Unit Practice Test

for Board Examination

Time Allowed : 2 Hrs. Maximum Marks : 35

1. State the condition resulting in reverse osmosis. (1)

2. 2.5 g each of two solutes X and Y (molar mass of X > Y) are dissolved separately in 50 g each of the same solvent. Which will show greater elevation in boiling point? (1)

3. Write the mathematical form of Raoult's law of relative lowering of vapour pressure. (1)

4. What is the value of van't Hoff factor for a compound which undergoes tetramerisation in an organic solvent ? (1)

5. How is the molarity of a solution different from its molality ? (1)

6. Why does solution of ethanol and cyclohexane show positive deviation from Raoult's law. (2)

7. Why do gases always tend to be less soluble in liquids as the temperature is raised? (2)

8. How many grams of potassium chloride should be added to 1.5 kg of water to lower its freezing point to –7.5°C? K_f for water = 1.86°C kg mol^{-1}. (2)

9. Sodium chloride solution boils at higher temperature than water, while it freezes at lower temperature than water. Explain. (2)

10. Why is the freezing point depression of 0.1 M KCl solution nearly twice that of 0.1 M sucrose solution? (2)

11. A solution contains 0.8960 *g* of K_2SO_4 in 500 mL solution. Its osmotic pressure is found to be 0.690 atm at 27°C. Calculate the value of Van't Hoff factor. (R = 0.082 L atm K^{-1} mol^{-1}) (3)

12. State Raoult's law. How would you distinguish between ideal and non-ideal solutions with the help of the law. (3)

13. Why do we get sometimes abnormal molar masses of the substances by using colligative properties of the solutions? State the factors with suitable examples which bring abnormality in results. (3)

14. Two aqueous solutions containing respectively 7.5 g of urea (molar mass = 60) and 42.57 g of substance X in 100 g of water freeze at the same temperature. Calculate the molecular mass of X. (3)

15. Benzene and toluene form ideal solution over the entire range of composition. The vapour pressure of pure benzene and toluene at 300 K are 50.71 mm Hg and 32.06 mm Hg. respectively. Calculate the mole fraction of benzene in vapour phase if 80 g of benzene is mixed with 100 g of toluene. (3)

16. (*a*) What is relative lowering in vapour pressure? Show that relative lowering in vapour pressure is a colligative property.

(*b*) Calculate the normal freezing point of a sample of sea water containing 3.8 % NaCl and 0.12% $MgCl_2$ by mass. Given K_f = 1.86 K kg mol^{-1}, molar mass of NaCl = 58.5 and $MgCl_2$ = 95 g mol^{-1}.

(*c*) Calculate the volume of 80% H_2SO_4 by weight (density = 1.8 g/mol) required to prepare 1L of 0.2 M solution. (5)

► To check your performance, see HINTS AND SOLUTIONS TO SOME QUESTIONS at the end of Part I of the book.

1. When pressure larger than osmotic pressure is applied on the solution.

2. Solution containing solute Y will show greater elevation in boiling point because $\Delta T_b \propto \frac{1}{M}$.

3. $\frac{p_1^o - p}{p_1^o} = x_2$ (mole fraction of solute)

4. 0.25

5. Molarity depends upon temperature while molality is independent of temperature.

6. The addition of cyclohexane will tend to break some of the hydrogen bonds present in ethyl alcohol molecules and therefore, the attractive forces will decrease. Thus, the molecules in the solution will have greater tendency to change into vapours or vapour pressure of the solution will be more than expected according to Raoult's law. Therefore, the solution will show positive deviations from Raoult's law.

7. The dissolution of gases in a liquid is exothermic process. Therefore, in accordance with Le-Chatelier principle, with increase in temperature, equilibrium shifts in the backward direction.

$$\text{Liquid} + \text{Gas} \rightleftharpoons \text{Dissolved gas} \; ; \; \Delta H = -\text{ve}$$

8. $\Delta T_f = 0 - (-7.5) = 7.5$, $i = 2$ (for KCl)

$$\Delta T_f = \frac{i \times K_f \times w_B \times 1000}{M_B \times w_A}$$

$$7.5 = \frac{2 \times 1.86 \times w_B \times 1000}{74.5 \times 1500}$$

$$\therefore \quad w_B = 225.3 \text{ g}$$

9. There is elevation in boiling point on the addition of a non-volatile solute and consequently boiling point of sodium chloride solution is more than that of water. On the otherhand, freezing point of a liquid depresses on the addition of a non-volatile solute and therefore, a solution of sodium chloride freezes at lower temperature than freezing point of water.

10. 0.1 KCl ionises as : $KCl \longrightarrow K^+ + Cl^-$. Therefore, it gives almost double the number of particles than 0.1 M sucrose, which does not ionise.

11. Let us first calculate observed molar mass, $M_B = \dfrac{w_B \times R \times T}{\pi \times V}$

$w_B = 0.8960$ g, V = 500 ml = 0.5 L

R = 0.082 L atm mol^{-1} K^{-1}, π = 0.690 atm, T = 300 K

$$M_B = \frac{0.896 \times 0.082 \times 300}{0.690 \times 0.5} = 63.9$$

$$\text{Normal molar mass} = 2 \times 39 + 32 + 4 \times 32 = 174$$

$$\text{Van't Hoff factor, } i = \frac{\text{Normal molar mass}}{\text{Observed molar mass}} = \frac{174}{63.9} = \mathbf{2.72.}$$

14. For urea, $$M_B = \frac{K_f \times 7.5 \times 1000}{\Delta T \times 100} = 60$$

For X, $$M'_B = \frac{K_f \times 42.75 \times 1000}{\Delta T \times 100}$$

Dividing $$\frac{60}{M'_B} = \frac{7.5}{42.75}$$

$\therefore$ $$M'_B = \frac{60 \times 42.75}{7.5} = 342$$

15. $$\text{Moles of benzene} = \frac{80}{78} = 1.026$$

$$\text{Moles of toluene} = \frac{100}{92} = 1.087$$

$$\text{Mole fraction of benzene, } x_b = \frac{1.026}{1.026 + 1.087} = 0.486$$

Mole fraction of toluene, $$x_t = 1 - 0.486 = 0.514$$

$$p_b = p_b^\circ x_b = 50.71 \times 0.0486 = 24.65 \text{ mm Hg}$$

$$p_t = p_t^\circ x_t = 32.06 \times 0.514 = 16.48 \text{ mm Hg}$$

$$\text{Total vapour pressure} = 24.65 + 16.48 = 41.13 \text{ mm Hg}$$

Mole fraction of benzene in vapour phase,

$$y_b = \frac{24.65}{41.13} = 0.60$$

16. Moles of NaCl =3.8/58.5 = 0.065

Moles of $MgCl_2$ = 0.12/95 = 0.00126

$$NaCl \longrightarrow Na^+ + Cl^- \quad \text{(2 particles)}$$

$$MgCl_2 \longrightarrow Mg^{2+} + 2Cl^- \quad \text{(3 particles)}$$

$$\text{Total moles of all species} = 2 \times 0.065 + 3 \times 0.00126$$

$$= 0.1338 \text{ mol}$$

$$\text{Mass of water in 100 g of sea water} = 100 - (3.8 + 0.12) = 96.08 \text{ g}$$

$$\text{Molality} = \frac{0.1338}{96.08} \times 1000 = 1.39 \text{ m}$$

$$\Delta T_f = 1.86 \times 1.39 = 2.59$$

$$\text{Freezing point} = -2.59^\circ \text{ C}$$