

SOLUTION - XII

Question 1: 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.

Question 2: Vapour pressure of pure water at 298 K is 23.8 mm Hg. 50 g of urea (NH_2CONH_2) is dissolved in 850 g of water. Calculate the vapour pressure of water for this solution and its relative lowering.

Question 3: Boiling point of water at 750 mm Hg is 99.63°C . How much sucrose is to be added to 500 g of water such that it boils at 100°C . Molal elevation constant for water is $0.52 \text{ K kg mol}^{-1}$.

Question 4: Calculate the mass of ascorbic acid (Vitamin C, $\text{C}_6\text{H}_8\text{O}_6$) to be dissolved in 75 g of acetic acid to lower its melting point by 1.5°C . $K_f = 3.9 \text{ K kg mol}^{-1}$.

Question 5: Calculate the osmotic pressure in pascals exerted by a solution prepared by dissolving 1.0 g of polymer of molar mass 185,000 in 450 mL of water at 37°C .

Question 6: Concentrated nitric acid used in laboratory work is 68% nitric acid by mass in aqueous solution. What should be the M of such a sample of the acid if the density of the solution is 1.504 g mL^{-1} ?

Question 7: A solution of glucose in water is labelled as 10% w/w, what would be the molality and mole fraction of each component in the solution? If the density of solution is 1.2 g mL^{-1} , then what shall be the molarity of the solution?

Question 8: How many mL of 0.1 M HCl are required to react completely with 1 g mixture of Na_2CO_3 and NaHCO_3 containing equimolar amounts of both?

Question 9: A solution is obtained by mixing 300 g of 25% solution and 400 g of 40% solution by mass. Calculate the mass percentage of the resulting solution?

Question 10: An antifreeze solution is prepared from 222.6 g of ethylene glycol ($\text{C}_2\text{H}_6\text{O}_2$) and 200 g of water. Calculate the molality of the solution. If the density of the solution is 1.072 g mL^{-1} , then what shall be the molarity of the solution?

Question 11: A sample of drinking water was found to be severely contaminated with chloroform (CHCl_3), supposed to be a carcinogen. The level of contamination was 15 ppm (by mass):

(i) express this in percent by mass (ii) determine the molality of chloroform in the water sample.

Question 12: State Henry's law and mention some important applications?

Question 13: The partial pressure of ethane over a solution containing $6.56 \times 10^{-3} \text{ g}$ of ethane is 1 bar. If the solution contains $5.00 \times 10^{-2} \text{ g}$ of ethane, then what shall be the partial pressure of the gas?

Question 14: What is meant by positive and negative deviations from Raoult's law and how is the sign of $\Delta_{\text{sol}}H$ related to positive and negative deviations from Raoult's law?

Question 15: The vapour pressure of water is 12.3 kPa at 300 K. Calculate vapour pressure of 1 molal solution of a non-volatile solute in it.

Question 16: Calculate the mass of a non-volatile solute (molar mass 40 g mol^{-1}) which should be dissolved in 114 g octane to reduce its vapour pressure to 80%.

Question 17: A 5% solution (by mass) of cane sugar in water has freezing point of 271 K. Calculate the freezing point of 5% glucose in water if freezing point of pure water is 273.15 K.

Question 18: 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 K_f is $5.1 \text{ K kg mol}^{-1}$. Calculate atomic masses of A and B.

Question 19: Suggest the most important type of intermolecular attractive interaction in the following pairs.

(i) n-hexane and n-octane (ii) I_2 and CCl_4 (iii) NaClO_4 and water (iv) methanol and acetone (v) acetonitrile (CH_3CN) and acetone ($\text{C}_3\text{H}_6\text{O}$).

Question 20: Based on solute-solvent interactions, arrange the following in order of increasing solubility in n-octane and explain - Cyclohexane, KCl, CH_3OH , CH_3CN . (Ans) Cyclohexane < CH_3CN < CH_3OH < KCl

Question 21: Amongst the following compounds, identify which are insoluble, partially soluble and highly soluble in water? (i) phenol (ii) toluene (iii) formic acid (iv) ethylene glycol (v) chloroform (vi) pentanol

Question 22: If the solubility product of CuS is 6×10^{-16} , calculate the maximum molarity of CuS in aqueous solution.

Question 23: Nalorphene ($\text{C}_{19}\text{H}_{21}\text{NO}_3$), similar to morphine, is used to combat withdrawal symptoms in narcotic users. Dose of nalorphene generally given is 1.5 mg. Calculate the mass of $1.5 \times 10^{-3} \text{ m}$ aqueous solution required for the above dose.

Question 24: Calculate the amount of benzoic acid ($\text{C}_6\text{H}_5\text{COOH}$) required for preparing 250 mL of 0.15 M solution in methanol.

Question 25: 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.

- Question 26:** Calculate the depression in the freezing point of water when 10 g of $\text{CH}_3\text{CH}_2\text{CHO}$ is dissolved in 250 g of water. $K_a = 1.4 \times 10^{-3}$, $K_f = 1.86 \text{ K kg mol}^{-1}$.
- Question 27:** 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.
- Question 28:** Vapour pressure of water at 293 K is 17.535 mm Hg. Calculate the vapour pressure of water at 293 K when 25 g of glucose is dissolved in 450 g of water.
- Question 29:** Benzene and toluene form ideal solution over the entire range of composition. The vapour pressure of pure benzene and naphthalene 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.
- Question 30:** The air is a mixture of a number of gases. The major components are oxygen and nitrogen with approximate proportion of 20% is to 79% by volume at 298 K. The water is in equilibrium with air at a pressure of 10 atm. At 298 K if the Henry's law constants for oxygen and nitrogen are $3.30 \times 10^7 \text{ mm}$ and $6.51 \times 10^7 \text{ mm}$ respectively, calculate the composition of these gases in water.
- Question 31:** Determine the amount of CaCl_2 ($i = 2.47$) dissolved in 2.5 litre of water such that its osmotic pressure is 0.75 atm at 27°C .
- Question 32:** Determine the osmotic pressure of a solution prepared by dissolving 25 mg of K_2SO_4 in 2 liter of water at 25°C , assuming that it is completely dissociated.



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