UNIT-9

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MY REVISION TIMELINE:-

SUMMARY:-

- Solution is a homogeneous mixture of two or more substances, consisting of atoms, ions or molecules.
- > Types of solutions:
 - Solid solution
 - Liquid solution
 - Gaseous solution
- Concentration terms:
 - Molality (m)
 - Molarity (M)
 - Normality (N)
 - Formality (F)
 - Mole fraction (X)
 - Mass percentage $(\%\frac{w}{w})$
 - Volume percentage $(\% \frac{V}{v})$
 - Mass by volume percentage $(\% \frac{w}{n})$
 - Parts per million (ppm)
- Factors influencing the solubility
 - Nature of solute and solvent
 - Effect of temperature
- Henry's law: The partial pressure of the gas in vapour phase (vapour pressure of the solute) is directly proportional to the mole fraction (X) of the gaseous solute in the solution at low concentration.

 $P_{solute} = k_H X_{solute in solution}$

Raoult's law: In the case of a solution of volatile liquids, the partial vapour pressure of each component (A&B) of the solution is directly proportional to its mole fraction.

$$\mathbf{P}_{\mathbf{A}} = \mathbf{P}_{\mathbf{A}}^{\circ} \mathbf{X}_{\mathbf{A}} \qquad \mathbf{P}_{\mathbf{B}} = \mathbf{P}_{\mathbf{B}}^{\circ} \mathbf{X}_{\mathbf{B}}$$

 $A \rightarrow Solute \quad B \rightarrow Solvent$

Ideal solution: Solution in which each component i.e., the solute as well as the solvent obey Raoult's law over the entire range of concentration.

Note: Practically no solution is ideal over the entire range of concentration.

- Non-ideal solution: Solution which do not obey Raoult's law over the entire range of concentration.
- Factors responsible for deviation from Raoult's law:
- +1 Chemistry

- Solute-solvent interactions
- Dissociation of solute
- Associtaion of solute
- Temperature
- Pressure
- Concentration
- Colligative properties:
 - Relative lowering of vapour pressure
 - Elevation of boiling point
 - Depression in freezing point
 - Osmotic pressure
- Isotonic solutions: Two solutions having same osmotic pressure at a given temperature is called isotonic solutions.
- Reverse osmosis: A process in which a solvent passes through a semi permeable membrane in the opposite direction of osmosis.

FORMULAS:-

· . V 1				
·				
· . T Z 1				
$A + A_B = 1$				
100				
Volume percentage $(\% \frac{V}{V}) = \frac{Volume \ of \ solute \ (in \ ml)}{Volume \ of \ solution \ (in \ ml)} \times 100$				
$\frac{lute\ (in\ g)}{ution\ (in\ ml)} \times 100$				
Calculation of stock solution and final volume $C_sV_s = C_wV_w$				
Relative lowering of vapour pressure = $\frac{P^{\circ}_{solvent} - P_{solution}}{P^{\circ}_{solvent}} = X_{B} = \frac{n_{B}}{n_{A}}$				

K_b =
$$\frac{RT^2 M_{solvent}}{M_{trap}}$$
 i = $\frac{\partial Served colligative properties}{Calculated colligative properties}
 a Dissociation = $\frac{(1-1)}{n-1}$
 a Association = $\frac{n(1-1)}{n-1}$
TEXTBOOK EVALUATION Multiple choice questions:
 1. The molality of a solution containing 1.8g of glucose dissolved in 250g of water is
 (a) 0.2 M
 (b) 0.01 M
 (c) 0.02 M
 (d) 0.04 M
 Explanation:
 Molality = $\frac{m_2}{M_2 W_1} = \frac{1.8}{180 \times 0.25}$
 (d) 0.04 M
 Explanation:
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 (d) 0.04 M
 Explanation:
 Molality = $\frac{m_2}{M_2 W_1} = \frac{1.8}{180 \times 0.25}$
 (d) nolarity
 (c) mole fraction
 (d) (a) and (c)
 S Stomach acid, a dilute solution of HCI can be neutralised by reaction with Aluminium hydroxide
 Al(OH)₃ + 3HCl(aq) → AlCl₃ + 3H₂O
 How many millilitres of 0.1 M Al(OH)₃ solution are needed to neutralise 21 mL of 0.1 M
 HCl
 (a) 14 mL
 (b) 7 mL
 (c) 21 mL
 (d) none of these
 Explanation:
 $M_1 V_1 = M_2 V_2$
 $V_1 = \frac{0.1 \times 21}{0.3}$
U = $\frac{0.76}{0.3}$
U = $\frac{0.76}{0.3}$
U = $\frac{1.8}{0.3}$
U = $\frac{0.76}{0.3}$
U = $\frac{0.76}{0.3}$
U = $\frac{0.11}{0.00}$
U = $\frac{0.11}{0.3}$$

 $P_{N2} = 0.76 \text{ atm}$ $K_{H} = 7.6 \text{ x } 10^{4}$ x = ? $P_{N2} = K_{H} \cdot X$ $0.76 = 7.6 \text{ x } 10^{4} \times X$ $X = \frac{0.76}{7.6 \times 10^{4}}$

$$= P_1 - x_2(P_1 - P_2)$$

- 9. Osmotic pressure (π) of a solution is given by the relation
 - (a) $\pi = nRT$ (b) $\pi V = nRT$
 - (c) $\pi RT = n$ (d) none of these
- **10.** Which one of the following binary liquid mixtures exhibits positive deviation from Raoults law?
 - (a) Acetone + chloroform
 - (c) HCI + water

(b) Water + nitric acid

(d) ethanol + water

- **11.** The Henry's law constants for two gases A and B are x and y respectively. The ratio of mole fractions of A to B is 0.2. The ratio of mole fraction of B and A dissolved in water will be



12. At 100°C the vapour pressure of a solution containing 6.5g a solute in 100g water is 732mm. If $K_b = 0.52$, the boiling point of this solution will be

(a) $102^{\circ}C$ (b) $100^{\circ}C$ (c) $101^{\circ}C$ (d) $100.52^{\circ}C$ Explanation: $W_2 = 6.5g$ $W_1 = 100g$ $K_b = 0.52$ $\frac{\Delta P}{P^{\circ}} = \frac{W_2 M_1}{M_2 W_1}$ $\frac{760-732}{760} = \frac{6.5 \times 18}{M_2 \times 100}$ $M_2 = 31.75$ $\Delta T_b = K_b.m = \frac{0.52 \times 6.5 \times 100}{31.75 \times 100} = 1.06$ $T_b - 100 = 1.06$ $T_b = 100+1.06 = 101.06$

$T_b \approx 101^{\bullet}C$

13. According to Raoult's law, the relative	Lowering of vapour pressure for a solution is						
equal to							
(a) mole fraction of solvent	(b) mole fraction of solute						
(c) number of moles of solute	(d) number of moles of solvent						
14. At same temperature which pair of the f	following solutions are isotonic?						
(a) 0.2 M BaCl_2 and 0.2 M urea	(b) 0.1 M glucose and 0.2 M urea						
(c) 0.1 MNaCl and 0.1 MK ₂ SO ₄	(d) 0.1 MBa(NO ₃) ₂ and 0.1 MNa ₂ SO ₄						
Explanation:							
$0.1 \text{ x } 3 \text{ ion } [\text{Ba}^2 + 2\text{NO}_3^-]$							
0.1 x 3 ion [2Na ⁺ , SO ₄ ⁻]	A						
15. The empirical formula of a non-electrol	yte(X) is CH ₂ O. A solution containing six gram of						
X exerts the same osmotic pressure as that of 0.025 M glucose solution at the same							
temperature. The molecular formula of	temperature. The molecular formula of X is						
(a) $C_2H_4O_2$	(b) $C_8H_{16}O_8$						
(c) $C_4H_8O_4$	(d) CH ₂ O						
Explanation:	()~						
$C_1RT = C_2RT$							
$\frac{W_1}{W_2} = \frac{W_2}{W_2}$							
$M_1 \qquad M_2$							
$\frac{0}{n(30)} = 0.025$							
n = 8	· O'						
	Molecular formula = $C_8H_{16}O_8$						
16. The K_H for the solution of oxygen disso	<i>Molecular formula</i> = $C_8 H_{16} O_8$ lved in water is 4 x 10 ⁴ atm at a given						
16. The K_H for the solution of oxygen disso temperature. If the partial pressure of ox	<i>Molecular formula</i> = $C_8H_{16}O_8$ lived in water is 4 x 10 ⁴ atm at a given kygen in air is 0.4 atm, the mole fraction of						
16. The K _H for the solution of oxygen disso temperature. If the partial pressure of ox oxygen in solution is	<i>Molecular formula</i> = $C_8H_{16}O_8$ lved in water is 4 x 10 ⁴ atm at a given kygen in air is 0.4 atm, the mole fraction of						
16. The K_H for the solution of oxygen disso temperature. If the partial pressure of ox oxygen in solution is (a) 4.6 x 10 ³	$Molecular formula = C_8 H_{16} O_8$ Ived in water is 4 x 10 ⁴ atm at a given sygen in air is 0.4 atm, the mole fraction of (b) 1.6 x 10 ⁴						
 16. The K_H for the solution of oxygen disso temperature. If the partial pressure of ox oxygen in solution is (a) 4.6 x 10³ (c) 1 x 10⁻⁵ 	Molecular formula = $C_8H_{16}O_8$ lived in water is 4 x 10 ⁴ atm at a given kygen in air is 0.4 atm, the mole fraction of (b) 1.6 x 10 ⁴ (d) 1 x 10 ⁵						
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16. The K _H for the solution of oxygen disso temperature. If the partial pressure of ox oxygen in solution is (a) $4.6 \ge 10^3$ (c) $1 \ge 10^{-5}$ Explanation: $K_H = 4 \ge 10^4$ atm, $(P_{O2})_{air} = 0.4$ atm, $(x_{o2})_{in \text{ solution}} = ?$	Molecular formula = $C_8H_{16}O_8$ lved in water is 4 x 10 ⁴ atm at a given xygen in air is 0.4 atm, the mole fraction of (b) 1.6 x 10 ⁴ (d) 1 x 10 ⁵						
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 16. The K_H for the solution of oxygen disso temperature. If the partial pressure of ox oxygen in solution is (a) 4.6 x 10³ (c) 1 x 10⁻⁵ Explanation: K_H = 4 x 10⁴ atm, (Po₂)_{air} = 0.4 atm, (x_{o2})_{in solution} = ? air - in solution (Po₂)_{air} = K_H(x_{o2})_{in solution} 0.4 = 4 x 10⁴ (x_{o2})_{in solution} (x_{o2})_{in solution} = ^{0.4}/_{4×10⁴} 17. Normality of 1.25M sulphuric acid is (a) 1.25 N (c) 2.5 N 	$Molecular formula = C_8 H_{16} O_8$ lved in water is 4 x 10 ⁴ atm at a given xygen in air is 0.4 atm, the mole fraction of (b) 1.6 x 10 ⁴ (d) 1 x 10 ⁵ $= 1 \times 10^{-5}$ (b) 3.75 N (d) 2.25 N						
 16. The K_H for the solution of oxygen dissortemperature. If the partial pressure of oxoxygen in solution is (a) 4.6 x 10³ (c) 1 x 10⁻⁵ Explanation: K_H = 4 x 10⁴ atm, (Po2)air = 0.4 atm, (xo2)in solution = ? air - in solution (Po2)air = K_H(xo2)in solution 0.4 = 4 x 10⁴(xo2)in solution 0.4 = 4 x 10⁴(xo2)in solution (xo2)in solution = ^{0.4}/_{4×10⁴} 17. Normality of 1.25M sulphuric acid is (a) 1.25 N (c) 2.5 N Explanation: 	$Molecular formula = C_8 H_{16} O_8$ lved in water is 4 x 10 ⁴ atm at a given kygen in air is 0.4 atm, the mole fraction of (b) 1.6 x 10 ⁴ (d) 1 x 10 ⁵ $= 1 x 10^{-5}$ (b) 3.75 N (d) 2.25 N						
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	Normality of $H_2SO_4 = 2 \times 1.25$							
	-		Normality of $H_2SO_4 = 2.5N$					
18.	Two liquids X and Y on mixing gives a	warm solution. The s	solution is					
	(a) ideal							
	(b) non-ideal and shows positive deviation from Raoults law							
	(c) ideal and shows negative deviation from Raoults Law							
	(d) non – ideal and shows negative deviation from Raoults Law							
19.	• The relative lowering of vapour pressure of a sugar solution in water is 3.5×10^{-3} . The							
	mole fraction of water in that solution is							
	(a) 0.0035	(b) 0.35	4					
	(c) 0.0035/18	(d) 0.9965						
	Explanation:		\sim					
	$\frac{\Delta P}{P^{\circ}} = X_{sugar}$							
	$3.5 \times 10^{-3} = X_{sugar}$		$\sim ()'$					
	-		$X_{sugar} + X_{H2O} = 1$					
20.	The mass of a non-volatile solute (molar	mass 80 g mol ⁻¹) wl	hich should be dissolved in					
	92g of toluene to reduce its vapour press	sure to 90%	~					
	(a) 10g	(b) 20g						
	(c) 9.2 g	(d) 8.89g						
	Explanation:	0						
	$\frac{\Delta P}{P^{\circ}} = X_2$							
	$\frac{100-90}{100} = \frac{n_2}{100}$							
	$100 n_2 + n_1$ $n_2 + n_1 100 92$)						
	$\frac{n_2 + n_1}{n_2} = \frac{100}{10} n_1 = \frac{32}{92} = 1$							
	$1 + \frac{1}{2} = 10$							
	n_2 1							
	$n_2 = \frac{1}{9}$							
	$\frac{W_2}{M_2} = \frac{1}{9}$							
	$W_2 = \frac{80}{2}$							
	w ₂ - 9							
71	For a relation the plat of annuatic process		$W_2 = 8.89g$					
21.	1. For a solution, the plot of osmotic pressure (π) verses the concentration (e in mol L ⁻¹)							
	gives a straight line with slope 310 K where 'K' is the gas constant. The temperature at							
	(a) $310 \times 0.082 \text{ K}$	(b) 310°C						
	(a) 310×0.002 K	(1) 310 C						
	(c) 57°C	(a) $\frac{1}{20.082}$						
	Explanation:							

 $\pi = CRT$ m = RT310R = RTT = 310 K

T = 37°C
22. 200 ml of an aqueous solution of a protein contains 1.26g of protein. At 300K, the osmotic pressure of this solution is found to be 2.52 x 10⁻³ bar. The molar mass of protein will be (R = 0.083 Lhar mol⁻¹ K⁻¹)
(a) 62.22 Kg mol⁻¹ (b) 12444 g mol⁻¹
(c) 300g mol⁻³ (d) none of these
Explanation:

$$\pi = CRT$$

 $\pi = \frac{W}{M \times v} RT$
 $M = \frac{126 \times 0.083 \times 300}{2.52 \times 10^{-3} \times 0.2}$
M = 62.22 kg mol⁻¹
23. The Van't Hoff factor (i) for a dilute aqueous solution of the strong electrolyte barium hydroxide is
(a) 0 (b) 1
(c) 2 (d) 3
Explanation:
Ba(OH)2 dissociates to form Ba⁺² and 2OH⁺ ion
 $\alpha = \frac{t-1}{n-1}$
 $i = \alpha(n-1) + 1$
n = i = 3
24. What is the molality of a 10% w/w aqueous sodium hydroxide solution?
(a) 2.778 (b) 2.5
(c) 10 (a) 0.4
Explanation:
Molality = $\frac{No of moles of solute}{Weight of solvent (ln Kg)}$
Molality = $\frac{\frac{4}{20}}{0.1}$
25. The correct equation for the degree of an associating solute, 'n' molecules of which undergoes association in solution, is
(a) $\alpha = \frac{n(t-1)}{1-n}$ (b) $\alpha^2 = \frac{n(t-1)}{n-1}$
(c) $\alpha = \frac{n(t-1)}{1-n}$ (d) $\alpha = \frac{n(t-1)}{n(1-t)}$
26. Which of the following aqueous solutions has the highest boiling point?
(a) 0.1 M KNO3 (b) 0.1 M KaSO4

Explanation:

Elevation of boiling point is more in the case of Na_3PO_4 (no. of ions 4; (i.e.,) $3Na^+$, PO_4^{3-})

i = 2.50

 $\alpha = 0.92$

- **27.** The freezing point depression constant for water is 1.86° k kg mo1⁻¹. If 5g Na₂SO₄ is dissolved in 45g water, the depression in freezing point is 3.64°C. The Van't Hoff factor for Na₂SO₄ is
 - (a) 2.50 (b) 2.63 (c) 3.64 (d) 5.50
 - **Explanation:**

 $\Delta T_F = i \times K_F \times m$ $\mathbf{i} = \frac{\Delta T_F \times M_2 \times W_1}{\Delta T_F \times M_2 \times W_1}$ $\overline{K_F \times W_2 \times 1000}$ $i = \frac{3.64 \times 142 \times 45}{2}$ 1.86×5×1000

- 28. Equimolal aqueous solutions of NaCI and KCI are prepared. If the freezing point of NaCI
 - is -2° C, the freezing point of KCI solution is expected to be
 - $(a) 2^{\circ}C$ $(b) - 4^{\circ}C$ $(c) - 1^{\circ}C$ (d) $0^{\circ}C$
- 29. Phenol dimerises in henzene having van't Hoff factor 0.54. What is the degree of association?
 - (b) 92 (a) 0.46 (c) 46 (d) 0.92 **Explanation:** $\alpha = \frac{n(i-1)}{n-1}$ $\alpha = \frac{2(1-1)}{2-1}$
- 30. Assertion: An ideal solution obeys Raoults Law

Reason: In an ideal solution, solvent-solvent as well as solute-solute interactions are similar to solute-solvent interactions.

(a) both assertion and reason are true and reason is the correct explanation of assertion

- (b) both assertion and reason are true but reason is not the correct explanation of assertion
- (c) assertion is true but reason is false
- (d) both assertion and reason are false

Write brief answers to the following questions:-

31. Define i)Molality ii)Normality.

- > The number of moles of solute present in one kg of solvent.
 - $Molality = \frac{No.of moles of solute}{Mass of solvent (in kg)}$
- > The number of gram equivalents of solute present in one litre of solution.

Normality =
$$\frac{No.of \ gram \ equivalent \ of \ solute}{Volume \ of \ Solution \ (in \ L)}$$

- 32. What is a vapour pressure of liquid? What is relative lowering of vapour pressure?
 - > The pressure of vapour in equilibrium with its liquid is the **vapour pressure** of the liquid at the given temperature.

- The ratio of the difference between the vapour pressure of pure solvent and the vapour pressure of a solution to the vapour pressure of pure solvent is relative lowering of vapour pressure.
- $\blacktriangleright \text{ Relative lowering of vapour pressure} = \frac{P^{\circ}_{solvent} P_{solution}}{P^{\circ}_{solvent}}$

33. State and explain Henry's law.

- Henry's law states "that the partial pressure of the gas in vapour phase is directly proportional to the mole fraction (x) of the gaseous solute in the solution at low concentrations."
- Henry's law can be expressed as

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\mathbf{P}_{\text{solute}} \propto \mathbf{x}_{\text{solute in solution}}
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 $\mathbf{P}_{solute} = \mathbf{K}_{\mathbf{H}}$. $\mathbf{x}_{solute in solution}$

where

 $\mathbf{x}_{solute} = mole fraction of solute in the solution$

 $\mathbf{K}_{\mathbf{H}} =$ empirical constant.

 $P_{solute} = Vapour pressure of the solute (or) the partial pressure of the gas in vapour state. The value of K_H depends on the nature of the gaseous solute and solvent.$

- Limitations of Henry's law:
 - Henry's law is applicable at moderate temperature and pressure only.
 - Only the less soluble gases obeys Henry's law.
 - The gases reacting with the solvent do not obey Henry's law. For example, ammonia or HCl reacts with water and hence does not obey this law.
 NH₃ + H₂O ≒ NH₄⁺ + OH⁻
 - The gases obeying Henry's law **should not associate or dissociate** while dissolving in solvent.

34. State Raoult law and obtain expression for lowering of vapour pressure when -non-volatile solute is dissolved in solvent.

Raoult's law states that "In the case of a solution of volatile liquids, the partial

vapour pressure of each component (A&B) of the solution is directly proportional to its **mole fraction**."

According to Raoult's law,

P_{solution} $\propto x_A$ Where x_A is the mole fraction of the solvent P_{solution} = k . x_A When $x_A = 1$, $k = P^\circ_{solvent}$ (P°_{solvent} is the partial pressure of pure solvent) P_{solution} = P°_{solvent} - x_A $1 - \frac{P_{solution}}{P^\circ_{solvent}} = 1 - x_A$ Lowering of vapour pressure = P°_{solvent} - P_{solution} Relative lowering of vapour pressure = $\frac{P^\circ_{solvent} - P_{solution}}{P^\circ_{solvent}} = x_B$ where x_B = Mole fraction of solute.

 $(x_A + x_B = 1, x_B = 1 - x_A)$

The relative lowering of vapour pressure of an ideal solution containing the **non volatile solute** is equal to the **mole fraction of the solute** at a given temperature.

- 35. What is molal depression constant? Does it depend on nature of the solute?
 - Molal freezing point depression constant or cryoscopic constant is the depression in freezing point for one molal solution.
 - > It doesn't depend on the nature of the solute but **depends on the nature of solvent**.

36. What is osmosis?

Osmosis is a **spontaneous process** by which the solvent molecules pass through a **semi permeable membrane** from a solution of **lower concentration** to a solution of **higher concentration**.

37. Define the term 'isotonic solution'.

Two solutions having **same osmotic pressure** at a given temperature is called isotonic solution.

38. You are provided with a solid 'A' and three solutions of A dissolved in water – one saturated, one unsaturated, and one super saturated. How would you determine which solution is which?

Add the solute to all the solutions and structures

- > If the **solute dissolves**, then that solution is an **unsaturated** one.
- > If the solute settle down at the bottom then that solution is a saturated one.
- > If **precipitation** (crystallisation) occurs then that solution is a **super standard** one.

39. Explain the effect of pressure on the solubility.

- Generally the change in pressure does not have any significant effect in the solubility of solids and liquids as they are not compressible.
- However, the solubility of gases generally increases with increase of pressure. Consider a saturated solution of a gaseous solute dissolved in a liquid solvent in a closed container. In such a system, the following equilibrium exists.
- ➤ Gas (in gaseous state) \(\sigma\) Gas (in solution)
- According to Le-Chatelier principle, the increase in pressure will shift the equilibrium in the direction which will reduce the pressure. Therefore, more number of gaseous molecules dissolves in the solvent and the solubility increases.

40. A sample of 12 M Concentrated hydrochloric acid has a density 1.2 gL⁻¹. Calculate the molality.

Given:

Molarity = 12 M HCIDensity of the solution = 1.2 g L^{-1} In 12 M HCl solution, there are 12 moles of HCl in 1 litre of the solution. Calculate mass of water (solvent)

Formula used:

Molality (m) = $\frac{No.of \text{ moles of solute}}{Mass \text{ of solvent (in kg)}}$

Solution:

Mass of 1 litre HCI solution = density x volume = $1.2 \text{gmL}^{-1} \text{ x } 1000 \text{ mL} = 1200 \text{ g}$ Mass of HCI = No. of moles of HCI x molar mass of HCI = $12 \text{mol x } 36.5 \text{ g mol}^{-1} = 438 \text{ g}$ Mass of water = mass of HCI solution – mass of HCI Mass of water = 1200 - 438 = 762 g

Molality (m) = $\frac{No.of \text{ moles of solute}}{Mass \text{ of solvent (in kg)}}$ Molality (m) = $\frac{12}{0.762}$

Molality (m) = 15.75m

41. A 0.25 M glucose solution at 370.28 K has approximately the pressure as blood does what is the osmotic pressure of blood?

Given: C = 0.25 MT = 370.28 KFormula used: $(\pi)_{gIucose} = CRT$ Solution: $(\pi)_{glucose} = CRT$ $(\pi) = 0.25 \text{ mol } L^{-1} \ge 0.082 \text{ L} \text{ atm } \text{K}^{-1} \text{ morl}^{-1} \ge 370.28 \text{ K}$

 $(\pi) = 7.59 atm$

42. Calculate the molality of a solution containing 7.5 g of glycine (NH₂-CH₂-COOH) dissolved in 500 g of water. ~;0

Given:

Mass of glycine = 7.5gMass of water = 500g = 0.5kgFormula used: Molality (m) = $\frac{No.of \text{ moles of solute}}{Mass of solvent (in kg)}$

Solution:

No. of moles of glycerine = $\frac{Mass \ of \ glycine}{Molar \ mass \ of \ glycine}$ No. of moles of glycerine = $\frac{7.5}{75}$ No. of moles of glycerine = 0.1Molality (m) = $\frac{No.of \text{ moles of solute}}{Mass \text{ of solvent (in kg)}}$ Molality (m) = $\frac{0.1}{0.5}$

Molality (m) = 0.2m

43. Which solution has the lower freezing point? 10 g of methanol (CH₃OH) in 100g of water (or) 20 g of ethanol (C₂H₅OH) in 200 g of water.

Given:

Mass of methanol = 10g in 100g of water Mass of ethanol -20g in 200g of water Formula used: $\Delta T_f = K_f \cdot m \text{ i.e. } \Delta T_f \propto m$ Solution: $m_{CH_3OH} = \frac{\frac{10}{32}}{\frac{0.1}{20}} = 3.125 \mathrm{m}$ $m_{C_2H_5OH} = \frac{\overline{46}}{0.2} = 2.174$ m

Therefore, depression in freezing point is more in methanol solution and it will have lower freezing point.

44. How many moles of solute particles are present in one litre of 10⁻⁴ M potassium sulphate? Solution:

In 10^{-4} M K₂SO₄ solution, there are 10^{-4} moles of potassium sulphate. K_2SO_4 molecule contains 3 ions (2 K⁺ and $1SO_4^{2-}$) 1 mole of K_2SO_4 contains 3 x 6.023 x 10²³ ions 10 mole of K₂SO₄ contains 3 x 6.023 x 10^{23} x 10^{-4} ions

 $= 18.069 \times 10^{19}$

45. Henry's law constant for solubility of methane in benzene is 4.2x10⁻⁵ mm Hg at a particular constant temperature. At this temperature calculate the solubility of methane at i) 750 mm Hg ii) 840 mm Hg.

Given: $(K_{\rm H})_{\rm Benzene} = 4.2 \text{ x } 10^{-5} \text{ mm Hg}$ Solubility of methane = ? P = 750 mm HgP = 840 mm HgFormula used: According to Henry's Law, $P = K_H$. $x_{solution}$ Solution: i) 750 mm Hg = 4.2×10^{-5} mm Hg . x_{solution} $x_{\text{solution}} = \frac{750}{4.2 \times 10^{-5}}$

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ii) Similarly at P = 840 \text{ mm Hg}
solubility = \frac{840}{4.2 \times 10^{-5}}
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i.e., *solubility* = 178.5×10^{5}

solubility = 200×10^5

46. The observed depression in freezing point of water for a particular solution is 0.093° C. Calculate the concentration of the solution in molality. Given that molal depression constant for water is 1.86 kKg mol⁻¹.

Given: $T_1 = 0.093^{\circ}C = 0.093K$ m = ? $K_{\rm f} = 1.86 {\rm K \ kg \ mol^{-1}}$ Formula used: $\Delta T_f = k_f \cdot m$ Solution: ΔT_f m = k_f 0.093 m = 1.86 $m = 0.05 \text{ mol kg}^{-1}$

m = 0.05m

47. The vapour pressure of pure benzene (C_6H_6) at a given temperature is 640 mm Hg. 2.2 g of non-volatile solute is added to 40 g of benzene. The vapour pressure of the solution is 600 mm Hg. Calculate the molar mass of the solute?

Given: P°C₆H₆ = 640 mm Hg W₂ = 2.2 g (non volatile solute) W₁ = 40 g (benzene) P_{solution} = 600 mm Hg M₂ = ? Formula used: $\frac{P^{\circ}solvent - P_{solution}}{P^{\circ}solvent} = x_2$ Solution: $\frac{P^{\circ}solvent - P_{solution}}{640 - 600} = \frac{n_2}{n_1 + n_2} [n_1 >> n_2; n_1 + n_2 = n_1]$ $\frac{40}{640} = \frac{n_2}{n_1}$ $0.0625 = \frac{W_2}{M_2} \frac{M_1}{W_1}$ $M_2 = \frac{2.2 \times 78}{0.0625 \times 40}$

 $M_2 = 68.64 \text{ gmol}^{-1}$