Solutions

Question1

A solution of two miscible liquids showing negative deviation from Raoult's law will have :

[27-Jan-2024 Shift 1]

Options:

A.

increased vapour pressure, increased boiling point

B.

increased vapour pressure, decreased boiling point

C.

decreased vapour pressure, decreased boiling point

D.

decreased vapour pressure, increased boiling point

Answer: D

Solution:

Solution with negative deviation has

$P_T < P_{A^0} X_A + P_{B^0} X_B$

$P_A < P_{A^0} X_A$

$P_B < P_{B^0} X_B$

If vapour pressure decreases so boiling point increases.

Question2

The quantity which changes with temperature is:

[27-Jan-2024 Shift 2]

Options:

A.

Molarity

B.

Mass percentage

C.

Molality

D.

Mole fraction

Answer: A

Solution:

1. Molarity $= \frac{\text{Moles of solute}}{\text{Volume of solution}}$

Since volume depends on temperature, molarity will change upon change in temperature.

Question3

A solution of H_2SO_4 is 31.4% H_2SO_4 by mass and has a density of 1.25g/mL. The molarity of the H_2SO_4 solution is M (nearest integer) [Given molar mass of $H_2SO_4 = 98 \text{gmol}^{-1}$]

[29-Jan-2024 Shift 1]

Options:

Answer: 4

Solution:

$$M = \frac{n_{\text{solute}}}{V} \times 1000$$

$$= \frac{\left(\frac{31.4}{98}\right)}{\left(\frac{100}{1.25}\right)} \times 1000$$

$$= 4.005 \approx 4$$

Question4

The osmotic pressure of a dilute solution is 7×10^5Pa at 273K. Osmotic pressure of the same solution at 283K is $\times 10^4 \text{Nm}^{-2}$.

[29-Jan-2024 Shift 1]

Answer: 72.56

Solution:

$$\pi = CRT$$

$$\Rightarrow \frac{\pi_1}{\pi_2} = \frac{T_1}{T_2}$$

$$\Rightarrow \pi_2 = \frac{\pi_1 T_2}{T_1} = \frac{7 \times 10^5 \times 283}{273}$$

$$= 72.56 \times 10^4 Nm^{-2}$$

Question5

Molality of $0.8 M H_2SO_4$ solution (density $1.06 g cm^{-3}$) is ____ $\times 10^{-3}$ m.

[29-Jan-2024 Shift 2]

Answer: 815

Solution:

$$m = \frac{M \times 1000}{d_{sol} \times 1000 - M \times \text{ Molar mass }_{solute}}$$

$$815 \times 10^{-3} m$$

Question6

What happens to freezing point of benzene when small quantity of napthalene is added to benzene?

[30-Jan-2024 Shift 1]

Options:

A.

Increases

B.

Remains unchanged

C.

First decreases and then increases

D.

Decreases

Answer: D

Solution:

On addition of naphthalene to benzene there is depression in freezing point of benzene.

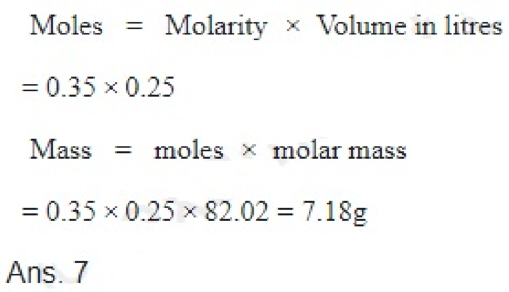
Question7

The mass of sodium acetate (CH_3COONa) required to prepare 250mL of 0.35M aqueous solution is ______g. (Molar mass of CH_3COONa is $82.02 g mol^{-1}$)

[30-Jan-2024 Shift 1]

Answer: 7

Solution:



Moles = Molarity × Volume in litres

$= 0.35 \times 0.25$

Mass = moles × molar mass

$= 0.35 \times 0.25 \times 82.02 = 7.18 g$

Ans. 7

Question8

The solution from the following with highest depression in freezing point/lowest freezing point is

[30-Jan-2024 Shift 2]

Options:

A.

180g of acetic acid dissolved in water

B.

180g of acetic acid dissolved in benzene

C.

180g of benzoic acid dissolved in benzene

D.

180g of glucose dissolved in water

Answer: A

Solution:

ΔT_f is maximum when $i \times m$ is maximum.

1) $m_1 = \frac{180}{60} = 3, i = 1 + \alpha$

Hence

$\Delta T_f = (1 + \alpha) \cdot k_f = 3 \times 1.86 = 5.58^\circ C (\alpha << 1)$

2) $m_2 = \frac{180}{60} = 3, i = 0.5, \Delta T_f = \frac{3}{2} \times k_f' = 7.68^\circ C$

3) $m_3 = \frac{180}{122} = 1.48, i = 0.5, \Delta T_f = \frac{1.48}{2} \times k_f' = 3.8^\circ C$

4) $m_4 = \frac{180}{180} = 1, i = 1, \Delta T_f = 1 \cdot k_f' = 1.86^\circ C$

As per NCERT, $k_f'(H_2O) = 1.86 k \cdot kg\, mol^{-1}$

$k_f'(\text{ Benzene }) = 5.12 k \cdot kg\, mol^{-1}$

Question9

If a substance ' A ' dissolves in solution of a mixture of ' B ' and ' C ' with their respective number of moles as n_A, n_B and n_C, mole fraction of C in the solution is:

[30-Jan-2024 Shift 2]

Options:

A.

$$\frac{n_C}{n_A \times n_B \times n_C}$$

B.

$$\frac{n_C}{n_A + n_B + n_C}$$

C.

$$\frac{n_C}{n_A - n_B - n_C}$$

D.

$$\frac{n_B}{n_A + n_B}$$

Answer: B

Solution:

Mole fraction of $C = \frac{n_C}{n_A + n_B + n_C}$

Question10

Identify the mixture that shows positive deviations from Raoult's Law

[31-Jan-2024 Shift 1]

Options:

A.

$(CH_3)_2CO + C_6H_5NH_2$

B.

$CHCl_3 + C_6H_6$

C.

$CHCl_3 + (CH_3)_2CO$

D.

$(CH_3)_2CO + CS_2$

Answer: D

Solution:

$(CH_3)_2CO + CS_2$ Exibits positive deviations from Raoult's Law

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Question11

We have three aqueous solutions of NaCl labelled as ' A ', ' B ' and ' C ' with concentration 0.1M, 0.01M & 0.001M, respectively. The value of

van t' Haft factor (i) for these solutions will be in the order.

[1-Feb-2024 Shift 1]

Options:

A.

$i_A < i_B < i_C$

B.

$i_A < i_C < i_B$

C.

$i_A = i_B = i_C$

D.

$i_A > i_B > i_C$

Answer: A

Solution:

Salt	**Values of i (for different conc. of a Salt)**		
	0.1 M	0.01M	0.001M
NaCl	1.87	1.94	1.94

i approach 2 as the solution become very dilute.

Question12

Mass of ethylene glycol (antifreeze) to be added to 18.6kg of water to protect the freezing point at −24°C is_____ kg (Molar mass in gmol−1 for ethylene glycol 62,Kf of water = 1.86K kgmol^{-1})

[1-Feb-2024 Shift 2]

Answer: 15

Solution:

$$\Delta T_f = iK_f \times \text{ molality}$$

$$24 = (1) \times 1.86 \times \frac{W}{62 \times 18.6}$$

$$W = 14880 \text{ gm}$$

$$= 14.880 \text{ kg}$$

Question13

In the depression of freezing point experiment
A. Vapour pressure of the solution is less than that of pure solvent
B. Vapour pressure of the solution is more than that of pure solvent
C. Only solute molecules solidify at the freezing point
D. Only solvent molecules solidify at the freezing point
[24-Jan-2023 Shift 1]

Options:

A. A and D only

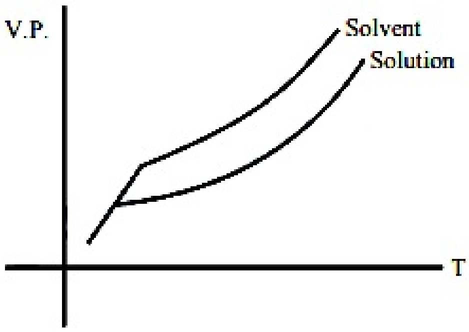
B. B and C only

C. A and C only

D. A only

Answer: A

Solution:



Vapour pressure (V.P.) of solvent is greater than vapour pressure (V.P.) of solution.
Only solvent freezes.

Question14

The Total pressure observed by mixing two liquid A and B is 350 mm Hg when their mole fractions are 0.7 and 0.3 respectively.
The Total pressure becomes 410 mm Hg if the mole fractions are changed to 0.2 and 0.8 respectively for A and B. The vapour pressure of pure A is____ mm Hg. (Nearest integer)
Consider the liquids and solutions behave ideally.
[24-Jan-2023 Shift 2]

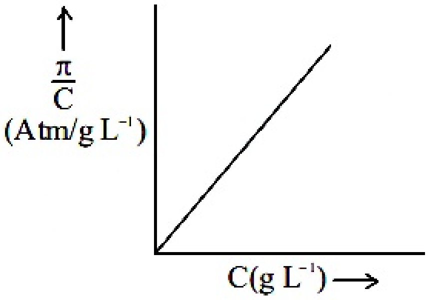
Answer: 314

Solution:

Let V.P. of pure A be P_A^0
Let V.P of pure B be P_B^0
When $X_A = 0.7 \& X_B = 0.3$
$P_s = 350$
$\Rightarrow P_A^0 \times 0.7 + P_B^0 \times 0.3 = 350 \ldots$ (i)
When $X_A = 0.2 \& X_B = 0.8$
$P_s = 410$
$\Rightarrow P_A^0 \times 0.2 + P_B^0 \times 0.8 = 410 \ldots$ (ii)
Solving (i) and (ii)
$P_A^0 = 314 \, \mathrm{mm\,Hg}$
$P_B^0 = 434 \, \mathrm{mm\,Hg}$
$= (314)$

Question15

The osmotic pressure of solutions of PVC in cyclohexanone at 300K are plotted on the graph.
The molar mass of PVC is ________ $\mathbf{g\ mol^{-1}}$
(Nearest integer)



(Given : $\mathbf{R = 0.083 L\,atm\,K^{-1}\,mol^{-1}}$)
[25-Jan-2023 Shift 1]

Answer: 41500

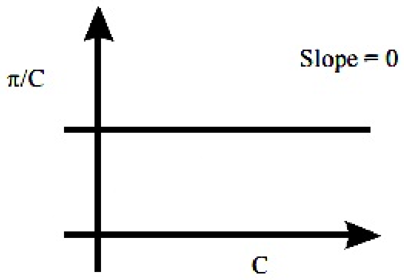
Solution:

$$\pi = M' RT = \left(\frac{W/M}{V} \right) RT$$

$$\Rightarrow \quad \pi = \left(\frac{W}{V} \right) \left(\frac{1}{M} \right) RT = C \left(\frac{RT}{M} \right)$$

$$\Rightarrow \quad \frac{\pi}{C} = \frac{RT}{M} \neq f(c)$$

If we assume graph between $\frac{\pi}{C}$ and C



Assuming π vs C graph

$$\text{Slope} = \frac{RT}{M} = \frac{0.083 \times 300}{M} = 6 \times 10^{-4}$$

$$\therefore \ M = \frac{0.083 \times 300}{6 \times 10^{-4}} = \frac{830 \times 300}{6}$$

$$= 41,500 \text{ gm / mole}$$

Question16

The number of pairs of the solution having the same value of the osmotic pressure from the following is ________.
(Assume 100\% ionization)
A. $0.500 M C_2H_5OH(aq)$ and $0.25 M KBr(aq)$
B. $0.100 M K_4[Fe(CN)_6]$ (aq) and $0.100 M FeSO_4(NH_4)_2SO_4(aq)$
C. $0.05 M K_4[Fe(CN)_6](aq)$ and $0.25 M NaCl$ (aq)
D. $0.15 M NaCl(aq)$ and $0.1 M BaCl_2$ (aq)
E. $0.02 M KCl . MgCl_2.6H_2O(aq)$ and $0.05 M KCl(aq)$
[25-Jan-2023 Shift 2]

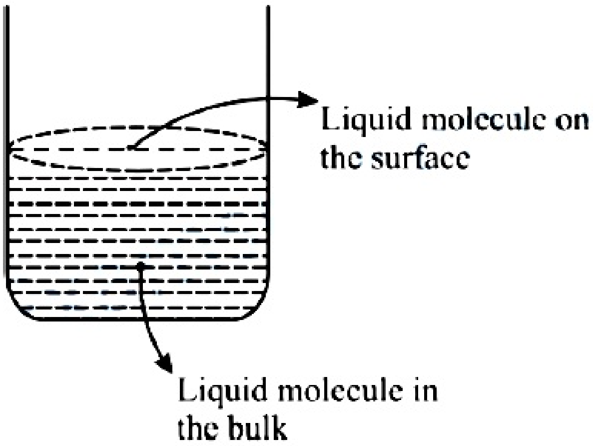
Answer: 4

Solution:

$\pi = iCRT$
$\pi \propto iC$
A, B, D and E have same value of osmatic pressure.

Question17

Based on the given figure, the number of correct statement / s is/are ______



A. Surface tension is the outcome of equal attractive and repulsion forces acting on the liquid molecule in bulk.
B. Surface tension is due to uneven forces acting on the molecules present on the surface.
C. The molecule in the bulk can never come to the liquid surface.
D. The molecules on the surface are responsible for vapour pressure if the system is a closed system.
[25-Jan-2023 Shift 2]

Answer: 2

Solution:

Solution:
B and D options are correct.

Question18

Solid Lead nitrate is dissolved in 1 litre of water. The solution was found to boil at 100.15°C. When 0.2 mol of NaCl is added to the resulting solution, it was observed that the solution froze at $-0.8^{\circ}C$. The solubility product of $PbCl_2$ formed is ________ $\times 10^{-6}$ at 298K. (Nearest integer)
Given : $K_b = 0.5 K\,kg\,mol^{-1}$ and $K_f = 1.8\,kg\,mol^{-1}$.
Assume molality to be equal to molarity in all cases.
[29-Jan-2023 Shift 1]

Answer: 13

Solution:

Let a mole $Pb(NO_3)_2$ be added
$Pb(NO_3)_2 \to Pb^{2+} + 2NO_3^-$
$\quad a \qquad\quad a \qquad\quad 2a$
$\Delta T_b = 0.15 = 0.5[3a] \Rightarrow a = 0.1$
$Pb_{(aq)}^{2+} + 2Cl_{(aq)}^- \to PbCl_2(s)$
$t = 0$ 0.1 0.2
$t = \infty$ $(0.1 - x)$ $(0.2 - 2x)$
In final solution

$$\Delta T_f = 0.8 = 1.8\left[\frac{0.3 - 3x + 0.2 + 0.2}{1}\right]$$

$$\Rightarrow x = \frac{2.3}{27}$$

$$\Rightarrow K_{sp} = \left(0.1 - \frac{2.3}{27}\right)\left(0.2 - \frac{4.6}{27}\right)^2 = 13 \times 10^{-6}$$

Question19

Match List I with List II.

List-I	List-II
A. van't Hofffactor, i	I. Cryoscopic constant
B. k_f	II. Isotonic solutions
C. Solutions with same osmotic pressure	III. $\frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$
D. Azeotropes	IV. Solutions with same composition of vapour above it

Choose the correct answer from the options given below : [29-Jan-2023 Shift 2]

Options:

A. A-III, B-I, C-II, D-IV

B. A-III, B-II, C-I, D-IV

C. A-III, B-I, C-IV, D-II

D. A-I, B-III, C-II, D-IV

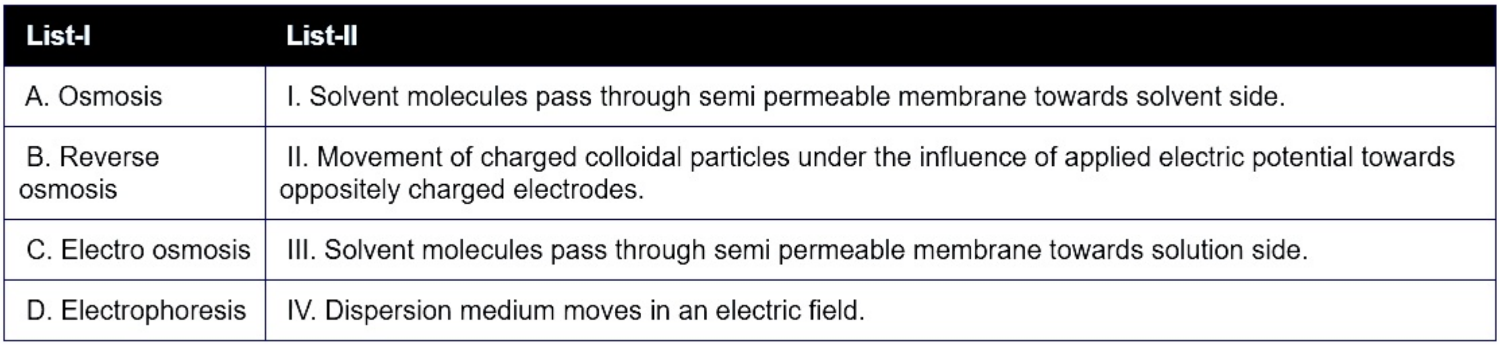
Answer: A

Solution:

(A) van't Hoff factor, i
$i = \frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$
(B) $k_f =$ Cryoscopic constant
(C) Solutions with same osmotic pressure are known as isotonic solutions.
(D) Solutions with same composition of vapour over them are called Azeotrope.

Question20

Match List-I and List-II.



List-I	List-II
A. Osmosis	I. Solvent molecules pass through semi permeable membrane towards solvent side.
B. Reverse osmosis	II. Movement of charged colloidal particles under the influence of applied electric potential towards oppositely charged electrodes.
C. Electro osmosis	III. Solvent molecules pass through semi permeable membrane towards solution side.
D. Electrophoresis	IV. Dispersion medium moves in an electric field.

Choose the correct answer from the options given below:
[29-Jan-2023 Shift 2]

Options:

A. A-I, B-III, C-IV, D-II

B. A-III, B-I, C-IV, D-II

C. A-III, B-I, C-II, D-IV

D. A-I, B-III, C-II, D-IV

Answer: B

Solution:

A. Osmosis III
B. Reverse osmosis I
C. Electro osmosis IV
D. Electrophoresis II

Question21

A solution containing 2g of a non-volatile solute in 20g of water boils at 373.52K. The molecular mass of the solute is _______ gmol^{-1}. (Nearest integer)
Given, water boils at 373K, K_b for water $= 0.52\,\text{K kg mol}^{-1}$
[30-Jan-2023 Shift 1]

Answer: 100

Solution:

$\Delta T_b = 373.52 - 373$
$= 0.52$
$\Delta T_b = Kb \cdot m$

$0.52 = 0.52 \times \frac{2}{\text{Molar Mass}} \times \frac{1}{20 \times 10^{-3}}$

Molar Mass $= 100\text{g / mol}$

Question22

A $300\,\text{mL}$ bottle of soft drink has $0.2\text{M}\,CO_2$ dissolved in it. Assuming CO_2 behaves as an ideal gas, the volume of the dissolved CO_2 at STP is ______ mL. (Nearest integer)

Given: At STP, molar volume of an ideal gas is

22.7Lmol^{-1}

[30-Jan-2023 Shift 1]

Answer: 1362

Solution:

Mole of $CO_2 = 0.2\text{M} \times (300 \times 10^{-3})\text{L}$

$= 0.06$ Mole

Volume of 0.06 mole CO_2 at S.T.P

$= 0.06 \times 22.7$

$= 1.362\text{L}$

Question23

Lead storage battery contains 38% by weight solution of H_2SO_4. The van't Hoff factor is 2.67 at this concentration. The temperature in Kelvin at which the solution in the battery will freeze is ______ (Nearest integer).

Given $K_f = 1.8\text{K kg mol}^{-1}$

[30-Jan-2023 Shift 2]

Answer: 243

Solution:

$\Delta T_f = i\,.\,K_f \cdot m$

$\Rightarrow \Delta T_f = 2.67 \times 1.8 \times \frac{38}{98} \times \frac{1000}{62}$

$\Rightarrow \Delta T_f = 30.05$

$\therefore$ F.P. $= 243\text{K}$

Question24

The total pressure of a mixture of non-reacting gases X (0.6g) and Y (0.45g) in a vessel is 740 mm of Hg. The partial pressure of the gas X is mm of Hg. (Nearest Integer)
(Given : molar mass X = 20 and Y = 45gmol^{-1})
[31-Jan-2023 Shift 1]

Answer: 555

Solution:

$$P_X = \chi_X{}^{P_T}$$

$$= \frac{\frac{0.6}{20}}{\frac{0.6}{20} + \frac{0.45}{45}} \times 740$$

$$P_X = 555 \, \text{mm Hg}$$

Question25

At 27°C, a solution containing 2.5g of solute in 250.0 mL of solution exerts an osmotic pressure of 400 Pa. The molar mass of the solute is ______ g mol^{-1} (Nearest integer)
(Given : $R = 0.083 \text{L bar K}^{-1} \text{mol}^{-1}$)
[31-Jan-2023 Shift 1]

Answer: 62250

Solution:

$$\pi = CRT$$

$$\frac{400 \, \text{Pa}}{10^5} = \frac{\frac{2.5\text{g}}{M_\circ}}{250 / 1000\text{L}} \times 0.83 \, \frac{\text{L} - \text{bar}}{\text{K} \cdot \text{mol}} \times 300\text{K}$$

$$M_0 = 62250$$

Question26

Evaluate the following statements for their correctness.
(A) The elevation in boiling point temperature of water will be same for 0.1M NaCl and 0.1M urea.
(B) Azeotropic mixtures boil without change in their composition
(C) Osmosis always takes place from hypertonic to hypotonic solution
(D) The density of 32% H_2SO_4 solution having molarity 4.09M is approximately $1.26 gmL^{-1}$
(E) A negatively charged sol is obtained when KI solution is added to silver nitrate solution.
Choose the correct answer from the options given below :
[31-Jan-2023 Shift 2]

Options:

A. B, D, and E only

B. A, B, and D only

C. A and C only

D. B and D only

Answer: D

Solution:

Solution:
(A) $\Delta T_b \propto i \times c$
(B) Azeotropic mixtures have same composition in both liquid and vapour phase.
(C) Osmosis always takes place from hypotonic to hypertonic solution.
(D) $M = \frac{30 \times 10 \times 1.26}{98} \approx 4.09M$
(E) When KI solutions is added to $AgNO_3$ solution, positively charged solution results due to adsorption of Ag^{ions} iom dispersion medium
AgI / Ag^+
Positively charged

Question27

20% of acetic acid is dissociated when its 5g is added to 500 mL of water. The depression in freezing point of such water is _______ $\times 10^{-3}$ ∘ C. Atomic mass of C, H and O are 12,1 and 16 a.m.u. respectively.
[Given : Molal depression constant and density of respectively.
[1-Feb-2023 Shift 2]

Answer: 372

Solution:

$i = 1 + (n - 1)\alpha$
$(i = 1 + 0.2(2 - 1) = 1.2$
$\Delta T_f = iK_fm$
$\Delta T_f = 1.2 \times 1.86 \times \frac{5 \times 1000}{60 \times 500}$
$\Delta t_f = 3.72$
$\Delta T_f = 372 \times 10^{-2}$

Question28

Mass of Urea (NH_2CONH_2) required to be dissolved in 1000g of water to reduce the vapour pressure of water by 25% is......g. (Nearest integer)
Given: Molar mass of N, C, O and H are 14, 12,16 and 12mol^{-1} respectively.
[6-Apr-2023 shift 1]

Answer: 1111

Solution:

$$\frac{P^0 - P_s}{P_s} = \frac{n_{\text{solute}}}{n_{\text{solvent}}} = \frac{\frac{x}{60}}{\frac{1000}{18}} = \frac{P^0 - 0.75P^0}{0.75P^0}$$

$$\Rightarrow x = \frac{10000}{9} = 1111\text{ gm}$$

Question29

Consider the following pairs of solution which will be isotonic at the same temperature. The number of pairs of solutions is/are..........
A. 1M aq. NaCl and 2M aq. Urea
B. 1M aq. $CaCl_2$ and 1.5M aq. KCl
C. 1.5M aq. $AlCl_3$ and 2M aq. Na_2SO_4
D. 2.5M aq. KCl and 1M aq. $Al_2(SO_4)_3$
[6-Apr-2023 shift 2]

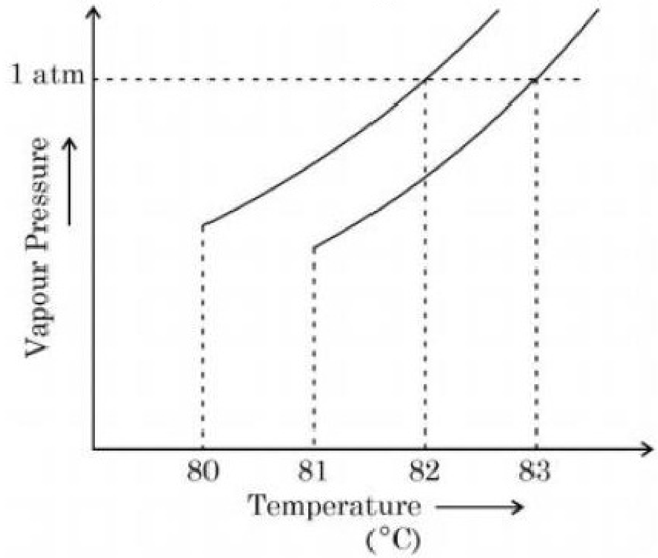
Answer: 4

Solution:

$\pi = icRT$
A, B, C and D are isotonic pairs.

Question30

The vapour pressure vs. temperature curve for a solution solvent system is shown below:



The boiling point of the solvent is ______ °C
[8-Apr-2023 shift 1]

Answer: 82

Solution:

Boiling point of solvent is 82°C
Boiling point of solvent is 83°C

Question31

If the boiling points of two solvents X and Y (having same molecular weights) are in the ratio 2 : 1 and their enthalpy of vaporizations are in the ratio 1 : 2, then the boiling point elevation constant of X is m times the boiling point elevation constant of Y . The value of m is ______ (nearest integer)
[8-Apr-2023 shift 2]

Options:

Answer: 8

Solution:

$$K_b = \frac{RT_b{}^2 m}{1000\ \Delta\ H_{vap}}$$

$$\frac{(K_b)_x}{(K_b)_y} = \frac{(T_b{}^2M)_x}{(T_b{}^2M)_y} \times \frac{(\Delta H)_y}{(\Delta H)_x} = \left(\frac{2}{1}\right)^2 \times \left(\frac{2}{1}\right) = \frac{8}{1}$$

Question32

If the degree of dissociation of aqueous solution of weak monobasic acid is determined to be 0.3 , then the observed freezing point will be ________ % higher than the expected/theoretical freezing point. (Nearest integer) [10-Apr-2023 shift 1]

Answer: 30

Solution:

For mono basic acid →$n = 2$

$i = 1 + (n - 1)\alpha = 1 + (2 - 1)0.3$

$i = 1.3$

$$\%\ \text{increase} = \frac{(\Delta T_f)_{obs} - (\Delta T_f)_{cal}}{(\Delta T_f)_{cal}} \times 100$$

$$= \frac{K_f \times i \times m - K_f \times m}{K_f \times m} \times 100$$

$$= \frac{i - 1}{1} \times 100 = 30\%$$

Question33

An aqueous solution of volume 300cm^3 contains 0.63g of protein. The osmotic pressure of the solution at 300 K is 1.29 mbar. The molar mass of the protein is _______ gmol^{-1} Given : R = 0.083L bar K^{-1}mol^{-1} [10-Apr-2023 shift 2]

Answer: 40535

Solution:

$$\because \pi = CRT$$
$$\pi = \frac{n}{V}RT$$
$$\pi = \frac{\omega}{V}\frac{RT}{M}$$
$$M = \frac{\omega RT}{\pi \times V}$$
$$M = \frac{0.63 \times 0.083 \times 300}{1.29 \times 10^{-3} \times 300 \times 10^{-3}}$$
$$M = 40535\,\text{gm / moL}$$

Question34

0.004 MK_2SO_4 solution is isotonic with 0.01M glucose solution. Percentage dissociation of K_2SO_4 is (Nearest integer)
[11-Apr-2023 shift 1]

Answer: 75

Solution:

For isotonic solution

$$(ic)_{\text{glucose}} = (ic)_{K_2SO_4}$$
$$0.01 = i(0.004)$$
$$i = \frac{0.01}{0.004} = \frac{10}{4} = \frac{5}{2}$$
$$1 + (n-1)\alpha = \frac{5}{2}$$
$$1 + (3-1)\alpha = \frac{5}{2} \quad (\because n = 3 \text{ for } K_2SO_4)$$
$$2\alpha = \frac{3}{2}$$
$$\alpha = \frac{3}{4} \rightarrow 75\%$$

Question35

What weight of glucose must be dissolved in 100g of water to lower the vapour pressure by 0.20 mmHg ?
(Assume dilute solution is being formed)
Given : Vapour pressure of pure water is 54.2 mmHg at room temperature. Molar mass of glucose is $180 gmol^{-1}$
[11-Apr-2023 shift 2]

Options:

A. 2.59g

B. 3.59g

C. 3.69g

D. 4.69g

Answer: C

Solution:

$$\frac{P^0 - P_s}{P^0} = \frac{n}{N} \text{ (for dilute solution)}$$
$$\frac{0.2}{54.2} = \frac{n \times 18}{100}$$
$$n = \frac{100}{271 \times 18}$$
$$w = \frac{100 \times 180}{271 \times 18};\ w = 3.69g$$

Question36

80 mole percent of MgCl_2 is dissociated in aqueous solution. The vapour pressure of 1.0 molal aqueous solution of $MgCl_2$ at 38°C is ______ mmHg. (Nearest integer)
Given : Vapour pressure of water at 38°C is 50 mm Hg.
[12-Apr-2023 shift 1]

Answer: 48

Solution:

$$MgCl_2 \rightarrow Mg^{+2} + 2Cl^-$$
$$1-\alpha \quad \alpha \quad 2\alpha$$
$$i = 1 + 2\alpha (\alpha = 0.8)$$
$$i = 2.6$$
$$\frac{\Delta p}{p^\circ} = \frac{i \times n_2}{n_1}$$
$$\Delta p = 2.34$$
$$p_s = 47.66$$
$$p_s \cong 48$$

Question37

Solution of 12g of non-electrolyte (A) prepared by dissolving it in 1000 mL of water exerts the same osmotic pressure as that of 0.05M glucose solution at the same temperature. The empirical formula of A is CH_2O. The molecular mass of A is ________ g. (Nearest integer)

[13-Apr-2023 shift 1]

Answer: 240

Solution:

$$\pi_A = \pi_{\text{glucose}}$$
$$C_A RT = CRT$$
$$\frac{12 / M_A}{1} = 0.05$$
$$M_A(\text{ Molar mass of } A) = \frac{12}{0.05} = \frac{1200}{5} = 240\,\text{gm}$$

Question38

Sea water contains 29.25%NaCl and 19%$MgCl_2$ by weight of solution. The normal boiling point of the sea water is ______ °C (Nearest integer)
Assume 100% ionization for both NaCl and $MgCl_2$
Given : $K_b(H_2O) = 0.52\,K\,kg\,mol^{-1}$
Molar mass of NaCl and $MgCl_2$ is 58.5 and 95$g\,mol^{-1}$ respectivley.
[13-Apr-2023 shift 2]

Answer: 116

Solution:

$$\text{Amount of solvent } = 100 - (29.25 + 19) = 51.75g$$
$$\Delta T_b = \left[\frac{2 \times 29.25 \times 1000}{58.5 \times 51.75} + \frac{3 \times 19 \times 1000}{95 \times 51.75}\right] \times 0.52$$
$$\Delta T_b = 16.075$$
$$\Delta T_b = (T_b)_{\text{solution}} - (T_b)_{\text{solvent}}$$
$$(t)_{\text{solution}} = 100 + 16.07$$
$$= 116.07^{\circ}C$$

Question39

The vapour pressure of 30%(w / v) aqueous solution of glucose is ______ mm Hg at 25°C.
[Given : The density of 30%(w / v), aqueous solutions of glucose is $1.2\,g\,cm^{-3}$ and vapour pressure of pure water is 24 mm Hg.]

(Molar mass of glucose is 180gmol^{-1})
[15-Apr-2023 shift 1]

Answer: 23

Solution:

$$\frac{24 - P_s}{P_s} = \frac{m \times 18}{1000}$$

wt of solute $= 30\,\text{gm}$
Volume of solution $= 100\,\text{mL}$
wt. of solution $= 1.2 \times 100 = 120\,\text{gm}$
wt. of solvent $= 120 - 30 = 90\,\text{gm}$

$$m\ \frac{30 \times 1000}{180 \times 90} = 185$$

$$\frac{24 - P_s}{P_s} = \frac{1.85 \times 18}{1000}$$

$$24 - P_s = 0.0333 P_s$$

$$P_s(1.033) = 24$$

$$P_s = 23.22$$

Question40

The osmotic pressure of blood is 7.47 bar at 300K. To inject glucose to a patient intravenously, it has to be isotonic with blood. The concentration of glucose solution in gL^{-1} is
(Molar mass of glucose $= 180 \text{gmol}^{-1}$, $R = 0.083 \text{Lbar}^{-1}\text{mol}^{-1}$)
_____(Nearest integer)
[24-Jun-2022-Shift-1]

Answer: 54

Solution:

$7.47 = C \times 0.083 \times 300$
$(\pi = CRT)$
(Where C represents the concentration of glucose solution and π represents osmotic pressure)

$$C = \frac{7.47}{0.083 \times 300}(\text{mol}\,\text{L}^{-1})$$

$$\text{which in gm / L} = \frac{7.47}{0.083 \times 300} \times 180$$

$$= 54\,\text{gm} / 1$$

Question41

A company dissolves ' x ' amount of CO_2 at 298K in 1 litre of water to prepare soda water. X = ______ $\times 10^{-3}$g. (nearest integer)
(Given : partial pressure of CO_2 at 298K = 0.835 bar.
Henry's law constant for CO_2 at 298K = 1.67 kbar.
Atomic mass of H, C and O is 1,12 , and 6gmol^{-1}, respectively)
[24-Jun-2022-Shift-2]

Answer: 1221

Solution:

According to Henry's law, partial pressure of a gas is given by
$P_g = (K_H)X_g$
where X_g is mole fraction of gas in solution
$0.835 = 1.67 \times 10^3 \left(X_{CO_2}\right)$
$X_{CO_2} = 5 \times 10^{-4}$
Mass of CO_2 in 1L water $= 1221 \times 10^{-3}$g

Question42

1L aqueous solution of H_2SO_4 contains 0.02m mol H_2SO_4.50% of this solution is diluted with deionized water to give 1L solution (A). In solution (A), 0.01m mol of H_2SO_4 are added. Total m mols of H_2SO_4 in the final solution is ____$\times 10^3$m mols
[25-Jun-2022-Shift-1]

Answer: 0

Solution:

$n_{H_2SO_4}$ in Sol^{n}A = 50% of original solution $= 0.01\text{m mol}$
$n_{H_2SO_4}$ in Final solution $= 0.01 + 0.01$
$= 0.02\text{m mol}$
$= 0.00002 \times 10^3\text{m mol}$
The answer 0

Question43

Solute A associates in water. When 0.7g of solute A is dissolved in 42.0g of water, it depresses the freezing point by 0.2°C. The percentage association of solute A in water, is :
[Given : Molar mass of A = $93 \mathrm{gmol}^{-1}$. Molal depression constant of water is $1.86 \mathrm{K\,kg\,mol}^{-1}$.]
[25-Jun-2022-Shift-2]

Options:

A. 50%

B. 60%

C. 70%

D. 80%

Answer: D

Solution:

$\Delta T = ik_f \times m$

$0.2 = i \times 1.86 \times \frac{0.7}{93} \times \frac{1000}{42}$

$i = \frac{0.2 \times 93 \times 6}{1.86 \times 100}$

$i = 0.60$

$2A \rightleftharpoons A_2$

$1 - \alpha \quad \frac{\alpha}{2}$

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

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

$1 - \frac{\alpha}{2} = 0.60$

$1 - 0.60 = \frac{\alpha}{2}$

$\alpha = 0.80$

Question44

A 0.5 percent solution of potassium chloride was found to freeze at −0.24°C. The percentage dissociation of potassium chloride is____ (Nearest integer)
(Molal depression constant for water is $1.80 \mathrm{K\,kg\,mol}^{-1}$ and molar mass of KCl is $74.6 \mathrm{gmol}^{-1}$)
[26-Jun-2022-Shift-1]

Answer: 98

Solution:

$$\Delta T_f = iK_b m$$
$$i = \frac{0.24 \times 99.5 \times 74.6}{1.80 \times 0.5 \times 1000}$$
$$= 1.98$$
$$\alpha = \frac{i - 1}{n - 1} = \frac{0.98}{1} = 0.98 = 98\%$$

Question45

The osmotic pressure exerted by a solution prepared by dissolving 2.0g of protein of molar mass $60\,\mathrm{kg\,mol^{-1}}$ in $200\mathrm{mL^{m}}$ of water at 27°C is ______ Pa. [integer value] (use $R = 0.083\mathrm{L_{bar}\ mol^{-1}K^{-1}}$)
[26-Jun-2022-Shift-2]

Answer: 415

Solution:

$$\pi = iCRT$$
$$= \frac{1 \times 2}{60000 \times 0.2} \times 0.083 \times 300$$
$$= 0.00415 \text{ bar} \quad (\because 1.\text{ bar}. = 10^5\,\text{Pa})$$
$$\text{So, } 0.00415 \times 10^5\,\text{Pa} = 415\,\text{Pa}$$

Question46

Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : At 10°C, the density of a 5M solution of KCl [atomic masses of K & Cl are 39&35.5$\mathrm{gmol^{-1}}$ respectively], is ' x ' $\mathrm{gml^{-1}}$. The solution is cooled to −21°C. The molality of the solution will remain unchanged.
Reason (R): The molality of a solution does not change with temperature as mass remains unaffected with temperature.
In the light of the above statements, choose the correct answer from the options given below :
[27-Jun-2022-Shift-1]

Options:

A. Both (A) and (R) are true and (R) is the correct explanation of (A).

B. Both (A) and (R) are true but (R) is not the correct explanation of (A).

C. (A) is true but (R) is false.

D. (A) is false but (R) is true.

Answer: A

Solution:

Molality and Mass are temperature Independent so on changing temp., molality and mass remain unchanged.

Question47

2g of a non-volatile non-electrolyte solute is dissolved in 200g of two different solvents A and B whose ebullioscopic constants are in the ratio of 1 : 8. The elevation in boiling points of A and B are in the ratio $\frac{x}{y}$(x : y). The value of y is_____ (Nearest integer)
[27-Jun-2022-Shift-1]

Answer: 8

Solution:

$$\Delta T\,b = kbm$$
$$\frac{(\Delta T_{\,b})_A}{(\Delta T_{\,b})_B} = \frac{(k_b)_A}{(k_b)_B}$$
$$= \frac{1}{8} = \frac{x}{y}$$
$$\therefore y = 8$$

Question48

A solution containing 2.5×10^{-3} kg of a solute dissolved in 75×10^{-3} kg of water boils at 373.535K. The molar mass of the solute is _____ $\mathrm{g\,mol^{-1}}$. [nearest integer] (Given : $K_b(H_2O) = 0.52\,\mathrm{K\,kg\,mol^{-1}}$ and boiling point of water = 373.15K)
[27-Jun-2022-Shift-2]

Answer: 45

Solution:

$$W_{\text{solute}} = 2.5 \times 10^{-3}\,\text{kg}$$
$$W_{\text{solvent}} = 75 \times 10^{-3}\,\text{kg}$$
$$\Delta T_b = 373.535 - 373.15$$
$$= 0.385\text{K}$$
$$K_b(H_2O) = 0.52\,\text{K kg mol}^{-1}$$
$$\Delta T_b = \frac{K_b \times 10^3 \times W_{\text{solute}}}{M_{\text{solute}} \times W_{\text{solvent}}}$$
$$M_{\text{solute}} = \frac{0.52 \times 10^3 \times 2.5 \times 10^{-3}}{75 \times 10^{-3} \times 0.385}$$
$$= 45.02$$
$$\approx 45$$

Question49

The vapour pressures of two volatile liquids A and B at 25°C are 50 Torr and 100 Torr, respectively. If the liquid mixture contains 0.3 mole fraction of A, then the mole fraction of liquid B in the vapour phase is $\frac{x}{17}$. The value of x is___
[28-Jun-2022-Shift-1]

Answer: 14

Solution:

$$\frac{y_B}{1 - y_B} = \frac{P_B{}^{o}}{P_A{}^{o}}\left[\frac{X_B}{1 - X_B}\right]$$
$$\Rightarrow \frac{y_B}{1 - y_B} = \frac{100}{50}\left[\frac{0.7}{0.3}\right] = \frac{14}{3}$$
$$\Rightarrow y_B = \frac{14}{17}$$

Question50

1.2 mL of acetic acid is dissolved in water to make 2.0L of solution. The depression in freezing point observed for this strength of acid is 0.0198°C. The percentage of dissociation of the acid is_____ (Nearest integer)
[Given : Density of acetic acid is $1.02\,\text{g mL}^{-1}$, Molar mass of acetic acid is $60\,\text{g mol}^{-1}$, $K_f(H_2O) = 1.85\,\text{K kg mol}^{-1}$]

[29-Jun-2022-Shift-1]

Answer: 5

Solution:

$\mathrm{M = d \times V = 1.02 \times 1.2 = 1.224\,gm}$
Moles of acetic acid $= 0.0204$ moles in 2L
So molality $= 0.0102\,\mathrm{mol / kg}$
Now $\Delta T_f = i \times K_f \times M$
$i = 1 + \alpha$ for acetic acid
$0.0198 = (1 + \alpha) \times 1.85 \times 0.0102$
$\alpha = 0.04928$
$\cong 5\%$

Question51

Elevation in boiling point for 1.5 molal solution of glucose in water is 4K. The depression in freezing point for 4.5 molal solution of glucose in water is 4K. The ratio of molal elevation constant to molal depression constant (K_b / K_f) is____

[29-Jun-2022-Shift-2]

Answer: 3

Solution:

$\Delta T_b = iK_b m$
$\Delta T_f = iK_f m$

$$\frac{4}{4} = \frac{K_b 1.5}{K_f 4.5}$$

$$\frac{K_b}{K_f} = 3$$

Question52

The depression in freezing point observed for a formic acid solution of concentration $0.5\mathrm{mLL}^{-1}$ is $0.0405^{\circ}\mathrm{C}$. Density of formic acid is $1.05\mathrm{gmL}^{-1}$. The Van't Hoff factor of the formic acid solution is nearly : (Given for water $k_f = 1.86\mathrm{kkgmol}^{-1}$)

[25-Jul-2022-Shift-1]

Options:

A. 0.8

B. 1.1

C. 1.9

D. 2.4

Answer: C

Solution:

Solution:

ΔT_f of formic acid $= 0.0405^\circ C$
Concentration $= 0.5\,mL / L$
and density $= 1.05g / mL$
$\therefore$ Mass of formic acid in solution $= 1.05 \times 0.5g$
$= 0.525g$
$\therefore$ According to Van't Hoff equation,
$\Delta T_f = ik_f \cdot m$

$$0.0405 = i \times 1.86 \times \frac{0.525}{46 \times 1}$$

(Assuming mass of 1L water $= kg$)

$$i = \frac{0.0405 \times 46}{1.86 \times 0.525} = 1.89 \approx 1.9$$

Question53

Two solutions A and B are prepared by dissolving 1g of non-volatile solutes X and Y, respectively in 1 kg of water. The ratio of depression in freezing points for A and B is found to be 1 : 4. The ratio of molar masses of X and Y is

[25-Jul-2022-Shift-2]

Options:

A. 1 : 4

B. 1 : 0.25

C. 1 : 0.20

D. 1 : 5

Answer: B

Solution:

Solution:

$\Delta T_f = ik_f \times m$

$$\frac{\Delta T_{f(A)}}{\Delta T_{f(B)}} = \frac{1}{4}$$

$$\frac{i \times K_f \times \frac{1}{M_A} \times 1}{i \times K_f \times \frac{1}{M_B} \times 1} = \frac{1}{4}$$

$$\frac{M_B}{M_A} = \frac{1}{4}$$

$M_A : M_B = 4 : 1$

Question54

The elevation in boiling point for 1 molal solution of non-volatile solute A is 3K. The depression in freezing point for 2 molal solution of A in the same solvent is 6K. The ratio of K_b and K_f i.e., K_b / K_f is 1 : X. The value of X is [nearest integer]
[26-Jul-2022-Shift-2]

Answer: 1

Solution:

Molality of a solution of non volatile solute (A) = 1
Elevation in boiling point is given by
$\Delta T_b = K_b m$
$3 = K_b \times 1$
Molality of (A) in the same solvent = 2
Depression in freezing point is given by
$\Delta T_f = K_f m$
$6 = K_f \times 2 \; \ldots (2)$
Dividing (1) by (2)

$$\frac{K_b}{K_f} = \frac{1}{X} = \frac{1}{1}$$

$\therefore \; X = 1$

Question55

Boiling point of a 2% aqueous solution of a non-volatile solute A is equal to the boiling point of 8% aqueous solution of a non-volatile solute B. The relation between molecular weights of A and B is
[27-Jul-2022-Shift-1]

Options:

A. $M_A = 4M_B$

B. $M_B = 4M_A$

C. $M_A = 8M_B$

D. $M_B = 8M_A$

Answer: B

Solution:

For A : 100 gm solution →2 gm solute A

$$\therefore \text{ Molality } = \frac{2 / M_A}{0.098}$$

For B : 100 gm solution →8 gm solute B

$$\therefore \text{ Molality } = \frac{8 / M_B}{0.092}$$

$$\because (\Delta T_B)_A = (\Delta T_B)_B$$

∴ Molality of A = Molality of B

$$\therefore \frac{2}{0.098M_A} = \frac{8}{0.092M_B}$$

$$\frac{2}{98} \times \frac{92}{8} = \frac{M_A}{M_B}$$

$$\frac{1}{4.261} = \frac{M_A}{M_B}$$

$$\therefore M_B = 4.261 \times M_A$$

Question56

When a certain amount of solid A is dissolved in 100g of water at 25°C to make a dilute solution, the vapour pressure of the solution is reduced to one-half of that of pure water. The vapour pressure of pure water is 23.76 mmHg. The number of moles of solute A added is _______ . (Nearest Integer)
[27-Jul-2022-Shift-2]

Answer: 5.55

Solution:

∵ Diliute solution given:

$$\frac{P^0 - P_S}{P^0} \sim \frac{{}^{n}\ \text{solute}}{{}^{n}\ \text{solvent}}$$

$$\frac{P^0 - P^0 / 2}{P^0} = \frac{{}^{n}\ \text{solute}}{{}^{n}\ \text{solvent}}$$

$${}^{n}\ \text{Solute} \sim \frac{{}^{n}\ \text{solvent}}{2} = \frac{100}{18 \times 2} = 2.78\,\text{mol}$$

More accurate approach:

$$\frac{P^0 - P_S}{P_S} = \frac{{}^{n}\ \text{Solute}}{{}^{n}\ \text{solvent}}$$

$$\frac{P^0 - P^0 / 2}{P^0 / 2} = \frac{{}^{n}\ \text{solute}}{{}^{n}\ \text{solvent}}$$

$${}^{n}\ \text{Solute} = {}^{n}\ \text{solvent} = \frac{100}{18} = 5.55\,\text{mol}$$

Question57

150g of acetic acid was contaminated with 10.2g ascorbic acid ($C_6H_8O_6$) to lower down its freezing point by ($x \times 10^{-1}$)°C. The value of x is ______. (Nearest integer)
[Given $K_f = 3.9 K\,kg\,mol^{-1}$; molar mass of ascorbic acid . = $176 g mol^{-1}$]
[28-Jul-2022-Shift-1]

Answer: 15

Solution:

M.wt. of Acetic acid = 60g
M.wt. of Ascorbic acid = 176g

$$\Delta T_f = K_f m$$

$$\Delta T_f = \frac{3.9 \times 10.2 \times 1000}{176 \times 150}$$

$$\Delta T_f = 1.506$$

$$= 15.06 \times 10^{-1}$$

$$= 15$$

Question58

A gaseous mixture of two substances A and B, under a total pressure of 0.8 atm is in equilibrium with an ideal liquid solution. The mole fraction of substance A is 0.5 in the vapour phase and 0.2 in the liquid phase. The vapour pressure of pure liquid A is atm. (Nearest integer)
[28-Jul-2022-Shift-2]

Answer: 2

Solution:

Given that $X_A = 0.2$, $Y_A = 0.5$, $P_T = 0.8$ atm
We know that $P_A = Y_A \times P_T$

$$P_A = 0.5 \times 0.8 = 0.4$$

Now $P_A = X_A \times P_A^\circ \Rightarrow P_A^\circ = \frac{0.4}{0.2} = 2$ atm

---

Question59

If O_2 gas is bubbled through water at 303K, the number of millimoles of O_2 gas that dissolve in 1 litre of water is _______. (Nearest Integer)
(Given : Henry's Law constant for O_2 at 303K is 46.82k bar and partial pressure of O_2 = 0.920 bar)
(Assume solubility of O_2 in water is too small, nearly negligible)
[29-Jul-2022-Shift-1]

Answer: 1

Solution:

$$P = K_H \times X$$

$$0.920\,\text{bar} = 46.82 \times 10^3\,\text{bar} \times \frac{\text{mol of}_2}{\text{mol of}_2\,\text{O}}$$

$$0.920 = 46.82 \times 10^3 \times \frac{\text{mol of}_2}{1000 / 18}$$

$$0.920 = 46.82 \times n_{O_2}$$

$$P = \frac{0.920}{46.82 \times 18} = n_{O_2}$$

$$\Rightarrow 1.09 \times 10^{-3} n_{O_2}$$

$$\Rightarrow \text{m mol of } O_2 = 1$$

Question60

'x' g of molecular oxygen (O_2) is mixed with 200g of neon (Ne). The total pressure of the nonreactive mixture of O_2 and Ne in the cylinder is 25 bar. The partial pressure of Ne is 20 bar at the same temperature and volume. The value of ' x ' is. _______.
[Given: Molar mass of $O_2 - 32g^{mol} mol^{-1}$.
Molar mass of .Ne = $20gmol^{-1}$]
[29-Jul-2022-Shift-2]

Answer: 80

Solution:

$$O_2 + N\,e$$
$$\text{Xgm}\ 200\text{gm}$$

$P_{total} = 25\ \text{bar}\ ;\ P_{Ne} = 20$

$P_{O_2} + P_{Ne} = 25$

$P_{O_2} = 25 - 20 = 5\ \text{bar}$

$$5 = \frac{\frac{x}{32}}{\frac{x}{32} + \frac{200}{20}} \times 25$$

$$\frac{1}{5} = \frac{\frac{x}{32}}{\frac{x}{32} + 10}$$

$$\frac{1}{5} = \frac{x \times 32}{32(x + 320)}$$

$5x = x + 320$

$4x = 320$

$$x = \frac{320}{4} = 80\,\text{gm}$$

Question61

1.80g of solute A was dissolved in 62.5cm^{3} of ethanol and freezing point of the solution was found to be 155.1K. The molar mass of solute A is $g\,mol-1$ ______.
[Given : Freezing point of ethanol is 156.0K.
Density of ethanol is 0.80gcm^{-3}.
Freezing point depression constant of ethanol is 2.00$K\,kg\,mol^{-1}$]
[29-Jul-2022-Shift-2]

Answer: 80

Solution:

Solution:

Mass of solvent $= d\,x v = 0.8 \times 62.5 = 50\,\text{gram}$

$\Delta T_f = k_f \times m$

$$0.9 = 2\left[\frac{1.8 \times 1000}{M_{Solute} \times 50}\right]$$

$$M_{Solute} = \left(\frac{2 \times 1.8 \times 1000}{0.9 \times 50}\right) = 80$$

Question62

C_6H_6 freezes at 5.5°C. The temperature at which a solution 10g of C_4H_{10} in 200g of C_6H_6 freeze is .... $^\circ$C. (The molal freezing point depression constant of C_6H_6 is 5.12°C / m.)
[24 Feb 2021 Shift 2]

Answer: 1

Solution:

Pure solvent : $C_6H_6(l)$
Given, $T_f^{\circ} = 5.5^{\circ}C$
$K_f = 5.12^{\circ}C / m \Rightarrow m = 200g$
$m_{solute} = 10g$
Molar mass of solute $C_4H_{10} = 12 \times 4 + 10 = 58$
Solute (C_4H_{10}) is non-dissociative;
$\therefore i = 1$
$\therefore \Delta T_f = iK_f m$

$$\Rightarrow (T_f^{\circ} - T_f^{1}) = 1 \times 5.12 \times \frac{(10 / 58)}{(200 / 1000)}$$

$5.5 - T_f^{1} = 5.12 \times 5 \times 10$
58
or $T_f^{1} \approx 1^{\circ}C$

Question63

When 12.2g of benzoic acid is dissolved in 100g of water, the freezing point of solution was found to be $-0.93^{\circ}C(K_f(H_2O) = 1.86K\,kg\,mol^{-1})$. The number (n) of benzoic acid molecules associated (assuming 100% association) is ....
[26 Feb 2021 Shift 2]

Answer: 2

Solution:

$$\underset{\text{Benzoic acid}}{nPhCOOH} \xrightarrow{\text{Association}} (PhCOOH)_n$$

Assuming 100% association ($\alpha = 1$),

$$\Rightarrow i = 1 - \alpha\left(1 - \frac{1}{n}\right) = \frac{1}{n}[\because \alpha + 1]$$

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

$$0 - (0.93) = 1.86 \times \frac{w_B \times 1000}{w_A \times M_B} \times \frac{1}{n}$$

[$\because w_B =$ mass of PhCOOH $= 12.2g$
$w_A =$ mass of $H_2O = 100g$
$M_B =$ molar mass of PhCOOH]
$= 122 gmol^{-1}$

$$= 186 \times \frac{12.2 \times 1000}{100 \times 122} \times \frac{1}{n}$$

$$\Rightarrow n = \frac{1.86 \times 12.2 \times 1000}{0.93 \times 100 \times 122} = 2$$

$\therefore$ Number of benzoic acid molecules associated, $n = 2$

Question64

If a compound AB dissociates to the extent of 75% in an aqueous solution, the molality of the solution which shows a 2.5K rise in the boiling point of the solution is .... molal. (Rounded off to the nearest integer) [$K_b = 0.52\,K\,kg\,mol^{-1}$]

[25 Feb 2021 Shift 2]

Answer: 3

Solution:

As AB is a binary electrolyte,

$\therefore\ AB \rightleftharpoons A^+ + B^-,\ n = 2$

$$i = 1 + \alpha(n-1) = 1 + \frac{75}{100}(2-1) = 1.75$$

Given, $\Delta T_b = 2.5K$

$K_b = 0.52\,K\,kg\,mol^{-1}$

$\Delta T_b = K_b \times m \times i$

$$m = \frac{\Delta T_b}{K_b \times i} = \frac{2.5}{0.52 \times 1.75}$$

$\therefore\ = 2.74 \sim 3\,mol\ /\ kg$

Question65

1 molal aqueous solution of an electrolyte A_2B_3 is 60% ionised. The boiling point of the solution at 1atm is .... K (Rounded off to the nearest integer). [Given, K_b for $(H_2O) = 0.52\,K\,kg\,mol^{-1}$]

[25 Feb 2021 Shift 1]

Answer: 375

Solution:

Given, $K_b(H_2O) = 0.52\,K\,kg\,mol^{-1}$

$A_2B_3 \longrightarrow 2A^{+3} + 3B^{-2}$

No. of ions, $n = 5$, concentration, $m = 1$ molal (Given)

$$\alpha = \frac{60}{100} = 0.6$$

$\Delta T_b = i \cdot K_f \cdot m$

$= [(1 + (n-1)\alpha] \times K_f \times m$

$\Delta T_b = [(1 + (5-1)0.6] \times 0.52 \times 1$

$= (1 + 2.4) \times 0.52$
$\Delta T_b = 1.768$
$T_b = 1.768 + 373.15$
$= 374.91 = 375K$

Question66

When 9.45g of $ClCH_2COOH$ is added to 500 mL of water, its freezing point drops by 0.5°C. The dissociation constant of $ClCH_2COOH$ is $x \times 10^{-3}$. The value of x is_____ (Rounded off to the nearest integer) $\left[K_{f(H_2O)} = 1.86K\,kg\,mol^{-1}\right]$

[24 Feb 2021 Shift 1]

Answer: 35

Solution:

Solution:

$ClCH_2COOH \rightleftharpoons ClCH_2COO^- + H^+$
Total dissociated $= 1 + \alpha$
$\Rightarrow i = 1 + \alpha$
$\Delta T_f = ik_1m$
$\Rightarrow 0.5 = (1 + \alpha)(1.86) \times \frac{9.45}{94.5} \times \frac{1000}{500}$
$\Rightarrow 0.5 = (1 + \alpha)(1.86)(0.2)$
$\Rightarrow 1 + \alpha = 1.34 \Rightarrow \alpha = 0.34$
$ClCH_2COOH \rightleftharpoons ClCH_2COO^- + H^+$

$$\begin{array}{llll} \text{At } t = 0 & \alpha & 0 & 0 \\ \text{At time } t & C - C\alpha & C\alpha & C\alpha \end{array}$$

$K_a = \frac{(C\alpha)^2}{C - C\alpha} = \frac{C\alpha^2}{1 - \alpha}$
$\Rightarrow K_a = \frac{0.2 \times (0.34)^2}{1 - 0.34} = 0.035$
$\therefore K_a = 35 \times 10^{-3}$.

Question67

A solute a dimerises in water. The boiling point of a 2 molar solution of A is 100.52°C.
The percentage association of A is (Round off to the nearest integer)
[Use : K_b for water $= 0.52K\,kg\,mol^{-1}$, boiling point of water $= 100^\circ C$]

[18 Mar 2021 Shift 2]

Answer: 100

Solution:

Given : $T_b = 100.52^\circ C$
$T_b^\circ = 100^\circ C$
$\Rightarrow K_b = 0.52 K\,kgmol^{-1}$
Elevation in boiling point,
$\Delta T_b = T_b - T_b^0$
$\Delta T_b = 100.52 - 100$
$\Delta T_b = 0.52^\circ C$
For dimerisation (van't Hoff factor) $i = \left(1 - \frac{\alpha}{2}\right)$
$\because \ \Delta T_b = i \times K_b \times m$
$0.52 = \left(1 - \frac{\alpha}{2}\right) \times 0.52 \times 2$
$\alpha = 1$
So, percentage association $= 100\%$

Question68

2 molal solution of a weak acid HA has a freezing point of $3.885^\circ C$. The degree of dissociation of this acid is .... $\times 10^{-3}$.
(Round off to the nearest integer).
[Given : Molal depression constant of water $= 1.85 K\,kgmol^{-1}$, freezing point of pure water $= 0^\circ C$]
[18 Mar 2021 Shift 1]

Answer: 50

Solution:

Given
Depression in freezing point,
$K_f \ = 1.85 K\,kgmol\,mol^{-1}$
$T_f^\circ \ = 0^\circ C$
$T_f \ = 3.885^\circ C$
$\Delta T_f \ = T_f - T_f^\circ$
$\ = 3.885 - 0 = 3.885^\circ C$
$\Delta T_f \ = 3.885^\circ C$
$\Delta T_f \ = i \times K_f \times m$
$3.885 \ = i \times 1.85 \times 2$
but, $i = (1 + \alpha)$
$3.885 = (1 + \alpha) \times 1.85 \times 2$
$\Rightarrow \ \alpha = \frac{0.185}{3.7} \Rightarrow \alpha = 0.05$
$\alpha = 50 \times 10^{-3}$

Question69

A 1 molal $K_4Fe(CN)_6$ solution has a degree of dissociation of 0.4. Its boiling point is equal to that of another solution which contains 18.1 weight per cent of a non-electrolytic solute A. The molar mass of A is ……. u. (Round off to the nearest integer).
[Density of water $= 1.0 gcm^{-3}$]
[17 Mar 2021 Shift 2]

Answer: 85

Solution:

Solution:

	$K_4Fe(CN)_6$	$\rightleftharpoons$	$4K^+$	$+$	$[Fe(CN)_6]^{4-}$
Initial conc.	$1m$		0		0
Final conc.	$(1-0.4)m$		4×0.4		$0.4m$
	$= 0.6m$		$= 1.6m$		

Effective molality $= 0.6 + 1.6 + 0.4 = 2.6m$
As elevation in boiling point is a colligative property which depends on the amount of solute. So, to have same boiling point, the molality of two solutions should be same.
Molality of non-electrolyte solution = molality of $K_4[Fe(CN)_6] = 2.6m$
Now, 18.1 weight per cent solution means $18.1g$ solute is present in $100g$ solution and hence, $(100 - 18.1 =)81.9g$ water.
Molality $= \dfrac{(\text{ Mass of solute } / \text{ Molar mass of solute})}{\text{Mass of solvent } (g)} \times 1000$
Now, $2.6 = \dfrac{18.1/M}{81.9/1000}$
where, M is the molar mass of non-electrolyte solute
Molar mass of solute, $M = 85$

Question70

The exact volumes of 1M NaOH solution required to neutralise 50mL of 1M H_3PO_3 solution and 100mL of 2M H_3PO_2 solution, respectively, are
[16 Mar 2021 Shift 2]

Options:

A. 100mL and 100mL

B. 100mL and 50mL

C. 100mL and 200mL

D. 50mL and 50mL

Answer: C

Solution:

$\underset{\underset{1M}{50\,ml}}{H_3PO_3} + \underset{\underset{V=?}{1M}}{2NaOH} \longrightarrow Na_2HPO_3 + 2H_2O$

Millimoles of $H_3PO_3 = M \times V = 1 \times 50 = 50$

For 1 millimole of H_3PO_3, we require 2 millimoles of $NaOH$.

For 50 millimole of H_3PO_3, we require $(2 \times 50) = 100$ millimoles of $NaOH$.

Millimoles of $NaOH = M \times V = 100$

$1 \times V = 100$

$V = 100mL$

$\underset{\underset{2M}{100\,mL}}{H_3PO_2} + \underset{\underset{V=?}{1M}}{NaOH} \rightarrow NaH_2PO_2 + H_2O$

Millimoles of $H_3PO_2 = M \times V = 2 \times 100 = 200$

For 1 millimole of H_3PO_2, we require 1 millimoles of $NaOH$.

For 200 millimole of H_3PO_2, we require 200 millimoles of $NaOH$.

So, volume of $NaOH = 200mL$

Question71

A 6.50 molal solution of KOH (aq) has a denisity of $1.89gcm^{-3}$. The molarity of the solution is ...... $mol\,dm^{-3}$ (Round off to the nearest integer).
[Atomic masses: K : 39.0u, O : 16.0u, H : 1.0u]
[16 Mar 2021 Shift 1]

Answer: 9

Solution:

Solution:

Molality $(m) = \dfrac{M \times 1000}{\{(1000d) - M \times M_{solute}\}}$

where, M = molarity

d = density of solution

M_{solute} = molar mass of solute

Putting the values,

$6.50 = \dfrac{M \times 1000}{(1000 \times 1.89) - (M \times 56)}$

On solving, $M = \dfrac{12285}{1364}$

M = 9 molar

Question72

At 20°C, the vapour pressure of benzene is 70 torr and that of methyl benzene is 20 torr. The mole fraction of benzene in the vapour phase at 20°C above an equimolar mixture of benzene and methyl benzene is ________ $\times 10^{-2}$. (Nearest integer)
[20 Jul 2021 Shift 1]

Answer: 78

Solution:

$P°_B = 40$
$P°_T = 20$
$K_B = 0.5 = K_T$

$$\text{Now } y_B = \frac{K_B P°_B}{K_B P°_B + K_T P°_T}$$

$$= \frac{70 \times 0.5}{70 \times 0.5 + 20 \times 0.5}$$

Question73

1.46g of a biopolymer dissolved in a 100mL water at 300K exerted an osmotic pressure of 2.42×10^{-3} bar
The molar mass of the biopolymer is _____ $-10^{4}\mathrm{gmol}^{-1}$. (Round off to the Nearest Integer)
[Use : $R = 0.083\mathrm{L\ bar\ mol}^{-1}\mathrm{K}^{-1}$]
[27 Jul 2021 Shift 1]

Answer: 15

Solution:

Solution:
$\pi = CRT$
$\pi =$ osmotic pressure
$C =$ molarity
$T =$ Temperature of solution
let the molar mass be M gm / mol
2.42×10^{-3} bar =

$$\frac{\left(\frac{1.46\mathrm{g}}{\mathrm{M\ gm/mol}}\right)}{0.1\mathrm{l}} \times \left(\frac{0.083\mathrm{l} - \mathrm{bar}}{\mathrm{mol} - \mathrm{K}}\right) \times (300\mathrm{K})$$

$\Rightarrow M = 15.02 \times 10^{4}\mathrm{g/mol}$

Question74

When 3.00g of a substance 'X′ is dissolved in 100g of CCl_4, it raises the boiling point by 0.60K. The molar mass of the substance ' X ' is ________ g mol^{-1}. (Nearest integer).
[Given K_b for CCl_4 is $5.0\mathrm{K\ kgmol}^{-1}$]
[25 Jul 2021 Shift 2]

Answer: 250

Solution:

$\Delta T_b = K_b \times \text{molality}$

$0.60 = 5 \times \left(\frac{3 / M}{100 / 100}\right)$

$M = 250$

Question75

Which one of the following 0.06M aqueous solutions has lowest freezing point?
[22 Jul 2021 Shift 2]

Options:

A. $Al_2(SO_4)_3$

B. $C_6H_{12}O_6$

C. KI

D. K_2SO_4

Answer: A

Solution:

$T_f - T_f' = iK_f m$

For minimum T_f'

'i' should be maximum.

$Al_2(SO_4)_3 \quad i = 5$

$C_6H_{12}O_6 \quad i = 1$

$KI \quad i = 2$

$K_2SO_4 \quad i = 3$

Question76

The water having more dissolved O_2 is :
[22 Jul 2021 Shift 2]

Options:

A. boiling water

B. water at 80°C

C. polluted water

D. water at 4°C

Answer: D

Solution:

Solution:
On heating concentration of O_2 in water decreases.
So boiling water and water at 80°C having less O_2 concentration. Polluted water also having less O_2 concentration. So water at 4°C having maximum O_2 concentration.

Question77

The density of NaOH solution is $1.2 \mathrm{gcm}^{-3}$. The molality of this solution is ________ m.
(Round off to the Nearest Integer)
[Use : Atomic masses : Na : 23.0u O : 16.0u H : 1.0u
Density of H_2O : $1.0 \mathrm{gcm}^{-3}$]
[27 Jul 2021 Shift 1]

Answer: 5

Solution:

Consider $1l$ solution
mass of solution $= (1.2 \times 1000) \mathrm{g}$
$= 1200 \mathrm{gm}$
Neglecting volume of $NaOH$
Mass of water $= 1000 \mathrm{gm}$
⇒ Mass of $NaOH = (1200 - 1000) \mathrm{gm}$
$= 200 \mathrm{gm}$

$$\Rightarrow \text{Moles of } NaOH = \frac{200 \mathrm{g}}{50 \mathrm{g} / \mathrm{mol}} = 5 \mathrm{mol}$$

$$\Rightarrow \text{molality} = \frac{5 \mathrm{mol}}{1 \mathrm{kg}} = 5 \mathrm{m}$$

Question78

CO_2 gas is bubbled through water during a soft drink manufacturing process at $298K$. If CO_2 exerts a partial pressure of 0.835 bar then $x \mathrm{m}$ mol of CO_2 would dissolve in 0.9L of water. The value of x is ________.
(Nearest integer)
(Henry's law constant for CO_2 at $298K$ is 1.67×10^3 bar)

[25 Jul 2021 Shift 1]

Answer: 25

Solution:

From Henry's law
$P_{gas} = K_H \cdot X_{gas}$
$0.835 = 1.67 \times 10^3 \times \frac{n(CO_2)}{\frac{0.9 \times 1000}{18}}$
$n(CO_2) = 0.025$
Millimoles of $CO_2 = 0.025 \times 1000 = 25$

Question79

The vapour pressures of A and B at 25°C are $90 \mathrm{mmHg}$ and $15 \mathrm{mmHg}$ respectively. If A and Bare mixed such that the mole fraction of A in themixture is 0.6, then the mole fraction of B in the vapour phase is $x \times 10^{-1}$. The value of x is ________.(Nearest integer)
[20 Jul 2021 Shift 2]

Answer: 1

Solution:

Given $P°_A = 90 \mathrm{mmHg}$
, at 25°C
$P°_B = 15 \mathrm{mm\,Hg}$

and $\left.\begin{array}{l} X_A = 0.6 \\ X_B = 0.4 \end{array}\right\} \; P_T = X_A P°_A + X_B P_B°$
$= (0.6 \times 90) + (0.4 \times 15)$
$= 54 + 6 = 60 \mathrm{mm}$
Now mol fraction of B in the vapour phase
i.e. $Y_B = \frac{P_B}{P_T} = \frac{X_B P°_B}{60} = 0.1 = 1 \times 10^{-1}$
therefore: $x = 1$

Question80

40g of glucose (Molar mass $= 180$) is mixed with $200 \mathrm{~mL}$ of water. The freezing point of solution is .... K. (Nearest integer)

[Given, $K_f = 1.86 \mathrm{K\,kg\,mol^{-1}}$, density of water $= 1.00 \mathrm{gcm^{-3}}$, freezing point of water $= 273.15\mathrm{K}$]
[27 Aug 2021 Shift 2]

Answer: 271

Solution:

40 g of glucose mixed with 200 mL of water
180 g of glucose = 1 moles of glucose
40 g of glucose mol = 0.22 mol
1 mL of water $= 1\mathrm{g}$ of water $[\mathrm{d} = 1\mathrm{g} / \mathrm{cm}^2, 1\,\mathrm{mL} = 1\mathrm{cm}^3]$
200 mL of water $= 200\mathrm{g}$ of water
$\Delta T_f = K_f\, m$
where, $\Delta T_f =$ depression in freezing point,
$K_f =$ molal elevation constant $= 1.86\,\mathrm{Kkg\,mol^{-1}}$ and
m = molality of solution

$$\Delta T_f = \frac{1.86 \times 0.22}{200} \times 1000, (\because 1000\mathrm{g} = 1\,\mathrm{kg})$$

$\Delta T_f = 2\mathrm{K}$

$$\therefore (T_f - T_f') = 2 \left[\begin{array}{c} T_f = \text{freezing point of water}(273\mathrm{K}) \\ T_f' = \text{freezing point of solution} \end{array} \right]$$

$273\mathrm{K} - T_f' = 2\mathrm{K}$
$T_f' = (273 - 2)\mathrm{K} = 271\mathrm{K}$

Question81

1 kg of 0.75 molar aqueous solution of sucrose can be cooled up to −4°C before freezing. The amount of ice (in g) that will be separated out is .... (Nearest integer)
[Given, $K_f(H_2O) = 1.86\,\mathrm{Kkg\,mol^{-1}}$]
[27 Aug 2021 Shift 1]

Answer: 518

Solution:

Let mass of water (initially present) = x g
Mass of sucrose $= (1000 - \mathrm{x})\mathrm{g}$

$$\text{Moles of sucrose} = \frac{1000 - \mathrm{x}}{342}$$

$$\text{Molality} = \frac{\text{moles of sucrose}}{\text{mass of water(initially)}}$$

$$0.75 = \frac{\left(\frac{1000 - x}{342}\right)}{\left(\frac{x}{1000}\right)}$$

$\frac{x}{1000} = \frac{1000 - x}{342 \times 0.75}$

$256.5x = 10^6 - 1000x$

$\Rightarrow x = 795.86$ g

Moles of sucrose = 0.5969

New mass of $H_2O = a\,kg$

Depression in freezing point $\Delta T_f = K_f \times m$

$4 = \frac{0.5969}{a} \times 1.86$

$\Rightarrow a = 0.2775$ kg

Ice separated $= 795.86 - 277.5$

$= 518.3$ g ≈ 518 g.

Question82

If the degree of dissociation of aqueous solution of weak monobasic acid is determined to be 0.3 , then the observed freezing point will be ________ % higher than the expected/theoretical freezing point. (Nearest integer) [27 Aug 2021 Shift 1]

Answer: 30

Solution:

For mono basic acid $\rightarrow n = 2$

$i = 1 + (n-1)\alpha = 1 + (2-1)0.3$

$i = 1.3$

$$\%\ \text{increase} = \frac{(\Delta T_f)_{obs} - (\Delta T_f)_{cal}}{(\Delta T_f)_{cal}} \times 100$$

$$= \frac{K_f \times i \times m - K_f \times m}{K_f \times m} \times 100$$

$$= \frac{i-1}{1} \times 100 = 30\%$$

Question83

1.22g of an organic acid is separately dissolved in 100g of benzene ($K_b = 2.6\,K\,kg\,mol^{-1}$) and 100g of acetone ($K_b = 1.7\,Kkg\,mol^{-1}$). The acid is known to dimerise in benzene but remain as a monomer in acetone. The boiling point of the solution in acetone increases by 0.17°C. The increase in boiling point of solution in benzene in °C is $x \times 10^{-2}$. The value of x is....... (Nearest integer)

[Atomic mass: C = 12.0, H = 1.0, O = 16.0]
[31 Aug 2021 Shift 2]

Answer: 13

Solution:

With benzene as solvent, RCOOH dimerises.
$2\,\mathrm{RCOOH} \rightleftharpoons (\mathrm{RCOOH})_2$
$\therefore i = \frac{1}{2}$
$\Delta T_b = i \times K_b \times m$
where, $\Delta T_b =$ boiling point elevation,
$K_b =$ ebulliscopic constant
m = molality
i = van’t Hoff factor
$\Delta T_b = \frac{1}{2} \times 2.6 \times \frac{1.22 / M_W}{100 / 1000}$ ...(i)
With acetone as solvent, no dimerisation.
$\therefore$ i = 1
$\Delta T_b = i \times K_b \times m$
$0.17 = 1 \times 1.7 \times \frac{1.22 / M_W}{100 / 1000}$ ...(ii)
Eq. (i) divide by Eq. (ii),

$$\frac{\Delta T_b}{0.17} = \frac{\frac{1}{2} \times 2.6 \times \frac{1.22 / M_w}{100 / 1000}}{1 \times 1.7 \times \frac{1.22 / M_w}{100 / 1000}}$$

$\Rightarrow \Delta T_b = \frac{0.26}{2} = 13 \times 10^{-2}$
x = 13

Question84

Which one of the following 0.10M aqueous solutions will exhibit the largest freezing point depression?
[31 Aug 2021 Shift 1]

Options:

A. Hydrazine

B. Glucose

C. Glycine

D. $KHSO_4$

Answer: D

Solution:

The van't Hoff factor (i) is highest for $\mathrm{KHSO_4}$ as it dissociate into its ions. van’t Hoff factor is the ratio of total number of ions produced after complete dissociation to before dissociation. Hydrazine, glucose and glycine will not dissociate to produce ions.
Whereas, $\mathrm{KHSO_4}$ dissociates into ions.
$\mathrm{KHSO_4 \rightarrow K^+ + HSO_4^-}$
Hence, i will highest for $\mathrm{KHSO_4}$.
∴ Colligative property i.e. freezing point depression will be highest for $\mathrm{KHSO_4}$ as $\Delta T_f \propto i$ [∵ m is constant i.e. 0.1]
Hence, correct option is (d).

Question85

In a solvent 50% of an acid HA dimerizes and the rest dissociates. The van't Hoff factor of the acid is _____ $\times 10^{-2}$.
(Round off to the nearest integer)
[27 Jul 2021 Shift 2]

Answer: 125

Solution:

Solution:

	$2HA$	$\rightleftharpoons$	H_2A_2	HA	$\rightleftharpoons$	H^+	$+$	A
Initial moles	$a \times \frac{50}{100}$		0	$a \times \frac{50}{100}$		0		0
Final moles	0		$0.25a$	0		$0.5a$		$0.5a$

Now, $i = \frac{\text{final moles}}{\text{initial moles}} = \frac{0.25a + 0.5a + 0.5a}{0.5a + 0.5a}$
$= 1.25 = 125 \times 10^{-2}$

Question86

83g of ethylene glycol dissolved in 625g of water. The freezing point of the solution is ....K. (Nearest integer)
[Use, molal freezing point depression constant of water $= 1.86\,\mathrm{K\,kg\,mol^{-1}}$, Freezing point of water $= 273\mathrm{K}$ and Atomic masses : $\mathrm{C} = 12.0\mathrm{u}$, $\mathrm{O} = 16.0\mathrm{u}$, $\mathrm{H} = 1.0\mathrm{u}$]
[26 Aug 2021 Shift 2]

Answer: 269

Solution:

$\Delta T_f = iK_f \times m$
For ethylene glycol, $i = 1$
Molality $(m) = \frac{\text{Number of moles of solute}}{\text{Weight of solvent(kg)}}$
$\Delta T_f = 1 \times 1.86 \times \frac{83 \times 1000}{62 \times 625} \simeq 3.98$
Freezing point of solution = Freezing point $-\Delta T_f$ of water
$= 273 - 3.98 \simeq 269.$

Question87

Of the following four aqueous solutions, total number of those solutions whose freezing point is lower than that of 0.10M C_2H_5OH is .... (Integer answer)
(i) $0.10 M Ba_3(PO_4)_2$
(ii) $0.10 M Na_2SO_4$
(iii) $0.10 M$ KCl
(iv) $0.10 M Li_3PO_4$
[26 Aug 2021 Shift 1]

Answer: 4

Solution:

Solution:
As $0.10 M C_2H_5OH$ is non-dissociative in nature and all salts
[$0.10 M Ba_3(PO_4)_2$, $0.10 M Na_2SO_4$,
$0.10 M$ KCl, $0.10 M Li_3PO_4$] are electrolyte and dissociative in nature.
$\Delta T_f = iK_f m$
Where i is van't Hoff factor.
i > 1 for all other electrolytes where dissociation takes place.
So, for all these electrolytes effective molarity is more than 0.10. So, all the elecrolytes given will have low freezing point.

Question88

The molarity of the solution prepared by dissolving 6.3g of oxalic acid ($H_2C_2O_4.2H_2O$) in 250 mL of water in mol L^{-1} is $x \times 10^{-2}$. The value of x is .... (Nearest integer)
[Atomic mass H = 1.0, C = 12.0, O = 16.0]
[31 Aug 2021 Shift 1]

Answer: 20

Solution:

$$\text{Molarity} = \frac{\text{number of moles of solute}}{\text{volume of solution(in litre)}}$$
$$= \frac{\text{weight of solute / molecular mass of solute}}{\text{volume of solution(in litre)}}$$
Molecular mass of solute $[H_2C_2O_4.2H_2O] = 126g$
$$x \times 10^{-2} = \frac{6.3g / 126g}{250\,mL} \times 1000$$
$x \times 10^{-2} = 0.2$
$x \times 10^{-2} = 20 \times 10^{-2}$
$\therefore x = 20$

Question89

100 mL of Na_3PO_4 solution contains 3.45g of sodium. The molarity of the solution is ...... $\times 10^{-2}\,mol\,L^{-1}$. (Nearest integer)
[Atomic masses −Na = 23.0u, O = 16.0u,, P = 31.0u]
[26 Aug 2021 Shift 2]

Answer: 50

Solution:

Solution:
Number of mole of Na^{+}ions
$$= \frac{\text{mass of sodium}}{\text{molar mass of sodium}} = \frac{3.45}{23}$$
So, number of mole of $Na_3PO_4 = \frac{\text{moles of sodium}}{3}$
{as 1 molecule of Na_3PO_4 contains 3 atoms of Na }
$$= \frac{3.45}{3 \times 23} = 0.05$$
$$\text{Molarity} = \frac{\text{Moles of } Na_3PO_4}{\text{Volume of solution(in L)}} = \frac{0.05}{100} \times 1000$$
∴ Answer is 50

Question90

If 80g of copper sulphate $CuSO_4.5H_2O$. is dissolved in deionised water to make 5L of solution. The concentration of the copper sulphate solution is $x \times 10^{-3}\,mol\,L^{-1}$. The value of x is ....
[Atomic masses Cu = 63.54u, S = 32u, O = 16u, H = 1u]
[1 Sep 2021 Shift 2]

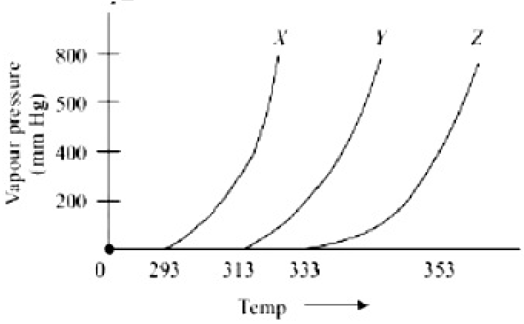
Answer: 64

Solution:

Given, mass of $CuSO_4.5H_2O$ = 80g
The concentration of copper sulphate solution is $x \times 10^{-3}$ mol / L.
Molarity $= \frac{\text{Number of moles of solute}}{\text{Volume of solution(L)}}$ ...(i)
Molar mass of $CuSO_4 \cdot 5H_2O$ = 63.54 + 32 + 16 × 4
= 5 × 18 = 249.54 g/mol
Number of moles of solute $= \frac{\text{Weight of solute}}{\text{Molecular mass of solute}}$
$= \frac{80g}{249.54g / mol} = 0.32\,mol$
Volume of solution = 5 L
From Eq. (i),
Molarity $= \frac{0.3205}{5} = 64.11 \times 10^{-3}\,mol / L$
∴ x = 64.11
or x ≈ 64
Hence, answer is 64.

Question91

The vapour pressure of solution will be less than the vapour pressure of pure solvent, so some vapour molecules will get condensed to maintain new equilibrium.



The following inferences are made:
(A) X has higher intermolecular interactions compared to Y .
(B) X has lower intermolecular interactions compared to Y .
(C) Z has lower intermolecular interactions compared to Y.
The correct inference(s)is/are:
[Jan. 08,2020(I)]

Options:

A. (A) and (C)

B. (A)

C. (B)

D. (C)

Answer: C

Solution:

Solution:
At a particular temperature as intermolecular force of attraction increases vapour pressure decreases. Thus, intermolecular forces are inversely proportional to vapour pressure and directly proportional to temperature. Therefore X has lower intermolecular interactions compared to Y.

Question92

At 35˚C, the vapour pressure of CS_2 is 512mmH g and that of acetone is 344mmH g. A solution of CS_2 in acetone has a total vapour pressure of 600mmH g. The false statement amongst the following is:

[Jan. 07,2020(I)]

Options:

A. Raoult's law is not obeyed by this system

B. a mixture of 100mLCS_2 and 100mL acetone has a volume <200mL

C. CS_2 and acetone are less attracted to each other than to themselves

D. heat must be absorbed in order to produce the solution at 35˚C

Answer: B

Solution:

Solution:
Mixture of carbon disulphide and acetone will show positive deviation from Raoult's Law. The dipolar interaction between solute (CS_2) solvent (acetone) molecules in solution are weaker. So the vapour pressure of solution will be greater thanthe individual vapoure pressure of pure components.

Question93

Two open beakers one containing a solvent and the other containing a mixture of that solvent with a non volatile solute are together sealed in a container. Over time:

[Jan. 07,2020 (II)]

Options:

A. the volume of the solution increases and the volume of the solvent decreases

B. the volume of the solution decreases and the volume of the solvent increases

C. the volume of the solution and the solvent does not change

D. the volume of the solution does not change and the volume of the solvent decreases

Answer: A

Solution:

Solution:
There will be lowering in vapour pressure in second beaker.

Question94

How much amount of $NaCl$ should be added to 600g of water ($\rho = 1.00g / mL$) to decrease the freezing point of water to $-0.2^{\circ}C$? ______ . (The freezing point depression constant for water $= 2K\,kgmol^{-1}$)
[NV, Jan. 09,2020 (I)]

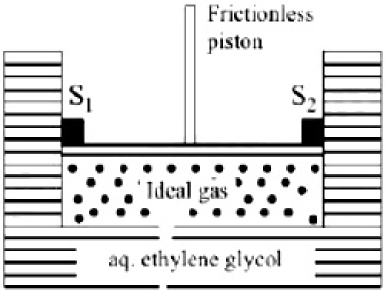
Answer: 1.75

Solution:

$$\Delta T_f = iK_f m$$
$$0.2 = 2 \times 2 \times \frac{w}{58.5} \times \frac{1000}{600}$$
$$w = \frac{0.2 \times 58.5 \times 600}{1000 \times 4} = \frac{1.2 \times 58.5}{40} = 1.75g$$

Question95

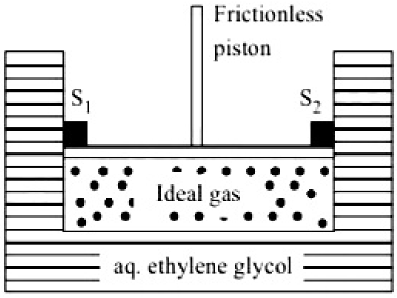
A cylinder containing an ideal gas ($0.1mol$ of $1.0dm^3$) is in thermal equilibrium with a large volume of $0.5mol\,al$ aqueous solution of ethylene glycol at its freezing point. If the stoppers S_1 and S_2 (as shown in the figure)are suddenly withdrawn, the volume of the gas in litres after equilibrium is achieved will be ______ .
(Given, K_f (water) $= 2.0K\,kgmol^{-1}$, $R = 0.08dm^3aamK^{-1}mol^{-1}$)



[NV, Jan.09,2020 (II)]

Answer: 2.18

Solution:



$K_f = 2.0\text{K kgmol}^{-1}$; $m = 0.5$
$\Delta T_f = K_f m = 0.5 \times 2$
$T_{\text{initial}} = 272\text{K}$
$n = 0.1\text{mol}$ $V = 1\text{d m}^3$
$P_{gs} = \frac{nRT}{V} = \frac{0.1 \times 0.08 \times 272}{1} = 2.176\text{atm}$
After releasingpiston
$P_1V_1 = P_2V_2$
$2.176 \times 1 = 1 \times V_2$
$V_2 = 2.18\text{d m}^3$

Question96

A set of solutions is prepared using 180g of water as a solvent and 10g of different non-volatile solutes A, B and C. The relative lowering of vapour pressure in the presence of these solutes are in the order [Given, molar mass of
$A = 100\text{gmol}^{-1}$; $B = 200\text{gmol}^{-}$; $C = 10,000\text{gmol}^{-}$]
[Sep. 06, 2020(II)]

Options:

A. B > C > A

B. C > B > A

C. A > B > C

D. A > C > B

Answer: C

Solution:

Solution:
Relative lowering in vapour pressure (RLVP)
$= \frac{P - P_s}{P} = \frac{n}{n + N}$
n→ moles of solute
N → moles of solvent
$n_A = \frac{10}{100}, n_B = \frac{10}{200}, n_C = \frac{10}{10000}$
Moles of solvent (H_2O) $= \frac{180}{18} = 10\text{mol}$
$\text{RLV } P_A = \frac{0.1}{10.1} = \frac{1}{101}$
$\text{RLV } P_B = \frac{0.05}{10.05} = \frac{1}{201}$
$\text{RLV } P_C = \frac{10^{-3}}{10} = 10^{-4}$

From the above relation
RLV P(A) > RLV P(B) > RLV P(C)

Question97

At 300K , the vapour pressure of a solution containing 1 mole of n - hexane and 3 moles of n -heptane is 550mm of Hg. At the same temperature, if one more mole of n heptane is added to this solution, the vapour pressure of the solution increases by 10mm of H g. What is the vapour pressure in mmH g of n -heptane in its pure state ________ ?
[NV, Sep. 04, 2020(I)]

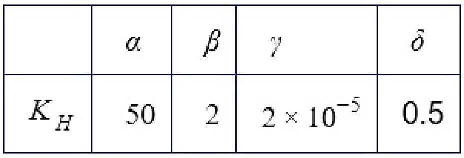
Answer: 600

Solution:

$P_{\text{total}} = P_{\text{hexane}}{}^{0} \cdot X_{\text{hexane}} + P_{\text{heptane}}{}^{0} \cdot X_{\text{heptane}}$
$550 = [P_{\text{hexane}}{}^{o}] \times \frac{1}{4} + [P_{\text{heptane}}{}^{\circ}] \times \frac{3}{4}$
$\Rightarrow 2200 = P_{\text{hexane}}{}^{\circ} + 3P_{\text{heptane}}{}^{\circ}$ .....(i)
$560 = [P_{\text{hexane}}{}^{0}] \times \frac{1}{5} + [P_{\text{heptane}}{}^{\circ}] \times \frac{4}{5}$
$\Rightarrow 2800 = P_{\text{hexane}}{}^{o} + 4P_{\text{heptane}}{}^{o}$ .....(ii)
From equation (i) and (ii),
$P_{\text{heptane}}{}^{o} = 600$mm of H g

Question98

Henry's constant (in k bar) for four gases α, β, γ and δ in water at 298K is given below:



	α	β	γ	δ
K_H	50	2	2×10^{-5}	0.5

(density of water = 10^3kgm^{-3} at 298K)
This table implies that:
[Sep. 03, 2020(I)]

Options:

A. α has the highest solubility in water at a given pressure

B. solubility of γ at 308K is lower than at 298K

C. The pressure of a 55.5 molal solution of y is 1 bar

D. The pressure of 55.5 molal solution of δ is 250 bar

Answer: D

Solution:

(a) From Henry's law $p = K_H(x)$
Higher the value of K_H smaller will be the solubility of the gas, so γ is more soluble.
(b) Though solubility of gases will decrease with increase in temperature but this conclusion can not be drawnfrom the given table.
(c) For γ

$$(p)_\gamma = (K_H)_\gamma \cdot (x)_\gamma$$

$$= 2 \times 10^{-5}\left[\frac{55.5}{55.5 + \frac{1000}{18}}\right] = 10^{-5}\text{k bar } = 10^{-2}\text{bar}$$

(d) For δ⇒

$$p_\delta = (K_H)_8 \cdot (x)_\delta$$

$$= 0.5\left[\frac{55.5}{55.5 + \frac{1000}{18}}\right]$$

$$= 0.5 \times 0.5 = 0.25\text{k bar } = 250\text{bar.}$$

Question99

An open beaker of water in equilibrium with water vapour is in a sealed container. When a few grams of glucose are added to the beaker of water, the rate at which water molecules:
[Sep. 02,2020I)]

Options:

A. leaves the vapour increases

B. leaves the solution increases

C. leaves the solution decreases

D. leaves the vapour decreases

Answer: A

Solution:

Solution:
The vapour pressure of solution will be less than the vapour pressure of pure solvent, so some vapour molecules will get condensed to maintain new equilibrium.

Question100

The elevation of boiling point of 0.10m aqueous $CrCl_3$, xNH_3 solution is two times that of 0.05m aqueous $CaCl_2$ solution. The value of x is _______ .
[Assume 100% ionisation of the complex and $CaCl_2$, coordination

number of Cr as 6, and that all NH_3 molecules are present inside the coordination sphere]
[NV, Sep. 06, 2020 (I)]

Answer: 5

Solution:

Molality of $CaCl_2$ solution $= 0.05m$
$\Delta T_b = iK_b m = 3 \times K_b \times 0.05 = 0.15K_b$
Molality of $CrCl_3 xNH_3 = 0.10m$
$\Delta T_b' = iK_b \times 0.10 \Rightarrow \Delta T_b' = 2\Delta T_b$
$iK_b \times 0.10 = 2 \times 0.15K_b \Rightarrow i = 3$
Since, co-ordination number of Cr is 6 .
$\therefore$ The complex is $[Cr(NH_3)_5Cl]Cl_2$.
$\therefore x = 5$.

Question101

The osmotic pressure of a solution of $NaCl$ is 0.10atm and that of a glucose solution is 0.20atm. The osmotic pressure of a solution formed by mixing 1 L of the sodium chloride solution with 2L of the glucose solution is $x \times 10^{-3}$atm $\cdot$ x is ______ . (nearest integer)
[NV, Sep.04, 2020 (II)]

Answer: 167

Solution:

For $NaCl$: $\pi_1 = iC_1RT \Rightarrow C_1 = \frac{0.10}{2RT}$
For Glucose: $\pi_2 = C_2RT \Rightarrow C_2 = \frac{0.20}{RT}$
When 1L of $NaCl$ solution and 2L glucose solution are mixed.
$\therefore C_1' = \frac{0.10}{6RT}$ and $C_2' = \frac{0.20 \times 2}{3RT} = \frac{0.40}{3RT}$
$\therefore \pi_{Total} = iC_1'RT + C_2'RT = \frac{0.10}{3} + \frac{0.40}{3} = \frac{0.50}{3}$
$\pi_{Total} = 167 \times 10^{-3}$ atm

Question102

If $250cm^3$ of an aqueous solution containing 0.73g of a protein A is

isotonic with one litre of another aqueous solution containing 1.65g of a protein B, at 298K, the ratio of the molecular masses of A and B is ______ $\times 10^{-2}$ (to the nearest integer).
[NV, Sep. 03, 2020 (II)]

Answer: 177

Solution:

$\pi_A = iC_ART$, $\pi_B = iC_BRT$
For isotonic solution,
$\pi_A = \pi_B$ $i_1C_1 = i_2C_2$ (For protein i = 1)
$\Rightarrow C_1 = C_2$
$$\Rightarrow \frac{0.73 \times 1000}{M_A \times 250} = \frac{1.65}{M_B \times 1}$$
$$\therefore \frac{M_A}{M_B} = \frac{0.73 \times 4}{1.65} = 1.77 = 177 \times 10^{-2}$$

Question103

A solution of sodium sulfate contains 92g of Na^+ ions per kilogram of water. The molality of Na^+ ions in that solution in mol kg^{-1} is:
[Jan. 9, 2019(I)]

Options:

A. 12

B. 4

C. 8

D. 16

Answer: B

Solution:

Number of moles in 92g of $Na^+ = \frac{92}{23} = 4\text{mol}$

Molality (m) = $\frac{\text{Number of moles}}{\text{Mass of solvent (in kg)}}$

$\therefore \ m = \frac{4}{1} = 4\text{mol kg}^{-1}$

Question104

Liquids A and B form an ideal solution in the entire composition range. At 350K, the vapor pressures of pure A and pure B are 7×10^3Pa and 12×10^3Pa, respectively. The composition of the vapour is in equilibrium with a solution containing 40 mole percent of A at this temperature is:
[Jan. 10,2019(I)]

Options:

A. $x_A = 0.37; x_B = 0.63$

B. $x_A = 0.28; x_B = 0.72$

C. $x_A = 0.4; x_B = 0.6$

D. $x_A = 0.76; x_B = 0.24$

Answer: B

Solution:

$P_A{}^{\circ} = 7 \times 10^3$
$P_B{}^{\circ} = 12 \times 10^3$
$x_A{}' = 0.4; x_B{}' = 1 - 0.4$
$x_B{}' = 0.6$
$P_{total} = P_A{}^{\circ} x_A{}' + P_B{}^{\circ} x_B{}'$
$= 7 \times 10^3 \times 0.4 + 12 \times 10^3 \times 0.6$
$= (7 \times 0.4 + 12\infty \times 0.6) \times 10^3 = 10^4$
$\therefore_A = \dfrac{P_A{}^{\circ} x_A{}'}{P_{total}} = \dfrac{7 \times 10^3 \times 0.4}{10^4}$
$\therefore\ x_A = 0.28, x_B = 1 - 0.28 = 0.72$

Question105

Which one of the following statements regarding Henry's law is not correct?
[Jan. 9,2019(I)]

Options:

A. Higher the value of K_H at a given pressure, higher is the solubility of the gas in liquids.

B. Different gases have different K_H (Henry's law constant) values at the same temperature.

C. The partial pressure of the gas in vapour phase is proportional to the mole fraction of the gas in the solution.

D. The value of K_H increases with increase of temperature and K_H is function of the nature of the gas.

Answer: A

Solution:

Solution:
The solubility of the gas in liquids decreases with the increase in value of K_H at a given pressure.

Question106

Freezing point of a 4% aqueous solution of X is equal to freezing point of 12% aqueous solution of Y. If molecular weight of X is A, then molecular weight of Y is:
[Jan. 12,2019 (I)]

Options:

A. 3A

B. 2A

C. A

D. 4A

Answer: A

Solution:

$(\Delta T_f)_x = (\Delta T_f)_y$
$K_f m_x = K_f m_y$
$m_x = m_y$
$$\frac{\text{No. of moles of } x}{\text{wt. of solvent in kg}} = \frac{\text{No. of moles of } y}{\text{wt. of solvent in kg}}$$
Given, 4% aqueous solution of x = 4g of solute, x present in 100g of H_2O
12% aqueous solution of y = 12g of solute, y present in 100g of H_2O
Now, $\frac{4g}{m_1} \times \frac{1000}{100} = \frac{12g}{m_2} \times \frac{1000}{100}$
$\frac{4g}{A} = \frac{12g}{m_2}$ $[m_1 = A]$
$m_2 = 3A$

Question107

Molecules of benzoic acid (C_6H_5COOH) dimerise in benzene. 'w' g of the acid dissolved in 30g of benzene shows a depression in freezing point equal to 2K. 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 $= 122 g mol^{-1}$)
[Jan. 12, 2019 (II)]

Options:

A. 2.4g

B. 1.0g

C. 1.5g

D. 1.8g

Answer: A

Solution:

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

$t = 0$	1	0
$t = t_{eq}$	$1 - \alpha$	$\frac{\alpha}{2}$

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

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

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

$\Delta T_f = iK_f m$

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

$w = 2.4g$

Question108

The freezing point of a diluted milk sample is found to be $-0.2^{\circ}C$, while it should have been $-0.5^{\circ}C$ for pure milk. How much water has been added to pure milk to make the diluted sample?
[Jan. 11,2019(I)]

Options:

A. 1 cup of water to 2 cups of pure milk

B. 3 cups of water to 2 cups of pure milk

C. 1 cup of water to 3 cups of pure milk

D. 2 cups of water to 3 cups of pure milk

Answer: B

Solution:

Freezing point of diluted milk $= -0.2^{\circ}C$
$\Delta T_f' = 0.2^{\circ}C$
Freezing point of pure milk $= -0.5^{\circ}C$

$\Delta T_f' = 0.5^{\circ}C$

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

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 5cups of diluted milk.

Question109

K_2HgI_4 is 40% ionised in aqueous solution. The value of its van't Hoff factor (i) is :
[Jan. 11, 2019 (II)]

Options:

A. 1.6

B. 1.8

C. 2.0

D. 2.2

Answer: B

Solution:

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

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

$i = 1.8$

Question110

Elevation in the boiling point for 1 molal solution of glucose is 2K. The depression in the freezing point for 2 molal solution of glucose in the same solvent is 2K. The relation between K_b and K_p is:
[Jan. 10, 2019 (II)]

Options:

A. $K_b = 1.5K_f$

B. $K_b = K_f$

C. $K_b = 0.5K_f$

D. $K_b = 2K_r$

Answer: D

Solution:

According to the question we can write

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

$\Delta T_f = K_j m \Rightarrow K_j(2) = 2 \Rightarrow K_f = 1 K\, m^{-1}$

So, $\frac{K_b}{K_f} = \frac{2}{1}$

$\therefore K_b = 2K_f$

Question111

A solution containing 62g ethylene glycol in 250g water is cooled to $-10^{\circ}C$. If K_f for water is $1.86 K\, kg mol^{-1}$, the amount of water (in g) separated as ice is:
[Jan. 9, 2019 (II)]

Options:

A. 48

B. 32

C. 64

D. 16

Answer: C

Solution:

As we know,

$\Delta T_f = K_f \cdot m$

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

$\Rightarrow w = \; = \frac{1.86 \times 1000}{10} = 186 g$

Total amount of water $= 250 g$

$\therefore$ The amount of water separated as ice

$= 250 - 186 = 64 g$

Question112

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 :
[April 12, 2019 (I)]

Options:

A. 13.88×10^{-2}

B. 13.88×10^{-1}

C. 13.88

D. 13.88×10^{-3}

Answer: C

Solution:

Let, 1 mole be present in the solution,
$n_{\text{solute}} = 0.2\text{mol}$
$n_{\text{solvent}} = 0.8\text{mol}$
$= 0.8 \times 18\text{g}$ molality
$= \dfrac{\text{Moles of solute}}{\text{Kilogram of solvent}}$
$\therefore \text{m} = \dfrac{0.2 \times 1000}{0.8 \times 18} = \dfrac{1000}{4 \times 18} \approx 13.88$

Question113

What would be the molality of 20% (mass/mass) aqueous solution of KI ? (molar mass of $\text{KI} = 166\text{gmol}^{-1}$)
[April9, 2019 (II)]

Options:

A. 1.08

B. 1.35

C. 1.48

D. 1.51

Answer: D

Solution:

20% W\/W KI solution (Given)
i.e. 100g solution contains 20gKI
$\therefore$ Mass of solvent $= 100 - 20 = 80\text{g}$
No. of moles of KI is $\dfrac{20}{166} = 0.121\text{mol}$
$\therefore$ Molality $= \dfrac{0.121 \times 1000}{80} = 1.51\text{m}$

Question114

1g of a non-volatile non-electrolyte solute is dissolved in 100g of two different solvents A and B whose ebullioscopic constants are in the ratio

of 1 : 5. The ratioof the elevation in their boiling points, $\frac{\Delta T_b(A)}{\Delta T_b(B)}$, is:
[April 10, 2019 (II)]

Options:

A. 5 : 1

B. 10 : 1

C. 1 : 5

D. 1 : 0.2

Answer: C

Solution:

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

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

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

Question115

Liquid 'M' and liquid ' N ' form an ideal solution. The vapour pressures of pure liquids 'M' and 'N' are 450 and 700 mmH g, respectively, at the same temperature. Then correct statement is:
(x_M = Mole fraction of $^{\circ}M^{\prime}$ 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)
[April 9,2019 (I)]

Options:

A. $\frac{x_M}{x_N} = \frac{y_M}{y_N}$

B. $(x_M - y_M) < (x_N - y_N)$

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

D. $\frac{x_M}{x_N} > \frac{y_M}{y_N}$

Answer: D

Solution:

$P_M{}^0 = 450 mmHg, P_N{}^0 = 700 mmHg$
$P_M = P_M{}^0 x_M = y_M P_T$
$\Rightarrow P_M{}^\circ = \frac{y_M}{x_M}(P_T)$ Similarly,
$P_N{}^o = \frac{y_N}{x_N}(P_T)$
Given, $P_M{}^o < P_N{}^\circ$
$\Rightarrow \frac{y_M}{x_M} < \frac{y_N}{x_N}$
$\Rightarrow \frac{y_M}{y_N} < \frac{x_M}{x_N}$

Question116

The vapour pressures of pure liquids A and B are 400 and 600mmHg, 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:
[April 8,2019(I)]

Options:

A. 450mmHg, 0.4, 0.6

B. 500mmHg, 0.5, 0.5

C. 450mmHg, 0.5, 0.5

D. 500mmHg, 0.4, 06

Answer: D

Solution:

Solution:
$P = x_B p_B{}^\circ + x_A p_A{}^\circ$
$= 0.5 \times 600 + 0.5 \times 400 = 300 + 200 = 500$
Using the relation $p_i = y_i P_{\text{Total}}$, we can calculate the mole fractions of the components in vapour phase.
$p_B = y_B p_{\text{total}}$
$y_B = \frac{p_B}{P_{\text{Total}}} = \frac{300}{500} = \frac{3}{5} = 0.6$
$y_A = \frac{p_A}{P_{\text{Total}}} = \frac{200}{500} = \frac{2}{5} = 0.4$

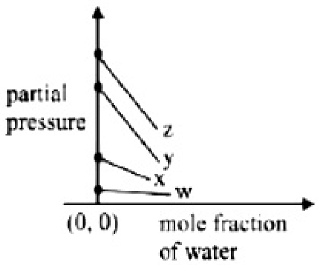
Question117

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 40kbar. respectively. The correct plot for the given data is:

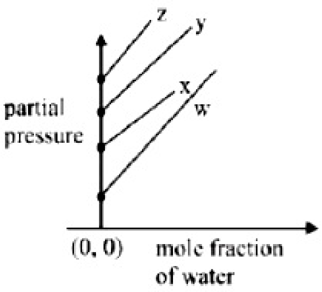
[April 8, 2019 (II)]

Options:

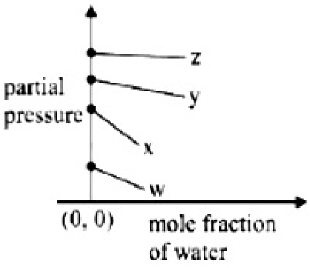
A.



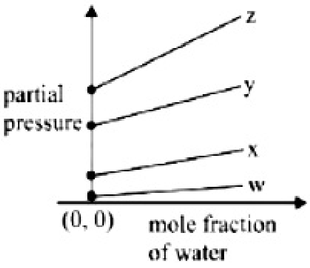
B.



C.



D.



Answer: A

Solution:

According to Henry's law

$P = K_H \cdot X_{gas}$

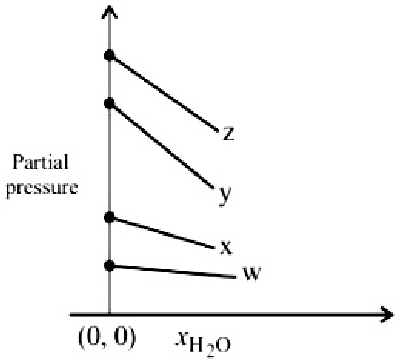
$\because X_{gas} + X_{H_2O} = 1$

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

$\therefore P = K_H \left(1 - X_{H_2O}\right)$

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

$y = c + mx;\ m = -K_H \Rightarrow$ slope is negative.



Gas	K_H
w	0.5
x	2
y	35
z	50

Question118

A solution is prepared by dissolving 0.6g of urea (molar mass $= 60 g mol^{-1}$) and 1.8g of glucose (molar mass $= 180\ g mol^{-1}$) in 100mL, of water at 27°C. The osmotic pressure of the solution is: ($R = 0.08206 L atm K^{-1} mol^{-1}$)
[April 12, 2019 (II)]

Options:

A. 8.2atm

B. 2.46atm

C. 4.92atm

D. 1.64atm

Answer: C

Solution:

Solution:
Osmotic pressure (π) = CRT
Since, there are two solutes i.e. urea and glucose.
$\therefore \pi = (C_1 + C_1)RT$

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

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

Question119

At room temperature, a dilute solution of urea is prepared by dissolving 0.60g of urea in 360g of water. If the vapour pressure of pure water at this temperature is 35mmHg, lowering of vapour pressure will be : (molar mass of urea $= 60\mathrm{g\,mol}^{-1}$)
[April 10, 2019 (I)]

Options:

A. $0.027\mathrm{mmHg}$

B. $0.028\mathrm{mmHg}$

C. $0.017\mathrm{mmHg}$

D. $0.031\mathrm{mmHg}$

Answer: C

Solution:

Solution:
Relative lowering of vapour pressure, is given by,

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

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

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

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

Question120

The osmotic pressure of a dilute solution of an ionic compound XY in water is four times that of a solution of 0.01M $BaCl_2$ in water. Assuming complete dissociation of the given ionic compounds in water, the concentration of XY (in mol L^{-1}) in solution is:
[April 9, 2019 (I)]

Options:

A. 4×10^{-2}

B. 6×10^{-2}

C. 4×10^{-4}

D. 16×10^{-4}

Answer: B

Solution:

Solution:
We know, $\pi = iCRT$; $\pi_{xy} = 4\pi_{BaCl_2}$

Since both are ionic solute, i.e.,
$XY \rightarrow X^{+} + Y^{-} \Rightarrow i = 2$
$BaCl_{2} \rightarrow B^{2}a^{+} + 2Cl^{-} \Rightarrow i = 3$
Now,
$2[XY] = 4 \times 3 \times [0.01]$
$[XY] = 0.06$
$= 6 \times 10^{-2} mol / L$

Question121

Molar 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 $K_{2}SO_{4}$ is:
(Assume complete dissociation of the electrolyte)
[April 9, 2019 (II)]

Options:

A. 0.18K

B. 0.24K

C. 0.12K

D. 0.36K

Answer: D

Solution:

Solution:
Dissociation of Potassium Sulphate ($K_{2}SO_{4}$),
$K_{2}SO_{4} \longrightarrow 2K^{+} + SO_{4}^{2-}$
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.
$= 3 \times 4 \times 0.03 = 0.36K$

Question122

For 1 molal aqueous solution of the following compounds, which one will show the highest freezing point?
[2018]

Options:

A. $[Co(H_{2}O)_{6}]Cl_{3}$

B. $[Co(H_{2}O)_{5}Cl]Cl_{2} \cdot H_{2}O$

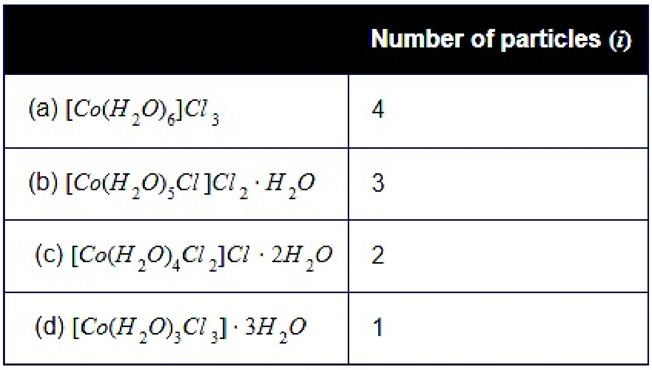
C. $[Co(H_{2}O)_{4}Cl_{2}]Cl.2H_{2}O$

D. $[Co(H_{2}O)_{3}Cl_{3}].3H_{2}O$

Answer: D

Solution:

Solution:



	Number of particles (i)
(a) $[Co(H_2O)_6]Cl_3$	4
(b) $[Co(H_2O)_5Cl]Cl_2 \cdot H_2O$	3
(c) $[Co(H_2O)_4Cl_2]Cl \cdot 2H_2O$	2
(d) $[Co(H_2O)_3Cl_3] \cdot 3H_2O$	1

z; where $\Delta T_f = (T_f - T_f')$
Remember, greater the no. of particles, lower will be the freezing point. Compound (d) will have the highest freezing point due to least number of particles.

Question123

The mass of non-volatile, non-electrolyte solute (molar mass $= 50 \text{gmol}^{-1}$) needed to be dissolved in 114g octane to reduce its vapour pressure to 75%, is [Online April 16,2018]

Options:

A. 37.5g

B. 75g

C. 150g

D. 50g

Answer: C

Solution:

Solution:
Molar mass of octane $= 114 \text{g} / \text{mol}$
From the lowering of vapour pressure we have,

$$\frac{\Delta P}{P} = \frac{\frac{W_2}{M_2}}{\frac{W_2}{M_2} + \frac{W_1}{M_1}}$$

$$\frac{75}{100} = \frac{\frac{W_2}{50 \text{g} / \text{mol}}}{\frac{W_2}{50 \text{g} / \text{mol}} + \frac{114 \text{g}}{114 \text{g} / \text{mol}}}$$

$$0.75 = \frac{\frac{W_2}{50}}{\frac{W_2}{50} + 1}$$

$\frac{W_2}{50} + 1 = \frac{W_2}{50 \times 0.75}$
$W_2 = 150g$
Note : W_2 and M_2 are mass and molar mass of solute whereas W_1 and M_1 are mass and molar mass of octane.

Question124

Two 5 molal solutions are prepared by dissolving a non-electrolyte, non-volatile solute separately in the solvents X and Y. The molecular weights of the solvents are M_X and M_Y, respectively where $M_X = \frac{3}{4}M_Y$. The relative lowering of vapour pressure of the solution in X is "m" times that of the solution in Y. Given that the number of moles of solute is very small in comparison to that of solvent, the value of "m" is: [Online April 15, 2018 (II)]

Options:

A. $\frac{3}{4}$

B. $\frac{1}{2}$

C. $\frac{1}{4}$

D. $\frac{4}{3}$

Answer: A

Solution:

Solution:
The relationship between molar masses of the two solvents is
$M_X = \frac{3}{4}M_Y \ldots$ (i)
The relative lowering of vapour pressure of the two solutions is
$\left(\frac{\Delta P}{P}\right)_X = m\left(\frac{\Delta P}{P}\right)_Y$
But, the relativelowering of vapour pressure of solutions is directly proportional to the mole fraction of solute. Given 5 molal solution, means 5 moles of solute are dissolved in 1kg (or 1000g) of solvent.
The number of moles of solvent $= \frac{1000g}{M}$
The mole fraction of solute $= \frac{5}{1000 / M}$
$= M \times \frac{5}{1000}$
Hence, $M_X \times \frac{5}{1000} = m \times M_Y \times \frac{5}{1000}$ … (ii)
Substitute equation (i) in equation (ii)
$\frac{3}{4} \times M_Y \times \frac{5}{1000} = m \times M_Y \times \frac{5}{1000}$
$m = \frac{3}{4}$

Question125

A solution is prepared by mixing 8.5g of CH_2Cl_2 and 11.95 g of $CHCl_3$. If vapour pressure of CH_2Cl_2 and $CHCl_3$ at 298 K are 415 and 200mmHg respectively, the mole fraction of $CHCl_3$ invapour form is: (Molar mass of Cl $= 35.5gmol^{-1}$)
[Online April 9, 2017]

Options:

A. 0.162

B. 0.675

C. 0.325

D. 0.486

Answer: C

Solution:

Solution:
Molar mass of $CHCl_3 = 119.5g / mol$
Molar mass of $CH_2Cl_2 = 85g / mol$
Moles of $CHCl_3 = \frac{11.95}{119.5} = 0.1mol$
Moles of $CH_2Cl_2 = \frac{8.5}{85} = 0.1mol$
Mole fraction of $CHCl_3 = \frac{0.1}{0.2} = 0.5mol$
Mole fraction of $CH_2Cl_2 = \frac{0.1}{0.2} = 0.5mol$
(Given -
Vapour pressure of $CHCl_3 = 200mmHg = 0.263atm.$
Vapour pressure of $CH_2Cl_2 = 415mmHg = 0.546atm.)\ (1atm = 760mmHg)$
$\therefore P_{(total)} =$ Mole fraction of $CHCl_3 \times$
(Vapour pressure of $CHCl_3$) + Mole fraction of CH_2Cl_2
$\times$(Vapour pressure of CH_2Cl_2)
$= 0.5 \times 0.263 + 0.5 \times 0.546 = 0.4045$
Mole fraction of $CHCl_3$ in vapour form
$= \frac{\text{vapour pressure}}{P_{total}} = \frac{0.1315}{0.4045} = 0.325.$

Question126

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:
(K_f for benzene $= 5.12K\,kgmol^{-1}$)
[2017]

Options:

A. 64.6%

B. 80.4%

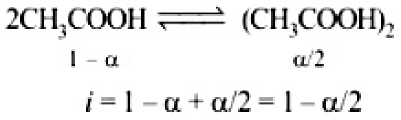
C. 74.6%

D. 94.6%

Answer: D

Solution:

In benzene,



$$\underset{1-\alpha}{2CH_3COOH} \rightleftharpoons \underset{\alpha/2}{(CH_3COOH)_2}$$

$$i = 1 - \alpha + \alpha/2 = 1 - \alpha/2$$

Here α is degree of association

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

$$0.45 = \left(1 - \frac{\alpha}{2}\right)(5.12)\frac{\left(\frac{0.2}{60}\right)}{\frac{20}{1000}}$$

$1 - \frac{\alpha}{2} = 0.527$

$\alpha = 0.945$

% degree of association $= 94.6\%$

Question127

5g of Na_2SO_4 was dissolved in xg of H_2O. The change in freezing point was found to be 3.82°C. If Na_2SO_4 is 81.5% ionised, the value of x (K_f for water $= 1.86°C kg mol^{-1}$) is approximately:
(molar mass of S = 32gmol^{-1} and that of Na = 23gmol^{-1})
[Online April 8, 2017]

Options:

A. 15g

B. 25g

C. 45g

D. 65g

Answer: C

Solution:

Molality (experimental)

$$= \frac{\Delta T_f}{K_f} = \frac{3.82}{1.86} = 2.054 \text{mol} / 1000 \text{g solvent}$$

$$\text{Molality (theortical)} = \frac{\text{moles of solute}}{\text{wt. of solvent(g)}} \times 1000$$

$$= \frac{5g / 142g / mol e}{x} \times 1000$$

$$Na_2SO_4 \longrightarrow 2Na^+ + SO_4^{2-}$$

Moles before dissociation	1	0	0
Moles after dissociation	$1-\alpha$	2α	α

Von't Hoff factor (i) $= \dfrac{\text{Moles after dissociation}}{\text{Moles before dissociation}}$

$= \dfrac{(1-\alpha)+2\alpha+\alpha}{1}$

Na_2SO_4 is ionised 81.5%

means $\alpha = 0.815$

$= \dfrac{(1-0.815)+2\times0.815+0.815}{1}$

$= 2.63$.

$i = \dfrac{\text{Observed molality}}{\text{Calculated molality}}$

$2.63 = \dfrac{2.054}{\dfrac{0.0352}{x}\times1000}$

$x = 45.07g$

Question128

The solubility of N_2 in water at 300K and 500 torr partial pressure is $0.01 gL^{-1}$. The solubility (in gL^{-1})at 750 torr partial pressure is: [Online April9, 2016]

Options:

A. 0.0075

B. 0.005

C. 0.02

D. 0.015

Answer: D

Solution:

Solution:

According to Henry's law

$\dfrac{P_1}{P_2} = \dfrac{S_1}{S_2}$

$\dfrac{500}{750} = \dfrac{0.01}{S_2}$

$\therefore S_2 = \dfrac{750\times0.01}{500} = 0.015 g / L$

Question129

An aqueous solution of a salt MX_2 at certain temperature has a van't Hoff factor of 2 . The degree of dissociation for this solution of the salt is:

[Online April 10,2016]

Options:

A. 0.50

B. 0.33

C. 0.67

D. 0.80

Answer: A

Solution:

Solution:

Van't Hoff factor (i)

$$= \frac{\text{No. of particles after association or dissociation}}{\text{No. of particles before association or dissociation}}$$

$$\begin{array}{llll} \text{For} & MX_2 \rightleftharpoons & M^{2+} & +2X^- \\ t=0 & 1 & 0 & 0 \\ \text{at eq.} & 1-\alpha & \alpha & 2\alpha \end{array}$$

Total no. of particles $= 1 - \alpha + \alpha + 2\alpha = 1 + 2\alpha$

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

$\therefore \alpha = 0.50$ or 50%

Question130

18 g glucose ($C_6H_{12}O_6$) is added to 178.2g water. The vapour pressure of water (in torr) for this aqueous solution is:

[2016, 2006]

Options:

A. 752.4

B. 759.0

C. 7.6

D. 76.0

Answer: A

Solution:

Solution:

According to Raoult's Law

$$\frac{P^\circ - P_s}{P_s^\circ} = \frac{W_B \times M_A}{M_B \times W_A} \quad ...\text{(i)}$$

Here $P^\circ =$ Vapour pressure of pure solvent,

$P_s =$ Vapour pressure of solution

$W_B =$ Mass of solute, $W_A =$ Mass of solvent

$M_B =$ Molar mass of solute, $M_A =$ Molar Mass of solvent

Vapour pressure of pure water at 100°C (by assumption = 760 torr)
By substituting values in equation (i) we get,

$$\frac{760 - P_s}{P_s^{\circ}} = \frac{18 \times 18}{180 \times 178.2} \ldots \text{(ii)}$$

On solving (ii) we get
$P_s = 752.4$ torr

Question131

A solution at 20°C is composed of 1.5mol of benzene and 3.5mol of toluene. If the vapour pressure of pure benzene and pure toluene at this temperature are 74.7 torr and 22.3 torr, respectively, then the total vapour pressure of the solution and the benzene mole fraction in equilibrium with it will be, respectively:
[Online April 10,2015]

Options:

A. 35.8 torr and 0.280

B. 38.0 torr and 0.589

C. 30.5 torr and 0.389

D. 30.5 torr and 0.480

Answer: B

Solution:

Solution:
Total V.P. of solution $= P_A^{\circ} X_A + P_B^{\circ} X_B$
Given, $P_A^{\circ} = 74.7$ torr, $P_B^{\circ} = 22.3$ torr
$n_{\text{benzene}} = 1.5$ mol, $n_{\text{toluene}} = 3.5\text{mol}$
$n_{\text{solution}} = 1.5 + 3.5 = 5\text{mol}$

$$x_A = \frac{n_{\text{benzene}}}{n_{\text{solution}}} = \frac{1.5}{5} = 0.3$$

$$x_B = \frac{n_{\text{toluene}}}{n_{\text{solution}}} = \frac{3.5}{3} = 0.7$$

Total V.P. of solution $= (0.3 \times 74.7 + 0.5 \times 22.3)$ torr
$= (22.4 + 15.6)$ torr $= 38$ torr

Mole fraction of benzenein vapour form $= \frac{22.4}{38} = 0.589$

Question132

The vapour pressure of acetone at 20°C is 185 torr. When 1.2g of a non-volatile substance was dissolved in 100g of acetone at 20°C, its vapour pressure was 183 torr. The molar mass (gmol^{-1}) of the substance is :
[2015]

Options:

A. 128

B. 488

C. 32

D. 64

Answer: D

Solution:

Solution:
Using relation,

$$\frac{P^\circ - P_s}{P^\circ} = \frac{w_2 M_1}{w_1 M_2}$$

where $w_1, M_1 =$ mass in g and mol. mass of solvent
$w_2, M_2 =$ mass in g and mol. mass of solute
$P^\circ = 185$ torr, $P_s = 183$torr

$$\frac{185 - 183}{185} = \frac{1.2 \times 58}{100 \times M_2}$$

(Mol. mass of acetone $= 58$)
$M_2 = 64.68 \approx 64$
$\therefore$ Molar mass of substance $= 64$

Question133

Determination of the molar mass of acetic acid in benzene using freezing point depression is affected by:

[Online April 11, 2015]

Options:

A. partial ionization

B. dissociation

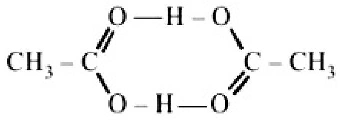
C. complex formation

D. association

Answer: D

Solution:

Solution:
Acetic acid contain carboxylic group $-\mathrm{COOH}$ which can form H-bonding so acetic acid dimerises.



Question134

Choose the correct statement with respect to the vapour pressure of a liquid among the following:
[Online April 19, 2014]

Options:

A. Increases linearly with increasing temperature

B. Increases non-linearly with increasing temperature

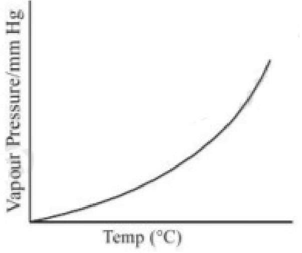
C. Decreases linearly with increasing temperature

D. Decreases non-linearly with increasing temperature

Answer: B

Solution:

Solution:
If we plot a graph between the vapour pressure and the temperature. We would get a curve that rises faster as T increases, giving a curved line.



Question135

For an ideal solution of two components A and B, which of the following is true?
[Online April 19,2014]

Options:

A. $\Delta H_{\text{mixing}} < 0$ (zero)

B. $\Delta H_{\text{mixing}} > 0$ (zero)

C. $A-B$ interaction is stronger than $A-A$ and $B-B$ interactions

D. $A-A$, $B-B$ and $A-B$ interactions are identical.

Answer: D

Solution:

Solution:
Solutions in which solute-solute and solvent-solvent interactions are almost similar to solute solvent interactions are known as ideal solution.

Question136

Consider separate solutions of $0.500\mathrm{M}\ C_2H_5OH\ (aq)$, $0.100\ \mathrm{M}\ Mg_3(PO_4)_2(aq)$, $0.250\mathrm{M}\ KBr(aq)$ and $0.125\mathrm{M}\ Na_3PO_4(aq)$ at $25^\circ C$. Which statement is true about these solutions, assuming all salts to be strong electrolytes?
[2014]

Options:

A. They all have the same osmotic pressure.

B. $0.100\mathrm{M}\ Mg_3(PO_4)_2(aq)$ has the highest osmotic pressure.

C. $0.125\mathrm{M}\ Na_3PO_4(aq)$ has the highest osmotic pressure.

D. $0.500\mathrm{M}\ C_2H_5OH\ (aq)$ has the highest osmotic pressure.

Answer: A

Solution:

Solution:
$\pi = iCRT$ $\pi_{C_2H_5OH} = 1 \times 0.500 \times R \times T = 0.5RT$
$\pi_{Mg_3(PO_4)_2} = 5 \times 0.100 \times R \times T = 0.5RT$
$\pi_{KBr} = 2 \times 0.250 \times R \times T = 0.5RT$
$\pi_{Na_3PO_4} = 4 \times 0.125 \times RT = 0.5RT$
Since the osmotic pressure of all the given solutions is equal. Hence all are isotonic solutions.

Question137

The observed osmotic pressure for a $0.10\mathrm{M}$ solution of $Fe(NH_4)_2(SO_4)_2$ at $25^\circ C$ is $10.8\mathrm{atm}$. The expected and experimental (observed) values of van't Hoff factor (i) will be respectively:
$(R = 0.082\,\mathrm{L\,atm\,K^{-1}mol^{-1}})$
[Online April 19, 2014]

Options:

A. 5 and 4.42

B. 4 and 4.00

C. 5 and 3.42

D. 3 and 5.42

Answer: A

Solution:

Given, $\pi_{ob} = 10.8 \text{atm}$

$\pi_{nor} = CRT = 0.10 \times 0.0821 \times 298 = 2.446$

Now experimental value of (i)

$$= \frac{\text{Observed osmotic pressure}}{\text{Normal osmotic pressure}} = \frac{10.8}{2.446} = 4.42$$

Question138

The molarity of a solution obtained by mixing 750mL of 0.5(M)HCl with 250mL of 2(M)HCl will be: [2013]

Options:

A. 0.875M

B. 1.00M

C. 1.75M

D. 0.975M

Answer: A

Solution:

Solution:

From molarity equation :

$$M_1V_1 + M_2V_2 = M \times V$$

$$M = \frac{M_1V_1 + M_2V_2}{V} \text{ where } V = \text{ total volume}$$

$$= \frac{750 \times 0.5 + 250 \times 2}{1000}$$

$$= 0.875M$$

Question139

Vapour pressure of pure benzene is 119 torr and that of toluene is 37.0 torr at the same temperature. Mole fraction of toluene in vapour phase which is in equilibrium with a solution of benzene and toluene having a mole fraction of toluene 0.50, will be : [Online April 23, 2013]

Options:

A. 0.137

B. 0.237

C. 0.435

D. 0.205

Answer: B

Solution:

Solution:

$P_A = P_A^\circ \times X_A =$ total pressure $\times y_A$

$P_B = P_B^\circ \times X_B =$ total pressure $\times y_B$

where x and y represents mole fraction in liquid and vapour phase respectively.

$$\frac{P_B^\circ X_B}{P_A^\circ X_A} = \frac{y_B}{y_A}; \quad \frac{P_B^0(1 - X_A)}{P_A^\circ X_A} = \frac{1 - y_A}{y_A}$$

on putting values $\frac{119(1 - 0.50)}{37 \times 0.50} = \frac{1 - y_A}{y_A}$

on solving $y_A = 0.237$

Question140

12g of a nonvolatile solute dissolved in 108g of water produces the relative lowering of vapour pressure of 0.1. The molecular mass of the solute is :
[Online April9, 2013]

Options:

A. 80

B. 60

C. 20

D. 40

Answer: C

Solution:

Solution:

$$\frac{P^\circ - P_s}{P^\circ} = \frac{W_B \times M_A}{M_B \times W_A}$$

$$0.1 = \frac{12}{M_B} \times \frac{18}{108}$$

$$m_B = \frac{12 \times 18}{0.1 \times 108} = 20$$

Question141

A molecule M associates in a given solvent according to the equation $M \rightleftharpoons (M)_n$. For a certain concentration of M, the van't Hoff factor was found to be 0.9 and the fraction of associated molecules was 0.2. The value of n is:
[Online April 22, 2013]

Options:

A. 3

B. 5

C. 2

D. 4

Answer: C

Solution:

Solution:
van't Hoff factor (i) and the degree of association are related as below:

$$i = 1 - \alpha\left(1 - \frac{1}{n}\right)$$

$$0.9 = 1 - 0.2\left(1 - \frac{1}{n}\right)$$

On solving,

$$\left(1 - \frac{1}{n}\right) = \frac{1}{2}$$

$$\frac{1}{n} = 1 - \frac{1}{2} = \frac{1}{2}$$

$$\therefore n = 2$$

Question142

How many grams of methyl alcohol should be added to 10 litre tank of water to prevent its freezing at 268K ?(K_f for water is 1.86K kgmol $^{-1}$) [Online April 25, 2013]

Options:

A. 880.07g

B. 899.04g

C. 886.02g

D. 868.06g

Answer: D

Solution:

Solution:

$$\Delta T_f = K_f m$$

where $m =$ molality

$$273 - 268 = 1.86 \times \frac{w}{M \times V}$$

$$5 = 1.86 \times \frac{w}{32 \times 10}$$

$$w = \frac{5 \times 32 \times 10}{1.86} = 860.2 \approx 868.06g$$

Question143

The density of a solution prepared by dissolving 120g of urea (mol. mass = 60u) in 1000g of water is 1.15g / mL. The molarity of this solution is :
[2012]

Options:

A. 0.50M

B. 1.78M

C. 1.02M

D. 2.05M

Answer: D

Solution:

$$\text{Molarity} = \frac{\text{Moles of solute}}{\text{Volume of solution } (\ell)}$$
$$\text{Mass of solution} = 1000 + 120 = 1120$$
$$d = \frac{M}{V}; V = \frac{M}{d} = \frac{1120}{1.15}\text{mL}$$
$$= \frac{120 \times 1.15}{60 \times 1120} \times 1000 = 2.05\text{M}$$

Question144

K_f for water is 1.86K kgmol $^{-1}$. If your automobile radiator holds 1.0kg of water, how many grams of ethylene glycol ($C_2H_6O_2$) must you add to get the freezing point of the solution lowered to $-2.8^\circ C$?
[2012]

Options:

A. 72g

B. 93g

C. 39g

D. 27g

Answer: B

Solution:

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

Given $\Delta T_f = 2.8$, $K_f = 1.86\text{K kgmol}^{-1} i = 1$

(ethylene glygol is a non- electrolyte)

Wt. of solvent $= 1\text{kg}$
Let of wt of solute $= x$
Mol. wt of ethylene glycol $= 62$

$$2.8 = 1 \times 1.86 \times \frac{x}{62 \times 1}$$

or $x = \dfrac{2.8 \times 62}{1.86} = 93\text{g}$

Question145

A solution containing 0.85g of $ZnCl_2$ in 125.0g of water freezes at $-0.23^\circ C$. The apparent degree of dissociation of the salt is (K_f for water $= 1.86 \text{K kgmol}^{-1}$, atomic mass: $Zn = 65.3$ and $Cl = 35.5$)
[Online May 12, 2012]

Options:

A. 1.36%

B. 73.5%

C. 7.35%

D. 2.47%

Answer: B

Solution:

$$\text{Mol.wt. } (M_B) = \frac{K_f \times W_B \times 1000}{\Delta T_f \times W_A}$$

$$= \frac{1.86 \times 0.85 \times 1000}{0.23 \times 125} \approx 55\text{g}$$

Where,
$W_B = 0.85\text{g}$
$W_A = 125\text{g}$
$\Delta T_f = 0^\circ C - (-23^\circ C) = 23^\circ C$

$$\text{Now, } i = \frac{M_{\text{normal}}}{M_{\text{observed}}} = \frac{136.3}{55} = 2.47$$

$$\underset{1-\alpha}{ZnCl_2} = \underset{\alpha}{Zn^{2+}} + \underset{2\alpha}{2Cl^-}$$

$$\text{Van't Hoff factor (i)} = \frac{1 - \alpha + \alpha + 2\alpha}{1} = 2.47$$

$\therefore\ \alpha = 0.735 = 73.5\%$

Question146

The freezing point of a 1.00m aqueous solution of HF is found to be $-1.91^\circ C$. The freezing point constant of water, K_f is 1.86K kgmo^{-1}. The percentage dissociation of HF at this concentration is
[Online May 26, 2012]

Options:

A. 30%

B. 10%

C. 5.2%

D. 2.7%

Answer: D

Solution:

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

$i = \dfrac{\Delta T_f}{K_f \times m} = \dfrac{1.91}{1.86 \times 1} = 1.02$

For $HI \rightleftharpoons H^+ + I^-$

$1 - \alpha + \alpha + \alpha = i = 1.027$

$1 + \alpha = 1.027$

$\alpha = 0.027$ or 2.7%

Question147

Liquids A and B form an ideal solution. At $30^\circ C$, the total vapour pressure of a solution containing 1 mol of A and 2 mol of B is $250 \mathrm{mmHg}$. The total vapour pressure becomes $300 \mathrm{mmHg}$ when 1 more mol of A is added to the first solution. The vapour pressures of pure A and B at the same temperature are
[Online May 19, 2012]

Options:

A. $150, 450 \mathrm{mmHg}$

B. $125, 150 \mathrm{mmHg}$

C. $450, 150 \mathrm{mmHg}$

D. $250, 300 \mathrm{mmHg}$

Answer: C

Solution:

Solution:
Let vapour pressure of A $= P_A^\circ$
Vapour pressure of B $= P_B^\circ$
In first solution,
Mole fraction of $A(X_A) = \dfrac{1}{1+2} = \dfrac{1}{3}$
Mole fraction of $B(X_B) = \dfrac{2}{1+2} = \dfrac{2}{3}$
According to Raoult's law,
Total vapour pressure $= 250 = P_A^\circ X_A + P_B^0 X_B$

$250 = \frac{1}{3}P_A^\circ + \frac{2}{3}P_B^\circ$ ....(i)

In second solution

Mole fraction of $A(X_A) = \frac{2}{2+2} = \frac{2}{4} = \frac{1}{2}$

Mole fraction of $B(X_B) = \frac{2}{4} = \frac{1}{2}$

∴ Total vapour pressure $= 300 = P_A^\infty X_A + P_B^\circ X_B$

$300 = \frac{1}{2}P_A^\circ + \frac{1}{2}P_B^\circ$ .....(ii)

Multiplying equation (i) by $\frac{1}{2}$ and equation (ii) by $\frac{1}{3}$

$\frac{1}{6}P_A^\circ + \frac{2}{6}P_B^\circ = 125$

$\frac{1}{6}P_A^\circ + \frac{1}{6}P_B^\circ = 100$

$\frac{1}{6}P_B^\circ = 25$

$P_B^\circ = 25 \times 6 = 150\text{mmHg}$ On substituting value of P_B° in equation (ii) we get

$300 = P_A^\circ \times \frac{1}{2} + 150 \times \frac{1}{2}$

$P_A^\circ = 450\text{mmHg}$

Question148

A 5% solution of cane sugar (molar mass 342) is isotonic with 1% of a solution of an unknown solute. The molar mass of unknown solute in g / mol is :
[2011RS]

Options:

A. 171.2

B. 68.4

C. 34.2

D. 136.2

Answer: B

Solution:

For isotonic solutions

$\pi_1 = \pi_2$

$C_1 = C_2$

$$\frac{5/342}{0.1} = \frac{1/M}{0.1}$$

$$\frac{5}{342} = \frac{1}{M}$$

$$\Rightarrow M = \frac{342}{5} = 68.4\text{g/mol}$$

Question149

On mixing, heptane and octane form an ideal solution. At 373K, the

vapour pressures of the two liquid components (heptane and octane) are 105kPa and 45kPa respectively. Vapour pressure of the solution obtained by mixing 25.0g of heptane and 35g of octane will be (molar mass of heptane = 100gmol^{-1} and of octane = 114 gmol^{-1})
[2010]

Options:

A. 72.0kPa

B. 36.1kPa

C. 96.2kPa

D. 144.5kPa

Answer: A

Solution:

$$
\begin{aligned}
& P_{Total} = P_A{}^{\circ}X_A + P_B{}^{\circ}X_B \\
& = P_{Heptane}{}^{\circ}X_{Heptane} + P_{Octane}{}^{\circ}X_{Octane} \\
& = 105 \times \frac{25/100}{\frac{25}{100} + \frac{35}{114}} + 45 \times \frac{35/114}{\frac{25}{100} + \frac{35}{114}} \\
& = 105 \times \frac{0.25}{0.25 + 0.3} + 45 \times \frac{0.3}{0.25 + 0.3} \\
& = \frac{105 \times 0.25}{0.55} + \frac{45 \times 0.3}{0.55} = \frac{26.25 + 13.5}{0.55} \\
& = 72 kPa
\end{aligned}
$$

Question150

If sodium sulphate is considered to be completely dissociated into cations and anions in aqueous solution, the change in freezing point of water (ΔT_j), when 0.01 mol of sodium sulphate is dissolved in 1kg of water, is ($K_j = 1.86 K\, kgmol^{-1}$)
[2010]

Options:

A. 0.372K

B. 0.0558K

C. 0.0744K

D. 0.0186K

Answer: B

Solution:

Sodium sulphate dissociates as

$Na_2SO_4(s) \longrightarrow 2Na^+ + SO_4^{2-}$

Hence van't Hoff factor, i = 3

Now $\Delta T_f = iK_f \cdot m$

$= 3 \times 1.86 \times 0.01 = 0.0558K$

Question151

Two liquids X and Y form an ideal solution. At $300K$, vapour pressure of the solution containing $1mol$ of X and $3mol$ of Y is $550mmHg$. At the same temperature, if 1 mol of Y is further added to this solution, vapour pressure of the solution increases by $10mmHg$. Vapour pressure (in $mmHg$) of X and Y in their pure states will be, respectively:
[2009]

Options:

A. 300 and 400

B. 400 and 600

C. 500 and 600

D. 200 and 300

Answer: B

Solution:

$P_{total} = P_x^\circ X_x + P_y^\circ X_y$

$550 = P_x^\circ \times \frac{1}{4} + P_y^\circ \times \frac{3}{4}$

$P_x^\circ + 3P_y^\circ = 550 \times 4 \ldots$ (i)

In second case,

$P_{total} = P_x^\circ \times \frac{1}{5} + P_y^\circ \times \frac{4}{5}$

$P_x^\circ + 4P_y^\circ = 560^\circ 5 \ldots$ (ii)

Subtract (i) from (ii)

$\therefore P_y^\circ = 560 \times 5 - 550 \times 4 = 600$

$\because P_x^\circ = 400$

Question152

A binary liquid solution is prepared by mixing n-heptane and ethanol. Which one of the following statements is correct regarding the behaviour of the solution?
[2009]

Options:

A. The solution is non-ideal, showing -ve deviation from Raoult's Law.

B. The solution is non-ideal, showing + ve deviation from Raoult's Law.

C. n-Heptane shows + ve deviation while ethanol shows - ve deviation from Raoult's Law.

D. The solution formed is an ideal solution.

Answer: B

Solution:

Solution:
For this solution intermolecular interactions between n -heptane and ethanol are weaker than n -heptane $-\mathrm{n}-$ heptane & ethanol-ethanol interactions, hence the solution of n -heptane and ethanol is non-ideal and shows positive deviation from Raoult'slaw.

Question153

At 80°C, the vapour pressure of pure liquid ' A ' is 520mm Hg and that of pure liquid ' B ' is 1000mmHg. If a mixture solution of ' A ' and 'B' boils at 80°C and at 1 atm pressure, the amount of ' A ' in the mixture is (1atm = 760mmHg)

[2008]

Options:

A. 52 mol percent

B. 34mol percent

C. 48 mol percent

D. 50mol percent

Answer: D

Solution:

Solution:
At 1 atmospheric pressure the boiling point of mixture is 80°C.
At boiling point the vapour pressure of mixture, $P_T = 1$ atmosphere $= 760 \mathrm{mmHg}$.
Using the relation,
$P_T = P_A^{\circ} X_A + P_B^{\circ} X_B$, we get
$P_B^{\circ} = 1000 \mathrm{mmHg}, X_A + X_B = 1 \}$
or $760 = 520 X_A + 1000 - 1000 X_A$
or $480 X_A = 240$
or $X_A = \frac{240}{480} = \frac{1}{2}$ or 50 mol. percent

Question154

The vapour pressure of water at 20°C is 17.5mmHg. If 18 g of glucose ($C_6H_{12}O_6$) is added to 178.2g of water at 20°C, the vapour pressure of the resulting solution will be

[2008]

Options:

A. $17.325\mathrm{mmHg}$

B. $15.750\mathrm{mmHg}$

C. $16.500\mathrm{mmHg}$

D. $17.500\mathrm{mmHg}$

Answer: A

Solution:

Solution:
Note: On addition of glucose to water, vapour pressure of water will decrease. The vapour pressure of a solution of glucose in water can be calculated using the relation

$$\frac{P^{\circ}-P_s}{P^{\circ}}=\frac{\text{Moles of glucose in solution}}{\text{Moles of water in solution}}$$

or $\frac{17.5-P_s}{17.5}=\frac{18/180}{178.2/18}$ $[\because P^{\circ}=17.5]$

or $17.5-P_s=\frac{0.1\times 17.5}{9.9}$

or $P_s=17.325\mathrm{mmHg}$.

Question155

A mixture of ethyl alcohol and propyl alcohol has a vapour pressure of 290mm at 300K . The vapour pressure of propyl alcohol is 200mm. If the mole fraction of ethyl alcohol is 0.6, its vapour pressure (in mm) at the same temperature will be [2007]

Options:

A. 360

B. 350

C. 300

D. 700

Answer: B

Solution:

$P_A^{\circ}=?$, Given $P_B^{\circ}=200\mathrm{mm}$, $X_A=0.6$,
$X_B=1-0.6=0.4$, $P=290$
$P=P_A+P_B=P_A^{\circ}X_A+P_B^{\circ}X_B$
$290=P_A^{\circ}\times 0.6+200\times 0.4$
$\therefore P_A^{\circ}=350\mathrm{mm}$

Question156

Equal masses of methane and oxygen are mixed in an empty container at 25˚C. The fraction of the total pressure exerted by oxygen is [2007]

Options:

A. 1 / 2

B. 2 / 3

C. $\frac{1}{3} \times \frac{273}{298}$

D. 1 / 3

Answer: D

Solution:

Let the mass of methane and oxygen $= \mathrm{mg}$.
Mole fraction of O_2

$$= \frac{\text{Moles of } O_2}{\text{Moles of } O_2 + \text{Moles of } CH_4}$$

$$= \frac{m/32}{m/32 + m/16} = \frac{m/32}{3m/32} = \frac{1}{3}$$

Partial pressure of $O_2 =$ Total pressure × mole fraction of O_2,

$$P_{O_2} = P \times \frac{1}{3} = \frac{1}{3}P$$

Question157

A 5.25% solution of a substance is isotonic with a 1.5% solution of urea (molar mass $= 60 \mathrm{gmol}^{-1}$) in the same solvent. If the densities of both the solutions are assumed to be equal to $1.0 \mathrm{gcm}^{-3}$, molar mass of the substance will be
[2007]

Options:

A. $210.0 \mathrm{gmol}^{-1}$

B. $90.0 \mathrm{gmol}^{-1}$

C. $115.0 \mathrm{gmol}^{-1}$

D. $105.0 \mathrm{gmol}^{-1}$.

Answer: A

Solution:

Osmotic pressure (π) of isotonic solutions are equal. For solution of unknown substance
($\pi = CRT$)

$C_1 = \frac{5.25/M}{V}$

For solution of urea,

$C_2(\text{ concentration }) = \frac{1.5/60}{V}$

Given, $\pi_1 = \pi_2$

$\because \pi = CRT$

$\therefore C_1RT = C_2RT$

or $C_1 = C_2$

or $\frac{5.25/M}{V} = \frac{1.5/60}{V}$

$\therefore M = 210 g/mol$

Question158

Among the following mixtures, dipole-dipole as the major interaction, is present in
[2006]

Options:

A. KCl and water

B. benzene and carbon tetrachloride

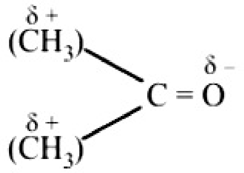
C. benzene and ethanol

D. acetonitrile and acetone

Answer: D

Solution:

Acetonitrile $\left(\overset{\delta+}{CH}_3 - C \equiv \overset{\delta-}{N}\right)$ and acetone



both are polar molecules, hence dipole-dipole interaction exists between them. Between KCl and water, ion-dipole interaction is found and in benzene-ethanol and benzene- carbon tetrachloride dispersion force is present.

Question159

Benzene and toluene form nearly ideal solution. At 20°C, the vapour pressure of benzene is 75 torr and that of toluene is 22 torr. The partial vapour pressure of benzene at 20°C for a solution containing 78g of benzene and 46g of toluene in torr is
[2005]

Options:

A. 53.5

B. 37.5

C. 25

D. 50

Answer: D

Solution:

Vapour pressure of benzene $= 75$ torr
Vapour pressure of toluene $= 22$ torr
mass of benzene in $= 78\text{g}$
Moles of benzene $= \frac{78}{78} = 1\text{mol}$
$\therefore$ (Mol.wt of benzene $= 78$)
Mass of toluene in solution $= 46\text{g}$
Hence moles of toluene $= \frac{46}{92} = 0.5\text{mol}$
Now partial pressure of benzene
$= P_b{}^0 \cdot X_b = 75 \times \frac{1}{1+0.5} = 75 \times \frac{1}{1.5}$
$= 75 \times \frac{2}{3} = 50$

Question160

Equimolar solutions in the same solvent have [2005]

Options:

A. Different boiling and different freezing points

B. Same boiling and same freezing points

C. Same freczing point but different boiling points

D. Same boiling point but different freezing points

Answer: B

Solution:

Solution:
Equimolar solutions of normal solutes in the same solvent will have the same b. pts and same f . pts.

Question161

For which of the following parameters, the structural isomers C_2H_5OH and CH_3OCH_3 would be expected to have the same values?(Assume ideal behaviour).

[2004]

Options:

A. Boiling points

B. Vapour pressure at the same temperature

C. Heat of vaporization

D. Gaseous densities at the same temperature and pressure

Answer: D

Solution:

Solution:
Gaseous densities of ethanol and dimethyl ether would be same at same temperature and pressure. The heat of vaporisation, V.P. and b.pts will differ due to H bonding in ethanol.

Question162

Which of the following liquid pairs shows a positive deviation from Raoult's law?
[2004]

Options:

A. Water - nitric acid

B. Benzene-methanol

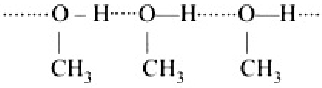
C. Water - hydrochloric acid

D. Acetone-chloroform

Answer: B

Solution:

Note: Positive deviations are shown by such solutions in which solvent-solvent and solute-solute interactions are stronger than the solvent-solute interactions. In such solutions, the interactions among molecules becomes weaker. Therefore, their escaping tendency increases which results in the increase in their partial vapour pressure.
In a solution of methanol there exists intermolecular H-bonding.



$$\cdots\cdots\underset{\underset{CH_3}{|}}{O}-H\cdots\underset{\underset{CH_3}{|}}{O}-H\cdots\cdots\underset{\underset{CH_3}{|}}{O}-H\cdots$$

In this solution benzene molecules come between methanol molecules which weaken intermolecular forces. This results in increase in vapour pressure.

Question163

Which one of the following aqueous solutions will exihibit highest

boiling point?
[2004]

Options:

A. $0.015M$ urea

B. $0.01M\ KNO_3$

C. $0.01M\ Na_2SO_4$

D. $0.015M$ glucose

Answer: C

Solution:

$\because \Delta T_b = T_b - T^\circ$
Where T_b = b . pt of solution
T_b° = b.pt of solvent or $T_b = T_b^\circ + \Delta T_b$
Note: Elevation in boiling point is a colligative property, which depends upon the no. of particles. Thus greater the number of particles, greater is it elevation and hence greater will be its boiling point.
$Na_2SO_4 \rightleftharpoons 2Na^+ + SO_4^{2-}$
Since Na_2SO_4 has maximum number of particles (3), hence has maximum boiling point.

Question164

Which one of the following statements is FALSE?
[2004]

Options:

A. The correct order of osmotic pressure for $0.01M$ aqueous solution of each compound is $BaCl_2 > KCl > CH_3COOH >$ sucrose

B. The osmotic pressure (π) of a solution is given by the equation $\pi = MRT$, where M is the molarity of the solution

C. Raoult's law states that the vapour pressure of a component over a solution is proportional to its mole fraction

D. Two sucrose solutions of same molality prepared in different solvents will have same freczing point depression

Answer: D

Solution:

Solution:
$\Delta T_f = i \times K_f \times m$.
Since K_f has different values for different solvents, hence even if m is same, ΔT_f will be different.

Question165

If liquids A and B form an ideal solution
[2003]

Options:

A. the entropy of mixing is zero

B. the free energy of mixing is zero

C. the free energy as well as the entropy of mixing is zero

D. the enthalpy of mixing is zero

Answer: D

Solution:

Solution:
When A and B form an ideal solution, $\Delta H_{mix} = 0$

Question166

A pressure cooker reduces cooking time for food because
[2003]

Options:

A. boiling point of water involved in cooking is increased

B. the higher pressure inside the cooker crushes the food material

C. cooking involves chemical changes helped by a rise in temperature

D. heat is more evenly distributed in the cooking space

Answer: A

Solution:

Solution:
Note: On increasing pressure, the temperature is also increased. Thus in pressure cooker due to increase in pressure the b.p. of water increases.

Question167

In a 0.2 molal aqueous solution of a weak acid HX, the degree of ionization is 0.3. Taking K_f for water as 1.85, the freezing point of the solution will be nearest to
[2003]

Options:

A. $-0.360^{\circ}\mathrm{C}$

B. $-0.260^{\circ}\mathrm{C}$

C. $+0.480^{\circ}\mathrm{C}$

D. $-0.480^{\circ}\mathrm{C}$

Answer: D

Solution:

$$
\begin{aligned}
&\Delta T_f = i \times K_f \times m;\\
&\Delta T_f = 1.85 \times 0.2 \times 1.3 = 0.480^{\circ}\mathrm{C}\\
&\quad (HX \rightleftharpoons H^{+} + X^{-},\quad i = 1.3)\\
&\quad 1 - 0.3\\
&\Delta T_f = T_f^{\circ} - T_f\\
&\therefore T_f = 0 - 0.480^{\circ}\mathrm{C} = -0.480^{\circ}\mathrm{C}
\end{aligned}
$$

Question168

In mixture A and B components show -ve deviation as [2002]

Options:

A. $\Delta V_{\text{mix}} > 0$ [2002]

B. $\Delta H_{\text{mix}} < 0$

C. $A - B$ interaction is weaker than $A - A$ and $B - B$ interaction

D. $A - B$ interaction is stronger than $A - A$ and $B - B$ interaction.

Answer: D

Solution:

Solution:
In solution containing A and B component showing negative deviation A-A and B-B interactions are weaker than that of A-B interactions. For such solutions,
$\Delta H = -\mathrm{ve}$ and $\Delta V = -\mathrm{ve}$

Question169

Freczing point of an aqueous solution is $(-0.186)^{\circ}\mathrm{C}$. Elevation of boiling point of the same solution is $K_b = 0.512^{\circ}\mathrm{C}$, $K_f = 1.86^{\circ}\mathrm{C}$, find the increase in boiling point. [2002]

Options:

A. 0.186˚C

B. 0.0512˚C

C. 0.092˚C

D. 0.2372˚C.

Answer: B

Solution:

$$\Delta T_b = K_b \frac{W_B}{M_B \times W_A} \times 1000$$

$$\Delta T_f = K_f \frac{W_B}{M_B \times W_A} \times 1000$$

$$\frac{\Delta T_b}{\Delta T_f} = \frac{K_b}{K_f}; \frac{\Delta T_b}{0.186} = \frac{0.512}{1.86}$$

$$= 0.0512^\circ\text{C}.$$
