Q1 - 2024 (04 Apr Shift 1)

The Molarity (M) of an aqueous solution containing 5.85 g of NaCl in 500 mL water is : (Given : Molar Mass Na : 23 and Cl : $35.5 \mathrm{gmol}^{-1}$)

(1) 2

(2) 20

(3) 4

(4) 0.2

Q2 - 2024 (04 Apr Shift 1)

2.5 g of a non-volatile, non-electrolyte is dissolved in 100 g of water at $25^{\circ}\mathrm{C}$. The solution showed a boiling point elevation by $2^{\circ}\mathrm{C}$. Assuming the solute concentration is negligible with respect to the solvent concentration, the vapor pressure of the resulting aqueous solution is ____ mm of Hg (nearest integer)

[Given : Molal boiling point elevation constant of water $(\mathrm{K_b}) = 0.52\ \mathrm{K.\,kgmol^{-1}}$,

$1\ \mathrm{atm\ pressure} = 760\ \mathrm{mm\ of\ Hg}$, molar mass of water $= 18\ \mathrm{g\ mol^{-1}}$]

Q3 - 2024 (04 Apr Shift 2)

2.7 kg of each of water and acetic acid are mixed. The freezing point of the solution will be $-x^{\circ}\mathrm{C}$. Consider the acetic acid does not dimerise in water, nor dissociates in water. $x =$ ______ (nearest integer)

[Given: Molar mass of water $= 18\ \mathrm{g\ mol^{-1}}$, acetic acid $= 60\ \mathrm{g\ mol^{-1}}$

$\mathrm{K_f H_2O} : 1.86\ \mathrm{K\ kg\ mol^{-1}}$

$\mathrm{K_f}$ acetic acid: $3.90\ \mathrm{K\ kg\ mol^{-1}}$

freezing point: $\mathrm{H_2O} = 273\ \mathrm{K}$, acetic acid $= 290\ \mathrm{K}$]

Q4 - 2024 (05 Apr Shift 1)

An artificial cell is made by encapsulating 0.2M glucose solution within a semipermeable membrane. The osmotic pressure developed when the artificial cell is placed within a 0.05M solution of NaCl at 300 K is ______ $\times 10^{-1}$ bar. (nearest integer).

[Given : $R = 0.083$ Lbarmol^{-1} K^{-1}]

Assume complete dissociation of NaCl

Q5 - 2024 (05 Apr Shift 2)

Considering acetic acid dissociates in water, its dissociation constant is 6.25×10^{-5}. If 5 mL of acetic acid is dissolved in 1 litre water, the solution will freeze at $-x \times 10^{-2}{}^{\circ}$C, provided pure water freezes at 0°C.

$x =$ ______ . (Nearest integer)

Given :

$(K_f)_{water} = 1.86$ K kg mol^{-1}.

density of acetic acid is 1.2 g mol^{-1}.

molar mass of water $= 18$ g mol^{-1}.

molar mass of acetic acid=60 gmol^{-1}.

density of water $= 1$ g cm^{-3}

Acetic acid dissociates as $CH_3COOH \rightleftharpoons CH_3COO^{\ominus} + H^{\oplus}$

Q6 - 2024 (06 Apr Shift 1)

Given below are two statements:

Statement I : Gallium is used in the manufacturing of thermometers.

Statement II : A thermometer containing gallium is useful for measuring the freezing point (256 K) of brine solution.

In the light of the above statements, choose the correct answer from the options given below :

(1) Both Statement I and Statement II are true

(2) Statement I is false but Statement II is true

(3) Both Statement I and Statement II are false

(4) Statement I is true but Statement II is false

Q7 - 2024 (06 Apr Shift 1)

Consider the dissociation of the weak acid HX as given below

$HX(aq) \rightleftharpoons H^{+}(aq) + X^{-}(aq), Ka = 1.2 \times 10^{-5}$

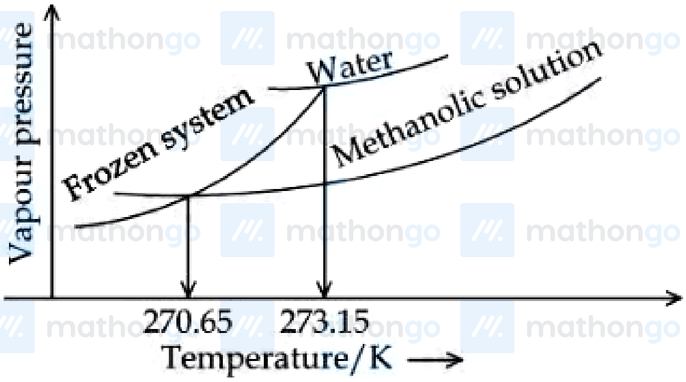
[K_a : dissociation constant]

The osmotic pressure of 0.03M aqueous solution of HX at 300 K is _______ $\times 10^{-2}$ bar (nearest integer).

[Given : $R = 0.083$ Lbarmol^{-1} K^{-1}]

Q8 - 2024 (06 Apr Shift 2)

When ' x ' $\times 10^{-2}$ mL methanol (molar mass $= 32$ g; density $= 0.792$ g/cm^3) is added to 100 mL water (density $= 1$ g/cm^3), the following diagram is obtained.



$x =$ ______ (nearest integer).

[Given : Molal freezing point depression constant of water at 273.15 K is 1.86 K kg mol^{-1}]

Q9 - 2024 (08 Apr Shift 1)

A solution containing 10 g of an electrolyte AB_2 in 100 g of water boils at $100.52^{\circ}C$. The degree of ionization of the electrolyte (α) is _______ $\times 10^{-1}$. (nearest integer)

[Given : Molar mass of $AB_2 = 200$ g mol^{-1}, K_b (molal boiling point elevation const. of water) $= 0.52$ K kg mol^{-1}, boiling point of water $= 100^{\circ}C$; AB_2 ionises as $AB_2 \rightarrow A^{2+} + 2B^-$]

Q10 - 2024 (08 Apr Shift 2)

A solution is prepared by adding 1 mole ethyl alcohol in 9 mole water. The mass percent of solute in the solution is ________ (Integer answer) (Given : Molar mass in gmol^{-1} Ethyl alcohol : 46 water: 18)

Q11 - 2024 (08 Apr Shift 2)

Molality of an aqueous solution of urea is 4.44 m. Mole fraction of urea in solution is $x \times 10^{-3}$. Value of x is ______ - (Integer answer)

Q12 - 2024 (09 Apr Shift 2)

The vapour pressure of pure benzene and methyl benzene at $27^{\circ}C$ is given as 80 Torr and 24 Torr, respectively. The mole fraction of methyl benzene in vapour phase, in equilibrium with an equimolar mixture of those two liquids (ideal solution) at the same temperature is ________ $\times 10^{-2}$ (nearest integer)

Answer Key

Q1 (4)	**Q2** (707)	**Q3** (31)	**Q4** (25)
Q5 (19)	**Q6** (4)	**Q7** (76)	**Q8** (543)
Q9 (5)	**Q10** (22)	**Q11** (74)	**Q12** (23)

Q1

$$M = \frac{n_{NaCl}}{V_{sol}\ (\text{in L})}$$

$$M = \frac{\frac{5.85}{58.5}}{0.5} = 0.2M$$

Q2

$$2 = 0.52 \times m$$
$$m = \frac{2}{0.52}$$

According to question, solution is much diluted

$$\text{so } \frac{\Delta P}{P^{\circ}} = \frac{n_{solute}}{n_{solvent}}$$

$$\frac{\Delta P}{P^{\circ}} = \frac{m}{1000} \times M_{solvent}$$

$$\Delta P = P^{\circ} \times \frac{m}{1000} \times M_{solvent}$$

$$= 760 \times \frac{\frac{2}{0.52}}{1000} \times 18 = 52.615$$

$$P_5 = 760 - 52.615 = 707.385 \text{ mm of Hg}$$

Q3

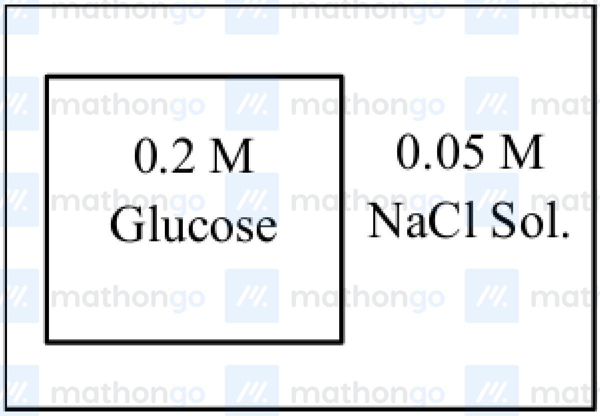
As moles of water > moles of CH_3COOH water is solvent.

$$T_F^{\circ} - (T_F)_S = K_F \times M$$

$$0 - (T_F)_S = 1.86 \times \frac{2700/60}{2700/1000}$$

$$(T_F)_S = -31^{\circ}C.$$

Q4



$\mathrm{NaCl} \longrightarrow \mathrm{Na}^{+} + \mathrm{Cl}^{-}$
$0.05\mathrm{M} \quad 0.05\mathrm{M} \quad 0.05\mathrm{M}$
$\text{Total } \mathrm{C}_1 = 0.05 + 0.05 = 0.1\mathrm{M(NaCl)}$
$\mathrm{C}_2 = 0.2\mathrm{M}(\text{ glucose })$
$\pi = (\mathrm{C}_2 - \mathrm{C}_1)\,\mathrm{RT}$
$= (0.2 - 0.1) \times 0.083 \times 300$
$= 2.49\mathrm{bar}$
$= 24.9 \times 10^{-1}\text{ bar}$

Q5

$\text{Mass of } \mathrm{CH_3COOH} = \mathrm{V} \times \mathrm{d}$
$= 5\mathrm{ml} \times 1.2\ \mathrm{g/ml}$
$= 6\mathrm{gm}$
$\mathrm{n}_{\mathrm{CH_3COOH}} = \frac{6}{60} = 0.1\text{ mol}$
$\mathrm{m}_{\mathrm{CH_3COOH}} \approx \mathrm{M}_{\mathrm{CH_3COOH}} = \frac{0.1}{1} = 0.1\mathrm{M}$
$\mathrm{CH_3COOH} \rightleftharpoons \mathrm{CH_3COO}^{-} + \mathrm{H}^{+}$
C

$C - C\alpha \quad C\alpha \quad C\alpha$

$K_a = \frac{C\alpha^2}{1-\alpha}$

$1 - \alpha \approx 1 \Rightarrow K_a = C\alpha^2$

$\alpha = \sqrt{\frac{Ka}{C}} = \sqrt{\frac{6.25 \times 10^{-5}}{0.1}} = 25 \times 10^{-3}$

$V.f.\ (i) = 1 + \alpha(n-1) = 1 + \alpha(2-1) = 1 + \alpha$

$= 1 + 25 \times 10^{-3} = 1.025$

$\Delta T_f = iK_f m$

$= (1.025)(1.86)(0.1)$

$= 0.19$

$= 19 \times 10^{-2}$

Q6

Statement $-I \Rightarrow$ Correct

Statement - II $\Rightarrow$ False

Ga is used to measure high temperature

Q7

$HX \rightleftharpoons H^+ + X^- \quad K_a = 1.2 \times 10^{-5}$

$0.03M$

$0.03 - x \quad x \quad x$

$K_a = 1.2 \times 10^{-5} = \frac{x^2}{0.03 - x}$

$0.03 - x \approx 0.03$ (K_a is very small)

$\frac{x^2}{0.03} = 1.2 \times 10^{-5}$

$x = 6 \times 10^{-4}$

Final solution : $0.03 - x + x + x$

$= 0.03 + x = 0.03 + 6 \times 10^{-4}$

$\Pi = \left(0.03 + \left(6 \times 10^{-4}\right)\right) \times 0.083 \times 300$

$= 76.19 \times 10^{-2} \approx 76 \times 10^{-2}$

Q8

$\Delta T_f = 273.15 - 270.65 = 2.5 \text{ K}$
$\Delta T_f = K_f m \Rightarrow 2.5 = 1.86 \times \frac{n}{0.1}$
$\Rightarrow n = 0.1344$ moles
$\Rightarrow w = 0.1344 \times 32 = 4.3$ g
Volume $= \frac{4.3}{0.792} = 5.43\text{ml} = 543 \times 10^{-2}\text{ml}$

Q9

$AB_2 \rightarrow A^{+2} + 2\,B^{\ominus}$
$i = 1 + (3-1)\alpha$
$i = 1 + 2\alpha$
$\Delta T_b = k_b im$
$0.52 = 0.52(1+2\alpha)\frac{\frac{10}{200}}{\frac{100}{1000}}$
$1 = (1+2\alpha)\frac{10}{20}$
$2 = 1 + 2\alpha$
$\alpha = 0.5$
Ans. $\alpha = 5 \times 10^{-1}$

Q10

Mass percent of Alcohol
$= \frac{\text{Mass of ethyl alcohol}}{\text{Total mass of solution}} \times 100$
$= \frac{1 \times 46}{1 \times 46 + 9 \times 18} \times 100 = \frac{4600}{208}$
$= 22.11$ Or 22

Q11

Molality of urea is 4.44 m, that means 4.44 moles of urea present in 1000gm of water.
$\therefore X_{ura} = \frac{4.44}{4.44 + \frac{1000}{18}}$
$= 0.0740$

OR
74×10^{-3}
$X = 74$

Q12

$$\begin{aligned} X_{\text{methylbenzene}} &= 0.5 \\ Y_{\text{methylbenzene}} &= \frac{P_{\text{methylbenzene}}}{P_{\text{total}}} \\ Y_{\text{methylbenzene}} &= \frac{0.5 \times 24}{0.5 \times 80 + 0.5 \times 24} \\ &= \frac{12}{40 + 12} = 0.23 = 23 \times 10^{-2} \end{aligned}$$