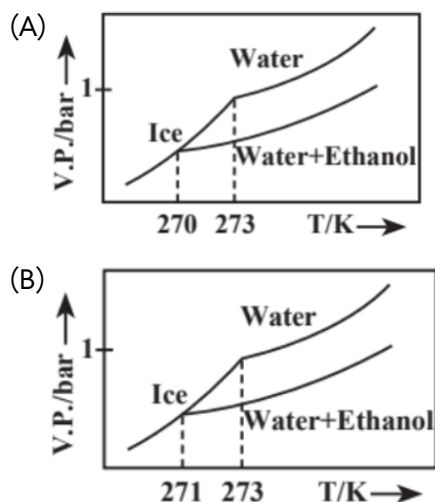


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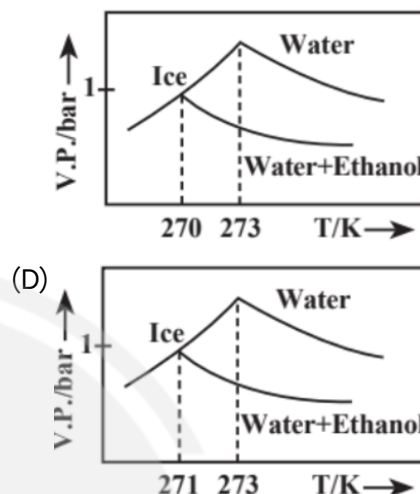
Physical Chemistry By Amit Mahajan Sir
Solutions

- Q1** The molarity of H_2SO_4 solution, which has a density 1.84g/cc at 35°C and contains 98% by weight is-
- (A) 1.84M (B) 18.4M
(C) 20.6M (D) 24.5M
- Q2** What is the molarity of K^+ in aqueous solution that contains 17.4 ppm of K_2SO_4 (174 g mol^{-1})?
- (A) $2 \times 10^{-2}\text{ M}$
(B) $2 \times 10^{-3}\text{ M}$
(C) $4 \times 10^{-4}\text{ M}$
(D) $2 \times 10^{-4}\text{ M}$
- Q3** Pure water freezes at 273 K and 1 bar . The addition of 34.5 g of ethanol to 500 g of water changes the freezing point of the solution. Use the freezing point depression constant of water as 2 K kg mol^{-1} . The figures shown below represent plots of vapour pressure (V.P.) versus temperature (T). [Molecular weight of ethanol is 46 g mol^{-1}]

Among the following, the option representing change in the freezing point is



(C)



- Q4** A compound H_2X with molar weight of 80 g is dissolved in a solvent having density of 0.4 g ml^{-1} . Assuming no change in volume upon dissolution, the molality of a 3.2 molar solution is-
- (A) 6 (B) 7
(C) 8 (D) 9
- Q5** When a gas is bubbled through water at 298 K , a very dilute solution of gas is obtained. Henry's law constant for the gas is 100 k bar . If gas exerts a pressure of 1 bar , the number of moles of gas - dissolved in 1 litre of water is
- (A) 0.555
(B) 55.55×10^{-5}
(C) 55.55×10^{-3}
(D) 5.55×10^{-5}
- Q6** O_2 is bubbled through water at 293 K . Assume that O_2 exerts a partial pressure of 0.98 bar , find that solubility of O_2 in g L^{-1} . The value of Henry's Law constant K_H for O_2 is 34.84 k bar
- (A) 0.05 (B) 0.08



(C) 0.07 (D) 0.01

Q7 Two liquids A and B form ideal solutions. At 300 K, the vapour pressure of solution containing 1 mole of A and 3 mole of B is 550 mm Hg. At the same temperature, if one more mole of B is added to this solution, the vapour pressure of the solution increases by 10 mm Hg. The vapour pressure of A and B in their pure states (in mm Hg) are respectively

- (A) 400,600 (B) 500,500
(C) 600,400 (D) None of these

Q8 At a given temperature, total vapour pressure (in Torr) of a mixture of volatile components A and B is given by

$$P = 240 + 120 X_B$$

Hence, vapour pressure of pure A and B respectively (in Torr) are -

- (A) 120,75 (B) 120,195
(C) 240,360 (D) 75,45

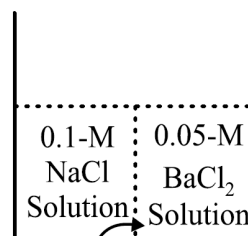
Q9 The vapour pressure lowering caused by the addition of 100 g of sucrose (molecular mass = 342) to 1000 g of water if the vapour pressure of pure water at 25° C is 23.8 mm Hg

- (A) 1.25 mm Hg (B) 0.125 mm Hg
(C) 1.15 mm Hg (D) 0.012 mm Hg

Q10 When 10 g of a non-volatile solute is dissolved in 100 g of benzene, it raises boiling point by 1 °C, then molecular mass of the solute is (k_b for $C_6H_6 = 2.53 \text{ K kg mol}^{-1}$)

- (A) 223 g/mol (B) 233 g/mol
(C) 243 g/mol (D) 253 g/mol

Q11 Study the following figure and choose the correct option



Semipermeable membrane

- (A) There will be no movement of any solution across the membrane
(B) Solvent of $BaCl_2$ will flow towards the NaCl solution
(C) NaCl will flow towards the $BaCl_2$ solution
(D) The osmotic pressure of 0.1 M NaCl is equal to the osmotic pressure of 0.05 M $BaCl_2$, assuming complete dissociation of the electrolyte.

Q12 A solution containing 6 g of a solute dissolved in 250 ml of water gave an osmotic pressure of 4.5 atm at 27° C. Calculate the boiling point of the solution. The molal boiling point elevation constant for water is $0.52 \text{ K kg mol}^{-1}$.

- (A) 100.095 °C
(B) 10.095 °C
(C) 1.095 °C
(D) 1000.095 °C

Q13 Insulin is dissolved in a suitable solvent and the osmotic pressure π in atm of solutions of various concentrations C in g/cm^3 is measured at 27°C. The slope of plot of π against C is found to be $4.1 \times 10^{-3} \text{ atm cm}^3 \text{ g}^{-1}$. The molecular mass of insulin is:

- (A) 6×10^3 (B) 3×10^6
(C) 6×10^6 (D) 3×10^3

Q14 Observe the following abbreviations π_{obs} = observed colligative property π_{cal} = theoretical colligative property assuming normal behaviour of solute. Van't Hoff factor (i) is given by

- (A) $i = \pi_{\text{obs}} \times \pi_{\text{cal}}$
(B) $i = \pi_{\text{obs}} + \pi_{\text{cal}}$
(C) $i = \pi_{\text{obs}} - \pi_{\text{cal}}$



$$(D) i = \frac{\pi_{\text{obs}}}{\pi_{\text{cal}}}$$

- Q15** Which one of the following equimolal aqueous solutions will have maximum freezing point?

(Assume equal ionisation in each case)

- (A) $[Cr(H_2O)_6]Cl$
 (B) $[CrCl_2(H_2O)_5]Cl_2 \cdot H_2O$
 (C) $[CrCl_2(H_2O)_4]Cl_2 \cdot H_2O$
 (D) $[Fe(H_2O)_3Cl_3] \cdot 3H_2O$

- Q16** A 0.001 molal solution of $[Pt(NH_3)_4Cl_4]$ in water had a freezing point depression of $0.0054^\circ C$. If K_f for water is 1.80, the correct formula for the above compound assuming its complete dissociation is

- (A) $[Pt(NH_3)_4Cl_3]Cl$
 (B) $[Pt(NH_3)_4Cl_2]Cl_2$
 (C) $[Pt(NH_3)_4Cl]Cl_3$
 (D) $[Pt(NH_3)_4Cl_4]$

- Q17** Calculate the apparent degree of ionization of an electrolyte MX_2 in water, if the observed molar mass of the solute by measuring elevation in boiling point is 65.6g (Normal molar mass of the solute = 164g).

- (A) 75% (B) 85%
 (C) 65% (D) 25%

- Q18** For a dilute solution containing 2.5g of a non-volatile non-electrolyte solute in 100g of water, the elevation in boiling point at 1atm pressure is $2^\circ C$. 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) 740
 (C) 736 (D) 718

- Q19** The osmotic pressure of a dilute solution of an ionic compound XY in water is four times that of a solution of 0.01 M $BaCl_2$ in water. Assuming complete dissociation of the given ionic compounds in water, the concentration of XY (in $mol L^{-1}$) in solution is :

- (A) 4×10^{-2}

- (B) 6×10^{-2}
 (C) 4×10^{-4}
 (D) 16×10^{-4}

- Q20** Molal depression constant for a solvent is $4.0 K kg mol^{-1}$. The depression in the freezing point of the solvent for $0.03 mol kg^{-1}$ solution K_2SO_4 is : (Assume complete dissociation of the electrolyte)

- (A) 0.18K (B) 0.24K
 (C) 0.12K (D) 0.36K

- Q21** Molecules of benzoic acid (C_6H_5COOH) dimerise in benzene. 'w' g of the acid dissolved in 30g of benzene shows a depression in freezing point equal to 2K. If the percentage association of the acid to form dimer in the solution is 80, the w is: (Given that $K_f = 5 K kg mol^{-1}$, Molar mass of benzoic acid = $122 g mol^{-1}$)

- (A) 2.4g (B) 1.0g
 (C) 1.5g (D) 1.8g

- Q22** The density of 'x' M solution ('x' molar) of NaOH is $1.12 g mL^{-1}$, while in molality, the concentration of the solution is 3m (3 molal). Then x is (Given: Molar mass of NaOH is $40 g/mol$)

- (A) 3.5 (B) 3.0
 (C) 3.8 (D) 2.8

- Q23** Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A): 3.1500 g of hydrated oxalic acid dissolved in water to make 250.0 mL solution will result in 0.1 M oxalic acid solution.

Reason (R): Molar mass of hydrated oxalic acid is $126 g mol^{-1}$.

In the light of the above statements, choose the **correct** answer from the options given below:

- (A) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).
 (B) (A) is false but (R) is true.
 (C) (A) is true but (R) is false.
 (D) Both (A) and (R) are true and (R) is the correct explanation of (A).

Q24



Liquid 'M' and liquid 'N' form an ideal solution.
The vapour pressures of pure liquids 'M' and 'N' are 450 and 700 mm Hg, respectively, at the same temperature. Then, correct statement is

(X_M = Mole fraction of 'M' in solution;

X_N = Mole fraction of 'N' in solution;

y_M = Mole fraction of 'M' in vapour phase;

y_N = Mole fraction of 'N' in vapour phase)

(A) $\frac{X_M}{X_N} = \frac{y_M}{y_N}$

(B) $\frac{X_M}{X_N} > \frac{y_M}{y_N}$

(C) $\frac{X_M}{X_N} < \frac{y_M}{y_N}$

(D) $(X_M - y_M) < (X_N - y_N)$

- Q25** A solution of two miscible liquids showing negative deviation from Raoult's law will have:
(A) increased vapour pressure, increased boiling point
(B) increased vapour pressure, decreased boiling point
(C) decreased vapour pressure, decreased boiling point
(D) decreased vapour pressure, increased boiling point
- Q26** What happens to freezing point of benzene when small quantity of naphthalene is added to benzene?
(A) Increases
(B) Remains unchanged
(C) First decreases and then increases
(D) Decreases
- Q27** The solution from the following with highest depression in freezing point/lowest freezing point is
(A) 180g of acetic acid dissolved in water
(B) 180g of acetic acid dissolved in benzene
(C) 180g of benzoic acid dissolved in benzene
(D) 180g of glucose dissolved in water
- Q28** In the depression of freezing point experiment
(A) Vapour pressure of the solution is less than that of pure solvent

- (B) Vapour pressure of the solution is more than that of pure solvent
(C) Only solute molecules solidify at the freezing point
(D) Only solvent molecules solidify at the freezing point
(A) (A) and (D) only
(B) (B) and (C) only
(C) (A) and (C) only
(D) (A) only

Q29 Match List-I with List-II.

List-I		List-II	
(A)	Van't Hoff Factor, i	(I)	Cryoscopic constant
(B)	k_f	(II)	Isotonic solutions
(C)	Solutions with same osmotic pressure	(III)	Normal molar mass Abnormal molar mass
(D)	Azeotropes	(IV)	Solutions with same composition of vapour above it

Choose the **correct** answer from the options given below:

- (A) (A)-(III), (B)-(I), (C)-(II), (D)-(IV)
(B) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)
(C) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)
(D) (A)-(I), (B)-(III), (C)-(II), (D)-(IV)

- Q30** The depression in freezing point observed for a formic acid solution of concentration 0.5 mL L^{-1} is 0.0405°C . Density of formic acid is 1.05 gm L^{-1} . The Van't Hoff factor of the formic acid solution is nearly: (Given for water $K_f = 1.86 \text{ k kg mol}^{-1}$)
(A) 0.8
(B) 1.1
(C) 1.9
(D) 2.4
- Q31** A 10 mL solution of a solute in water is found to exert an osmotic pressure of 4 atm at 298 K. When this solution is diluted to 40 mL, the osmotic pressure becomes approximately:
(A) 1 atm
(B) 2 atm
(C) 8 atm
(D) 0.5 atm
- Q32** A compound is known to dimerize completely in benzene. If 0.5 mol of the compound is dissolved



in benzene, how many effective particles are present for colligative calculations?

- (A) 0.25 mol (B) 0.50 mol
(C) 1.00 mol (D) 0.75 mol

Q33 Which of the following solution will have highest freezing point

- (A) 1M urea (B) 1M Na_2SO_4
(C) 1M NaCl (D) 1M $\text{Al}_2(\text{SO}_4)_3$

Q34 Determine the **van't Hoff factor** for 0.6 mL of acetic acid (density = 1.06 g/mL) dissolved in 1 litre of water, which lowers the freezing point by 0.0205°C . $K_f = 1.86\text{K kg mol}^{-1}$

- (A) 1.021 (B) 0.970
(C) 1.041 (D) 0.990

Q35 The observed molar mass of a solute in a solution is 30% less than its actual molar mass. Assuming ideal behaviour and dissociation into two ions, what is the degree of dissociation (α)?

- (A) 0.60 (B) 0.30
(C) 0.43 (D) 0.86

Q36 Which of the following statements regarding Henry's Law and gas solubility are **correct**?

1. The solubility of a gas in a liquid increases with partial of a gas.
2. Henry's constant (K_H) has the same value for all gases at a given temperature.
3. The value of Henry's constant is inversely proportional to solubility.
4. Gases with high values of Henry's constant are more soluble at a given pressure.
5. The solubility of gases generally increases with temperature.

- (A) 1, 3 (B) 1, 4
(C) 1, 3, 5 (D) 2, 4

Q37 Consider the concept of abnormal molar mass due to solute association/dissociation:

1. Dimerisation leads to higher observed molar mass.
2. Dissociation leads to lower molar mass than expected.
3. Colligative properties depends only on

number of solute particles.

4. van't Hoff factor is always < 1 for electrolytes.
5. i is defined as ratio of calculated colligative property to the observed colligative property.

Which of the above statements are **correct**?

- (A) 1, 2, 3, 5 (B) 1, 3, 4
(C) 2, 4, 5 (D) 1, 2, 3

Q38 Which statements best describe depression in freezing point?

1. It is directly proportional to molality of the solute.
2. It occurs due to the lowering of vapour pressure of the solution.
3. It is influenced by the dissociation of electrolytes.
4. Solutions with lower molar mass solutes show higher freezing point depression for same mass.
5. $\Delta T_f = i k_b m$.

- (A) 1, 2, 3, 4 (B) 2, 3, 4
(C) 1, 2, 5 (D) 1, 4

Q39 Given below are two statements:

Statement I: Relative lowering of vapour pressure is a colligative property that is useful only when the solute is volatile.

Statement II: The relative lowering of vapour pressure is equal to the mole fraction of solute.

In the light of the above statements, choose the most appropriate answer from the options given below:

- (A) Statement I is correct but Statement II is incorrect.
(B) Statement I is incorrect but Statement II is correct.
(C) Both Statement I and Statement II are correct.
(D) Both Statement I and Statement II are incorrect.

Q40 Given below are two statements:

Statement I: Mole fraction is affected by changes in temperature and pressure due to the expansion of the solvent.



Statement II: The sum of mole fractions of all components in a solution is always unity.

In the light of the above statements, choose the most appropriate answer from the options given below:

- (A) Statement I is correct but Statement II is incorrect.
- (B) Statement I is incorrect but Statement II is correct.
- (C) Both Statement I and Statement II are correct.
- (D) Both Statement I and Statement II are incorrect.

Q41 Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:

Assertion (A): Raoult's Law is a special case of Henry's law.

Reason (R): According to Raoult's law

$$P_A = X_A P_A^\circ \text{ and according to Henry's law } P = K_H X$$

In the light of the above statements, choose the **correct** answer from the options given below:

- (A) A is true but R is false.
- (B) A is false but R is true.
- (C) Both A and R are true and R is the correct explanation of A.
- (D) Both A and R are true but R is NOT the correct explanation of A.

Q42 Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:

Assertion (A): The enthalpy of mixing of the pure component to form the solution is zero.

Reason (R): No heat is absorbed or evolved when the components are mixed.

In the light of the above statements, choose the **correct** answer from the options given below:

- (A) A is true but R is false.
- (B) A is false but R is true.
- (C) Both A and R are true and R is the correct explanation of A.
- (D)

Both A and R are true but R is NOT the correct explanation of A.

Q43 Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:

Assertion (A): For non-electrolytes, the van't Hoff factor is greater than 1.

Reason (R): Non-electrolytes dissociate into multiple particles in solution.

In the light of the above statements, choose the correct answer from the options given below:

- (A) A is true but R is false.
- (B) A is false but R is true.
- (C) Both A and R are true and R is the correct explanation of A.
- (D) Both A and R are true but R is NOT the correct explanation of A.

Q44 Find the percentage by mass and mass fraction of insulin in the solution prepared by dissolving 4.48g of insulin in 26.52g of water.

- (A) 0.125 (B) 0.145
- (C) 0.368 (D) 0.482

Q45 Which one has the highest boiling point

- (A) 0.1M Na_2SO_4
- (B) 0.1M MgSO_4
- (C) 0.1M $\text{Al}^{2+}(\text{SO}_4)_3$
- (D) 0.1M BaSO_4

Q46 An azeotropic solution of two liquids has boiling point lower than either of them when it

- (A) shows negative deviation from Raoult's law
- (B) shows no deviation from Raoult's law
- (C) shows positive deviation from Raoult's law
- (D) is saturated

Q47 The vapour pressure will be lowest for

- (A) 0.1 M sugar solution
- (B) 0.1 M KCl solution
- (C) 0.1 M $\text{Cu}(\text{NO}_3)_2$ solution
- (D) 0.1 M AgNO_3 solution

Q48 Van't Hoff factor of Hg_2Cl_2 in its aqueous solution will be (Hg_2Cl_2 is 80% ionized in the



solution)

- (A) 1.6 (B) 2.6
(C) 3.6 (D) 4.6

Q49 Two solutions A and B are separated by semi-permeable membrane. If liquid flows from A to B then

- (A) A is less concentrated than B
(B) A is more concentrated than B
(C) Both have same concentration
(D) None of these

Q50 What would be the molality of 20% (mass/mass) aqueous solution of KI? (molar mass of KI = 166 g mol⁻¹)

- (A) 1.08 (B) 1.35
(C) 1.48 (D) 1.51

Q51 After adding a solute freezing point of solution decreases to -0.186°C . Calculate ΔT_b if $K_f = 1.86$ and $K_b = 0.521$.

- (A) 0.521°C (B) 0.0521°C
(C) 1.86°C (D) 0.0186°C

Q52 One mole of non-volatile solute is dissolved in two moles of water. The vapour pressure of the solution relative to that of water is

- (A) $2/3$ (B) $1/3$
(C) $1/2$ (D) $3/2$

Q53 Match List-I with List-II:

	List-I		List-II
(A)	Molarity	(I)	Moles of solutes/mass of solvent (kg)
(B)	Molality	(II)	Moles of component total moles
(C)	Mole fraction	(III)	Moles of solute/volume of solution(L)
(D)	Mass percent	(IV)	Mass of $\times 100$ solute/total mass

Choose the **correct** answer from the options given below:

- (A) A-III, B-I, C-II, D-IV
(B) A-IV, B-III, C-II, D-I
(C) A-II, B-III, C-IV, D-I
(D) A-II, B-I, C-III, D-IV

Q54 Match List-I with List-II:

	List-I		List-II
(A)	High altitude sickness	(I)	Lower O ₂ partial pressure in air
(B)	Carbonated drink bottling	(II)	High pressure for gas solubility
(C)	Bends in divers	(III)	Sudden release of dissolved N ₂
(D)	Solubility of gas $\propto 1/K_H$	(IV)	K_H high \rightarrow gas is less soluble

Choose the **correct** answer from the options given below:

- (A) A-I, B-II, C-III, D-IV
(B) A-IV, B-III, C-II, D-I
(C) A-II, B-III, C-IV, D-I
(D) A-II, B-I, C-III, D-IV

Q55 Match List-I with List-II:

	List-I		List-II
(A)	Ideal solution	(I)	$P = K_n X$
(B)	Negative deviation	(II)	A-B interaction < A-A, B-B
(C)	Positive deviation	(III)	$\Delta H_{\text{mix}} = 0, \Delta V_{\text{mix}} = 0$
(D)	Henry's law	(IV)	A-B interaction > A-A, B-B

Choose the **correct** answer from the options given below

- (A) A-III, B-II, C-I, D-IV
(B) A-IV, B-III, C-II, D-I
(C) A-II, B-III, C-IV, D-I
(D) A-II, B-I, C-III, D-IV

Q56 Two open beakers one containing a solvent and the other containing a mixture of that solvent



with a non volatile solute are together sealed in a container. Over time:

- (A) the volume of the solution increases and the volume of the solvent decreases
- (B) the volume of the solution decreases and the volume of the solvent increases
- (C) the volume of the solution and the solvent does not change
- (D) the volume of the solution does not change and the volume of the solvent decreases

Q57 Example of liquid solute and solid solution is:

- (A) Amalgam of mercury with sodium
- (B) Copper dissolved in gold.
- (C) Glucose in water
- (D) H_2 in Palladium

Q58 **Correct** formula representation of is:

- (A) $K_f = \frac{R \times M_1 \times T_f^2}{\Delta_{fus} H}$
- (B) $K_f = \frac{M_1 \times T_f^2}{R \times \Delta_{fus} H}$
- (C) $K_f = \frac{M_1 \times T_f^2}{R \times 1000 \times \Delta_{fus} H}$
- (D) $K_f = \frac{R \times M_1 \times T_f^2}{1000 \times \Delta_{fus} H}$

Q59 Density of 2.03 M aqueous solution of acetic acid is 1.017 g mL^{-1} (molecular mass of acetic acid is 60). calculate the molality of solution?

- (A) 2.27
- (B) 1.27
- (C) 3.27
- (D) 4.27

Q60 A solution of sucrose ($C_{12}H_{22}O_{11}$) is prepared by dissolving 342 g of sucrose in 1000 g of water. Which of the following statements is true regarding the boiling point of this solution compared to pure water?

- (A) The boiling point of the solution will be lower than that of pure water.
- (B) The boiling point of the solution will be the same as that of pure water.
- (C) The boiling point of the solution will be higher than that of pure water due to the increase in vapour pressure.
- (D) The boiling point of the solution will be higher than that of pure water due to the decrease in vapour pressure.



Answer Key

Q1 (B)
Q2 (D)
Q3 (A)
Q4 (C)
Q5 (B)
Q6 (A)
Q7 (A)
Q8 (C)
Q9 (B)
Q10 (D)
Q11 (B)
Q12 (A)
Q13 (C)
Q14 (D)
Q15 (D)
Q16 (B)
Q17 (A)
Q18 (A)
Q19 (B)
Q20 (D)
Q21 (A)
Q22 (A)
Q23 (D)
Q24 (B)
Q25 (D)
Q26 (D)
Q27 (A)
Q28 (A)
Q29 (A)
Q30 (C)

Q31 (A)
Q32 (A)
Q33 (A)
Q34 (C)
Q35 (C)
Q36 (A)
Q37 (D)
Q38 (A)
Q39 (B)
Q40 (B)
Q41 (C)
Q42 (C)
Q43 (B)
Q44 (B)
Q45 (C)
Q46 (C)
Q47 (C)
Q48 (B)
Q49 (A)
Q50 (D)
Q51 (B)
Q52 (A)
Q53 (A)
Q54 (A)
Q55 (A)
Q56 (A)
Q57 (A)
Q58 (A)
Q59 (A)
Q60 (D)



Hints & Solutions

Q1 Text Solution:

Assume 1 L of solution:

Mass of solution = 1840 g

Since 98% is H_2SO_4 :

Mass of H_2SO_4 = 98% of 1840 g =

$0.98 \times 1840 = 1803.2$ g

Moles of H_2SO_4 = $1803.2 / 98 = 18.4$ mol

Volume of solution = 1 L

So, Molarity = moles / volume = $18.4 \text{ mol} / 1 \text{ L} = 18.4 \text{ M}$

Q2 Text Solution:

17.4 ppm = 17.4 mg of K_2SO_4 per 1 kg (or 1000 g or 1 L) of water

So, 17.4 mg = 0.0174 g K_2SO_4

2. Moles of K_2SO_4 :

$$\text{Moles of } \text{K}_2\text{SO}_4 = \frac{0.0174}{174} = 1.0 \times 10^{-4} \text{ mol}$$

3. Each K_2SO_4 gives 2 K^+ ions:

$$\text{Moles of } \text{K}^+ = 2 \times 1.0 \times 10^{-4} = 2.0 \times 10^{-4} \text{ mol}$$

4. Volume of solution = 1 L \Rightarrow Molarity = moles / volume = $2.0 \times 10^{-4} \text{ M}$

Q3 Text Solution:

$$\Delta T_f = K_f \times m$$

$$273 - T'_f = 2 \times \frac{34.5 \times 1000}{46 \times 500}$$

$$\therefore T'_f = 270 \text{ K}$$

Thus, freezing point of solution is 270K.

Further, as T increases, vapour pressure increases.

Hence, these facts coincide with the curve given in (a).

Q4 Text Solution:

Let's consider 1 L of solution.

- Moles of solute (H_2X) = Molarity \times Volume = $3.2 \text{ mol/L} \times 1 \text{ L} = 3.2 \text{ mol}$.
- If $V_{\text{solution}} = 1 \text{ L}$, then $V_{\text{solvent}} \approx 1 \text{ L} = 1000 \text{ mL}$.
- Mass of solvent = Volume of solvent \times density of solvent = $1000 \text{ mL} \times 0.4 \text{ g/mL} = 400 \text{ g} = 0.4 \text{ kg}$.
- Molality (m) = Moles of solute / Mass of solvent (kg) = $3.2 \text{ mol} / 0.4 \text{ kg} = 8 \text{ m}$.

Q5 Text Solution:

$$C = k_H \cdot x \text{ or } x = \frac{P}{k_H}$$

Where:

x = mole fraction of the gas in solution

P = 1 bar (given pressure of gas)

$k_H = 100 \text{ kbar} = 100 \times 10^3 \text{ bar}$

$$\text{So, } x = \frac{1}{100 \times 10^3} = 10^{-5}$$

Now, mole fraction of gas

$$x = \frac{n_{\text{gas}}}{n_{\text{gas}} + n_{\text{water}}} \approx \frac{n_{\text{gas}}}{n_{\text{water}}} \text{ (since dilute solution)}$$

In 1 L (1000 g) of water:

$$n_{\text{water}} = \frac{1000}{18} \approx 55.56 \text{ mol}$$

So,

$$x = \frac{n_{\text{gas}}}{55.56} = 10^{-5} \Rightarrow n_{\text{gas}} = 10^{-5} \times 55.56 \approx 5.56 \times 10^{-4}$$

Q6 Text Solution:

Given: $\text{PO}_2 = 0.98 \text{ bar}$. K_H for $\text{O}_2 = 34.84 \text{ kbar} = 34.84 \times 10^3 \text{ bar}$.

$$x_{\text{O}_2} = \text{PO}_2 / K_H = 0.98 \text{ bar} / (34.84 \times 10^3 \text{ bar}) = 0.98 / 34840 \approx 2.8128 \times 10^{-5}$$

Assume 1 L of water (solution). Moles of water (n_{water}) $\approx 55.55 \text{ mol}$.

$$n_{\text{O}_2} = x_{\text{O}_2} \times n_{\text{water}} =$$

$$2.8128 \times 10^{-5} \times 55.55 \approx 0.0015625 \text{ mol}$$

Molar mass of $\text{O}_2 = 32 \text{ g/mol}$.

$$\text{Mass of } \text{O}_2 = n_{\text{O}_2} \times \text{Molar mass } \text{O}_2 =$$

$$0.0015625 \text{ mol} \times 32 \text{ g/mol} = 0.050 \text{ g}$$

$$\text{Solubility} = 0.050 \text{ g} / 1 \text{ L} = 0.05 \text{ g L}^{-1}$$

Q7 Text Solution:

$$550 = \frac{1}{4}P_A^0 + \frac{3}{4}P_B^0 \rightarrow \text{Multiply by 4 :}$$

$$2200 = P_A^0 + 3P_B^0 \quad (3)$$

Equation (2) :

$$560 = \frac{1}{5}P_A^0 + \frac{4}{5}P_B^0 \rightarrow \text{Multiply by 5 :}$$

$$2800 = P_A^0 + 4P_B^0 \quad (4)$$

Subtract (3) from (4):

$$(2800 - 2200) = (P_A^0 + 4P_B^0) - (P_A^0 + 3P_B^0)$$

$$\Rightarrow 600 = P_B^0$$

Substitute into (3):

$$2200 = P_A^0 + 3 \times 600 = P_A^0 + 1800$$

$$\Rightarrow P_A^0 = 400$$



Q8 Text Solution:

We are given the expression for total vapour pressure:

$$P = 240 + 120 X_B$$

According to Raoult's Law:

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

Rewriting:

$$P = P_A^0 + (P_B^0 - P_A^0) X_B$$

Now compare with:

$$P = 240 + 120 X_B$$

Matching terms:

$$\begin{aligned} \cdot P_A^0 &= 240 \\ \cdot P_B^0 - P_A^0 &= 120 \Rightarrow P_B^0 = 240 + 120 \\ &= 360 \end{aligned}$$

Q9 Text Solution:

$$\Delta P = P^0 \times \frac{w_2/M_2}{w_1/M_1}$$

Where:

$$P^0 = 23.8 \text{ mm Hg}$$

$$w_2 = 100 \text{ g (sucrose)}$$

$$M_2 = 342 \text{ g/mol}$$

$$w_1 = 1000 \text{ g (water)}$$

$$M_1 = 18 \text{ g/mol}$$

Substitute values:

$$\begin{aligned} \Delta P &= 23.8 \times \frac{100/342}{1000/18} = 23.8 \times \frac{0.292}{55.56} \approx 23 \\ &.8 \times 0.00525 \approx 0.125 \text{ mm Hg} \end{aligned}$$

Q10 Text Solution:

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

Substitute known values:

$$1 = 2.53 \cdot \frac{10 \times 1000}{M_2 \times 100} \Rightarrow 1 = 2.53 \cdot \frac{100}{M_2}$$

Now solve:

$$M_2 = 2.53 \cdot 100 = 253 \text{ g/mol}$$

Q11 Text Solution:

The BaCl_2 solution has lower osmotic pressure (0.15RT) compared to the NaCl solution (0.2RT).

By osmosis, solvent (water) flows from lower osmotic pressure (BaCl_2 side) to higher osmotic pressure (NaCl side).

Q12 Text Solution:

The osmotic pressure formula is:

$$\Pi V = nRT$$

where $n = w/M$ (number of moles).

Substituting the values:

$$4.5 \times 0.250 = \left(\frac{6}{M}\right) \times 0.0821 \times 300$$

$$1.125 = \frac{6 \times 24.63}{M}$$

$$M = \frac{6 \times 24.63}{1.125} = \frac{147.78}{1.125} = 131.36 \text{ g/mol}$$

Molality (m) is given by:

$$m = \frac{\text{moles of solute}}{\text{mass of solvent (kg)}}$$

$$\text{Moles of solute} = \frac{6}{131.36} \approx 0.0457 \text{ mol}$$

Mass of water = 250g = 0.250kg (assuming density of water = 1 g/mL)

$$m = \frac{0.0457}{0.250} = 0.1828 \text{ mol/kg}$$

Boiling point elevation constant (K_b) = 0.52 K. kg mol⁻¹

$$\Delta T_b = K_b \times m = 0.52 \times 0.1828 = 0.095 \text{ K}$$

Step 4: Determine the Boiling point of the solution

Pure water boils at 100°C, so the new boiling point is :

$$T_b = 100 + \Delta T_b = 100 + 0.095 = 100.095^\circ \text{C}$$

Q13 Text Solution:

The plot of π vs. C has a slope of:

$$\text{Slope} = \frac{RT}{M}$$

Give the slope = $4.1 \times 10^{-3} \text{ atm} \cdot \text{cm}^3 \cdot \text{g}^{-1}$.

First, Convert R to consistent units (cm^3 instead of L):

$$R = 0.0821 \text{ L} \cdot \text{atm} \cdot \text{K}^{-1} \cdot \text{mol}^{-1} = 82.1 \text{ cm}^3 \cdot \text{atm} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$$

Now, substitute the slope and solve for M :

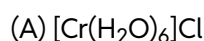
$$4.1 \times 10^{-3} = \frac{82.1 \times 300}{M}$$

$$M = \frac{82.1 \times 300}{4.1 \times 10^{-3}}$$

$$M = \frac{24,630}{4.1 \times 10^{-3}} = 6 \times 10^6 \text{ g/mol}$$

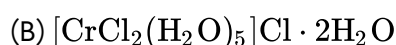
Q14 Text Solution:

$$i = \frac{\pi_{\text{obs}}}{\pi_{\text{cal}}} \rightarrow \text{Correct (ratio of observed to theoretical value)}.$$

Q15 Text Solution:

Dissociates as: $[\text{Cr}(\text{H}_2\text{O})_6]^+ + \text{Cl}^- \rightarrow \text{particles}$

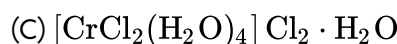
$$i = 2$$



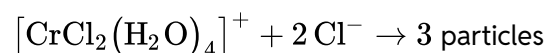
Dissociates as: $[\text{CrCl}_2(\text{H}_2\text{O})_5]^+ + \text{Cl}^- \rightarrow 2 \text{ particles}$



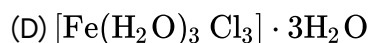
$$i = 2$$



Dissociates as:



$$i = 3$$



This is a neutral complex, not an ionic compound.

No dissociation \rightarrow 1 particle

$$i = 1$$

Conclusion:

Lowest van't Hoff factor = maximum freezing point

Option (D) has the lowest van't Hoff factor ($i = 1$)

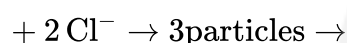
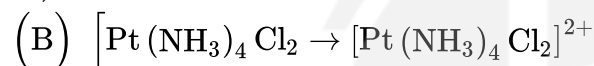
Q16 Text Solution:

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

$$0.0054 = i \cdot 1.80 \cdot 0.001$$

$$i = \frac{0.0054}{1.80 \cdot 0.001} = \frac{0.0054}{0.0018} = 3$$

So, van't Hoff factor $i = 3$



$$i = 3$$

Q17 Text Solution:



If α is the degree of ionization, then:

$$\text{Undissociated } MX_2 = 1 - \alpha$$

Dissociated:

$$M^{2+} = \alpha$$

$$2X^- = 2\alpha$$

So total number of particles:

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

Step 3 : equate and solve:

$$1 + 2\alpha = 2.5 \Rightarrow 2\alpha = 1.5 \Rightarrow \alpha = 0.75$$

Q18 Text Solution:

The elevation in boiling point is calculated as

$$\Delta T_b = K_b m$$

$$m = \text{molality} = \frac{n_2}{w_1} \times 1000 \left[n_2 \right]$$

= Number of moles of solute

By using Raoult's law of lowering of vapour pressure:

$$\frac{-\Delta p}{p^\circ} = x_2 = \frac{n_2}{n_1 + n_2} \approx \frac{n_2}{n_1} \Rightarrow -\Delta p = p^\circ \frac{n_2}{n_1}$$

$$= 760 \times \frac{5}{19} \times \frac{18}{100}$$

$$= 36 \text{ mm Hg}$$

$$\Rightarrow p = 760 - 36 = 724 \text{ mm of Hg}$$

Q19 Text Solution:

$$\pi = i \cdot C \cdot R \cdot T$$

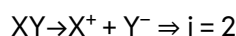
Since R and T are constant and same in both cases, we compare:

$$\frac{\pi_{XY}}{\pi_{BaCl_2}} = \frac{i_{XY} \cdot C_{XY}}{i_{BaCl_2} \cdot C_{BaCl_2}} = 4$$

Step 2: Determine van't Hoff factors:



XY (simple 1:1 electrolyte):



Step 3: Plug into equation:

$$\frac{2 \cdot C_{XY}}{3 \cdot 0.01} = 4 \Rightarrow \frac{2C_{XY}}{0.03} = 4 \Rightarrow 2C_{XY} = 0.12$$

$$\Rightarrow C_{XY} = 0.06 \text{ mol/L}$$

Final Answer: (B) $6 \times 10^{-2} \text{ mol/L}$

Q20 Text Solution:

We are given:

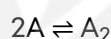
- Molal depression constant (K_f) = $4.0 \text{ K} \cdot \text{kg/mol}$
- Molality (m) = 0.03 mol/kg
- Electrolyte = K_2SO_4 , which dissociates completely as: $K_2SO_4 \rightarrow 2K^+ + SO_4^{2-} \Rightarrow i = 3$

Formula:

$$\Delta T_f = i \cdot K_f \cdot m = 3 \cdot 4.0 \cdot 0.03 = 0.36 \text{ K}$$

Q21 Text Solution:

For dimerization:



Let 1 mole of benzoic acid be taken.

80% dimerizes $\rightarrow 0.8/2 = 0.4$ moles of dimer formed

Remaining undimerized = $1 - 0.8 = 0.2$ mole

Total moles in solution:

$$i = \text{total particles after association} = 0.2 + 0.4 = 0.6$$

So,

$$i = \frac{\text{particles after association}}{\text{initial moles}} = \frac{0.6}{1} = 0.6$$

Step 2: Use freezing point depression formula

$$\Delta T_f = i \cdot K_f \cdot m \Rightarrow 2 = 0.6 \cdot 5 \cdot \left(\frac{w}{122 \cdot 0.03} \right)$$

Now solve for w:

$$2 = 3 \cdot \left(\frac{w}{3.66} \right) \Rightarrow \frac{w}{3.66} = \frac{2}{3} \Rightarrow w = \frac{2 \cdot 3.66}{3}$$

$$= 2.44 \text{ g}$$

Q22 Text Solution:



$$\text{Molality} = \frac{1000 \times M}{1000 \times d - M \times (M_w)_{\text{solute}}}$$

ATQ, Molality, $m = 3m$

$d = 1.12 \text{ g/mL}$

$MW = 40 \text{ g/mol}$

$$3 = \frac{1000 \times x}{1000 \times 1.12 - (x \times 40)}$$

On solving,

$x = 3$

Q23 Text Solution:

Hydrated oxalic acid is $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$

$$\text{Molarity, } M = \frac{W \times 1000}{M_w \times V}$$

Molar mass, $M_w = 126 \text{ g/mol}$

$$M = \frac{3.15 \times 1000}{126 \times 250} = \frac{12.6}{126} = 0.1$$

Reason is the correct explanation as it is used as a fact in explanation of assertion.

Q24 Text Solution:

$$\therefore P_N^\circ > P_M^\circ$$

$$\therefore y_N > x_N$$

$$\& x_M > y_M$$

Multiply we get

$$y_N x_M > x_N y_M$$

Q25 Text Solution:

Solution with negative deviation has, from Raoult's law

$$P_T < P_A^0 x_A + P_B^0 x_B$$

$$P_A < P_A^0 x_A$$

$$P_B < P_B^0 x_B$$

If vapour pressure decreases so boiling point increases.

Q26 Text Solution:

Adding naphthalene to benzene lowers its freezing point.

Q27 Text Solution:

ΔT_f is maximum when $(i \times m)$ value is maximum.

Also, molality (m) is maximum for compound with lesser molar mass of solute.

Among the given compounds, acetic acid has lowest molar mass.

For option (a),

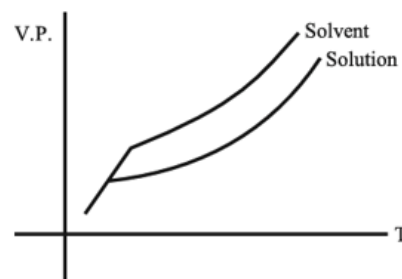
$$m = \frac{\frac{180}{60}}{M_{\text{solvent}} (\text{kg})} \text{ and } i = 1 + \alpha$$

For option (b),

$$m = \frac{\frac{180}{60}}{M_{\text{solvent}} (\text{kg})} = \text{and } i = 0.5$$

Therefore, $(i \times m)$ value for option (a) is greater than that of option (b). Hence, ΔT_f will be maximum for option (a).

Q28 Text Solution:



Vapour pressure (V.P.) of solvent is greater than vapour pressure (V.P.) of solution.

Freezing of only solvent will take place.

Q29 Text Solution:

(A) van't Hoff factor,

$$i = \frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$$

(B) k_f = Cryoscopic constant

(C) Solutions with same osmotic pressure are known as isotonic solutions.

(D) Solutions with same composition of vapour over them are called Azeotrope.

Q30 Text Solution:

Let us take 1 l of solution

Mass of solute = Volume \times Density

(Given: Density = 1.05, gm/mL)

$$= 0.5, \text{ mL} \times 1.05, \text{ gm / mL} = 0.525, \text{ gram}$$

Mass of solution = 1, kg. [considering very dilute solution]

$$\text{Mass of solvent} = 1000 - 0.525 = 999.475, \text{ gram}$$

Given ($\Delta T_f = 0.0405^\circ \text{C}$, $K_f = 1.86, \text{ K, Kg, mol}^{-1}$)

[K_f at $0^\circ \text{C} = 1.86^\circ \text{C, Kg/mol}$ or K_f at $273, \text{ K} = 1.86, \text{ K, Kg/mol}$]

$$\Delta T_f = i \times K_f \times M$$

$$\Rightarrow 0.0405 = i \times 1.86 \times \left(\frac{0.525 \times 1000}{46 \times 999.475} \right)$$

$$i = 1.9$$

Q31 Text Solution:

1 atm

Q60 Text Solution:



(4)

The boiling point of the solution will be higher than that of pure water due to the decrease in

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