



SOLUTIONS AND COLLIGATIVE PROPERTIES

Class 12 - Chemistry

Time Allowed: 1 hour and 30 minutes

Maximum Marks: 45

1. A 4% solution of urea (molar mass = 60 g mol^{-1}) is isotonic with 5.2% solution of an unknown organic substance. Calculate the molecular weight of the unknown organic substance. [1]
2. Calculate the molarity of a solution containing 5 g of NaOH in 450 mL solution. [1]
3. At 400°C , the vapour pressure of water is 55.3 mm Hg. Calculate the vapour pressure at the same temperature over 10% aqueous solution of urea [$\text{CO}(\text{NH}_2)_2$]? [1]
4. A 6% solution of glucose (molar mass = 180 g mol^{-1}) is isotonic with 2.5% solution of an unknown organic substance. Calculate the molecular weight of the unknown organic substance. [1]
5. The boiling point of benzene is 353.23 K. When 1.80 g of a non-volatile solute was dissolved in 90 g of benzene, the boiling point is raised to 354.11 K. Calculate the molar mass of the solute. K_b for benzene is $2.53 \text{ K kg mol}^{-1}$. [1]
6. Calculate the osmotic pressure of 0.25 M solution of urea at 37°C . $R = 0.083 \text{ L bar/mol/k}$. [1]
7. Calculate the molarity of NaOH solution obtained by dissolving 2g of NaOH in 50 mL of its solution. [1]
8. A 3% solution of glucose (molar mass = 180 g mol^{-1}) is isotonic with 25% solution of an unknown organic substance. Calculate the molecular weight of the unknown organic substance. [1]
9. The vapour pressure of pure liquid X and pure liquid Y at 25°C are 120 mm Hg and 160 mm Hg respectively. If equal moles of X and Y are mixed to form an ideal solution, calculate the vapour pressure of the solution. [1]
10. Calculate the freezing point of a solution containing 60 g of glucose (Molar mass = 180 g mol^{-1}) in 250 g of water. (K_f of water = $1.86 \text{ K kg mol}^{-1}$) [1]
11. An aqueous solution containing 20% by weight of liquid A (Mol.wt = 140) has vapour pressure of 160 mm at 57°C . Find the vapour pressure of pure A, if that of water is 150 mm at this temperature. [2]
12. Calculate molality of 2.5 g of ethanoic acid (CH_3COOH) in 75 g of benzene. [2]
13. $8.0575 \times 10^{-2} \text{ kg}$ of Glaubers's salt is dissolved in water to obtain 1 dm^3 of a solution of density 1077.2 kg m^{-3} . Calculate the molarity, molality and mole fraction of Na_2SO_4 in the solution. [2]
14. 200 cm^3 of an aqueous solution of a protein contains 1.26 g of the protein. The osmotic pressure of such a solution at 300 K is found to be $2.57 \times 10^{-3} \text{ bar}$. Calculate the molar mass of the protein. [2]
15.
 - i. What is the relationship between Molarity and Normality? [2]
 - ii. One litre of water at N.T.P. dissolves 0.08 g of nitrogen. Calculate the amount of nitrogen that can be dissolved in four litres of water at 0°C and at a pressure of 1520 mm. [2]
16. A solution is prepared by dissolving 5 g of a non-volatile solute in 200 g of water. It has a vapour pressure of 31.84 mm Hg at 300 K. Calculate the molar mass of the solute. (Vapour pressure of pure water at 300 K = 32 mm Hg) [2]

17. a. Find the value of van't Hoff factor for acetic acid in benzene as per the given equation: [2]
 $2\text{CH}_3\text{COOH} \rightleftharpoons (\text{CH}_3\text{COOH})_2$, assuming its complete association.
- b. Osmotic pressure of a solution containing 3.5 g of dissolved protein in 0.05 L of a solution is 0.035 atm at 310 K. Calculate the molar mass of the protein. ($R = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$)
18. The vapour pressure of pure benzene at a certain temperature is 0.850 bar. A non-volatile, non-electrolyte solid weighing 0.5 g when added to 39.0 g of benzene (molar mass 78 g mol^{-1}). Vapour pressure of the solution, then, is 0.845 bar. What is the molar mass of the solid substance? [2]
19. If benzoic acid ($M = 122 \text{ g mol}^{-1}$) is associated into a dimer when dissolved in benzene and the osmotic pressure of a solution of 6.1 g of benzoic acid in 100 mL benzene is 6.5 atm at 27°C , then what is the percentage association of benzoic acid? [2]
 (Given : $R = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$)
20. At 300 K, 30 g of glucose present in a litre of its solution has an osmotic pressure of 4.98 bar. If the osmotic pressure of a glucose solution is 1.52 bar at the same temperature, what would be its concentration? [2]
21. 2 g of benzoic acid ($\text{C}_6\text{H}_5\text{COOH}$) dissolved in 25 g of benzene shows a depression in freezing point equal to 1.62 K. Molal depression constant for benzene is $4.9 \text{ K kg mol}^{-1}$. What is the percentage association of acid if it forms a dimer in solution? [5]
22. a. Find the freezing point of a solution containing 0.520 g glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) dissolved in 80.2 g of water [5]
 [Given: K_f for water = 1.86 K m^{-1}]
- b. A solution of glycerol ($\text{C}_3\text{H}_8\text{O}_3$) in water was prepared by dissolving some glycerol in 500 g of water. This solution has a boiling point of 100.420°C , what mass of glycerol was dissolved to make this solution? (K_b for water = $0.512 \text{ K kg mol}^{-1}$)
23. i. Calculate the mass percentage of aspirin ($\text{C}_9\text{H}_8\text{O}_4$) in acetonitrile (CH_3CN) when 6.5 g of $\text{C}_9\text{H}_8\text{O}_4$ is dissolved in 450 g of CH_3CN . [5]
- ii. Commercially available concentrated hydro-chloric acid contains 38% HCl by mass and has density 1.19 g cm^{-3} . What is the molarity of this solution?