CHAPTER-1

SOLUTION

1. Define molarity
It is defined as the number of moles of solute dissolved per litre of the solution.

$$M = \frac{\text{No of moles of solute}}{\text{volume of soln in litres}}$$

2. Define molality
It is define as the number of moles of solute dissolved per 1000 g of the solvent.

$$m = \frac{\text{No of moles of solute}}{\text{Mass of solvent in Kg}}$$

3. What do you mean by mass percentage?
Mass percentage of a component in a given solution is the mass of the component per 100 gram of the solution. (w/w %)

$$(w/w\ \%) = \frac{\text{Mass of component in soln}}{\text{Total mass of soln}} \times 100$$

4. Define mole fraction.
It is define as the ratio of number of moles of one component to the total number of moles present in the solution.

$$X_A = \frac{n_A}{n_A + n_B} \qquad X_B = \frac{n_B}{n_A + n_B} \qquad X_A + X_B = 1$$

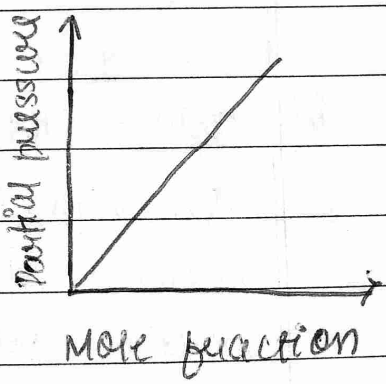
5. What are the factors that affect the solubility of solid in a liquid?

i) Nature of solute and solvent - Like dissolves like
ii) Effect of temperature - Solubility increases with increase in temperature.
iii) Effect of pressure - Pressure don't have significant effect on the solubility.

6. Why do gases always tend to be less soluble in liquids as the temperature is raised?
Solubility of a gas decreases with increase in temperature because in most of the cases the dissolution of gas is exothermic process.

7. State Henry's law?
Henry's law states that the partial pressure of the gas in the vapour phase is proportional to the mole fraction of the gas in the solution.

$$p \propto \chi$$
$$p = K_H \chi$$



*. Higher the value of K_H at a given pressure, lower is the solubility of the gas in liquid.

8. Why aquatic species are more comfortable in cold water rather than in warm waters?
Due to the presence of more oxygen. Solubility of oxygen in water increases with decrease in temperature

as solubility of a gas in given liquid decreases with increase in temperature

9. Explain the following phenomena with the help of Henry's law.
i) Painful condition known as bends.
ii) Feeling of weakness and discomfort in breathing.
iii) Why soda water bottle kept at room temperature fizzes on opening?

i) Henry's law represents a relation between solubility of gases in liquid and pressure. Scuba divers when come towards surface, the pressure gradually decreases. This reduce pressure releases the dissolve gas present in blood and leads to the formation of bubbles of nitrogen in blood.

ii) At high altitude atmospheric pressure is low as compared to surface which causes difficulty in breathing. On that condition we feel weakness and discomfort.

iii) Soda water bottles kept at room temperature fizzes on opening due to different pressure inside and outside the bottle. When the bottle is opened to air, partial pressure of CO_2 above the solution decreases. As a result, solubility decreases and hence CO_2 bubbles out.

10. State Raoult's law?
At a given temperature for a solution of volatile liquid, the partial vapour pressure of each component is equal to the product of vapour pressure of pure component and its mole fraction.

$$p_A = p^0_A x_A$$
$$p_B = p^0_B x_B$$
$$p_t = p_A + p_B$$
$$= p^0_A x_A + p^0_B x_B$$
$$= p^0_A x_A + p^0_B (1 - x_A)$$
$$= (p^0_A - p^0_B) x_A + p^0_B$$

Mole fraction of each component in vapour phase
$$Y_A = p_A / p_t$$

11. How Raoult's law is a special case of Henry's law.
a) Both Raoult's law and Henry's law apply to voltaile component in solution.
b) Both law states that vapour pressure of one component is directly proportional to mole fraction of that component.

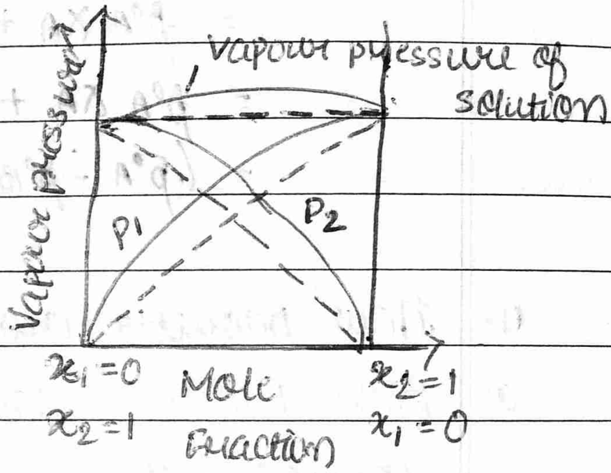
12. What do you mean by ideal and non-ideal solution?
Ideal solutions are such solutions which obey Raoult's law exactly over an entire range of concentration.

In ideal solutions the force of interaction between solute - solute, solute - solvent and solvent - solvent molecules is similar.
Characteristics of ideal solution.
1. Heat change in mixing is zero. $\Delta H_{mix} = 0$
2. Volume of mixing of solution is zero.

Non ideal solutions are such solutions which does not obey Raoult's law over the entire range of concentration

+ deviation - In this the interaction between solute-solvent molecules is less than that of solute-solute and solvent-solvent interaction. Hence the escaping tendency of molecules increases hence the vapour pressure is more than expected from Raoult's law.

Ex - Ethanol and acetone
Ethyl alcohol and cyclo hexane
Acetone and carbon disulphide
Benzene and acetone.



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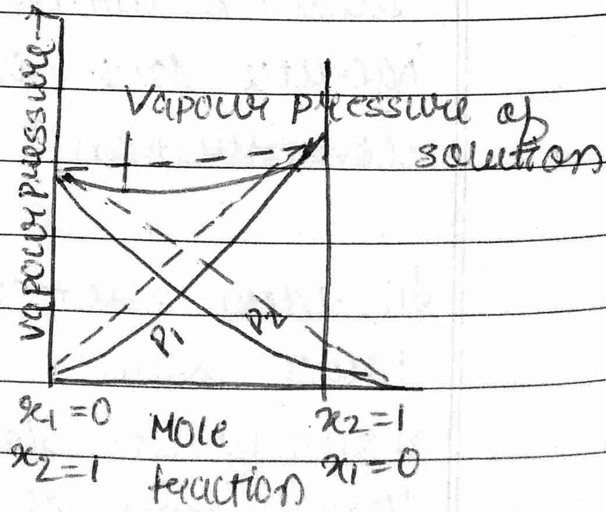
Ex - Phenol and aniline
Chloroform and acetone



13. Define azeotropes? What are two types of azeotropes give examples of each?

Azeotropes are constant boiling mixtures which can distill unchange in composition.

Types of azeotropes -

i) Minimum boiling azeotropes - solutions which shows positive deviation from Raoult's law.

Ex - Ethanol and water

ii) Maximum boiling azeotropes - solutions which shows negative deviation from Raoult's law.

ex - Nitric acid and water, hydrochloric acid and water.

14. What do you mean by colligative property?

The properties of the solution which depend only on the number of solute particles but not on the nature of solute.

• Relative lowering of vapour pressure of an ideal solution containing the non-volatile solute is equal to the mole fraction of solute at a given temperature.

$$\frac{p^0_A - p}{p^0_A} = \chi_B$$

where p - Total pressure.

p^0_A - pure vapour pressure.

χ_B - Mole fraction of solute.

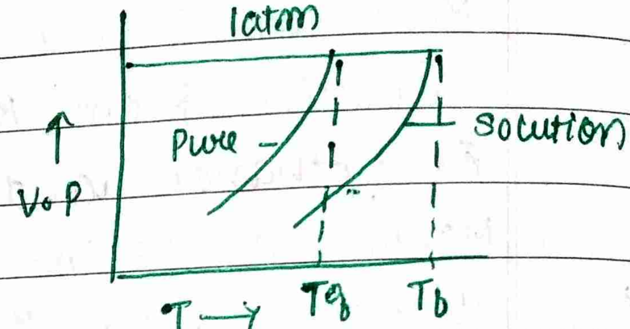
$$M_B = \frac{W_B \times M_A}{W_A \times \left(\frac{p^0_A - p}{p^0_A}\right)}$$

On adding a non-volatile solute to the liquid, the vapour pressure decreases and hence to boil it (vapour pressure = atmospheric pressure) more amount of temperature is required hence boiling point increases.

$\Delta T_b = T_b - T^o_b$

$\Delta T_b = m K_b$ K_b - Ebullioscopic constant, m - molality of soln

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

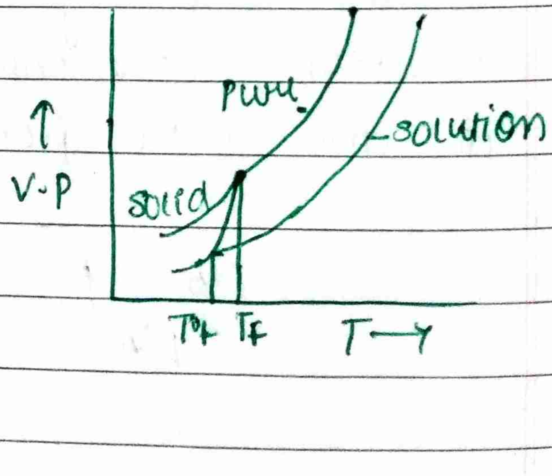


- On adding a non-volatile solute to the liquid the vapour pressure decreases and hence the freezing point (vapour pressure of solid = vapour pressure of liquid) decreases.

$\Delta T_f = T^o_f - T_f$

$\Delta T_f = m K_f$ · K_f = Cryoscopic constant, m - molality

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



- Osmosis is the phenomenon of the flow of solvent through semi-permeable membrane from pure solvent (L.C) to solution (H.C).

15. What do you mean by osmotic pressure?

Osmotic pressure is the excess of pressure which must be applied to a solution to prevent the passage of solvent into it through a semi permeable membrane.

- When the pressure applied exceeds the osmotic pressure the solvent flows out of solution and this phenomenon is called reverse osmosis.

$\pi = CRT$ R - 0.083 L bar mol^{-1}K^{-1}

8.134

C - concentration T - Temperature in kelvin

$$M_B = \frac{W_B \times R \times T \times 1000}{V_{soln} \times \pi}$$

- Isotonic soln - soln having same osmotic pressure.

Hypotonic soln - Body swells up, hypertonic soln - Body shrink up.

16. Define abnormal molar mass. Explain the cause of abnormal molar mass.

If the molar mass calculated using colligative property do not match with the expected or theoritical value of molar mass is called abnormal molar mass.

Cause of abnormal molar mass

i) When association or dissociation occur in the solution the number of solute particles changes and hence colligative property change which in turn effect the molar mass.

- Vant Hoff factor is used to identify the extent of dissociation or association of solute in solution.

$$i = \frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$$

$$i = \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$$

In case of association

$i < 1$ Degree of association $\alpha = \frac{i-1}{(1/n)-1}$

n - No of molecules formed after association

In case of dissociation

$i > 1$ Degree of dissociation $\alpha = \frac{i-1}{n-1}$

n - No of molecules formed after dissociation

17. Measurement of osmotic pressure method is preferred for the determination of molar masses of macromolecules such as proteins and polymers. Why?

i) It can be measured around room temperature
ii) Osmotic pressure values are larger and measurable even for dilute solutions.
iii) Molarity of the solution is used instead of molality.

18. Elevation of boiling point of 1M KCl solution is nearly double than that of 1M sugar solution?

Because on dissolution KCl forms two ions so the value of vant Hoff factor increases by two hence the boiling point.

19. An increase in temperature is observed on mixing chloroform and acetone.

A mixture of chloroform and acetone forms a a solution with negative deviation from Raoult's law. This is because chloroform forms hydrogen bond with acetone molecule. This decreases escaping tendency and the temperature of solution is increased because of stab[ility] attained by associating.

22. Red Blood cells shrink when placed in saline water but swell in distilled water?
RBCs shrink when placed in saline water because of ~~ox~~ exosmosis i.e water comes out from the cell to surrounding to equate the concentration. Whereas, when placed in distilled water concentration within the cell becomes more than the surrounding, hence water comes inside and endosmosis takes place to equate the concentration.

23. How does the sprinkling of salt help in clearing the snow covered roads in hilly areas?
When salt is spread over snow covered roads, snow starts melting from the surface because ~~of~~ depression of freezing point of water takes place due to addition of salt.