OPEN STUDENT FOUNDATION

Chapters: 1 | STD:12th Chemistry | Date : 18/02/24

Practice Sheet Day - 1

Section A

- **Choose correct answer from the given options. [Each carries 1 Mark]** **[10]**

1. Which of the following is appropriate for the solution made by mixing acetone and carbondisulphide ?
(A) Negative deviation from Raoult's law (B) $\Delta H_{mix} < 0$
(C) $\Delta V_{mix} > 0$ (D) Obey Raoult's law

2. 3.0 gram ethanoic acid in 50 gram benzene having _______ molality.
(Atomic weights : H = 1, C = 12, O = 16).
(A) 0.1 (B) 1.0 (C) 0.6 (D) 0.06

3. Which of the following mixture is non-ideal solution ?
(A) Chlorobenzene and bromobenzene (B) Benzene and toluene
(C) Chloroform and acetone (D) Bromoethane and chloroethane

4. Which of the following aqueous solution will have the boiling point 102.2° C ? The molal elevation constant for water is 2.2 K kg mol^{-1}.
(A) 1 m CH_3COOH (B) 1 m NaCl (C) 1 M NaCl (D) 1 m glucose

5. Under identical condition which solution has highest osmetic pressure ?
(A) 1 M $BaCl_2$ (B) 1 M NaCl (C) 1 M $FeCl_3$ (D) 1 M glucose

6. Molecular weight of glucose is 180. A solution of glucose which contains 18g/L, is
(A) 0.1 molal (B) 0.2 molal (C) 0.3 molal (D) 0.4 molal

7. Which of the following concentration term is/are independent of temperature ?
(A) Molarity (B) Molarity and mole fraction
(C) Mole fraction and molality (D) Molality and Normality

8. The Volume of 10 N and 4 N HCl required to make 1 L of 7 N HCl are
(A) 0.50 L of 10 N HCl and 0.5 L of 4 N HCl
(B) 0.60 L of 10 N HCl and 0.40 L of 4 N HCl
(C) 0.80 L of 10 N HCl and 0.20 L of 4 N HCl
(D) 0.75 L of 10 N HCl and 0.25 L of 4 N HCl

9. The Solubility order for the following gases is :
(A) $NH_3 > CO_2 > O_2 > H_2$ (B) $H_2 > O_2 > NH_3 > CO_2$
(C) $CO_2 > NH_3 > O_2 > N_2$ (D) $O_2 > H_2 > NH_3 > CO_2$

10. In a mixture A and B components show negative deviation as :
(A) ΔV_{mix} = +ve
(B) ΔH_{mix} = –ve
(C) A-B interaction is weaker than A–A and B–B interaction.
(D) None of the above reason in correct

Section B

- **Write the answer of the following questions. [Each carries 2 Marks]** **[6]**

1. What is semi permeable membrane ? Give examples.

2. Explain Raoult's Law as a special case of Henry's Law

3. Calculate the mass of urea (NH_2CONH_2) required in making 2.5 kg of 0.25 molal aqueous solution.

Section C

- **Write the answer of the following questions. [Each carries 3 Marks]** **[9]**

4. Explain Van't Hoff factor.

5. How many ml of 0.1 M HC1 are required to react completely with 1 g mixture of Na_2CO_3 and $NaHCO_3$ containing equimolar amounts of both ?

6. What is boiling point ? What is elevation of boiling point ? Explain Molal elevation constant and Derive It's formula.

Section D

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

7. What is Osmosis ? What is Osmotic Pressure? Derive it's formula.

8. 19.5 g of CH_2FCOOH is dissolved in 500 g of water. The depression in the freezing point of water observed is 1.0° C. Calculate the van't Hoff factor and dissociation constant of fluoroacetic acid.

9. Write Raoult's Law for Non-Volatile solute and volatile solvent and derive It's formula.

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Section A

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(D) Obey Raoult's law

➠ Ans : (C)

2. 3.0 gram ethanoic acid in 50 gram benzene having _______ molality.
(Atomic weights : H = 1, C = 12, O = 16).

(A) 0.1 (B) 1.0 (C) 0.6 (D) 0.06

➠ Ans : (B)

3. Which of the following mixture is non-ideal solution ?

(A) Chlorobenzene and bromobenzene
(B) Benzene and toluene
(C) Chloroform and acetone
(D) Bromoethane and chloroethane

➠ Ans : (C)

4. Which of the following aqueous solution will have the boiling point 102.2° C ? The molal elevation constant for water is 2.2 K kg mol^{-1}.

(A) 1 m CH_3COOH (B) 1 m NaCl (C) 1 M NaCl (D) 1 m glucose

➠ Ans : (D)

5. Under identical condition which solution has highest osmetic pressure ?

(A) 1 M $BaCl_2$ (B) 1 M NaCl (C) 1 M $FeCl_3$ (D) 1 M glucose

➠ Ans : (C)

6. Molecular weight of glucose is 180. A solution of glucose which contains 18g/L, is

(A) 0.1 molal (B) 0.2 molal (C) 0.3 molal (D) 0.4 molal

Ans. (A)

➪ Molality $= \frac{18}{180} = 0.1$ molal

7. Which of the following concentration term is/are independent of temperature ?

(A) Molarity
(B) Molarity and mole fraction
(C) Mole fraction and molality
(D) Molality and Normality

➠ Ans : (C)

8. The Volume of 10 N and 4 N HCl required to make 1 L of 7 N HCl are

(A) 0.50 L of 10 N HCl and 0.5 L of 4 N HCl
(B) 0.60 L of 10 N HCl and 0.40 L of 4 N HCl
(C) 0.80 L of 10 N HCl and 0.20 L of 4 N HCl
(D) 0.75 L of 10 N HCl and 0.25 L of 4 N HCl

Ans. (A)

➪ Let vilitre of 10 N HCl be mixed with (1–V) litre of 4 N HCl to give (V+1–V) = 1 L of 7 N HCl.

$N_1V_1 + N_2V_2 = N\ V$

$10V + 4\ (1 - V) = 7 \times 1$

$10V + 4 - 4V = 7$

$6V = 7 - 4$

$V = \frac{3}{6} = 0.50\ L$

Volume of 10 N Hcl = 0.50L

Volume of 4 N Hcl = 1 – 0.50 = 0.50 L

9. The Solubility order for the following gases is :

(A) $NH_3 > CO_2 > O_2 > H_2$ (B) $H_2 > O_2 > NH_3 > CO_2$

(C) $CO_2 > NH_3 > O_2 > N_2$ (D) $O_2 > H_2 > NH_3 > CO_2$

➠ Ans : (A)

10. In a mixture A and B components show negative deviation as :

(A) ΔV_{mix} = +ve

(B) ΔH_{mix} = –ve

(C) A-B interaction is weaker than A–A and B–B interaction.

(D) None of the above reason in correct

➠ Ans : (B)

Section B

● **Write the answer of the following questions. [Each carries 2 Marks]** **[6]**

1. What is semi permeable membrane ? Give examples.

➪ The membrane which allows only the small Molecule of solvent to pass but can not pass solute molecule is known as semi permeable membrane.

Example : Pig's bladder, parchment, cellophane

➪ These membranes appear to be continuous sheets or films, yet they contain a network of submicroscopic holes or pores.

2. Explain Raoult's Law as a special case of Henry's Law

➪ According to Raoult's law, the vapour pressure of a volatile component in a given solution is given by

$p_1 = p_1^0 \cdot x_1$

➪ According to henry's Law solubility of gasous solute in liquid solvent is given by

$p = K_H \cdot x$

➪ If we compare the equations for Raoult's law and Henry's law, it can be seen that the partial pressure of the volatile component or gas is directly proportional to its mole fraction in solution.

➪ Only the proportionality constant K_H differs from p_1^0.

➪ thus, Raoult's law becomes a special case of Henry's law in which K_H becomes equal to p_1^0.

3. Calculate the mass of urea (NH_2CONH_2) required in making 2.5 kg of 0.25 molal aqueous solution.

➪ Molar mass of Urea = 60 $g.mol^{-1}$

➪ 0.25 molal aqueous solution of Urea means 1000 g of water contains 0.25 mol

= (0.25 × 60)

= 15 g of Urea

➪ (1000 + 15) g of solution contain 15 g of Urea.

∴ 2500 g of solution contain = (?)

$$= \frac{2500 \times 15}{1015}$$

= 36.95 g

Section C

● **Write the answer of the following questions. [Each carries 3 Marks]** **[9]**

4. Explain Van't Hoff factor.

➪ van't Hoff introduced a factor *i*, known as the van't Hoff factor, to account for the extent of dissociation or association. This factor *i* is defined as :

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

$$= \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$$

$$i = \frac{\text{Total number of moles of particles after association/dissociation}}{\text{Number of moles of particles before association/dissociation}}$$

➪ Here abnormal molar mass is the experimentally determined molar mass and calculated colligative properties are obtained by assuming that the non-volatile solute is neither associated nor dissociated.

➪ In case of association, value of i is less than unity while for dissociation it is greater than unity.

➪ Inclusion of van't Hoff factor modifies the equations for colligative properties as follows :

➪ Relative lowering of vapour pressure of solvent,

$$\frac{p_1^0 - p_1}{p_1^0} = i.\frac{n_2}{n_1}$$

Elevation of Boiling point, $\Delta T_b = i\ K_b$ m

Depression of Freezing point, $\Delta T_f = i\ K_f$ m

Osmotic pressure of solution, $\pi = i\ n_2\ R\ T\ /\ V$

➪ *i* for several strong electrolytes. For KCl, NaCl and $MgSO_4$, *i* values approach 2 as the solution becomes very dilute. As expected, the value of *i* gets close to 3 for K_2SO_4.

Salt	*Values of i			van't Hoff Factor i for complete dissociation of solute
	0.1 m	0.01 m	0.001 m	
NaCl	1.87	1.94	1.97	2.00
KCl	1.85	1.94	1.98	2.00
$MgSO_4$	1.21	1.53	1.82	2.00
K_2SO_4	2.32	2.70	2.84	3.00

5. How many ml of 0.1 M HC1 are required to react completely with 1 g mixture of Na_2CO_3 and $NaHCO_3$ containing equimolar amounts of both ?

➪ Suppose mass of $Na_2CO_3 = x$ g

$\therefore$ mass of $NaHCO_3 = (1 - x)$ g

Molar mass of Na_2CO_3 = 106 $g.mol^{-1}$

Molar mass of $NaHCO_3$ = 84 $g.mol^{-1}$

Na_2CO_3 and $NaHCO_3$ both are equimolar

$\therefore$ Moles of Na_2CO_3 = Moles of $NaHCO_3$

$\therefore \frac{x}{106} = \frac{1-x}{84}$

$\therefore 84x = 106 - 106x$

$\therefore 84x + 106x = 106$

$\therefore 190x = 106$

$\therefore x = 0.5578$ g

$\therefore$ mass of $Na_2CO_3 = x = 0.5578$ g

$\therefore$ mass of $NaHCO_3 = 1 - x$

$= 1 - 0.5578$

$= 0.4422$ g

➪ Find out mass of HCl which react with Na_2CO_3 and $NaHCO_3$

$Na_2CO_3 + 2\ HCl \rightarrow 2\ NaCl + H_2O + CO_2$

106 g $= 2 \times 36.5$

$= 73$ g

106 g Na_2CO_3 react with 73 g of HCl

$\therefore$ 0.5578 g Na_2CO_3 react with (?)

mass of HCl $= \frac{0.5578 \times 73}{106}$

$= 0.384$ g

$NaHCO_3 + HCl \rightarrow NaCl + CO_2 + H_2O$

84 g 36.5 g

84 g $NaHCO_3$ react with 36.5 g of HCl

$\therefore$ 0.4422 g $NaHCO_3$ react with (?)

mass of HCl $= \frac{0.4422 \times 36.5}{84}$

$= 0.192$ g

Total mass of HCl $= 0.384 + 0.192$

$= 0.576$ g

$$M = \frac{\text{mass of HCl}}{\text{Molar mass of HCl} \times \text{Volume of Solution (L)}}$$

$$\therefore \quad 0.1 = \frac{0.576}{36.5 \times \text{Volume of Solution}}$$

$$\therefore \quad \text{Volume of Solution} = \frac{0.576}{36.5 \times 0.1}$$

$= 0.1578$ L

$= 157.8$ mL

6. What is boiling point ? What is elevation of boiling point ? Explain Molal elevation constant and Derive It's formula.

➪ **Boiling Point :**

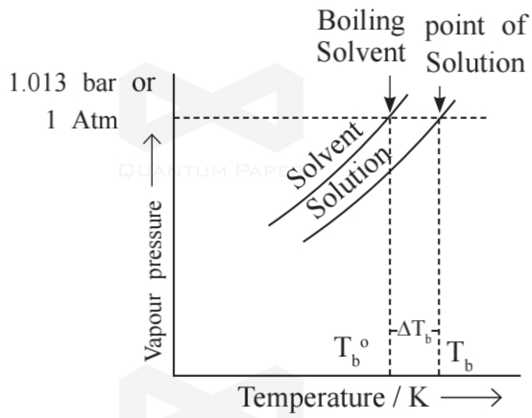
➠ "The temperature at which, the vapour pressure of solution is equal to the atmospheric pressure, such temperature is known as boiling point of such solution."

➪ For example, water boils at 373.15 K (100° C) because at this temperature the vapour pressure of water is 1.013 bar (1 atmosphere).

➪ vapour pressure of the solvent decreases in the presence of non-volatile solute.

➪ The vapour pressure of an aqueous solution of sucrose is less than 1.013 bar at 373.15 K. In order to make this solution boil, its vapour pressure must be increased to 1.013 bar by raising the temperature above the boiling temperature of the pure solvent (water).

➪ Thus, the boiling point of a solution is always higher than that of the boiling point of the pure solvent



➪ Let T_b^0 be the boiling point of pure solvent and T_b be the boiling point of solution. The increase in the boiling point $\Delta T_b = T_b - T_b^0$ is known as elevation of boiling point.

➪ Experiments have shown that for dilute solutions the elevation of boiling point (ΔT_b) is directly proportional to the molal concentration of the solute in a solution.

$\Delta T_b \propto m$

$\therefore \ \Delta T_b = K_b \ . \ m$ ....(1)

Where, K_b is called Boiling Point Elevation Constant or Molal Elevation Constant (Ebullioscopic Constant).

➪ **Molal elevation Constant :**

➠ "Increase in boiling point of a solution prepared by dissolving one gram molar mass of Non volatile solute in one kg of solvent is called as Molal elevation constant."

➪ Unit of K_b = K . kg.Mol^{-1}

➪ If w_2 gram of solute of molar mass M_2 is dissolved in w_1 gram of solvent, then molality, m of the solution is given by the expression :

$$m = \frac{\frac{W_2}{M_2}}{\frac{W_1}{1000}}$$

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

Substituting value of molality in eq. (1)

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

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

Where, w_2 = wt. of Solute

w_1 = wt. of Solvent

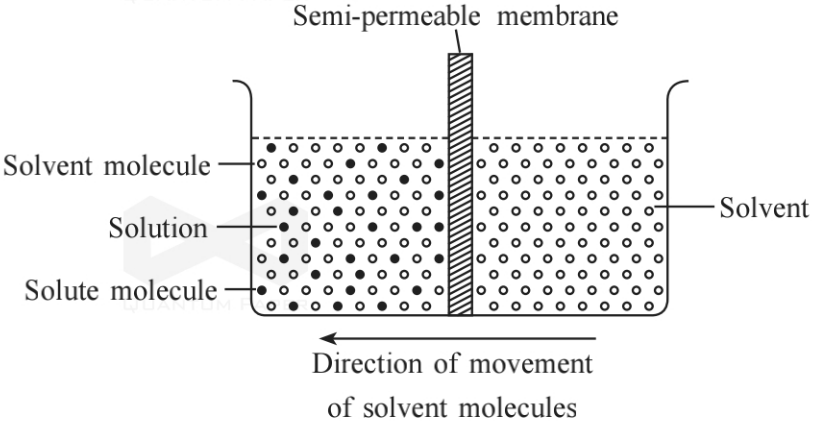
M_2 = Molar mass of Solute

Section D

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

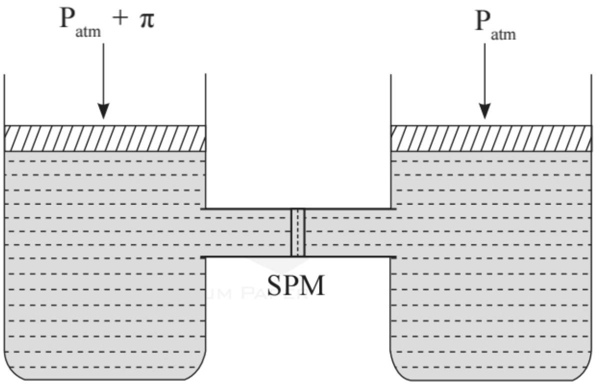
7. What is Osmosis ? What is Osmotic Pressure? Derive it's formula.

➪ If semi permeable membrane is placed between the solvent and solution as shown fig. the solvent molecules will flow through the membrane from pure solvent to the solution. This process of flow of the solvent is called osmosis.



➪ The flow will continue till the equilibrium is attained

➪ The flow of the solvent from its side to solution side across a semipermeable membrane can be stopped if some extra pressure is applied on the solution. This pressure that just stops the flow of solvent is called osmotic pressure of the solution.



➪ The osmotic pressure of a solution is the excess pressure that must be applied to a solution to prevent osmosis,

➪ Osmotic pressure is a colligative property as it depends on the number of solute molecules and not on their identity.

➪ osmotic pressure is proportional to the molarity, C of the solution at a given temperature T.

$\pi = CRT$

Where, π = Osmotic pressure

R = gas constant

$\therefore \pi = \frac{n_2 RT}{V} \quad \left(\because C = \frac{n_2}{V}\right)$

$\pi = \frac{W_2 RT}{M_2 V}$

W_2 = Wt. of Solute

M_2 = Molar mass of Solute

V = Volume of Solution(L)

T = Temperature

8. 19.5 g of CH_2FCOOH is dissolved in 500 g of water. The depression in the freezing point of water observed is 1.0° C. Calculate the van't Hoff factor and dissociation constant of fluoroacetic acid.

➪ $W_2 = 19.5$ g $\quad W_1 = 500$ g

$M_2 = 78$ g.Mol^{-1} $\quad \Delta T_f = 1.0°$ C

$K_f = 1.86$ K.kg.Mol^{-1}

$i = (?) \quad Ka = (?)$

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

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

$= \frac{1 \times 78 \times 500}{1.86 \times 19.5 \times 1000}$

$\therefore \; i = 1.07526$

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

$\therefore \propto \ = \ \frac{1.07526-1}{2-1}$

$\therefore \propto \ = \ 0.07526$

$C \ \text{(Molality)} = \frac{W_2 \times 1000}{M_2 \times W_1}$

$= \frac{19.5 \times 1000}{76 \times 500}$

$= 0.5131$

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

$= \frac{(0.07526)^2 \cdot (0.5131)}{1-0.07526}$

$= \frac{0.00290}{0.9247}$

$= 0.00313$

$Ka \ = \ 3.1 \ \times \ 10^{-3}$

9. Write Raoult's Law for Non-Volatile solute and volatile solvent and derive It's formula.

➪ The vapour pressure of a solvent in solution is less than that of the pure solvent.

➪ Raoult established that the lowering of vapour pressure depends only on the concentration of the solute particles and it is independent of their identity.

➪ A relation between vapour pressure of the solution, mole fraction and vapour pressure of the solvent, $p_1 \ = \ p_1^0 \ . \ x_1$

➪ The reduction in the vapour pressure of solvent (Δp_1) is given as :

$\Delta p_1 = \ p_1^0 \ - \ p_1$

$\therefore \ \Delta p_1 \ = \ p_1^0 \ - \ p_1^0 \ . \ x_1$

$\therefore \ \Delta p_1 \ = \ p_1^0(1 \ - \ x_1)$

$\therefore \ \Delta p_1 \ = \ p_1^0 x_2$

➪ The lowering of the vapour pressure is directly proportional to mole-Fraction of solute.

$\therefore \ \frac{\Delta p_1}{p_1^0} = x_2$

$\therefore \ \frac{p_1^0 - p_1}{p_1^0} \ = x_2$

$\therefore \ \frac{p_1^0 - p_1}{p_1^0} \ = \ \frac{n_2}{n_1 + n_2} \quad \left(\because x_2 = \frac{n_2}{n_1 + n_2}\right)$

Where, n_1 = Moles of solvent

n_2 = Moles of solute

➪ For dilute solutions $n_2 << n_1$

$\frac{p_1^0 - p_1}{p_1^0} \ = \ \frac{n_2}{n_1}$

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

Where, W_1 = Weight of solvent

W_2 = Weight of solute

M_1 = Molar mass of solvent

M_2 = Molar mass of solute

p_1^0 = Vapour pressure of pure solvent

p_1 = Vapour pressure of solution