Class 12 chapter 1: Solutions
Lecture 09

# Previous Year IIT Questions
## Colligative Properties

JEE 2016
Main

① 18g of glucose ($C_6H_{12}O_6$) is added to 178.2g water. The vapour pressure of water (in torr) for this aqueous solution is
a) 76.0 b) 752.4 c) 759.0 d) 7.6

Solution: $P_A = P_A^\circ \chi_{solvent}$

$$= 760 \times \frac{\frac{178.2}{18}}{\frac{178.2}{18} + \frac{18}{180}}$$

$$= 752.4$$

($P_s = P_s^\circ \chi_{solvent}$ or use $\frac{P_A^\circ - P_A}{P_A^\circ} = \chi_{solute}$)

② 2016 Advance Mixture (s) showing positive deviation from Raoult's Law is (are)
a) Carbon tetrachloride + methanol
b) Carbon disulphide + acetone
c) benzene + toulene
d) phenol + aniline

Solution: V.P has to Increase ⇒ Interactions should break
a) methanol has H-bonding ⟶ breaks due to $CCl_4$
b) acetone has dipole ⟶ weakens due to $CS_2$
c) ideal
d) phenol + aniline ⟶ forms H-bond ⟶ stronger interaction ⟶ −ve deviation

③ 2017 JEE Mains The freezing point of benzene decreases by 0.45°C when 0.2g of acetic acid is added to 20g of benzene. If acetic acid associates to form a dimer in benzene, percentage association of acetic acid in benzene will be (Kf for benzene 5.12 K kg/mol)

a) 64.6% b) 80.4% c) 74.6% d) 94.6%.

Solution: $\Delta T_f = K_f \times m \times i$

$$0.45 = 5.12 \times \frac{\frac{0.2}{60}}{\frac{20}{1000}} \times i$$

$$45 = \frac{256}{5} \times \frac{0.2}{3} \times \frac{1000}{20} \times i$$

$$i = \frac{135}{256}$$

$$\underset{1}{2CH_3COOH} \longrightarrow \underset{0}{(CH_3COOH)_2}$$

$$\underset{1-\alpha}{} \qquad \underset{\frac{\alpha}{2}}{}$$

$$i = 1 - \alpha + \frac{\alpha}{2} = 1 - \frac{\alpha}{2}$$

$$i = 1 - \frac{\alpha}{2}$$

$$\frac{135}{256} = 1 - \frac{\alpha}{2} \Rightarrow \frac{\alpha}{2} = 1 - \frac{135}{256} = \frac{121}{256}$$

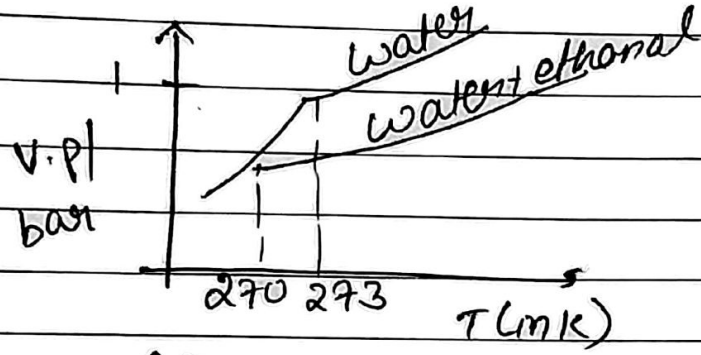
$$\frac{\alpha}{2} = \frac{121}{256\ 128} = \frac{121}{128}$$

$$\alpha \approx \frac{128}{128}\frac{60}{64} \approx \frac{15}{16} \times 0.9$$

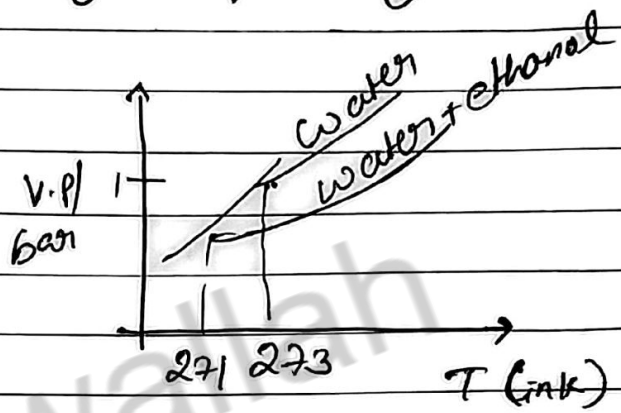
d) 94.6%

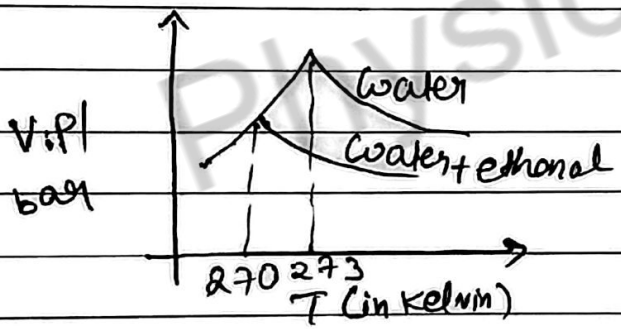
## 2017 Advance

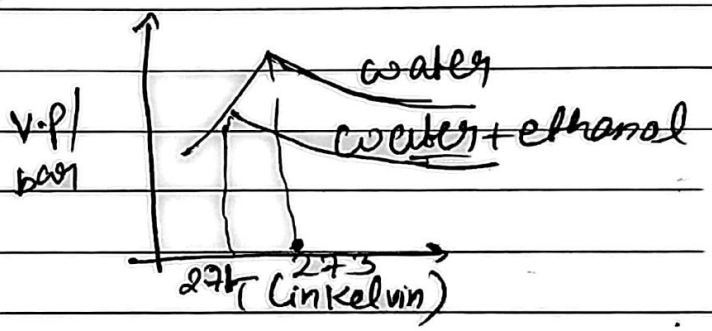
Pure water freezes at 273K and 1 bar. The addition of 34.5g of ethanol to 500g of water changes the freezing point of the solution. Use the freezing point depression constant of water as 2K Kg/mol. Molar Mass of ethanol 46g/mol The option representing change in freezing point.




(a)




$$\Delta T_f = K_f \times m$$

$$= 2 \times \frac{34.5}{46} = 3$$

$$0.5$$

$$T_f = 273 - 3 = 270$$

(a)

2014 JEE Mains

(4) Consider separate solutions of 0.5M $C_2H_5OH$ (aq), 0.1M $Mg_3(PO_4)_2$ (aq), 0.25M KBr (aq) and 0.125M $Na_3PO_4$ (aq) at 25°C. (All strong electrolytes) which has the highest osmotic pressure

Solution $\pi = MRTi$

$C_2H_5OH$ $\pi = RT \times 0.5 \times 1 = 0.5RT$

$Mg_3(PO_4)_2$ $\pi = RT \times 0.1 \times 5 = 0.5RT$

KBr $\pi = RT \times 0.25 \times 2 = 0.5RT$

$Na_3PO_4$ $\pi = RT \times 0.125 \times 4 = 0.5RT$

All have same Osmotic Pressure

IIT 2011

(5) The freezing point (in °C) of solution containing 0.1g of $K_3[Fe(CN)_6]$ (Mol wt = 329) in 100g water ($K_f = 1.86$ K kg/mol)

a) $-2.3 \times 10^{-2}$

b) $-5.7 \times 10^{-2}$

c) $-5.7 \times 10^{-3}$

d) $-1.2 \times 10^{-2}$

$$\Delta T_f = K_f \times m \times i$$

$$= 1.86 \frac{\frac{0.1}{329}}{\frac{100}{1000}} \times 4$$

$$= \frac{1.86 \times 0.1}{100 \quad 329 \times 01} \times 4$$

$$= \frac{186}{100 \times 329} \times 4 \simeq \frac{\overset{93}{\cancel{186}} \times 4}{100 \times \underset{40}{\cancel{320}}} = \frac{23.25}{1000}$$

$$= 2.3 \times 10^{-2} \qquad \text{(a)}$$

(6) 2015 Advance

If the freezing point of a 0.01 molal aqueous solution of a cobalt (III) chloride-ammonia complex (which behave as a strong electrolyte) is $-0.0558^\circ C$, the number of chloride(s) in the coordination sphere of the complex is :

($K_f$ for water 1.86 K kg/mol.) Answer (1)

Solution

$$\Delta T_f = K_f \times m \times i$$

$$0.0558 = 1.86 \times 0.01 \times i$$

$$i = 3$$

$$[\overset{+3}{Co}\overset{-1}{Cl_x}(\overset{0}{NH_3})_2]\overset{-1}{Cl_y} \longrightarrow [\overset{+3}{Co}\overset{-1}{Cl_x}(\overset{0}{NH_3})_2] + yCl$$

$\because i = 3$

$y = 2$

On Complex
Total charge = 0

$+3 - x - y = 0$

$+3 - x - 2 = 0$

$x = 1$