OPEN STUDENT FOUNDATION
STD:12th Chemistry
PRACTICE TEST-11

Date : 01/03/24

Section A

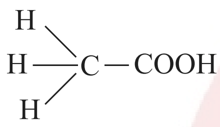
- **Write the answer of the following questions. [Each carries 2 Marks]** **[8]**

1. How to find out K_b and K_f ?

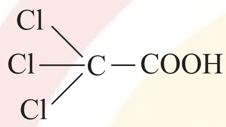
2. Which method is most suitable to determine Molecular mass of polymer ?

3. What is Isotonic, hypertonic and hypotonic Solution ?

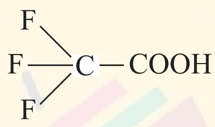
4. The depression in freezing point of water observed for the same amount of acetic acid, trichloroacetic acid and trifluoroacetic acid increases in the order given above. Explain briefly.



Acetic acid



Trichloroacetic acid



Trifluoroacetic acid

Section B

- **Write the answer of the following questions. [Each carries 3 Marks]** **[6]**

5. The vapour pressure of pure liquids A and B are 450 and 700 mm Hg respectively, at 350 K. find out the composition of the liquid mixture if total vapour pressure is 600 mm Hg. Also find the composition of the vapour phase.

6. 0.6 mL of acetic acid (CH_3COOH), having density 1.06 g mL^{-1}, is dissolved in 1 litre of water. The depression in freezing point observed for this strength of acid was 0.0205°C. Calculate the van't Hoff factor and the dissociation constant of acid.

Section C

- **Write the answer of the following questions. [Each carries 4 Marks]** **[12]**

7. 2 g of benzoic acid (C_6H_5COOH) dissolved in 25 g of benzene shows a depression in freezing point equal to 1.62 K. Molal depression constant for benzene is 4.9 K kg mol^{-1}. What is the percentage association of acid if it forms dimer in solution ?

8. A solution containing 30 g of Non-volatile solute exactly in 90 g of water has a vapour pressure of 2.8 kPa at 298 K. Further, 18 g of water is then added to the solution and the new vapour pressure becomes 2.9 kPa at 298 K. Calculate:

(i) molar mass of the solute

(ii) vapour pressure of water at 298 K.

9. Two elements A and B form compounds having formula AB_2 and AB_4. When dissolved in 20 g of benzene (C_6H_6), 1 g of AB_2 lowers the freezing point by 2.3 K whereas 1.0 g of AB_4 lowers it by 1.3 K. The molar depression constant for benzene is 5.1 K kg mol^{-1}. Calculate atomic masses of A and B.

Section A

● **Write the answer of the following questions. [Each carries 2 Marks]** **[8]**

1. How to find out K_b and K_f ?

➪ $K_f = \frac{R \times M_1 \times T_f^2}{1000 \times \Delta_{Fus}H}$

$K_b = \frac{R \times M_1 \times T_b^2}{1000 \times \Delta_{vap}H}$

Where R = gas constant

M_1 = Molar mass of solvent

T_f = Freezing point of pure solvent

T_b = Boiling point of pure solvent.

$\Delta_{Fus}H$ = Fusion enthalpy

$\Delta_{vap}H$ = Vapourisation enthalpy

2. Which method is most suitable to determine Molecular mass of polymer ?

➪ Measurement of osmotic pressure provides another method of determining molar masses of solutes. This method is widely used to determine molar masses of proteins, polymers and other Marco molecules.

➪ The osmotic pressure method has the advantage over other methods as pressure measurement is around the room temperature and the molarity of the solution is used instead of molality.

➪ As compared to other colligative properties, its magnitude is large even for very dilute solutions. The technique of osmotic pressure for determination of molar mass of solutes is particularly useful for biomolecules as they are generally not stable at higher temperatures and polymers have poor solubility.

3. What is Isotonic, hypertonic and hypotonic Solution ?

➪ **Isotonic Solution :**

- Two solutions having same osmotic pressure at a given temperature are called isotonic solutions.
- When such solutions are separated by semipermeable membrane no osmosis occurs between them.
- For example, the osmotic pressure associated with the fluid inside the blood cell is equivalent to that of 0.9% (mass/volume) sodium chloride solution,

➪ **Hypertonic Solution :**

- The solution which possess more osmotic pressure with respect to other solution is known as hypertonic solution.
- e.g. : if we place the cells in a solution containing more than 0.9% (mass/volume) sodium

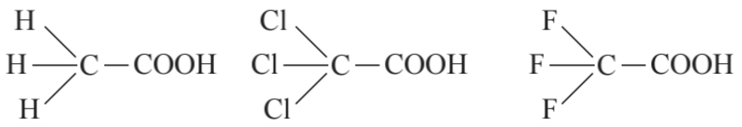
chloride, water will flow out of the cells and they would shrink. Such a solution is called hypertonic.

➪ **Hypotonic Solution :**

➠ The solution which possess less osmotic pressure with respect to other solution is known as hypotonic solution.

➠ e.g. : If the salt concentration is less than 0.9% (mass/volume), the solution is said to be hypotonic. In this case, water will flow into the cells it placed in this solution and they would swell.

4. The depression in freezing point of water observed for the same amount of acetic acid, trichloroacetic acid and trifluoroacetic acid increases in the order given above. Explain briefly.



Acetic acid Trichloroacetic acid Trifluoroacetic acid

➪ Among H, Cl, and F, H is least electronegative while F is most electronegative. Then, F can wirhdraw electrons towards itself more than Cl and H.

➪ Thus, trifluoroacetic acid can easily lose H+ ions i.e., trifluoroacetic acid ionizes to the largest extent. Now, the more ions produced, the greater is the depression of the freezing point. Hence, the depression in the freezing point increases in the order :

➪ Acetic acid < trichloroacetic acid < trifluoroacetic acid

Section B

● **Write the answer of the following questions. [Each carries 3 Marks]** **[6]**

5. The vapour pressure of pure liquids A and B are 450 and 700 mm Hg respectively, at 350 K. find out the composition of the liquid mixture if total vapour pressure is 600 mm Hg. Also find the composition of the vapour phase.

➪

liquid – A	liquid – B
$p_A^o = 450$ mm Hg	$p_B^o = 700$ mm Hg
$x_A = (?)$	$x_B = (?)$
$p_{Total} = 600$ mm Hg	
$y_A = (?)$	$y_B = (?)$

➪ According to Raoult's Law

$$p_{Total} = p_A^o + x_B(p_B^o - p_A^o)$$

$$\therefore 600 = 450 + x_B(700 - 450)$$

$$\therefore 600 = 450 + 250\, x_B$$

$$\therefore 600 - 450 = 250\, x_B$$

$$\therefore \frac{150}{250} = x_B$$

$$\therefore x_B = 0.6$$

$$x_A + x_B = 1$$

$\therefore\ x_A = 1 - x_B$

$= 1 - 0.6$

$\therefore\ x_A = 0.4$

➪ Composition in Vapour phase,

$p_A = y_A \cdot p_{Total}$

$\therefore\ \dfrac{p_A^o \cdot x_A}{p_{Total}} = y_A$

$\therefore\ y_A = \dfrac{450 \times 0.40}{600}$

$\therefore\ y_A = 0.3$

$y_A + y_B = 1$

$\therefore\ y_B = 1 - y_A$

$= 1 - 0.3$

$\therefore\ y_B = 0.7$

6. 0.6 mL of acetic acid (CH_3COOH), having density 1.06 g mL^{-1}, is dissolved in 1 litre of water. The depression in freezing point observed for this strength of acid was 0.0205°C. Calculate the van't Hoff factor and the dissociation constant of acid.

➪ Volume of acetic acid (V) = 0.6 mL,

$W_1 = 1000$ g

density = 1.06 $g.mL^{-1}$

Molar mass of acetic acid = 60 $g.Mol^{-1}$

$\Delta T_f = 0.0205°C$, $i = (?)$

$K_f = 1.86\ K.kg.Mol^{-1}$ Ka = (?)

mass of acetic acid(W_2) = d × V = 1.06 × 0.6 = 0.636 g

$$\Delta T_f = i \cdot K_f \cdot \frac{W_2 \times 1000}{M_2 \times W_1}$$

$$i = \frac{\Delta T_f \times M_2 \times W_1}{K_f \times W_2 \times 1000}$$

$$= \frac{0.0205 \times 60 \times 1000}{1.86 \times 0.636 \times 1000}$$

$i = 1.04$

$$\propto = \frac{i - 1}{n - 1}$$

$$= \frac{1.04 - 1}{2 - 1}$$

$\propto = 0.04$

Where, C = Concentration

$$C = \frac{W_2 \times 1000}{M_2 \times W_1}$$

$$= \frac{0.636 \times 1000}{60 \times 1000}$$

$= 0.0106$ Mol/L

$$Ka = \frac{\alpha^2 \cdot C}{1 - \alpha}$$

$$= \frac{(0.04)^2 \cdot (0.0106)}{1 - 0.04}$$

$$= \frac{0.00001696}{0.96}$$

$Ka = 1.76 \times 10^{-5}$

Section C

- **Write the answer of the following questions. [Each carries 4 Marks]** **[12]**

7. 2 g of benzoic acid (C_6H_5COOH) dissolved in 25 g of benzene shows a depression in freezing point equal to 1.62 K. Molal depression constant for benzene is 4.9 K kg mol^{-1}. What is the percentage association of acid if it forms dimer in solution ?

➪ $W_2 = 2$ g $\quad M_2 = 122$ g.Mol^{-1}

$W_1 = 25$ g

$\Delta T_f = 1.62$ K $\quad K_f = 4.9$ K.kg.Mol^{-1}

percentage association = (?) $\quad n = 2$

$$\Delta T_f = i \, . \, K_f \, . \, \frac{W_2 \times 1000}{M_2 \times W_1}$$

$$\therefore \quad i = \frac{\Delta T_f \times M_2 \times W_1}{K_f \times W_1 \times 1000}$$

$$= \frac{1.62 \times 122 \times 25}{4.9 \times 2 \times 1000}$$

$$i = 0.5041$$

$$\text{degree of association } (x) = \frac{i-1}{\frac{1}{n}-1}$$

$$= \frac{0.5041 - 1}{\frac{1}{2} - 1}$$

$$= \frac{0.4959}{0.5}$$

$$= 0.9918$$

$$= 99.18$$

➪ Therefore, degree of association of benzoic acid in benzene is 99.2%.

8. A solution containing 30 g of Non-volatile solute exactly in 90 g of water has a vapour pressure of 2.8 kPa at 298 K. Further, 18 g of water is then added to the solution and the new vapour pressure becomes 2.9 kPa at 298 K. Calculate :

(i) molar mass of the solute

(ii) vapour pressure of water at 298 K.

➪ $W_2 = 30$ g $W_1 = 90$ g

$M_2 = (?) \quad p_1 = 2.8$ kPa

$p_1^0 = (?)$

$$\frac{p_1^0 - p_1}{p_1^0} = \frac{\frac{W_2}{M_2}}{\frac{W_2}{M_2} + \frac{W_1}{M_1}}$$

$$\therefore \quad \frac{p_1^0 - 2.8}{p_1^0} = \frac{\frac{30}{M}}{\frac{30}{M} + \frac{90}{18}}$$

$$\therefore \quad 1 - \frac{2.8}{p_1^0} = \frac{\frac{30}{M}}{\frac{30}{M} + 5}$$

30

$$\therefore\ 1 - \frac{2.8}{p_1^0} = \frac{\frac{30}{M}}{\frac{30+5M}{M}}$$

$$\therefore\ 1 - \frac{2.8}{p_1^0} = \frac{30}{5(6+M)}$$

$$\therefore\ 1 - \frac{2.8}{p_1^0} = \frac{6}{6+M}$$

$$\therefore\ 1 - \frac{6}{6+M} = \frac{2.8}{p_1^0}$$

$$\therefore\ \frac{6+M-6}{6+M} = \frac{2.8}{p_1^0}$$

$$\therefore\ \frac{M}{6+M} = \frac{2.8}{p_1^0} \quad .....(1)$$

➪ after adding 18 g of water

$$\frac{p_1^0 - 2.9}{p_1^0} = \frac{\frac{30}{M}}{\frac{30}{M} + \frac{108}{18}}$$

$$\therefore\ 1 - \frac{2.9}{p_1^0} = \frac{\frac{30}{M}}{\frac{30}{M} + 6}$$

$$\therefore\ 1 - \frac{2.9}{p_1^0} = \frac{\frac{30}{M}}{\frac{30+6M}{M}}$$

$$\therefore\ 1 - \frac{2.9}{p_1^0} = \frac{30}{6(5+M)}$$

$$\therefore\ 1 - \frac{2.9}{p_1^0} = \frac{5}{5+M}$$

$$\therefore\ 1 - \frac{5}{5+M} = \frac{2.9}{p_1^0}$$

$$\therefore\ \frac{5+M-5}{5+M} = \frac{2.9}{p_1^0}$$

$$\therefore\ \frac{M}{5+M} = \frac{2.9}{p_1^0} \quad .....(2)$$

➪ Now ratio of eq. (1) & (2)

$$\frac{\frac{M}{6+M}}{\frac{M}{5+M}} = \frac{\frac{2.8}{p_1^0}}{\frac{2.9}{p_1^0}}$$

$$\therefore\ \frac{5+M}{6+M} = \frac{2.8}{2.9}$$

$\therefore$ (5 + M) 2.9 = (6 + M) 2.8

$\therefore$ 14.5 + 2.9 M = 16.8 + 2.8 M

$\therefore$ 2.9 M – 2.8 M = 2.3

$\therefore$ 0.1 M = 2.3

$\therefore$ M = 23 g/Mol

➪ Substituting value of M in eq. (1)

$$\frac{M}{6+M} = \frac{2.8}{p_1^0}$$

$$\therefore \quad \frac{23}{6+23} = \frac{2.8}{p_1^0}$$

$$\therefore \quad p_1^0 = \frac{2.8 \times 29}{23}$$

$$= 3.53 \text{ kPa}$$

9. Two elements A and B form compounds having formula AB_2 and AB_4. When dissolved in 20 g of benzene (C_6H_6), 1 g of AB_2 lowers the freezing point by 2.3 K whereas 1.0 g of AB_4 lowers it by 1.3 K. The molar depression constant for benzene is 5.1 K kg mol^{-1}. Calculate atomic masses of A and B.

➪ $$M_2 = K_f \cdot \frac{W_2 \times 1000}{\Delta T_f \times W_1}$$

For AB_2 : $W_2 = 1$ g $\quad W_1 = 20$ g

$M_{AB2} = (?) \quad \Delta T_f = 2.3$ K

$K_f = 5.1$ K.kg.Mol^{-1}

$$M_{AB2} = \frac{5.1 \times 1 \times 1000}{2.3 \times 20}$$

$$= 110.87 \text{ g.Mol}^{-1}$$

For AB_4 : $W_2 = 1$ g $\quad W_1 = 20$ g

$\Delta T_f = 1.3$ K $\quad M_{AB4} = (?)$

$$M_{AB4} = \frac{5.1 \times 1 \times 1000}{1.3 \times 20}$$

$$= 196.15 \text{ g.Mol}^{-1}$$

$$A + 2B = 110.87$$

$$A + 4B = 196.15$$

$$- \quad - \quad -$$

$$-2B = -85.28$$

$$\therefore B = 42.64 \ u$$

➪ putting value of B in *eq*.

$A + 2B = 110.87$

$A + 2(42.64) = 110.87$

$A + 85.28 = 110.87$

$A = 25.59 \ u$