Q1 - 25 July - Shift 1

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 g mL^{-1}. The Van't Hoff factor of the formic acid solution is nearly : (Given for water k_f = 1.86 K kg mol^{-1})

(A) 0.8 (B) 1.1

(C) 1.9 (D) 2.4

Space for your notes:

Q2 - 25 July - Shift 2

Two solutions A and B are prepared by dissolving 1 g of non-volatile solutes X and Y. respectively in 1 kg of water. The ratio of depression in freezing points for A and B is found to be 1 : 4. The ratio of molar masses of X and Y is :

(A) 1 : 4

(B) 1 : 0.25

(C) 1 : 0.20

(D) 1 : 5

Space for your notes:

Q3 - 26 July - Shift 2

The elevation in boiling point for 1 molal solution of non-volatile solute A is 3K. The depression in freezing point for 2 molal solution of A in the same solvent is 6 K. The ratio of K_b and K_f i.e., K_b/K_f is 1 : X. The value of X is [nearest integer]

Space for your notes:

Q4 - 27 July - Shift 1

Boiling point of a 2% aqueous solution of a non-volatile solute A is equal to the boiling point of 8% aqueous solution of a non-volatile solute B. The relation between molecular weights of A and B is.

(A) $M_A = 4M_B$ (B) $M_B = 4M_A$

(C) $M_A = 8M_B$ (D) $M_B = 8M_A$

Space for your notes:

Q5 - 27 July - Shift 2

When a certain amount of solid A is dissolved in 100 g of water at 25°C to make a dilute solution, the vapour pressure of the solution is reduced to one-half of that of pure water. The vapour pressure of pure water is 23.76 mmHg. The number of moles of solute A added is________. (Nearest Integer)

Assume moles of A to be less than moles of B

Space for your notes:

Q6 - 28 July - Shift 1

150 g of acetic acid was contaminated with 10.2 g ascorbic acid ($C_6H_8O_6$) to lower down its freezing point by ($x \times 10^{-1}$)°C. The value of x is _________.

(Nearest integer) [Given $K_f = 3.9$ K kg mol^{-1}; Molar mass of ascorbic acid = 176 g mol^{-1}]

Space for your notes:

Q7 - 28 July - Shift 2

A gaseous mixture of two substances A and B, under a total pressure of 0.8 atm is in equilibrium with an ideal liquid solution. The mole fraction of substance A is 0.5 in the vapour phase and 0.2 in the liquid phase. The vapour pressure of pure liquid A is _______ atm. (Nearest integer)

Space for your notes:

Q8 - 29 July - Shift 1

If O_2 gas is bubbled through water at 303 K, the number of millimoles of O_2 gas that dissolve in 1 litre of water is_______. (Nearest Integer)

(Given : Henry's Law constant for O_2 at 303 K is 46.82 k bar and partial pressure of O_2 = 0.920 bar)

(Assume solubility of O_2 in water is too small, nearly negligible)

Space for your notes:

Q9 - 29 July - Shift 2

'x' g of molecular oxygen (O_2) is mixed with 200 g of neon (Ne). The total pressure of the non-reactive mixture of O_2 and Ne in the cylinder is 25 bar. The partial pressure of Ne is 20 bar at the same temperature and volume. The value of 'x' is_____.

[Given: Molar mass of O_2 = 32 g mol^{-1}.

Molar mass of Ne = 20 g mol^{-1}]

Space for your notes:

Q10 - 29 July - Shift 2

1.80 g of solute A was dissolved in 62.5 cm^3 of ethanol and freezing point of the solution was found to be 155.1 K. The molar mass of solute A is __g mol^{-1}.

[Given: Freezing point of ethanol is 156.0 K.

Density of ethanol is 0.80 g cm^{-3}.

Freezing point depression constant of ethanol is 2.00 K kg mol^{-1}]

Space for your notes:

Answer Key

Q1 (C)	**Q2** (B)	**Q3** (1)	**Q4** (B)
Q5 (3)	**Q6** (15)	**Q7** (2)	**Q8** (1)
Q9 (80)	**Q10** (80)		

Q1 (C)

$[\text{HCOOH}] = 0.5 \text{ ml } l^{-1}$

$\Rightarrow (0.5 \text{ ml} \times 1.05 \text{ g ml}^{-1})$ HCOOH in 1L

$\Rightarrow 0.525$ g HCOOH in 1L

$$m = \frac{(0.525/46)}{1\text{kg}} \text{mol} \text{ [Assuming dilute solution]}$$

$$\therefore \Delta T_f = iK_f m \Rightarrow i = \frac{\Delta T_f}{k_f m} = \frac{0.0405 \times 46}{1.86 \times 0.525} = 1.9$$

Q2 (B)

$$\frac{\Delta T_{fx}}{\Delta T_{fy}} = \frac{k_f \cdot m_x}{k_f \cdot m_y} = \frac{\dfrac{1/M_x}{1}}{\dfrac{1/M_y}{1}}$$

$$\Rightarrow \frac{1}{4} = \frac{M_y}{M_x}$$

$$\Rightarrow M_x : M_y = 1 : 0.25$$

Q3 (1)

$\Delta T_b = iK_b m_1 \ \Delta T_f = iK_f m_2$

$$\frac{\Delta T_b}{\Delta T_f} = \frac{K_b \times 1}{K_f \times 2} \Rightarrow \frac{3}{6} = \frac{1}{2} = \frac{K_b}{K_f} \times \frac{1}{2}$$

$$\frac{K_b}{K_f} = \frac{1}{1} \Rightarrow x = 1$$

Q4 (B)

For A : 100 gm solution $\rightarrow$ 2 gm solute A

$$\therefore \text{Molality} = \frac{2/M_A}{0.098}$$

For B : 100 gm solution $\rightarrow$ 8 gm solute B

$$\therefore \text{Molality} = \frac{8/M_B}{0.092}$$

$$\because (\Delta T_B)_A = (\Delta T_B)_B$$

$$\therefore \text{Molality of A} = \text{Molality of B}$$

$$\therefore \frac{2}{0.098 M_A} = \frac{8}{0.092 M_B}$$

$$\frac{2}{98} \times \frac{92}{8} = \frac{M_A}{M_B}$$

$$\frac{1}{4.261} = \frac{M_A}{M_B}$$

$$\therefore M_B = 4.261 \times M_A$$

Q5 (3)

$\because$ Diliute solution given:

$$\frac{P^0 - P_S}{P^0} \sim \frac{{}^n\text{solute}}{{}^n\text{solvent}}$$

$$\frac{P^0 - P^0/2}{P^0} = \frac{{}^n\text{solute}}{{}^n\text{solvent}}$$

$${}^n\text{solute} \sim \frac{{}^n\text{solvent}}{2} = \frac{100}{18 \times 2} = 2.78\,\text{mol}$$

More accurate approach:

$$\frac{P^0 - P_S}{P_S} = \frac{{}^n\text{solute}}{{}^n\text{solvent}}$$

$$\frac{P^0 - P^0/2}{P^0/2} = \frac{{}^n\text{solute}}{{}^n\text{solvent}}$$

$${}^n\text{solute} = {}^n\text{solvent} = \frac{100}{18} = 5.55\,\text{mol}$$

Q6 (15)

150g CH_3COOH

10.2g ascorbic acid $\Rightarrow$ 0.058 moles

$$\Delta T_f = \left(x \times 10^{-1}\right)°C$$

$$\Delta T_f = k_f \cdot \text{molality}$$

$$= 3.9 \times \frac{0.058}{150} \times 1000$$

$$= 1.5°C$$

$$= 15 \times 10^{-1}°C$$

Q7 (2)

$$Y_A = 0.5 \Rightarrow Y_B = 0.5$$

$$P_A = P_B = 0.4 \text{ atm}$$

$$P_A = P_A^0 X_A$$

$$P_A^0 = 2$$

Q8 (1)

$$p = K_H \times x$$

$$\underset{\text{bar}}{0.920} = 46.82 \times 10^3 \text{ bar} \times \frac{\text{mol of } O_2}{\text{mol of } H_2O}$$

$$0.920 = 46.82 \times \cancel{10^3} \times \frac{\text{mol of } O_2}{\cancel{1000}/18}$$

$$0.920 = 46.82 \times n_{O_2}$$

$$p = \frac{0.920}{46.82 \times 18} = n_{O_2}$$

$$\Rightarrow 1.09 \times 10^{-3} = n_{O_2}$$

$$\Rightarrow \text{m mol of } O_2 = 1$$

Q9 (80)

$$\mathbf{O_2 + Ne}$$

$$\mathbf{Xgm \quad 200gm}$$

$$\mathbf{P_{total} = 25 \text{ bar} \; ; \; P_{Ne} = 20}$$

$$P_{O_2} + P_{Ne} = 25$$

$$P_{O_2} = 25 - 20 = 5 \text{ bar}$$

$$\frac{X}{32}$$

$$5=\frac{\frac{x}{32}}{\frac{x}{32}+\frac{200}{20}}\times 25$$

$$\frac{1}{5}=\frac{\frac{x}{32}}{\frac{x}{32}+10}$$

$$\frac{1}{5}=\frac{x\times 32}{32(x+320)}$$

$$5x=x+320$$

$$4x=320$$

$$x=\frac{320}{4}=80\text{ gm}$$

Q10 (80)

Mass of $C_2H_5OH = 62.5 \times 0.8 = 50$ g

$\Delta T_f = K_f \times m$

$$0.9 = 2 \times \frac{1.8 \times 1000}{M_w \times 50}$$

$$M_w = \frac{2 \times 1.8 \times 1000}{0.9 \times 50} = 80$$