JEE Mains 2019 Chapter wise Question Bank

Solutions and Colligative Properties - Questions

Q1

Which one of the following statements regarding Henry's law is not correct?

(1) Higher the value of K_H at a given pressure, higher is the solubility of the gas in liquids.
(2) Different gases have different K_H (Henry's law constant) values at the same temperature.
(3) The partial pressure of the gas in vapour phase is proportional to the mole fraction of the gas in the solution.
(4) The value of K_H increases with increase of temperature and K_H is function of the nature of the gas.

9 Jan Morning

Q2

A solution containing 62 g ethylene glycol in 250 g water is cooled to – 10°C. If K_f for water is 1.86 K kg mol^{-1}, the amount of water (in g) separated as ice is:

(1) 48 (2) 32
(3) 64 (4) 16

9 Jan Evening

Q3

Liquids A and B form an ideal solution in the entire composition range. At 350 K, the vapour pressures of pure A and pure B are 7×10^3 Pa and 12×10^3 Pa, respectively. The composition of the vapor is in equilibrium with a solution containing 40 mole percent of A at this temperature is:

(1) $x_A = 0.37; x_B = 0.63$
(2) $x_A = 0.28 ; x_B = 0.72$
(3) $x_A = 0.4 ; x_B = 0.6$
(4) $x_A = 0.76 ; x_B = 0.24$

10 Jan Morning

Q4

The amount of sugar ($C_{12}H_{22}O_{11}$) required to prepare 2 L of its 0.1 M aqueous solution is:

(1) 136.8 g (2) 17.1 g
(3) 68.4 g (4) 34.2 g

10 Jan Evening

Q5

Elevation in the boiling point for 1 molal solution of glucose is 2 K. The depression in the freezing point for 2 molal solution of glucose in the same solvent is 2 K. The relation between K_b and K_f is:

(1) $K_b = 1.5 K_f$
(2) $K_b = K_f$
(3) $K_b = 0.5 K_f$
(4) $K_b = 2 K_f$

10 Jan Evening

Q6

The freezing point of a diluted milk sample is found to be – 0.2°C, while it should have been – 0.5°C for pure milk. How much water has been added to pure milk to make the diluted sample?

(1) 1 cup of water to 2 cups of pure milk
(2) 3 cups of water to 2 cups of pure milk
(3) 1 cup of water to 3 cups of pure milk
(4) 2 cups of water to 3 cups of pure milk

11 Jan Morning

Q7

K_2HgI_4 is 40% ionised in aqueous solution. The value of its van't Hoff factor (i) is :

(1) 1.6 (2) 1.8
(3) 2.0 (4) 2.2

11 Jan Evening

Q8

Freezing point of a 4% aqueous solution of X is equal to freezing point of 12% aqueous salution of Y. If molecular weight of X is A, then molecular weight of Y is:

(1) 3A (2) 2A
(3) A (4) 4A

12 Jan Morning

Q9

8 g of NaOH is dissolved in 18 g of H_2O. Mole fraction of NaOH in solution and molality (in mol kg^{-1}) of the solution respectively are :

(1) 0.2, 22.20 (2) 0.2, 11.11
(3) 0.167, 11.11 (4) 0.167, 22.20

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Q10

Molecules of benzoic acid (C_6H_5COOH) dimerise in benzene. 'w' g of the acid dissolved in 30 g of benzene shows a depression in freezing point equal to 2 K. If the percentage association of the acid to form dimer in the solution is 80, then w is :
(Given that $K_f = 5$ K kg mol^{-1}, Molar mass of benzoic acid = 122 g mol^{-1})

(1) 2.4 g (2) 1.0 g
(3) 1.5 g (4) 1.8 g

12 Jan Evening

Q11

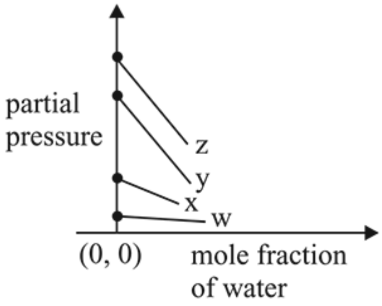
The vapour pressures of pure liquids A and B are 400 and 600 mmHg, respectively at 298K. On mixing the two liquids, the sum of their initial volumes is equal to the volume of the final mixture. The mole fraction of liquid B is 0.5 in the mixture. The vapour pressure of the final solution, the mole fractions of components A and B in vapour phase, respectively are:

(1) 450 mmHg, 0.4, 0.6 (2) 500 mmHg, 0.5, 0.5
(3) 450 mmHg, 0.5, 0.5 (4) 500 mmHg, 0.4, 06

8 April Morning

Q12

For the solution of the gases *w*, *x*, *y* and *z* in water at 298K, the Henrys law constants (K_H) are 0.5, 2, 35 and 40 kbar, respectively. The correct plot for the given data is :

(1)


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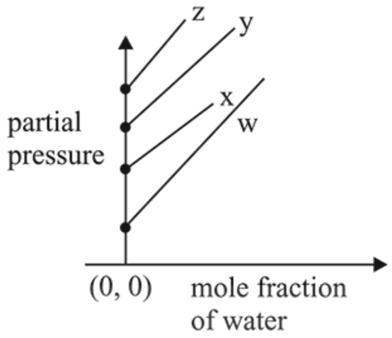

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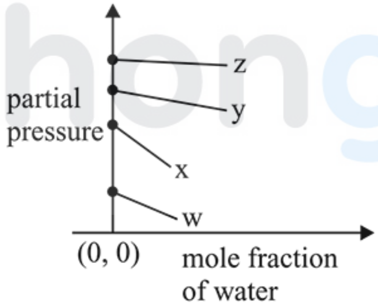

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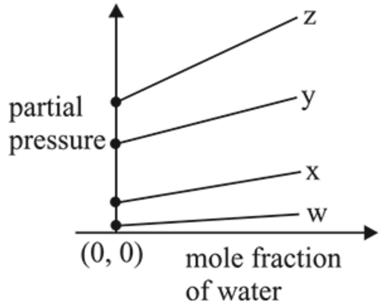

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Q13

Liquid 'M' and liquid 'N' form an ideal solution. The vapour pressures of pure liquids 'M' and 'N' are 450 and 700 mmHg, respectively, at the same temperature. Then correct statement is:
(x_M = Mole fraction of 'M' in solution;
x_N = Mole fraction of 'N' in solution;
y_M = Mole fraction of 'M' in vapour phase;
y_N = Mole fraction of 'N' in vapour phase)

(1) $\frac{x_M}{x_N} = \frac{y_M}{y_N}$

(2) $(x_M - y_M) < (x_N - y_N)$

(3) $\frac{x_M}{x_N} < \frac{y_M}{y_N}$

(4) $\frac{x_M}{x_N} > \frac{y_M}{y_N}$

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Q14

The osmotic pressure of a dilute solution of an ionic compound XY in water is four times that of a solution of 0.01 M $BaCl_2$ in water. Assuming complete dissociation of the given ionic compounds in water, the concentration of XY (in mol L^{-1}) in solution is:

(1) 4×10^{-2} (2) 6×10^{-2}
(3) 4×10^{-4} (4) 16×10^{-4}

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Q15

Molal depression constant for a solvent is 4.0 K kg mol^{-1}. The depression in the freezing point of the solvent for 0.03 mol kg^{-1} solution K_2SO_4 is:
(Assume complete dissociation of the electrolyte)

(1) 0.18 K (2) 0.24 K (3) 0.12 K (4) 0.36 K

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Q16

What would be the molality of 20% (mass/mass) aqueous solution of KI? (molar mass of KI = 166 g mol^{-1})

(1) 1.08 (2) 1.35 (3) 1.48 (4) 1.51

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Q17

At room temperature, a dilute solution of urea is prepared by dissolving 0.60 g of urea in 360 g of water. If the vapour pressure of pure water at this temperature is 35 mmHg, lowering of vapour pressure will be :
(molar mass of urea = 60 g mol^{-1})

(1) 0.027 mmHg (2) 0.028 mmHg
(3) 0.017 mmHg (4) 0.031 mmHg

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Q18

1 g of a non-volatile non-electrolyte solute is dissolved in 100 g of two different solvents A and B whose ebullioscopic constants are in the ratio of 1 : 5. The ratio of the elevation in their boiling points, $\frac{\Delta T_b(A)}{\Delta T_b(B)}$, is :

(1) 5 : 1 (2) 10 : 1 (3) 1 : 5 (4) 1 : 0.2

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Q19

The mole fraction of a solvent in aqueous solution of a solute is 0.8. The molality (in mol kg^{-1}) of the aqueous solution is :

(1) 13.88×10^{-2} (2) 13.88×10^{-1}
(3) 13.88 (4) 13.88×10^{-3}

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Q20

A solution is prepared by dissolving 0.6 g of urea (molar mass = 60 g mol^{-1}) and 1.8 g of glucose (molar mass = 180 g mol^{-1}) in 100 mL, of water at 27°C. The osmotic pressure of the solution is :

(R = 0.08206 L atm K^{-1} mol^{-1})

(1) 8.2 atm (2) 2.46 atm
(3) 4.92 atm (4) 1.64 atm

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Solutions and Colligative Properties - Answers

Q1

(1) The solubility of the gas in liquids decreases with the increase in value of K_H at a given pressure.

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Q2

(3) As we know,

$\Delta T_f = K_f \times m$

$\Rightarrow \quad 10 = 1.86 \times \dfrac{62 \times 1000}{62 \times w}$

$\Rightarrow \quad w = \dfrac{1.86 \times 1000}{10} = 186\text{ g}$

Total amount of water = 250 g

$\therefore$ The amount of water separated as ice

$= 250 - 186 = 64\text{ g}$

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Q3

(2) $P^\circ_A = 7 \times 10^3$

$P^\circ_B = 12 \times 10^3$

$x'_A = 0.4; \quad x'_B = 1 - 0.4$

$x'_B = 0.6$

$P_{total} = P^\circ_A x'_A + P^\circ_B x'_B$

$= 7 \times 10^3 \times 0.4 + 12 \times 10^3 \times 0.6$

$= (7 \times 0.4 + 12 \times 0.6) \times 10^3 = 10^4$

$x_A = \dfrac{P^\circ_A x'_A}{P_{total}} = \dfrac{7 \times 10^3 \times 0.4}{10^4}$

$\therefore x_A = 0.28, x_B = 1 - 0.28 = 0.72$

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Q4

(3) As we know,

$$\text{Molarity} = \frac{\text{No. of moles of sugar}}{\text{Volume of solution (in L)}}$$

$$\Rightarrow \quad 0.1 = \frac{\text{No. of moles of sugar}}{2\text{ L}}$$

So, no. of moles of sugar = 0.2 mole

$\therefore$ Mass of sugar = No. of moles of sugar × Molar mass of sugar

= 0.2 × 342 = 68.4 g

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Q5

(4) According to the question we can write

$\Delta T_b = K_b m \Rightarrow K_b(1) = 2 \Rightarrow K_b = 2\text{ Km}^{-1}$

$\Delta T_f = K_f m \Rightarrow K_f(2) = 2 \Rightarrow K_f = 1\text{ Km}^{-1}$

$\therefore K_f = 0.5\, K_b$

$\therefore K_b = 2K_f$

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Q6

(2) Freezing point of diluted milk = –0.2 °C

$$\Delta T_f' = 0.2\ °C$$

Freezing point of pure milk = –0.5 °C

$$\Delta T_f = 0.5\ °C$$

$$\frac{\Delta T_f}{\Delta T_f'} = \frac{K_f \times m}{K_f \times m'}\ ;\ m = \frac{\text{mole of solute}}{\text{mass of solvent (kg)}}$$

∵ Moles of solute are same in both samples.

$$\therefore\ \frac{0.5}{0.2} = \frac{W'}{W}$$

$$\frac{W'}{W} = \frac{5}{2};\ W' = \frac{5}{2}W$$

2 cups of pure milk is mixed with 3 cups of water to make 5 cups of diluted milk.

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Q7

(2) $K_2HgI_4 \rightleftharpoons 2K^+ + [HgI_4]^{2-}$; n = 3

$$\because\ \alpha = \frac{i-1}{n-1}\ ;\ 0.4 = \frac{i-1}{3-1}$$

i = 1.8

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Q8

(1)

$$(\Delta T_f)_x = (\Delta T_f)_y$$

$$K_f.m_x = K_f.m_y$$

$$\frac{4 \times 100}{A \times 96} = \frac{12 \times 100}{m_y \times 88}$$

$$m_y = 3.27\ A;\ y \approx 3\ A$$

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Q9

(3) No. of moles of H_2O $(n_1) = \frac{18}{18} = 1$

No. of moles of NaOH $(n_2) = \frac{8}{40} = \frac{1}{5}$

$$\text{Mole fraction of NaOH} = \frac{n_2}{n_2 + n_1} = \frac{\frac{1}{5}}{\frac{1}{5}+1} = 0.167$$

$$\text{Molality} = \frac{\text{No. of moles of solute}}{\text{Mass of solvent (kg)}}$$

$$= \frac{1}{5} \times \frac{1000}{18} = 11.11\ m$$

2+

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Q10

(1) $\underset{\text{w g}}{2C_6H_5COOH} \longrightarrow \underset{\text{Dimer}}{(C_6H_5COOH)_2}$

$$\begin{array}{lll} t = 0 & 1 & 0 \\ t = t_{eq} & 1-\alpha & \frac{\alpha}{2} \end{array}$$

$$\text{Moles at equilibrium} = 1 - \alpha + \frac{\alpha}{2} = 1 - \frac{\alpha}{2}$$

$$i = \frac{\text{Total moles at equilibrium}}{\text{Initial moles}} = \frac{1-\frac{\alpha}{2}}{1}$$

$$i = \frac{1 - \frac{0.8}{2}}{1} = 0.6$$

$$\Delta T_f = iK_f m$$

$$2 = 0.6 \times 5 \times \left(\frac{\frac{w}{122}}{30}\right) \times 1000$$

w = 2.4 g

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Q11

(4) $P = x_B\, p_B^\circ + x_A p_A^\circ$

$= 0.5 \times 600 + 0.5 \times 400 = 300 + 200 = 500$

Using the relation $p_i = y_i\, P_{\text{Total}}$, we can calculate the mole fractions of the components in vapour phase.

$$p_B = y_B\, p_{\text{total}}$$

$$y_B = \frac{p_B}{P_{\text{Total}}} = \frac{300}{500} = \frac{3}{5} = 0.6$$

$$y_A = \frac{p_A}{P_{\text{Total}}} = \frac{200}{500} = \frac{2}{5} = 0.4$$

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Q12

(1) According to Henry's law

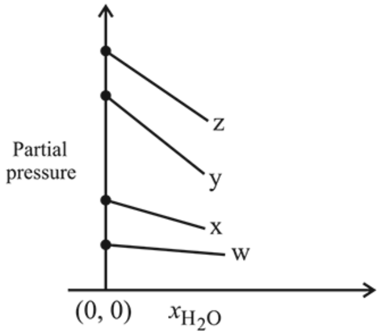
$P = K_H \cdot X_{gas}$

$\because \quad X_{gas} + X_{H_2O} = 1$

$\therefore \quad X_{gas} = 1 - X_{H_2O}$

$\therefore \quad P = K_H - K_H \cdot X_{H_2O}$

$y = c + mx$



Gas	K_H
w	0.5
x	2
y	35
z	50

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Q13

(4) $P_M^o = 450$ mmHg, $P_N^o = 700$ mmHg

$$P_M = P_M^o x_M = y_M P_T$$

$$P_M^o = \frac{y_M}{x_M}(P_T)$$

Similarly, $P_N^o = \frac{y_N}{x_N}(P_T)$

Given, $P_M^o < P_N^o$

$$\frac{y_M}{x_M} < \frac{y_N}{x_N}$$

$$\frac{y_M}{y_N} < \frac{x_M}{x_N}$$

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Q14

(2) We know, $\pi = iCRT$; $\pi_{xy} = 4\pi_{BaCl_2}$

$\therefore 2[XY] = 4 \ (0.01) \ 3$

$[XY] = 0.06$

$= 6 \ 10^{-2}$ mol/L

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Q15

(4) Dissociation of Potassium Sulphate (K_2SO_4),

$$K_2SO_4 \longrightarrow 2K^+ + SO_4^{2-}$$

i (Van't Hoff factor) = 3

We know that, $\Delta T_f = iK_f m$

where, K_f is molal depression constant and m is molality.

$= 3 \times 4 \times 0.03 = 0.36$ K

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Q16

(4) 20% W/W KI solution (Given)

i.e. 100 g solution contains 20 g KI

$\therefore$ Mass of solvent = 100 – 20 = 80 g

No. of moles of KI is $\frac{20}{166} = 0.121$ mol

$\therefore$ Molality $= \frac{0.121 \times 1000}{80} = 1.51$ m

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Q17

(3) Relative lowering of vapour pressure, is given by,

$$\frac{p^\circ - p}{p^\circ} = x_A = \frac{n_A}{n_A + n_B} \simeq \frac{n_A}{n_B}$$

Given, $p^\circ = 35\,\text{mm Hg}, n_{urea} = \frac{0.60}{60}, n_{water} = \frac{360}{18}$

$$\frac{p^\circ - p}{35} = \frac{0.6 \times 18}{60 \times 360} = \frac{1}{2000}$$

$\Delta p = p^\circ - p = 0.017$

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Q18

(3) Ebullioscopic constant (molal devation const.) is given by,

$$k_b = \frac{\Delta T_b}{m} \quad \Rightarrow \quad \frac{(k_b)_A}{(k_b)_B} = \frac{1}{5}$$

$$\therefore \frac{(\Delta T_b)_A}{(\Delta T_b)_B} = \frac{(k_b)_A}{(k_b)_B} = \frac{1}{5}$$

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Q19

(3) Let, 1 mole be present in the solution,

$n_{\text{solute}} = 0.2$ mol

$n_{\text{solvent}} = 0.8$ mol

$= 0.8 \times 18$ g

$$\text{molality} = \frac{\text{Moles of solute}}{\text{Kilogram of solvent}}$$

$$\therefore \quad m = \frac{0.2 \times 1000}{0.8 \times 18} = \frac{1000}{4 \times 18} \approx 13.88$$

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Q20

(3) Osmotic pressure (π) = CRT

Since, there are two solutes i.e. urea and glucose.

$\therefore \pi = (C_1 + C_1)$ RT

$$= \left(\frac{0.6}{60 \times 0.1} + \frac{1.8}{180 \times 0.1}\right) \times 0.0821 \times 300$$

$= 0.2 \times 0.0821 \times 300 = 4.926$ atm

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