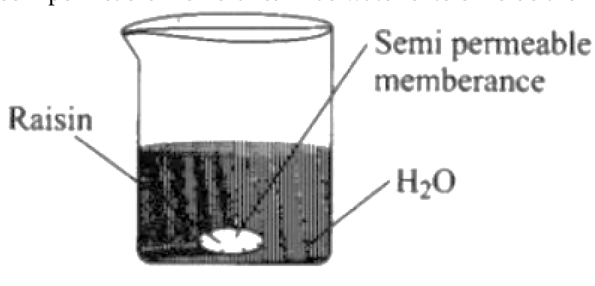
Solution

SOLUTIONS

Class 12 - Chemistry

1. T = 37^0C = 310 k
$\pi = CRT = \frac{n}{v}RT$
$= 0.25 \times 0.083 \times 310$
= 6.43 bar.
2. Azeotropes or azeotropic mixtures (meaning in greek boiling without change).
3. Common salt (NaCl) is a strong electrolyte that dissociates completely in aqueous solution to give Na^+ and Cl^- ions. Therefore these ions conducts electricity. On the other hand Sugar does not give ions in aqueous solution. Hence, it does not conduct electricity.
4. Azeotropes are binary mixtures having same composition in liquid and vapour phase and boil at a constant temperature. So the solutions (liquid mixtures) which boil at constant temperature and can distill unchanged in composition are called azeotropes.
5. $\frac{P_A^0 - P_A}{P_A^0} = \frac{W_B \times M_A}{W_A \times M_B}$
P_A^0 = Vapour pressure of water = 100
P_A = Vapour pressure of solution = 75
W_B = mass of urea = ?
M_A = molar mass of water = 18g
W_A = mass of water = 50g
M_B = molar mass of urea = 60g/mol
$\frac{100-75}{100} = \frac{W_B \times 18}{50 \times 60}$
$W_B = \frac{25 \times 60 \times 50}{100 \times 18} = 41.66g$
6. It means that 10 g of Na_2CO_3 is dissolved in 100-10 = 90 g of water.
7. As the temperature increases, volume increases and molarity decreases whereas molality does not change with any change in temperature.
8. The mass of a gas dissolved in a given mass of a solvent at any temperature is proportional to the pressure of the gas above the solvent.
The mathematical expression is $p = K_H\ x$
where K_H is Henry's Law constant, p is the partial pressure of the gas in the vapour phase, x is mole fraction of the gas.
9. Molality is temperature independent while molarity decreases with increase in concentration. This is because of expansion or contraction of the liquid with temperature.
10. Reverse osmosis occurs when a pressure greater than osmotic pressure is applied to the solution. So reverse osmosis is the process of movement of solvent through a semipermeable membrane from the solution to pure solvent by applying excess pressure greater than osmotic pressure on the solution side.
11. Raisins swell in size on keeping in water. This happens due to the phenomenon of osmosis. The outer skin of raisin acts as a semipermeable membrane. Water moves from a place of lower concentration to a place of higher concentration through the semipermeable membrane. Thus water enters inside the raisins and makes them swell.



Applications of the phenomenon

- Movement of the water from the soil into plant roots and subsequently into the upper portion of the plant is partly due to the process of osmosis.
- Preservation of meat against bacterial action by adding salt.

- Preservation of fruits against bacterial action by adding sugar. The bacterium in canned fruit loses water through the process of osmosis, shrivels, and dies.
- Reverse osmosis (the pure solvent flows out of the solution through a semi-permeable membrane) is used for the desalination of water.

12. Given,
$w_B = 8g, w_A = 100g, K_b = 2.02 Kg\,mol^{-1},\ M_B = ?$
Elevation in boiling point ($\Delta \mathrm{T}_b$)
$= 36.86^0 C - 35.60^0 C = 1.26^0 C$
We know that
$M_B = \frac{1000 \times w_B \times K_b}{\Delta T_b \times w_A} = \frac{1000 \times 8 \times 2.02}{1.02\ \times\ 100}$
$M_B = 158.43 g\,mol^{-1}$
13. Degree of dissociation of AB = $\frac{5}{100} = 0.05$
$AB \rightarrow A^{+} + B^{-}$
$M \quad 0 \quad 0$
No. of moles dissolved
No. of moles after dissociations
$m\,(1-\alpha) \qquad m\alpha \qquad m\alpha$
$0.1\,(1-0.05) \quad 0.1 \times 0.05 \quad 0.1 \times 0.05$
Total moles $= [0.1(1-0.05)] + (0.1 \times 0.05) + (.1 \times 0.05)$
= 0.095 + 0.005 + 0.005 = 0.105 m
$\Delta T_f = \mathrm{K_f.\,m}$
$= 1.86 \times 0.105$
= 0.1953 deg.
$T_f = 0^0 C - 0.1953 = -0.1953^0 C$
14. i. **Colligative properties:** The properties of solution which depend upon the number of solute particles and not upon the nature of the solute particles are known as colligative properties.
There are four colligative properties:
    a. Relative lowering of vapour pressure.
    b. Elevation of boiling point
    c. Depression of freezing point
    d. Osmotic pressure.

    ii. **Molality (m) :** It is the number of moles of solute dissolved per kilograms (kg) of the solvent. It is denoted by m.
Molality (m) $= \frac{\text{Mole of solute}}{\text{Mass of solvent in Kg}}$
$\therefore\ m = \frac{W_2 \times 1000}{M_2 \times W_1}$
Where W_1 = Mass of solvent
W_2 = Mass of solute
M_2 = Molar mass of solute
15. Solubility product of CuS, $K_sp = 6 \times 10^{-16}$
Let s be the solubility of CuS in $molL^{-1}$
$CuS \leftrightarrow Cu^{2+} + S^{2+}$
Now,$K_sp = \left[Cu^{2+}\right]\left[S^{2-}\right]$
$= s \times s$
$= s^2$
Then, we have, $K_sp = s^2 = 6 \times 10^{-16}$
$s = \sqrt{6 \times 10^{-16}} = 2.45 \times 10^{-8} molL^{-1}$
Hence, the maximum molarity of CuS in an aqueous solution is $2.45 \times 10^{-8} molL^{-1}$
16. The partial pressures are related to the mole fractions x_1 and x_2 of the two components 1 and 2 this relation is known as **Raoult's law** which state that For a solution of volatile liquids: the partial vapour pressure of each component of the solution is directly proportional to its mole fraction present in solution. Thus, for any component, partial vapour pressure,
p α $\chi \Rightarrow$ p = $p^o \chi$
Where P^o is the vapour pressure of pure component and χ is the mole fraction of that component.

The similarity between Raoult's law and Henry's law: Both laws state that the partial pressure of the volatile component is directly proportional to its mole fraction in the solution. In the case of Raoult's law, it is liquid and in the case of Henry's law, it is gas.

17. a. Given,

$w_B\ (glucose)$ = 0.520 g

$w_A\ (H_2O)$ = 80.2 g

$K_f\ (H_2O) = 1.86 Km^{-1}$

$M_2(glucose) = 180\ g\ mol^{-1}$

$\Delta T_f = \frac{K_f \times w_B \times 1000}{M_B \times w_A}$

$\Delta T_f = \frac{1.86Km^{-1} \times 0.520g \times 1000}{180g\ mol^{-1} \times 80.2g}$

$\Delta T_f = 0.0669\ K\ or\ 0.0669^0 C$

$T_f^0 - T_f = 0.0669^0 C$

$0 - T_f = 0.0669^0 C$

$T_f = 0.0669^0 C$

b. Given, w_A = 500 g

Boiling point of solution (T_b)= 100.42^0C

$\mathrm{K}_b(H_2O) = 0.512\ K\ kg\ mol^{-1} M_2(C_3H_8O_3)$

$= (3 \times 2) + (8 \times 1) + (3 \times 16)$

$= 92\ g\ mol^{-1}$

$\Delta T_b = T_b - T_b^0$

$= 373.42 - 373\ K\ = 0.420\ K$

As we know

$\Delta T_b = \frac{k_b \times w_B \times 1000}{M_B \times\ w_A}$

$\Rightarrow\ w_B = \frac{\Delta T_b \times M_B \times w_A}{K_b \times 1000}$

$w_B = \frac{0.42\ K \times 92\ g\ mol^{-1} \times 500g}{0.512\ K\ kg\ mol^{-} \times 100kg^{-1}} = 377.3g$

18. Given that, 0.6mL of acetic acid (CH_3COOH) density = 1.06gmL^{-1}

Number of moles of acetic acid = $\frac{0.6\mathrm{mL} \times 1.06\mathrm{gmL}^{-1}}{60\mathrm{gmol}^{-1}}$ = 0.0106 mol = n

Molality = $\frac{0.0106\mathrm{mol}}{1000\mathrm{mL} \times 1\mathrm{gmL}^{-1}}$ = 0.0106 mol kg^{-1}

Using equation of depression of freezing point ΔT_f = 1.86 K kg mol^{-1} $\times$ 0.0106 mol kg^{-1} = 0.0197K

van't Hoff Factor (i) = $\frac{\text{Observed freezing point}}{\text{Calculated freezing point}} = \frac{0.0205\mathrm{K}}{0.0197\mathrm{K}}$ = 1.041

Acetic acid is a weak electrolyte and will dissociate into two ions:

acetate and hydrogen ions per molecule of acetic acid. If x is the degree of dissociation of acetic acid, then we would have n(1 - x) moles of undissociated acetic acid, nx moles of CH_3COO^- and nx moles of H^+ ions,

$$\underset{\substack{n\ mol \\ n(1-x)}}{CH_3COOH} \rightleftharpoons \underset{\substack{0 \\ nx\ mol}}{H^+} + \underset{\substack{0 \\ nx\ mol}}{CH_3COO^-}$$

Thus total moles of particles are: n(1 - x + x + x) = n(1 + x)

i = $\frac{n(1+x)}{n}$ = 1 + x = 1.041

Thus degree of dissociation of acetic acid = x = 1.041 - 1.000 = 0.041

Then [CH_3COOH] = n(1 - x) = 0.0106(1 - 0.041)

[CH_3COO^-] = nx = 0.0106 $\times$ 0.041, [H^+] = nx = 0.0106 $\times$ 0.041}

K_a = $\frac{[\mathrm{CH_3COO^-}][\mathrm{H^+}]}{[\mathrm{CH_3COOH}]} = \frac{0.0106 \times 0.041 \times 0.0106 \times 0.041}{0.0106(1.00-0.041)}$

=1.86 $\times$ 10^{-5}

19. The colligative properties like elevation in boiling point and depression in freezing point depend upon molality of solution, this is called colligative molality. We get abnormal molecular mass if the solute either undergoes association or dissociation.

$\Delta T_f = iK_f \times m$

$0.256 = i \times 5.12 \times 0.1$

$i = \frac{0.256}{0.512} = \frac{1}{2}$

As the value of van't hoff factor is less than 1, the benzoic acid undergoes association in solution.
Benzoic acid exists as dimer in benzene.