

Solutions

SUBJECTIVE PROBLEMS:

Q 1.

What is the molarity and molarity of a 13% solution (by weight) of sulphuric acid with a density of 1.02 g/ml? To what volume should 100 ml of this acid be diluted in order to prepare a 1.5 N solution?

(IIT JEE-1978-3 Marks)

Q 2.

A bottle of commercial sulphuric acid (density 1.787 g/ml) is labeled as 89 percent by weight. What is the molarity of the acid. What volume of the acid has to be used to make 1 litre of 0.2 M H_2SO_4 ?

(IIT JEE-1979-3 Marks)

Q 3.

0.5 gm of fuming H_2SO_4 (Oleum) is dilute with water. This solution is completely neutralized by 26.7 ml of 0.4 N NaOH. Find the percentage of free SO_3 in the sample of oleum.

(IIT JEE-1980-4 Marks)

Q 4.

The vapour pressure of pure benzene is 639.7 mm of mercury and the vapour of a solution of a solute in benzene at the temperature is 631.9 mm of mercury. Calculate the molality of the solution.

(IIT JEE-1981-3 Marks)

Q 5.

Two liquid *A* and *B* form ideal solutions. At 300 K, the vapour pressure of a solution containing 1 mole of *A* and 3 moles of *B* is 550 mm of Hg. At the same temperature, if one more mole of *B* is added to this solution, the vapour pressure of the solution increases by 10 mm of Hg. Determine the vapour pressure of *A* and *B* in their pure states.

(IIT JEE-1982-4 Marks)

Q 6.

An organic compound $\text{C}_x\text{H}_y\text{O}_z$ was burnt with twice the amount of oxygen needed for complete combustion to CO_2 and H_2O . The hot gases when cooled to 0°C and 1 atm. Pressure, measured 2.24 liters. The water collected during cooling weighed 0.9 g. The vapour pressure of pure water at 20°C is 17.5 mm Hg and is lowered by 0.104 mm when 50 g of the organic compound are dissolved in 1000 g of water. Give the molecular formula of the organic compound.

(IIT JEE-1983-5 Marks)

Q 7.

Two volatile and miscible liquids can be separated by fractional distillation into pure component', is true under what condition? **(IIT JEE-1984-1 Mark)**

Q 8.

The vapour pressure of ethanol and methanol are 44.5 mm and 88.7 Hg respectively. An ideal solution is formed at the same temperature by mixing 60 g of ethanol with 40 g of methanol. Calculate the total vapour pressure of the solution and the mole fraction of methanol in the vapour.

(IIT JEE-1986-4 Marks)

Q 9.

The vapour pressure of a dilute aqueous solution of glucose ($C_6H_{12}O_6$) is 750 mm of mercury at 373 K. Calculate (i) molality and (ii) mole fraction of the solution. **(IIT JEE-1989-3 Marks)**

Q 10.

The vapour pressure of pure benzene at a certain temperature is 640 mm Hg. A non-volatile non-electrolyte solid weighing 2.175 g is added to 39.0 g of benzene. The vapour pressure of the solution is 600 mm Hg. What is the molecular weight of the solid substance? **(IIT JEE-1990-3 Marks)**

Q 11.

The degree of dissociation of calcium nitrate in a dilute aqueous solution, containing 7.0 g. of the salt per 100 gm of water at 100°C is 70%. If the vapour pressure of water at 100°C is 760 mm, calculate the vapour pressure of the solution. **(IIT JEE-1991-4 Marks)**

Q 12.

Addition of 0.643 g of a compound to 50 ml, of benzene (density : 0.879 g/ml.) lowers the freezing point from 5.51°C to 5.03°C. If K_f for benzene is 5.12 K kg mol⁻¹, calculate the molecular weight of the compound. **(IIT JEE-1992-2 Marks)**

Q 13.

What weight of the non-volatile solute, urea ($NH_2 - CO - NH_2$) needs to be dissolved in 100g of water, in order to decrease the vapour pressure of water by 25%? What will be the molality of the solution?

(IIT JEE-1993-3 Marks)

Q 14.

The molar volume of liquid benzene (density = 0.877 g mL^{-1}) increases by a factor of 2750 as it vaporizes at 20°C and that of liquid toluene (density = 0.867 g mL^{-1}) increases by a factor of 7720 at 20°C . A solution of benzene and toluene at 20°C has a vapour pressure of 46.0 Torr. Find the mole fraction of benzene in the vapour above the solution. **(IIT JEE-1996-3 Marks)**

Q 15.

A very small amount of a non-volatile solute (that does not dissociate) is dissolved in 56.8 cm^3 of benzene (density 0.889 g cm^{-3}). At room temperature vapour pressure of this solution is 98.88 mm Hg while that of benzene is 100 mm Hg. Find the molality of this solution. If the freezing temperature of this solution is 0.73 degree lower than that of benzene, what is the value of molal freezing point depression constant of benzene? **(IIT JEE-1997C-3 Marks)**

Q 16.

A solution of a nonvolatile solute in water freezes at -0.30°C . The vapour pressure of pure water at 298 K is 23.51 mm Hg and K_f for water is $1.86 \text{ K kg mol}^{-1}$. Calculate the vapour pressure of this solution at 298 K. **(IIT JEE-1998-4 Marks)**

Q 17.

Nitrobenzene is formed as the major product along with a minor product in the reaction of benzene with a hot mixture of nitric acid and sulphuric acid. The minor product consists of carbon : 42.86% hydrogen : 2.40%, nitrogen : 16.67%, and oxygen: 38.07% (i) Calculate the empirical formula of the minor product. (ii) When 5.5 g of the minor product is dissolved in 45 g of benzene, the boiling point of the solution is 1.84°C higher than that of pure benzene. Calculate the molar mass of the minor product and determine its molecular and structural formula. (Molal boiling point elevation constant of benzene is $2.53 \text{ K kg mol}^{-1}$.) **(IIT JEE-1999-10 Marks)**

Q 18.

To 500 cm^3 of water, $3.0 \times 10^{-3} \text{ kg}$ of acetic acid is added. If 23% of acetic acid is dissociated, what will be the depression in freezing point? K_f and density of water are $1.86 \text{ K kg}^{-1} \text{ mol}^{-1}$ and 0.997 g cm^{-3} , respectively. **(IIT JEE-2000-3 Marks)**

Q 19.

1.22g of benzoic acid is dissolved in 100 g of acetone and 100 g of benzene separately. Boiling point of the solution in acetone increases by 0.17°C , while that in the benzene increases by 0.13°C ; K_b for acetone and benzene is $1.7 \text{ K kg mol}^{-1}$ and $2.6 \text{ K kg mol}^{-1}$. Find molecular weight of benzoic acid in two cases and justify your answer. **(IIT JEE-2004-2 Marks)**

Q 20.

75.2 g of C_6H_5OH (phenol) is dissolved in a solvent of $K_f = 14$. If the depression in freezing point is 7 K then find the % of phenol that dimerises.

(IIT JEE-2006-6 Marks)