



DPP-6 Relative Lowering of Vapour Pressure – SOLUTIONS

Chapter: Solution

“Being ahead is useless if you stop running.”

TYPE-1 : Conceptual & Definition Based

1. **When nonvolatile solute is added in a solvent then relative lowering in vapour pressure depends upon:-**

- (1) $\frac{\text{Number of moles of solute}}{\text{Number of moles of solvent}}$
- (2) $\frac{\text{Number of moles of solute}}{\text{Number of moles of solvent}}$
- (3) $\frac{\text{Total number of moles of solution}}{\text{Number of moles of solution}}$
- (4) $\frac{\text{Number of moles of solute}}{\text{Number of moles of solute}}$

Explanation

Relative Lowering of Vapour Pressure (RLVP) is defined as:

$$\text{RLVP} = \frac{P^\circ - P_s}{P^\circ}$$

According to **Raoult's Law**:

$$\frac{P^\circ - P_s}{P^\circ} = \chi_{\text{solute}} = \frac{n_{\text{solute}}}{n_{\text{solute}} + n_{\text{solvent}}}$$

For dilute solutions where $n_{\text{solute}} \ll n_{\text{solvent}}$:

$$\text{RLVP} \approx \frac{n_{\text{solute}}}{n_{\text{solvent}}}$$

Approach

Think of it like a crowded room:

- The more “intruders” (solute) you add relative to “residents” (solvent), the more the property changes
- RLVP depends on the **ratio of solute to solvent**

The exact formula is mole fraction of solute, but for dilute solutions it simplifies to $\frac{n_{\text{solute}}}{n_{\text{solvent}}}$

Answer

Option (1) $\frac{\text{Number of moles of solute}}{\text{Number of moles of solvent}}$

2. **The relative lowering of vapour pressure is equal to the mole fraction of the nonvolatile solute, This statement was given by :**

- (1) Raoult
- (2) Henry
- (3) Joule
- (4) Dalton

Explanation

Raoult's Law (1887) states:

“The relative lowering of vapour pressure of a solution containing a non-volatile solute is equal to the mole fraction of the solute.”

Mathematically:

$$\frac{P^\circ - P_s}{P^\circ} = \chi_{\text{solute}}$$

Approach

Memory tip for different laws:

- **Raoult's Law:** Vapour pressure of solutions (non-volatile solute)
- **Henry's Law:** Solubility of gases in liquids
- **Dalton's Law:** Partial pressures of gas mixtures
- **Joule's Law:** Heat produced by electric current

“**R**aoult” → “**R**elative lowering” (both start with R!)

Answer

Option (1) Raoult

3. **The vapour pressure of a solution having solid as solute and liquid as solvent is :**

- (1) Directly proportional to mole fraction of the solvent
- (2) Inversely proportional to mole fraction of the solvent
- (3) Directly proportional to mole fraction of the solute
- (4) Inversely proportional to mole fraction of the solute

Explanation

According to Raoult's Law for non-volatile solute:

$$P_s = P^\circ \times \chi_{\text{solvent}}$$

Where:

- P_s = Vapour pressure of solution
- P° = Vapour pressure of pure solvent
- χ_{solvent} = Mole fraction of solvent

This shows $P_s \propto \chi_{\text{solvent}}$ (directly proportional)

Approach

Logic:

- More solvent molecules \rightarrow More molecules can escape \rightarrow Higher VP
- More solute molecules \rightarrow Fewer solvent molecules at surface \rightarrow Lower VP

Think of a dance floor:

- If 90% are dancers (solvent), many can leave (high VP)
- If only 50% are dancers, fewer can leave (low VP)

VP is directly proportional to how much solvent is present (its mole fraction).

Answer

Option (1) Directly proportional to mole fraction of the solvent

$$P_s = P^\circ \cdot \chi_{\text{solvent}}$$

TYPE-2 : Raoult's Law Formula Verification

1. **Which one of the following is the incorrect form of Raoult's law**

- (1) $\frac{P_s}{P^\circ} = \frac{N}{n + N}$
- (2) $\frac{P^\circ}{P^\circ - P_s} = 1 + \frac{N}{n}$
- (3) $\frac{P^\circ - P_s}{P_s} = \frac{n}{n + N}$
- (4) $\frac{P_s}{P^\circ - P_s} = \frac{N}{n}$

Explanation

Let's denote: n = moles of solute, N = moles of solvent

Basic Raoult's Law:

$$\frac{P^\circ - P_s}{P^\circ} = \frac{n}{n + N} \quad \dots(\text{RLVP} = \text{mole fraction of solute})$$

From this, we can derive:

$$\frac{P_s}{P^\circ} = \frac{N}{n + N} \quad \dots(\text{Option 1 - Correct})$$

Approach

Let's verify each option:

Option (1): $\frac{P_s}{P^\circ} = \frac{N}{n + N}$ (This is χ_{solvent})

Option (2): $\frac{P^\circ}{P^\circ - P_s} = 1 + \frac{N}{n}$

$$\begin{aligned} \frac{P^\circ - P_s}{P^\circ} &= \frac{n}{n + N} \\ \frac{P^\circ}{P^\circ - P_s} &= \frac{n + N}{n} = 1 + \frac{N}{n} \quad \checkmark \end{aligned}$$

Option (3): $\frac{P^\circ - P_s}{P_s} = \frac{n}{n + N}$

Actually: $\frac{P^\circ - P_s}{P_s} = \frac{n}{N}$ (not $\frac{n}{n + N}$) **INCORRECT!**

Option (4): $\frac{P_s}{P^\circ - P_s} = \frac{N}{n}$

Answer

Option (3) $\frac{P^\circ - P_s}{P_s} = \frac{n}{n + N}$

The correct form should be: $\frac{P^\circ - P_s}{P_s} = \frac{n}{N}$

2. If P_0 and P_S are the vapour pressure of solvent and its solution respectively. N_1 and N_2 are the mole fraction of solvent and solute respectively then :

(1) $P_S = \frac{P_0}{N_2}$

(2) $P_0 - P_S = P_0 N_2$

(3) $P_S = P_0 N_2$

(4) $\frac{(P_0 - P_S)}{P_S} = \frac{N_1}{(N_1 + N_2)}$

Explanation

Given: N_1 = mole fraction of solvent, N_2 = mole fraction of solute

Note: $N_1 + N_2 = 1$

Raoult's Law:

$$\frac{P_0 - P_S}{P_0} = N_2 \quad (\text{RLVP} = \text{mole fraction of solute})$$

Rearranging:

$$P_0 - P_S = P_0 \cdot N_2$$

Approach

Let's verify each option:

Option (1): $P_S = \frac{P_0}{N_2} \rightarrow$ This would mean $P_S > P_0$ for $N_2 < 1$

Option (2): $P_0 - P_S = P_0 N_2$

$$\frac{P_0 - P_S}{P_0} = N_2 \quad \checkmark \quad (\text{This is Raoult's Law!})$$

Option (3): $P_S = P_0 N_2 \rightarrow$ Should be $P_S = P_0 N_1$ (not N_2)

Option (4): $\frac{(P_0 - P_S)}{P_S} = \frac{N_1}{(N_1 + N_2)} = N_1$

Actually: $\frac{P_0 - P_S}{P_S} = \frac{N_2}{N_1}$

Answer

Option (2) $P_0 - P_S = P_0 N_2$

This is the direct form of Raoult's Law: Lowering of VP = $P^\circ \times \chi_{\text{solute}}$

3. If P° and P are the vapour pressure of solvent and solution n_1 and n_2 are the moles of solute and solvent then

$$(1) P^\circ = P \left(\frac{n_2}{n_1 + n_2} \right)$$

$$(2) P = P^\circ \left(\frac{n_2}{n_1 + n_2} \right)$$

$$(3) P^\circ = P \left(\frac{n_1}{n_1 + n_2} \right)$$

$$(4) P^\circ = P \times n_1$$

Explanation

Given: n_1 = moles of **solute**, n_2 = moles of **solvent**

Raoult's Law:

$$P = P^\circ \times \chi_{\text{solvent}} = P^\circ \times \frac{n_2}{n_1 + n_2}$$

Where $\chi_{\text{solvent}} = \frac{n_2}{n_1 + n_2}$

Approach

The VP of solution equals VP of pure solvent multiplied by mole fraction of solvent:

$$P_{\text{solution}} = P_{\text{solvent}}^{\circ} \times \chi_{\text{solvent}}$$

$$P = P^{\circ} \times \frac{n_{\text{solvent}}}{n_{\text{total}}} = P^{\circ} \times \frac{n_2}{n_1 + n_2}$$

This matches **Option (2)**!

Answer

Option (2) $P = P^{\circ} \left(\frac{n_2}{n_1 + n_2} \right)$

TYPE-3 : Mole Fraction Calculation

1. The vapour pressure of a dilute aqueous solution of glucose is 750 mm Hg at 373 K. Calculate the mole fraction of solute. (The vapour pressure of pure water is 760 mm Hg at 373 K)
- (1) 0.013
 - (2) 1.3
 - (3) 0.13
 - (4) None of these

Explanation

Given:

- $P^{\circ} = 760$ mm Hg (pure water at 373 K)
- $P_s = 750$ mm Hg (solution)

Using Raoult's Law:

$$\chi_{\text{solute}} = \frac{P^{\circ} - P_s}{P^{\circ}}$$

Approach

Step 1: Apply RLVP formula

$$\chi_{\text{solute}} = \frac{P^{\circ} - P_s}{P^{\circ}} = \frac{760 - 750}{760}$$

Step 2: Calculate

$$\chi_{\text{solute}} = \frac{10}{760} = 0.01316 \approx 0.013$$

Answer

Option (1) 0.013

$$\chi_{\text{glucose}} = \frac{760 - 750}{760} = \frac{10}{760} = 0.013$$

2. One mol of non volatile solute is dissolved in two mol of water. The vapour pressure of the solution relative to that of water is

- (1) $\frac{2}{3}$
- (2) $\frac{1}{3}$
- (3) $\frac{1}{2}$
- (4) $\frac{3}{2}$

Explanation

Given:

- Moles of solute = 1
- Moles of solvent (water) = 2
- Total moles = 1 + 2 = 3

We need to find: $\frac{P_s}{P^\circ}$ (relative vapour pressure)

Approach

Using Raoult's Law:

$$\frac{P_s}{P^\circ} = \chi_{\text{solvent}} = \frac{n_{\text{solvent}}}{n_{\text{total}}}$$

$$\frac{P_s}{P^\circ} = \frac{2}{1 + 2} = \frac{2}{3}$$

Think of it as: Out of 3 molecules, only 2 are water (which can evaporate), so VP is $\frac{2}{3}$ of pure water.

Answer

Option (1) $\frac{2}{3}$

$$\text{Relative VP} = \chi_{\text{solvent}} = \frac{2}{3}$$

3. The vapour pressure of a pure liquid solvent (X) is decreased to 0.60 atm. from 0.80 atm on addition of a non volatile substance (Y). The mole fraction of (Y) in the solution is:-

- (1) 0.20
- (2) 0.25
- (3) 0.5
- (4) 0.75

Explanation

Given:

- $P^\circ = 0.80$ atm (pure solvent X)
- $P_s = 0.60$ atm (solution)

Find: χ_Y (mole fraction of solute Y)

Approach

Using RLVP formula:

$$\chi_Y = \frac{P^\circ - P_s}{P^\circ} = \frac{0.80 - 0.60}{0.80}$$

$$\chi_Y = \frac{0.20}{0.80} = \frac{1}{4} = 0.25$$

Verification: $\chi_X = 1 - 0.25 = 0.75$

Check: $P_s = P^\circ \times \chi_X = 0.80 \times 0.75 = 0.60$

Answer

Option (2) 0.25

$$\chi_{\text{solute}} = \frac{0.80 - 0.60}{0.80} = 0.25$$

4. The vapour pressure of a solvent decreased by 10 mm of Hg when a non-volatile solute was added to the solvent. The mole fraction of solute in solution is 0.2, what would be the mole fraction of solute if decrease in vapour pressure is 20 mm of Hg?

- (1) 0.8
- (2) 0.6
- (3) 0.4
- (4) 0.2

Explanation

Given:

- When $\Delta P = 10$ mm Hg, $\chi_{\text{solute}} = 0.2$
- Find χ_{solute} when $\Delta P = 20$ mm Hg

Using: $\Delta P = P^\circ - P_s = P^\circ \times \chi_{\text{solute}}$

Approach

Step 1: Find P°

From first condition:

$$\Delta P = P^\circ \times \chi_{\text{solute}}$$

$$10 = P^\circ \times 0.2$$

$$P^\circ = \frac{10}{0.2} = 50 \text{ mm Hg}$$

Step 2: Find new mole fraction when $\Delta P = 20$ mm Hg

$$20 = 50 \times \chi_{\text{solute}}$$

$$\chi_{\text{solute}} = \frac{20}{50} = 0.4$$

Simple logic: If ΔP doubles ($10 \rightarrow 20$), χ_{solute} also doubles ($0.2 \rightarrow 0.4$) because they're directly proportional!

Answer

Option (3) 0.4

Since $\Delta P \propto \chi_{\text{solute}}$, doubling ΔP doubles the mole fraction.

TYPE-4 : Calculate Vapour Pressure of Solution

1. The vapour pressure of water at room temperature is 23.8 mm of Hg. The vapour pressure of an aqueous solution of sucrose with mole fraction 0.1 is equal to :

- (1) 23.9 mm Hg
- (2) 24.2 mm Hg
- (3) 21.42 mm Hg
- (4) 31.44 mm Hg

Explanation

Given:

- $P^\circ_{\text{water}} = 23.8$ mm Hg
- $\chi_{\text{sucrose}} = 0.1$ (mole fraction of solute)
- Therefore, $\chi_{\text{water}} = 1 - 0.1 = 0.9$

Approach

Using Raoult's Law:

$$P_s = P^\circ \times \chi_{\text{solvent}}$$

$$P_s = 23.8 \times 0.9$$

$$P_s = 21.42 \text{ mm Hg}$$

Quick check: VP should decrease when solute is added. $21.42 < 23.8$

Answer

Option (3) 21.42 mm Hg

$$P_s = 23.8 \times 0.9 = 21.42 \text{ mm Hg}$$

2. **18 g of glucose ($C_6H_{12}O_6$) is added to 178.2 g of water. The vapour pressure of this aqueous solution at 100 °C is :**

- (1) 759.00 torr
- (2) 7.60 torr
- (3) 76.00 torr
- (4) 752.40 torr

Explanation

Given:

- Mass of glucose = 18 g, Molar mass = 180 g/mol
- Mass of water = 178.2 g, Molar mass = 18 g/mol
- P_{water}° at 100°C = 760 torr (boiling point)

Approach

Step 1: Calculate moles

$$n_{\text{glucose}} = \frac{18}{180} = 0.1 \text{ mol}$$

$$n_{\text{water}} = \frac{178.2}{18} = 9.9 \text{ mol}$$

Step 2: Calculate mole fraction of solvent

$$\chi_{\text{water}} = \frac{9.9}{0.1 + 9.9} = \frac{9.9}{10} = 0.99$$

Step 3: Calculate VP of solution

$$P_s = P^\circ \times \chi_{\text{water}} = 760 \times 0.99 = 752.4 \text{ torr}$$

Answer

Option (4) 752.40 torr

$$P_s = 760 \times 0.99 = 752.4 \text{ torr}$$

3. **The vapour pressure of CCl_4 at 25°C is 143 mm Hg. If 0.5 gm of a non-volatile solute (mol. weight = 65) is dissolved in 100 g CCl_4 , the vapour pressure of the solution will be**

- (1) 199.34 mm Hg
- (2) 143.99 mm Hg
- (3) 141.43 mm Hg
- (4) 94.39 mm Hg

Explanation

Given:

- $P_{\text{CCl}_4}^\circ = 143 \text{ mm Hg}$
- Mass of solute = 0.5 g, Molar mass = 65 g/mol
- Mass of CCl_4 = 100 g, Molar mass = 154 g/mol

Approach

Step 1: Calculate moles

$$n_{\text{solute}} = \frac{0.5}{65} = 0.00769 \text{ mol}$$

$$n_{\text{CCl}_4} = \frac{100}{154} = 0.649 \text{ mol}$$

Step 2: Calculate mole fraction of solvent

$$\chi_{\text{CCl}_4} = \frac{0.649}{0.00769 + 0.649} = \frac{0.649}{0.657} = 0.988$$

Step 3: Calculate VP of solution

$$P_s = 143 \times 0.988 = 141.3 \approx 141.43 \text{ mm Hg}$$

Answer

Option (3) 141.43 mm Hg

4. The vapour pressure of water at 20°C is 17.5 mm Hg. If 18 g of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) is added to 178.2g of water at 20°C , the vapour pressure of the resulting solution will be :

[AIEEE-2008, 3/105]

- (1) 15.750 mm Hg
- (2) 16.500 mm Hg
- (3) 17.325 mm Hg
- (4) 17.675 mm Hg

Explanation

This is the same calculation as Q2, but at 20°C where $P^\circ = 17.5 \text{ mm Hg}$ instead of 760 torr.

Approach

From earlier: $\chi_{\text{water}} = 0.99$

$$P_s = P^\circ \times \chi_{\text{water}} = 17.5 \times 0.99 = 17.325 \text{ mm Hg}$$

Note: Same glucose-water ratio, just different temperature!

Answer

Option (3) 17.325 mm Hg

$$P_s = 17.5 \times 0.99 = 17.325 \text{ mm Hg}$$

5. **18 g glucose ($C_6H_{12}O_6$) is added to 178.2 g water. The vapor pressure of water (in torr) for this aqueous solution is.** [JEE(Main) 2016, 4/120]

- (1) 76.0
- (2) 752.4
- (3) 759.0
- (4) 7.6

Explanation

This is identical to Q2! At 100°C (since no temperature given, assume boiling point). Same calculation: $\chi_{\text{water}} = 0.99$, $P^\circ = 760$ torr

Approach

$$P_s = 760 \times 0.99 = 752.4 \text{ torr}$$

JEE loves this question! Remember the 18g glucose + 178.2g water combination - it gives exactly 0.1 mol glucose and 9.9 mol water.

Answer

Option (2) 752.4 torr

TYPE-5 : Calculate Molecular Weight of Solute

1. **The vapour pressure of pure A is 10 torr and at the same temperature when 1 g of B is dissolved in 20 gm of A, its vapour pressure is reduced to 9.0 torr. If the molecular mass of A is 200 amu, then the molecular mass of B is :**

- (1) 100 amu
- (2) 90 amu
- (3) 75 amu
- (4) 120 amu

Explanation

Given:

- $P_A^\circ = 10$ torr, $P_s = 9$ torr
- Mass of B (solute) = 1 g, $M_B = ?$
- Mass of A (solvent) = 20 g, $M_A = 200$ g/mol

Approach

Step 1: Use RLVP formula

$$\frac{P^\circ - P_s}{P^\circ} = \frac{n_B}{n_A + n_B}$$

For dilute solutions: $\frac{P^\circ - P_s}{P^\circ} \approx \frac{n_B}{n_A} = \frac{w_B/M_B}{w_A/M_A}$

Step 2: Substitute values

$$\frac{10 - 9}{10} = \frac{1/M_B}{20/200}$$

$$\frac{1}{10} = \frac{1/M_B}{0.1} = \frac{1}{0.1 \times M_B}$$

$$0.1 \times M_B = 10$$

$$M_B = 100 \text{ amu}$$

Answer

Option (1) 100 amu

2. The vapour pressure of a solution of 5 g. of non electrolyte in 100 g. of water at a particular temperature is 2985 Nm^{-2} . The vapour pressure of pure water at that temperature is 3000 Nm^{-2} . The molecular weight of the solute is :-

- (1) 180
- (2) 90
- (3) 270
- (4) 200

Explanation

Given:

- $P^\circ = 3000 \text{ Nm}^{-2}$, $P_s = 2985 \text{ Nm}^{-2}$
- Mass of solute = 5 g, Mass of water = 100 g

Approach

Step 1: Calculate RLVP

$$\frac{P^\circ - P_s}{P^\circ} = \frac{3000 - 2985}{3000} = \frac{15}{3000} = \frac{1}{200}$$

Step 2: Use formula

$$\frac{1}{200} = \frac{w \times M_{\text{solvent}}}{m \times W}$$

Where w = mass of solute, m = molar mass of solute, W = mass of solvent

$$\frac{1}{200} = \frac{5 \times 18}{m \times 100}$$
$$m = \frac{5 \times 18 \times 200}{100} = 180 \text{ g/mol}$$

Answer

Option (1) 180

The solute is likely glucose ($\text{C}_6\text{H}_{12}\text{O}_6$)!

3. The vapour pressure of benzene at a certain temperature is 640 mm of Hg. A non-volatile and non-electrolyte solid, weighing 2.175 g is added to 39.08 g of benzene. The vapour pressure of the solution is 600 mm of Hg. What is the molecular weight of solid substance?

- (1) 69.45
- (2) 59.6
- (3) 49.50
- (4) 79.8

Explanation

Given:

- $P^\circ = 640 \text{ mm Hg}$, $P_s = 600 \text{ mm Hg}$
- Mass of solute = 2.175 g
- Mass of benzene = 39.08 g, $M_{\text{benzene}} = 78 \text{ g/mol}$

Approach

Step 1: Calculate RLVP

$$\frac{P^\circ - P_s}{P^\circ} = \frac{640 - 600}{640} = \frac{40}{640} = \frac{1}{16}$$

Step 2: Apply formula

$$\frac{1}{16} = \frac{n_{\text{solute}}}{n_{\text{solute}} + n_{\text{benzene}}}$$

Let M = molar mass of solute

$$n_{\text{solute}} = \frac{2.175}{M}, \quad n_{\text{benzene}} = \frac{39.08}{78} = 0.501$$

$$\frac{1}{16} = \frac{2.175/M}{2.175/M + 0.501}$$

Solving: $M \approx 69.45$ g/mol

Answer

Option (1) 69.45

4. The vapour pressure of acetone at 20°C is 185 torr. When 1.2 g of a non-volatile substance was dissolved in 100 g of acetone at 20°C , its vapour pressure was 183 torr. The molar mass (g mol^{-1}) of the substance is: [JEE(Main) 2015, 4/120]

- (1) 32
- (2) 64
- (3) 128
- (4) 488

Explanation

Given:

- $P^\circ = 185$ torr, $P_s = 183$ torr
- Mass of solute = 1.2 g
- Mass of acetone = 100 g, $M_{\text{acetone}} = 58$ g/mol

Approach

Step 1: Use the formula

$$\frac{P^\circ - P_s}{P^\circ} = \frac{w \times M_{\text{solvent}}}{m \times W}$$

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

Step 2: Solve for m

$$\frac{2}{185} = \frac{69.6}{100m}$$

$$m = \frac{69.6 \times 185}{2 \times 100} = \frac{12876}{200} = 64.38 \approx 64 \text{ g/mol}$$

Answer

Option (2) 64 g mol⁻¹

5. The vapor pressure of benzene is 53.3 kPa at 60.3°C, but it fall to 51.5 kPa when 19 g of a nonvolatile organic compound is dissolved in 500g benzene. The molar mass of the nonvolatile compound is [NSEC-2015]

- (A) 82
(B) 85
(C) 88
(D) 92

Explanation

Given:

- $P^\circ = 53.3 \text{ kPa}$, $P_s = 51.5 \text{ kPa}$
- Mass of solute = 19 g
- Mass of benzene = 500 g, $M_{\text{benzene}} = 78 \text{ g/mol}$

Approach

Step 1: Calculate RLVP

$$\frac{P^\circ - P_s}{P^\circ} = \frac{53.3 - 51.5}{53.3} = \frac{1.8}{53.3} = 0.0338$$

Step 2: Calculate moles of benzene

$$n_{\text{benzene}} = \frac{500}{78} = 6.41 \text{ mol}$$

Step 3: Use RLVP = χ_{solute}

$$0.0338 = \frac{19/M}{19/M + 6.41}$$

Solving: $19/M = 0.0338 \times 6.41 / (1 - 0.0338) = 0.224$

$M = 19/0.224 = 85 \text{ g/mol}$

Answer

Option (B) 85

TYPE-6 : Calculate Weight of Solute / Lowering of VP

1. How many gram of a non volatile solute having a molecular weight of 90 are to be dissolved in 97.5 g water in order to decrease the vapour pressure of water by 2.5 percent :-

- (1) 25
- (2) 18
- (3) 12.5
- (4) 9

Explanation

Given:

- $M_{\text{solute}} = 90 \text{ g/mol}$
- Mass of water = 97.5 g
- Decrease in VP = 2.5% means $\frac{P^\circ - P_s}{P^\circ} = 0.025$

Approach

Step 1: Use RLVP formula

$$\frac{P^\circ - P_s}{P^\circ} = \frac{w \times M_{\text{solvent}}}{m \times W}$$

$$0.025 = \frac{w \times 18}{90 \times 97.5}$$

Step 2: Solve for w (mass of solute)

$$w = \frac{0.025 \times 90 \times 97.5}{18} = \frac{219.375}{18} = 12.19 \approx 12.5 \text{ g}$$

Answer

Option (3) 12.5 g

2. **At room temperature, a dilute solution of urea is prepared by dissolving 0.60 g of urea in 360 g of water. If the vapour pressure of pure water at this temperature is 35 mm Hg, lowering of vapour pressure will be : (molar mass of urea = 60 g mol⁻¹) [JEE(Main) 2019 Online (09-04-19)S1, 4/120]**

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

Explanation

Given:

- Mass of urea = 0.60 g, $M_{\text{urea}} = 60 \text{ g/mol}$
- Mass of water = 360 g
- $P^\circ = 35 \text{ mm Hg}$

Find: $\Delta P = P^\circ - P_s$ (lowering of VP)

Approach

Step 1: Calculate moles

$$n_{\text{urea}} = \frac{0.60}{60} = 0.01 \text{ mol}$$

$$n_{\text{water}} = \frac{360}{18} = 20 \text{ mol}$$

Step 2: Calculate mole fraction of solute

$$\chi_{\text{urea}} = \frac{0.01}{0.01 + 20} = \frac{0.01}{20.01} \approx 0.0005$$

Step 3: Calculate lowering of VP

$$\Delta P = P^\circ \times \chi_{\text{solute}} = 35 \times 0.0005 = 0.0175 \approx 0.017 \text{ mmHg}$$

Answer

Option (3) 0.017 mmHg

3. 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 : [JEE(Main)

2018 Online 15-04-18), 4/120]

- (1) $\frac{4}{3}$
(2) $\frac{3}{4}$
(3) $\frac{1}{2}$
(4) $\frac{1}{4}$

Explanation

Given:

- Both solutions are 5 molal (5 mol solute per 1000 g solvent)
- $M_X = \frac{3}{4}M_Y$
- RLVP in X = $m \times$ RLVP in Y

For dilute solutions: $\text{RLVP} \approx \frac{n_{\text{solute}}}{n_{\text{solvent}}}$

Approach

$$\text{Molality} = \frac{\text{moles of solute}}{1000 \text{ g of solvent}} = 5$$

So moles of solute = 5 (in both cases, per 1000 g solvent)

Moles of solvent:

$$n_X = \frac{1000}{M_X}, \quad n_Y = \frac{1000}{M_Y}$$

RLVP:

$$\text{RLVP}_X = \frac{5}{1000/M_X} = \frac{5M_X}{1000}$$

$$\text{RLVP}_Y = \frac{5}{1000/M_Y} = \frac{5M_Y}{1000}$$

Ratio:

$$m = \frac{\text{RLVP}_X}{\text{RLVP}_Y} = \frac{M_X}{M_Y} = \frac{3}{4}$$

Answer

Option (2) $\frac{3}{4}$

Since $M_X = \frac{3}{4}M_Y$, the ratio $m = \frac{3}{4}$

— **END OF SOLUTIONS** —

Being ahead is useless if you stop running. Keep solving!

