LIQUID SOLUTION

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

(1) heat must be absorbed in order to produce the solution at 35°C

(2) Raoult's law is not obeyed by this system

(3) a mixture of 100 mL CS_2 and 100 mL acetone has a volume < 200 mL

(4) CS_2 and acetone are less attracted to each other than to themselves

2. 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 -

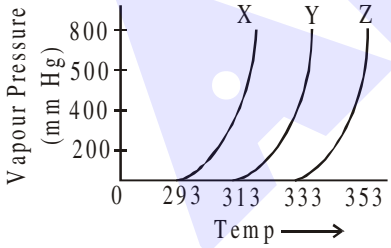
(1) The volume of the solution does not change and the volume of the solvent decreases

(2) The volume of the solution decrease and the volume of the solvent increases

(3) The volume of the solution increase and the volume of the solvent decreases

(4) The volume of the solution and the solvent does not change

3. A graph of vapour pressure and temperature for three different liquids X, Y and Z is shown below:



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 :

(1) A (2) (C)

(3) (B) (4) (A) and (C)

4. How much amount of NaCl should be added to 600 g of water (ρ = 1.00 g/mL) to decrease the freezing point of water to – 0.2 °C ? _____. (The freezing point depression constant for water = 2K kg mol^{-1})

5. The osmotic pressure of a solution of NaCl is 0.10 atm and that of a glucose solution is 0.20 atm. The osmotic pressure of a solution formed by mixing 1 L of the sodium chloride solution with 2 L of the glucose solution is $x \times 10^{-3}$ atm. x is _____. (nearest integer) :-

6. At 300 K, the vapour pressure of a solution containing 1 mole of n-hexane and 3 moles of n-heptane is 550 mm 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 10 mm of Hg. What is the vapour pressure in mm Hg of n-heptane in its pure state ____ ?

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

	α	β	γ	δ
K_H	50	2	2×10^{-5}	0.5

(density of water = 10^3 kg m^{-3} at 298 K)

This table implies that :

(1) The pressure of a 55.5 molal solution of γ is 1 bar

(2) The pressure of a 55.5 molal solution of δ is 250 bar

(3) Solubility of γ at 308 K is lower than at 298 K

(4) α has the highest solubility in water at a given pressure

8. If 250 cm^3 of an aqueous solution containing 0.73 g of a protein A is isotonic with one litre of another aqueous solution containing 1.65 g of a protein B, at 298 K, the ratio of the molecular mases of A and B is _____ $\times 10^{-2}$ (to the nearest integer).

9. A set of solutions is prepared using 180 g of water as a solvent and 10 g 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 g mol^{-1}; B = 200 g mol^{-1}; C = 10,000 g mol^{-1}]

(1) A > B > C

(2) A > C > B

(3) C > B > A

(4) B > C > A

SOLUTION

1. NTA Ans. (3)

Sol. The vapour pressure of mixture (= 600 mm Hg) is greater than the individual vapour pressure of its constituents (Vapour pressure of CS_2 = 512 mm Hg, acetone = 344 mm Hg). Hence, the solution formed shows positive deviation from Raoult's law.

$\Rightarrow (1)\Delta_{Sol}H > 0$, (2) Raoult's law is not obeyed

(3) $\Delta_{sol.}$ Volume > 0

(4) CS_2 and Acetone are less attracted to each ether than to themselves.

2. NTA Ans. (3)

Sol. The pure solvent solution will try to maintain higher vapour pressure in the sealed container and in return the solvent vapour molecules will condense in the solution of non-volatile solute as it maintains an equilibrium with lower vapour pressure. (Lowering of vapour pressure is observed when a non volatile solute is mixed in a volatile solvent)

This will eventually lead to increase in the volume of solution and decrease in the volume of solvent.

3. NTA Ans. (3)

Sol. Order of B.P. is : Z > Y > X

Order of vapour pressure : Z < Y < X

order of intermolecular interaction : Z > Y > X.

4. NTA Ans. (1.74 to 1.76 or 0.03)

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

$$0.2 = 2 \times 2 \times \frac{w/58.5}{600/1000}$$

w = 1.755 gm

5. Official Ans. by NTA (167)

Sol. Osmotic pressure = $\pi = i \times C \times RT$

For NaCl i = 2 so

$\pi_{NaCl} = i \times C_{NaCl} \times RT$ C_{NaCl} = conc. of NaCl

$0.1 = 2 \times C_{NaCl} \times RT$

$$C_{NaCl} = \frac{0.05}{RT}$$ $C_{glucose}$= conc. of glucose

For glucose i = 1 so

$\pi_{Glucose} = i \times C_{glucose} \times RT$

$0.2 = 1 \times C_{glucose} \times RT$

$$C_{Glucose} = \frac{0.2}{RT}$$ η_{NaCl} = No. of moles NaCl

η_{NaCl} in 1 L = $C_{NaCl} \times V_{Litre}$

$$= \frac{0.05}{RT}$$ $\eta_{glucose}$= No. of moles glucose

$\eta_{glucose}$ in 2 L = $C_{glucose} \times V_{Litre}$

$$= \frac{0.4}{RT}$$

$V_{Total} = 1 + 2 = 3L$

so Final conc. NaCl = $\frac{0.05}{3RT}$

Final conc. glucose = $\frac{0.4}{3RT}$

$\pi_{Total} = \pi_{NaCl} + \pi_{glucose}$

$$= \left[i \times C_{NaCl} + C_{glucose}\right] \times RT$$

$$= \left(\frac{2 \times 0.05}{3RT} + \frac{0.4}{3RT}\right) \times RT$$

$$= \frac{0.5}{3} \text{atm}$$

$= 0.1666$ atm

$= 166.6 \times 10^{-3}$ atm

$\Rightarrow 167.00 \times 10^{-3}$ atm

so x = 167.00

6. Official Ans. by NTA (600)

Sol. $$550 = P_A^o \times \frac{1}{4} + P_B^o \times \frac{3}{4}$$

$$2200 = P_A^o + 3P_B^o \quad \text{.....(i)}$$

$$2800 = P_A^o + 4P_B^o \quad \text{....(ii)}$$

$$560 = P_A^o \times \frac{1}{5} + P_B^o \times \frac{4}{5}$$

$$P_B^o = 600, P_A^o = 400$$

7. Official Ans. by NTA (2)

Sol. (1) $P_\gamma = K_H X_Y$

$$P_\gamma = 2\times10^{-15}\times\frac{55.5}{55.5+\frac{1000}{18}} = 2\times10^{-5}\text{ K bar}$$

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

(2) $P_\delta = K_H\, X_\delta$

$$P_\delta = 0.5\times\frac{55.5}{55.5+\frac{1000}{18}} = .249\text{ K bar} = 249\text{ bar}$$

(3) On increasing temperature solubility of gases decreases

(4) $K_H \downarrow$ solubility $\uparrow$ and lowest K_H is for γ.

8. Official Ans. by NTA (177)

9. Official Ans. by NTA (1)

Sol. Relative lowering of V.P. = $\frac{\Delta P}{P^0} = x_{solute}$

$$\left(\frac{\Delta P}{P^0}\right)_A = \frac{\frac{10}{100}}{\frac{10}{100}+\frac{180}{18}} : \left(\frac{\Delta P}{P^0}\right)_B = \frac{\frac{10}{200}}{\frac{10}{200}+\frac{180}{18}}$$

$$\left(\frac{\Delta P}{P^0}\right)_C = \frac{\frac{10}{10,000}}{\frac{10}{10,000}+\frac{180}{18}} : \left(\frac{\Delta P}{P^0}\right)_A > \left(\frac{\Delta P}{P^0}\right)_B > \left(\frac{\Delta P}{P^0}\right)_C$$