (in gm)

(c) Depression in freezing point (ΔT_f):

$\Delta T_f = K_f \times$ molality

$K_f = \frac{RT_f}{1000\ell_f} = \frac{RT_f \times M_{solvent}}{1000 \times \Delta H_{fusion}}$

T_f = freezing point of pure solvent in Kelvin

ℓ_f = Latent heat of fusion (per gram)

ΔH_{fusion} = Enthalpy of fusion (Per mole)

$M_{solvent}$ = Molar mass of solvent (in gram)

(d) Osmotic pressure : $\pi = CRT = h\rho g$

Vant Hoff factor : $i = \frac{n_{observed}}{n_{calculated}} = \frac{\text{Observed colligative property}}{\text{Theoretical colligative property}}$

For $A_X B_y$ (Degree of dissociation α)

$$i = \frac{1 + (x + y - 1)\alpha}{1}$$

SMART ACHIEVERS
smartachievers.online

LAST MOMENT REVIEW

LIQUID SOLUTION

Theory : ....

....

....

....

Exercise - 1 : Question ....

Exercise - 2 : Question ....

Exercise - 3 : Question ....

Exercise - 4 : Question ....

DPPs : ....

....

....

....

Other Sources : ....

....

....

SMART ACHIEVERS
smartachievers.online