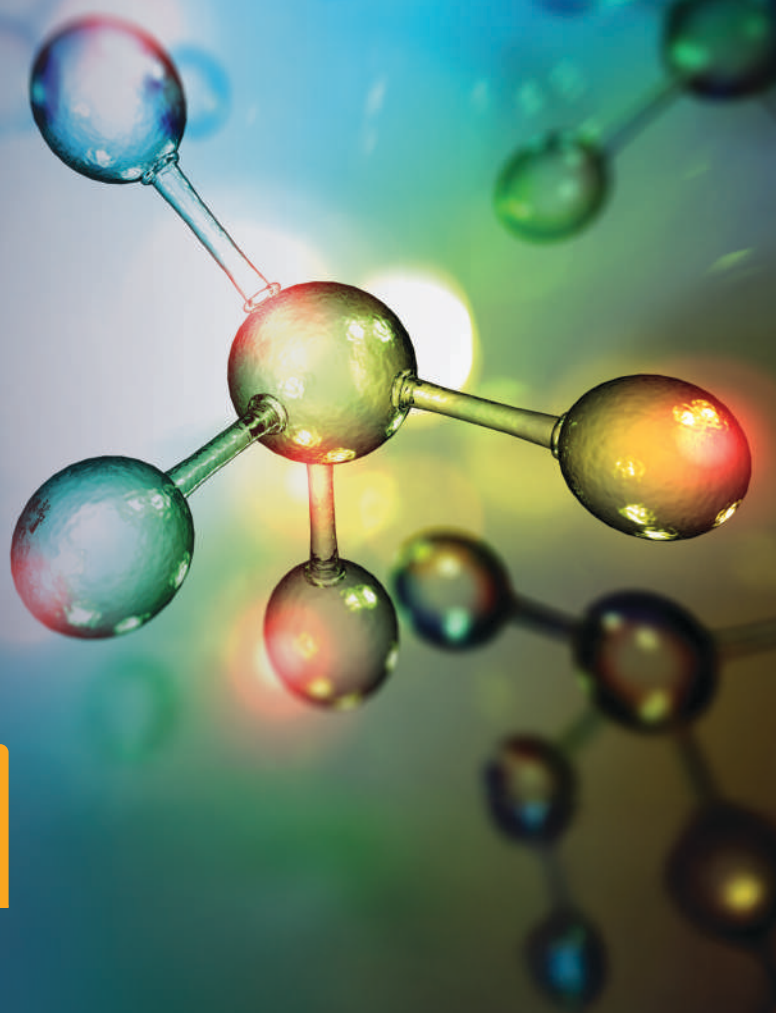
PHYSICS WALLAH

LAKSHYA JEE

CLASS-XII

- Solutions
- Electrochemistry
- Chemical Kinetics



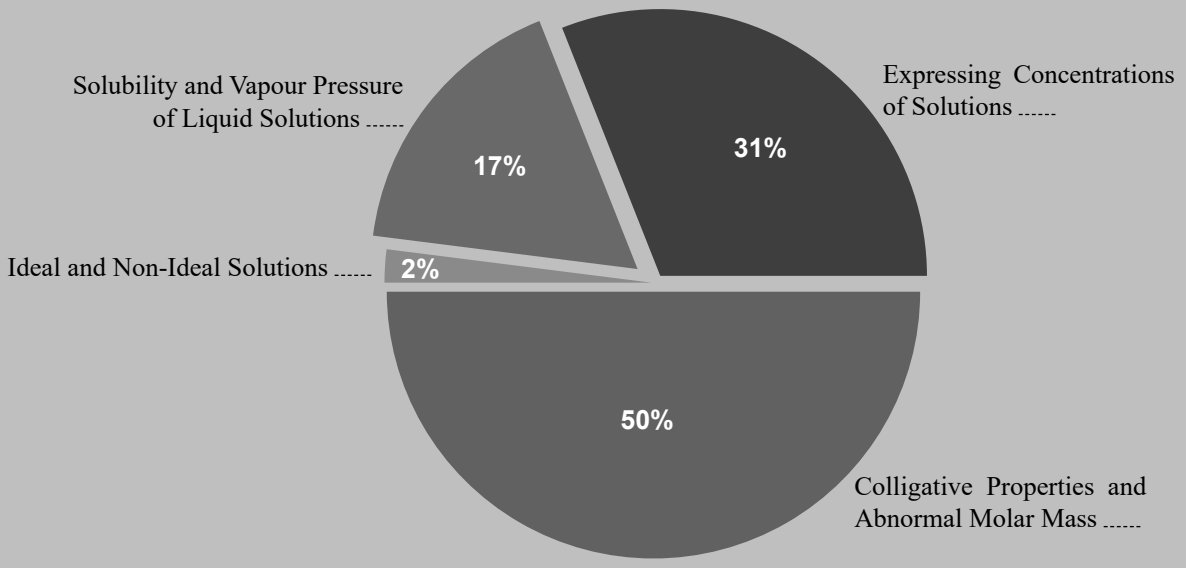
CHEMISTRY

Module 1

CHAPTER

1 Solutions

Topicwise Weightage of JEE Main 6 Years Paper (124 Sets)



"How's the Josh?" for these Topics: *Mark your confidence level in the blank space around the topic (Low-L, Medium-M, High-H)*

INTRODUCTION

A solution may be defined as a homogeneous mixture of a single phase containing two or more of the chemical species dispersed on a molecular scale. The characteristics of any one section of the homogeneous solution will be completely identical to those of any other section of the solution. Depending upon the number of total constituents present in the solution, it is called binary solution (two constituents), ternary solution (three constituents), quaternary solution (four constituents) and so on.

(*i*) **Solvent:** The liquid or medium of dissolution which allows the solute to dissolve in it so as to form a solution is called a solvent.

(*ii*) **Solute:** The substance which dissolves or disappears in the solvent to form a solution is called solute.

Solute + Solvent = Solution.

(*iii*) The component which has the same physical state in pure form as the solution is called solvent and the other is called solute. Example, in case of solution of sugar and water, sugar is the solute and water is solvent.

(*iv*) If both the components have same state as the solution, the one component which is in excess is called solvent and the other is called solute. Example, alcohol in water, benzene in toluene etc.

Types of Solution

S.No.	Solvent	Solute	Examples
1.	Gas	Gas	Mixture of gases, air.
2.	Gas	Liquid	Water vapour in air, mist.
3.	Gas	Solid	Sublimation of a solid into a gas, smoke storms.
4.	Liquid	Gas	CO_2 gas dissolve in water (aerated drink), soda water.
5.	Liquid	Liquid	Mixture of miscible liquids e.g. alcohol in water.
6.	Liquid	Solid	Salt in water, sugar in water.
7.	Solid	Gas	Adsorption of gases over metals, hydrogen over palladium.
8.	Solid	Liquid	Mercury in zinc, mercury in gold i.e. all amalgams.
9.	Solid	Solid	Homogeneous mixture of two or more metals (i.e. alloys) e.g. copper In gold. zinc In copper.

that dissolution process involves dynamic equilibrium and thus must follow Le Chatelier's principle. As dissolution is an exothermic process, the solubility should decrease with increase of temperature.

- K_H values for both N_2 and O_2 increase with increase of temperature indicating that the solubility of gases increases with decrease of temperature. It is due to this reason that **aquatic species are more comfortable in cold water rather than in warm water.**

Train Your Brain

Example 4. If N_2 gas is bubbled through water at 293K, how many millimoles of N_2 gas will be dissolved in 1L of water. Assume partial pressure of N_2 = 0.987 bar.
(Henry's Law constant for N_2 at 293K is 76.48 k bar)

Sol. $P_{N_2} = K_H.X_{N_2}$

$$X_{N_2} = \frac{0.987 \text{ bar}}{76480 \text{ bar}} = 1.29 \times 10^{-5}$$

1L water contains 55.5 moles of water. Let, *n* be the number of moles of N_2 in solution

$$X_{N_2} = \frac{n \text{ mol}}{n \text{ mol} + 55.5 \text{mol}} \approx \frac{n}{55.5}$$

$= 1.29 \times 10^{-5}$

$\therefore$ n = $(1.29 \times 10^{-5} \times 55.5)$ mol

$= 7.16 \times 10^{-4}$ mol

$= (7.16 \times 10^{-4} \times 1000)$ *m* mole

= 0.716 *m* mole

Example 5. Henry's Law constant of CO_2 in water at 298 K is 5/3 k bar. If pressure of CO_2 is 0.01 bar, then find its solubility in terms of mole fraction.

Sol. $P = K_H.X$

or, $P_{CO_2(g)} = K_H.X_{CO_2}$

or, $0.01 = (5/3) \times 1000 \times X_{CO_2}$

$\therefore X_{CO_2} = 6 \times 10^{-6}$

Example 6. Identify following statement as true or false and identify correct match.

(*i*) Cooling favours the solubility of exothermic solutions.

(*ii*) Heating favours the solubility of endothermic solutions.

(*iii*)

	(*i*)	(*ii*)
(*a*)	T	F
(*b*)	F	T
(*c*)	T	T
(*d*)	F	F

Sol.

(*i*) We know that solubility of exothermic solutions decreases on increase of temperature (heating). Therefore the given statement is true.

(*ii*) We know that solubility increases with increase of temperature (heating). Therefore the given statement is true.

(*iii*) (c) T, T

Concept Application

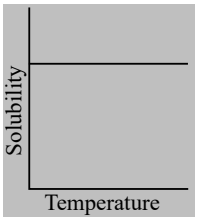
2. The boiling point of C_6H_6, CH_3OH, $C_6H_5NH_2$ and $C_6H_5NO_2$ are 80º, 67°, 180° and 210°C respectively. Which will show highest vapor pressure at room temperature?

(*a*) C_6H_6 (*b*) CH_3OH

(*c*) $C_6H_5NH_2$ (*d*) $C_6H_5NO_2$

3. Solubility of a substance remains unchanged on heating or cooling. Identify its solubility curve.

(*a*)



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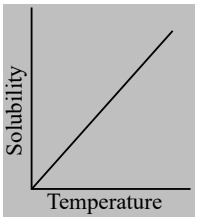

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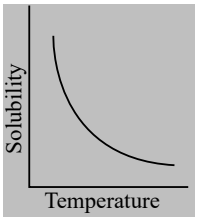
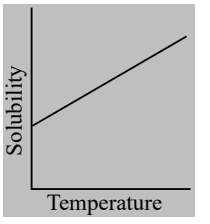
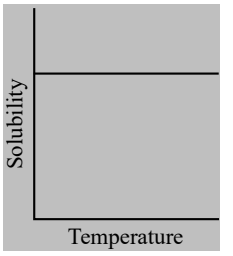


(*d*)

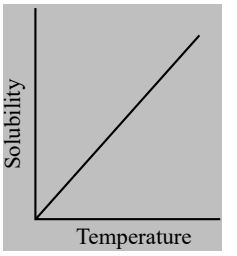


4. On cooling, solubility of a substance decreases. Identify its solubility curve.

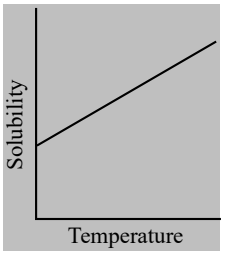
(*a*)



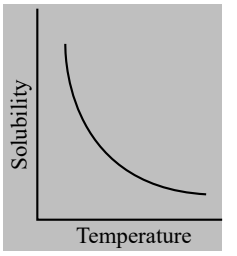
(*b*)



(*c*)



(*d*)



1. If 20 mL of 0.5 M Na_2SO_4 is mixed with 50 mL of 0.2 M H_2SO_4 and 30 mL of 0.4 M $Al_2(SO_4)_3$ solution. Calculate $[Na^+]$, $[H^+]$, $[Al^{3+}]$, and $[SO_4^{2-}]$. [Assuming 100% dissociation]

Sol. Molarity = $\frac{\text{moles}}{\text{volume}}$

(*i*) $Na_2SO_4 \rightarrow 2Na^+ + SO_4^{2-}$

10 m mol

— 20 10

Total volume = 100 mL

$\therefore [Na^+] = \frac{20}{100} = 0.2$ M

(*ii*) $H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$

10 m mol

— 20 10

Total volume = 100 mL

$[H^+] = \frac{20}{100} = 0.2$ M

(*iii*) $Al_2(SO_4)_3 \rightarrow 2Al^{3+} + 3SO_4^{2-}$

12 m mol

— 24 36

Total volume = 100 mL

$[Al^{3+}] = \frac{24}{100} = 0.24$ M

(*iv*) Total m mol of SO_4^{2-} = m.m of SO_4^{2-} from ($Na_2SO_4 + H_2SO_4 + Al_2(SO_4)_3$) = (10 + 10 + 36) = 56

Total volume = 100 mL

$[SO_4^{2-}] = \frac{10+10+36}{100} = \frac{56}{100} = 0.56$ M

2. Calculate molality of 1.2 M H_2SO_4 solution. If its density (ρ) = 1.4 g/mL?

(*a*) 0.936 (*b*) 0.562

(*c*) 0.386 (*d*) 0.425

Sol. Molality = $\frac{1.2\times1000}{1000\times1.4-1.2\times98} = 0.936$

Therefore, option (*a*) is the correct answer.

3. A 6.90 M solution of KOH in water has 30% by weight of KOH. Calculate density of solution (in g/mL).

(*a*) 9.345 g/mL

(*b*) 2.445 g/mL

(*c*) 5.852 g/mL

(*d*) 1.288 g/mL

Sol. Let V = 1 lt, then moles of solute = 6.9

wt. of solute = 6.9 × 56 gm

% by mass = $\frac{M_{solute}}{M_{solution}} \times 100$

So, = $\frac{6.9\times56}{d\times1000}\times100 = 30$

d = 1.288 g/mL

Therefore, option (*d*) is the correct answer.

4. The density of 3M solution of $Na_2S_2O_3$ is 1.25 g mL^{-1}. Calculate.

(*a*) The % by weight of $Na_2S_2O_3$

(*b*) Mole fraction of $Na_2S_2O_3$

Sol. (*a*) mass of solution = 1000 × 1.25 = 1250 gm

mass of $Na_2S_2O_3$ = 3 × 158 = 474

% (w/w) = $\frac{474}{1250} \times 100 = 37.92$

Therefore, 37.92 is the correct answer.

(*b*) $X_{Na_2S_2O_3} = \frac{3}{3+43.11} = 0.065.$

Mole of water solvent = $\frac{1250-474}{18} = 43.11$

Therefore, 43.11 is the correct answer.

5. Calculate molality of aqueous urea solution which has $X_{urea} = 0.2$.

(*a*) 15.99 (*b*) 13.88

(*c*) 10.99 (*d*) 19.76

Sol. $X_u + X_w = 1$

$X_w = 1–0.2 = 0.8$

Let total moles = 1

$n_u = 0.2$

$n_w = 0.8$

$w_{water} = 0.8 \times 18 = 14.4$

Molality (m) = $\frac{\text{Number of moles of solute}}{\text{Weight of solvent (kg)}}$

$= \frac{0.2}{14.4/1000} = 13.88$

Therefore, option (*b*) is the correct answer.

6. 10 gm of a solute is dissolved in 80 gm of acetone. Vapour pressure of this solution = 271 mm of Hg. If vapour pressure of pure acetone is 283 mm of Hg, then calculate molar mass of solute?

(*a*) 173 g/mol (*b*) 163 g/mol

(*c*) 143 g/mol (*d*) 183 g/mol

SINGLE CORRECT TYPE QUESTIONS

1. A 1% solution of solute 'X' is isotonic with a 6% solution of sucrose (molar mass = 342 g mol^{-1}). The molar mass of solute 'X' is:

(*a*) 34.2 g mol^{-1} (*b*) 57 g mol^{-1}

(*c*) 114 g mol^{-1} (*d*) 3.42 g mol^{-1}

2. Low concentration of oxygen in the blood and tissues of people living at high altitudes is due to:

(*a*) Low temperature

(*b*) Low atmospheric pressure

(*c*) High atmospheric pressure

(*d*) High temperature

3. Which of the following solutions would have the highest osmotic pressure:

(*a*) $\frac{M}{10}$ NaCl (*b*) $\frac{M}{10}$ Urea

(*c*) $\frac{M}{10}$ $BaCl_2$ (*d*) $\frac{M}{10}$ Glucose

4. For an electrolyte undergoing association in a solvent, the van't Hoff factor:

(*a*) is always greater than one

(*b*) has negative value

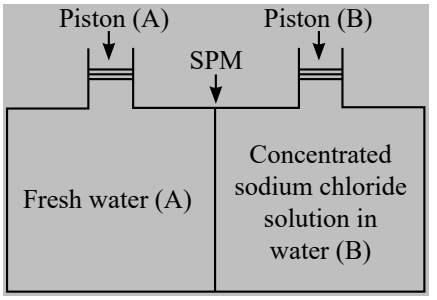
(*c*) has zero value

(*d*) is always less than one

5. Henry's law constant K of CO_2 in water at 25°C is 3×10^{-2} mol/L atm^{-1}. Calculation the mass of CO_2 present in 100 L of soft drink bottled with a partial pressure of CO_2 of 4 atm at the same temperature.

(*a*) 5.28 g (*b*) 12.0 g (*c*) 428 g (*d*) 528 g

6. Consider the following figure and mark the correct option.



(*a*) Water will move from side (A) to side (B) if a pressure lower than osmotic pressure is applied on piston (B).

(*b*) Water will move from side (B) to side (A) if a pressure greater than osmotic pressure is applied on piston (B).

(*c*) Water will move from side (B) to side (A) if a pressure equal to osmotic pressure is applied on piston (B).

(*d*) Water will move from side (A) to side (B) if pressure equal to osmotic pressure is applied on piston (A).

7. Van't Hoff factor for $Na_2SO_4.10H_2O$ solution, assuming complete ionization is

(*a*) 1 (*b*) 3 (*c*) 13 (*d*) 2

8. We have three aqueous solutions of NaCl labelled as 'A', 'B' and 'C' with concentrations 0.1M, 0.01M and 0.001M, respectively. The value of van't Hoff factor for these solutions will be in the order_____.

(*a*) i A < i B < i C (*b*) i A > iB > iC

(*c*) i A = i B = i C (*d*) i A < i B > i C

9. The relative lowering of vapour pressure of an aqueous solution containing non-volatile solute is 0.0225. The mole fraction of the non-volatile solute is:

(*a*) 0.80 (*b*) 0.725 (*c*) 0.15 (*d*) 0.0225

10. Which of the following statements is false?

(*a*) Two different solutions of sucrose of same molality prepared in different solvents will have the same depression in freezing point.

(*b*) The osmotic pressure of a solution is given by the equation $\Pi = CRT$ (where C is the molarity of the solution).

(*c*) Decreasing order of osmotic pressure for 0.01 M aqueous solutions of barium chloride, potassium chloride, acetic acid and sucrose is $BaCl_2 > KCl > CH_3COOH >$ sucrose.

(*d*) According to Raoult's law, the vapour pressure exerted by a volatile component of a solution is directly proportional to its mole fraction in the solution.

ASSERTION AND REASON TYPE QUESTIONS

11. **Assertion :** Addition of ethylene glycol to water lowers its freezing point.

Reason : Ethylene glycol is insoluble in water due to lack of its ability to form hydrogen bonds with water molecules.

(*a*) Both Assertion and Reason are true and Reason is correct explanation of Assertion.

(*b*) Both Assertion and Reason are true but Reason is not a correct explanation of Assertion.

(*c*) Assertion is true but Reason is false.

(*d*) Assertion is false but Reason is true.

12. **Assertion:** When NaCl is added to water a depression in freezing point is observed.

Reason: The lowering of vapour pressure of a solution causes depression in the freezing point.

(*a*) Both Assertion and Reason are true and Reason is correct explanation of Assertion.

(*b*) Both Assertion and Reason are true but Reason is not a correct explanation of Assertion.

(*c*) Assertion is true but Reason is false.

(*d*) Assertion is false but Reason is true.

MATCH THE COLUMN TYPE QUESTIONS

13. Match the column and choose correct option

Vant' Hoff factor		Behaviour of compound	
(A)	i = 1	P.	Impossible
(B)	i > 1	Q.	Association is the solution
(C)	i < 1	R.	Dissociation in the solution
(D)	i = 0	S.	No dissociation or association

(*a*) A–S, B–R, C–P, D–Q
(*b*) A–R, B–S, C–Q, D–P
(*c*) A–S, B–P, C–R, D–Q
(*d*) A–S, B–R, C–Q, D–P

14. Match the law given in column-I with expressions given in column-II.

	Column-I		Column-II
(i)	Raoult's law	(a)	$\Delta T_f = K_f m$
(ii)	Henry's law	(b)	$\Pi = CRT$
(iii)	Elevation of boiling point	(c)	$p = x_1 p_1^o + x_2 p_2^o$
(iv)	Depression in freezing point	(d)	$\Delta T_b = K_b m$
(v)	Osmotic pressure	(e)	$p = K_H x$

(*a*) (i)–(c), (ii)–(e), (iii)–(d), (iv)–(a), (v)–(b)
(*b*) (i)–(e), (ii)–(c), (iii)–(a), (iv)–(a), (v)–(d)
(*c*) (i)–(d), (ii)–(a), (iii)–(c), (iv)–(e), (v)–(b)
(*d*) (i)–(b), (ii)–(d), (iii)–(e), (iv)–(a), (v)–(c)

SHORT ANSWER TYPE QUESTIONS

15. Calculate the boiling point of the solution when 4 g of $MgSO_4$ (M = 120 g mol^{-1}) was dissolved in 100 g of water, assuming $MgSO_4$ undergoes complete ionization.
(K_b for water = 0.52 K kg mol^{-1})

16. The vapour pressure of a solvent at 283 K is 100 mm Hg. Calculate the vapour pressure of a dilute solution containing 1 mole of a strong electrolyte AB in 50 moles of the solvent at 283 K (assuming complete dissociation of solute AB).

17. An aqueous solution of 2% non-volatile solute exerts a pressure of 1.004 Bar at the normal boiling point of the solvent. What is the molar mass of the solute?

LONG ANSWER TYPE QUESTIONS

18. (a) Ishan's automobile radiator is filled with 1.0 kg of water. How many grams of ethylene glycol (Molar mass = 62 g mol^{-1}) must Ishan add to get the freezing point of the solution lowered to - 2.8 °C. K_f for water is 1.86 K kg mol^{-1}.

(b) What type of deviation from Raoult's law is shown by ethanol and acetone mixture ? Give reason.

19. A solution is prepared by dissolving 5 g of a non-volatile solute in 200 g of water. It has a vapour pressure of 31.84 mm Hg at 300 K. Calculate the molar mass of the solute.
(Vapour pressure of pure water at 300 K = 32 mm Hg)

20. (a) What is the value of 'i' for $Al_2(SO_4)_3$ when it is completely dissociated?

(b) Calculate the boiling point of a solution prepared by adding 15.00 g of NaCl to 250 g of water. (K_b = 0.512 K kg mol^{-1} and molar mass of NaCl = 58.44 g mol^{-1})

21. (a) What is the value of 'i' when solute is associated and dissociated ?

(b) Calculate the freezing point of an aqueous solution containing 10.50 g of $MgBr_2$ in 200 g of water. (Molar mass of $MgBr_2$ = 184, K_f = 1.86 K kg mol^{-1})

22. (a) Outer shells of two eggs are removed. One of the egg is placed in pure water and the other is placed in saturated solution of NaCl. What will be observed and why?

(b) A solution prepared by dissolving 8.95 mg of a gene fragment in 35.0 ml of water has an osmotic pressure of 0.335 ton at 25ºC. Assuming the gene fragment is a non-electrolyte, determine the molar mass?

23. (a) Define reverse osmosis.

(b) Why are aquatic species more comfortable in cold water in comparison to warm water ?

(c) A solution containing 2 g of glucose (M = 180 g mol^{-1}) in 100 g of water is prepared at 303 K. If the vapour pressure of pure water at 303 K is 32.8 mm Hg, what would be the vapour pressure of the solution ?

24. (a) At the same temperature, CO_2 gas is more soluble in water than O_2 gas. Which one of them will have higher value of K_H and why?

(b) How does the size of blood cells change when placed in an aqueous solution containing more than 0.9% (mass/volume) sodium chloride?

(c) 1 molal aqueous solution of an electrolyte A_2B_3 is 60% ionized. Calculate the boiling point of the solution.
(Given: K_b for H_2O = 0.52 K kg mol^{-1})

CASE STUDY BASED QUESTIONS

Read the passage given below and answer the following questions:

25. Boiling point or freezing point of liquid solution would be affected by the dissolved solids in the liquid phase. A soluble solid in solution has the effect of raising its boiling point and depressing its freezing point. The addition of non-volatile substances to a solvent decreases the vapor pressure and the added solute particles affect the formation of pure solvent crystals. According to many researches the decrease in freezing point directly correlated to the concentration of solutes dissolved in the solvent. This phenomenon is expressed as freezing point depression and it is useful for

several applications such as freeze concentration of liquid food and to find the molar mass of an unknown solute in the solution. Freeze concentration is a high quality liquid food concentration method where water is removed by forming ice crystals. This is done by cooling the liquid food below the freezing point of the solution. The freezing point depression is referred as a colligative property and it is proportional to the molar concentration of the solution (m), along with vapour pressure lowering, boiling point elevation, and osmotic pressure. These are physical characteristics of solutions that depend only on the identity of the solvent and the concentration of the solute. The characters are not depending on the solute's identity. (Jayawardena, J. A. E. C., Vanniarachchi, M. P. G. & Wansapala, M. A. J. (2017). Freezing point depression of different Sucrose solutions and coconut water.)

I. When a non volatile solid is added to pure water it will:

(*a*) Boil above 100°C and freeze above 0°C

(*b*) Boil below 100°C and freeze above 0°C

(*c*) Boil below 100°C and freeze below 0°C

(*d*) Boil above 100°C and freeze below 0°C

II. Colligative properties are:

(*a*) Dependent only on the concentration of the solute and independent of the solvent's and solute's identity.

(*b*) Dependent only on the identity of the solute and the concentration of the solute and independent of the solvent's identity.

(*c*) Dependent on the identity of the solvent and solute and thus on the concentration of the solute.

(*d*) Dependent only on the identity of the solvent and the concentration of the solute and independent of the solute's identity.

III. Assume three samples of juices A, B and C have glucose as the only sugar present in them. The concentration of sample A, B and C are 0.1M, .5M and 0.2 M respectively. Freezing point will be highest for the fruit juice:

(*a*) A

(*b*) B

(*c*) C

(*d*) All have same freezing point

IV. Identify which of the following is a colligative property:

(*a*) Freezing point (*b*) Boiling point

(*c*) Osmotic pressure (*d*) All of the above

Prarambh (Topicwise)

CONCENTRATION TERMS (REVISION OF MOLE)

1. The amount of anhydrous Na_2CO_3 present in 250 mL of 0.25 M solution is

(*a*) 225 g (*b*) 66.25 g

(*c*) 6.0 g (*d*) 6.625 g

2. 2.0 molar solution is obtained, when 0.5 mole solute is dissolved in

(*a*) 250 mL solvent (*b*) 250 g solvent

(*c*) 250 mL solution (*d*) 1000 mL solvent

3. 36 g of water and 828 g of ethyl alcohol form an ideal solution. The mole fraction of water in it, is

(*a*) 1.0 (*b*) 0.7

(*c*) 0.4 (*d*) 0.1

4. An X molal solution of a compound in benzene has mole fraction of solute equal to 0.2. The value of X is

(*a*) 14 (*b*) 3.2

(*c*) 4 (*d*) 2

5. 4.0 gm of NaOH is contained in one decilitre of solution. Its molarity would be

(*a*) 4 M (*b*) 2 M

(*c*) 1 M (*d*) 1.5 M

HENRY'S LAW AND BASICS OF VAPOUR PRESSURE

6. Calculate the solubility of gaseous oxygen in water at a temperature of 293 K when the partial pressure exerted by O_2 is 1 bar. (Given: K_H for O_2 34840 bar L mol^{-1})

(*a*) 2.87×10^{-5} mol/L (*b*) 4×10^{-4} mol/L

(*c*) 2.87×10^{-4} mol/L (*d*) 5×10^{-4} mol/L

7. Solubility of gas in water is x g/cm^3 at 300 K temperature. When temperature increases to 400 K, then solubility of gas

(*a*) Increases (*b*) Decreases

(*c*) Remain same (*d*) $\frac{1}{2}x$

8. Which one of the following gases has the lowest value of Henry's law constant?

(*a*) N_2 (*b*) He

(*c*) H_2 (*d*) CO_2

9. The vapour pressure of water depends upon

(*a*) Surface area of container

(*b*) Volume of container

(*c*) Temperature

(*d*) All of these

10. A vessel has nitrogen gas and water vapours in equilibrium with liquid water at a total pressure of 1 atm. The partial pressure of water vapours is 0.3 atm. The volume of this vessel is reduced to one third of the original volume, at the same temperature, then total pressure of the system is
(Neglect volume occupied by liquid water)
(*a*) 3.0 atm (*b*) 1 atm (*c*) 3.33 atm (*d*) 2.4 atm

V.P OF MIXTURE OF LIQUIDS

11. For a solution of two liquids A and B it was proved that $P = X_A \left(P_A^0 - P_B^0\right) + P_B^0$. The solution is
(*a*) Ideal (*b*) Non-ideal
(*c*) Semi ideal (*d*) None of these

12. 1 mole of n-heptane (V.P. = 92 mm of Hg) was mixed with 4 moles of n-octane (V.P = 31 mm of Hg), the vapour pressure of the resulting ideal solution is
(*a*) 46.2 mm of Hg (*b*) 40.0 mm of Hg
(*c*) 43.2 mm of Hg (*d*) 38.4 mm of Hg

13. Two liquids A and B form an ideal solution, What is the vapour pressure of solution containing 2 moles of A and 3 moles of B at 300 K? [Given: At 300 K, Vapour pressure of pure liquid A (P^o_A) = 100 torr, Vapour pressure of pure liquid B (P^o_B) = 300 torr]
(*a*) 200 torr (*b*) 140 torr (*c*) 180 torr (*d*) 220 torr

14. The vapour pressure of pure benzene and toluene are 160 and 60 torr respectively. The mole fraction of toluene in vapour phase in contact with equimolar solution of benzene and toluene is
(*a*) 0.50 (*b*) 0.60 (*c*) 0.27 (*d*) 0.73

DIFFERENCE BETWEEN IDEAL AND NON-IDEAL SOLUTION

15. Which pair from the following will not form an ideal solution?
(*a*) $CCl_4 + SiCl_4$ (*b*) $H_2O + C_4H_9OH$
(*c*) $C_2H_5Br + C_2H_5I$ (*d*) $C_6H_{14} + C_7H_{16}$

16. An ideal solution is that which
(*a*) Shows positive deviation from Raoult's law
(*b*) Shows negative deviation from Raoult's law
(*c*) Has no connection with Raoult's law
(*d*) Obeys Raoult's law

17. Which property is shown by an ideal solution?
(*a*) It follows Raoult's law (*b*) $\Delta H_{mix} = 0$
(*c*) $\Delta V_{mix} = 0$ (*d*) All of these

18. When two liquids A and B are mixed then their boiling points becomes greater than both of them. What is the nature of this solution?
(*a*) Ideal solution
(*b*) Non-ideal solution with positive deviation
(*c*) Non-ideal solution with negative deviation
(*d*) Normal solution

19. All form ideal solution except
(*a*) C_2H_5Br and C_2H_5I (*b*) C_6H_5Cl and C_6H_5Br
(*c*) C_6H_6 and $C_6H_5CH_3$ (*d*) C_2H_5I and C_2H_5OH

20. An azeotropic solution of two liquids has boiling point lower than either when it
(*a*) Shows a negative deviation from Raoult's law
(*b*) Shows no deviation from Raoult's law
(*c*) Shows positive deviation from Raoult's law
(*d*) Is saturated

RELATIVE LOWERING IN V.P

21. For a solution of volatile liquids, the partial vapour pressure of each component in solution is directly proportional to
(*a*) Molarity (*b*) Mole fraction
(*c*) Molality (*d*) Normality

22. When a substance is dissolved in a solvent, the vapour pressure of the solvent is decreased. This results in
(*a*) An increase in the b.p. of the solution
(*b*) A decrease in the b.p. of the solvent
(*c*) The solution having a higher freezing point than the solvent
(*d*) The solution having a lower osmotic pressure than the solvent

23. The vapour pressure lowering caused by the addition of 100 g of sucrose (molecular mass = 342) to 1000 g of water if the vapour pressure of pure water at 25ºC is 23.8 mm Hg, is
(*a*) 1.25 mm Hg (*b*) 0.125 mm Hg
(*c*) 1.15 mm Hg (*d*) 00.12 mm Hg

24. According to Raoult's law, the relative lowering of vapour pressure of a solution of non-volatile substance is equal to
(*a*) Mole fraction of the solvent
(*b*) Mole fraction of the solute
(*c*) Weight percentage of a solute
(*d*) Weight percentage of a solvent

25. The vapour pressure of water at 20°C is 17.54 mm Hg. When 20 g of a non-ionic, substance is dissolved in 100 g of water, the vapour pressure is lowered by 0.30 mm Hg. What is the molecular weight (in g/mol) of the substance? (Do not consider solution as dilute)
(*a*) 210.2 (*b*) 206.88
(*c*) 215.2 (*d*) 200.8

ELEVATION OF BOILING POINT AND DEPRESSION OF FREEZING POINT

26. The latent heat of vapourisation of water is 9700 Cal/mole and if the b.p. is 100° C, ebullioscopic constant of water is
(*a*) 0.513°C/molal (*b*) 1.026°C/molal
(*c*) 10.26°C/molal (*d*) 1.832°C/molal

27. If 0.15 g of a non-volatile solute dissolved in 15 g of solvent has boiling point higher by 0.216°C than that of the pure solvent, then molecular weight (in g/mol) of the substance (molal elevation constant for the solvent is 2.16° K kg/mol) is
(*a*) 1.01 (*b*) 10 (*c*) 10.1 (*d*) 100

44. One mole of a solute A is dissolved in a given volume of a solvent. The association of the solute take place according to $nA \rightleftharpoons A_n$.

If x is the degree of association of A, then Van't Hoff factor (i) is expressed as

(a) $i = 1 - x$ (b) $i = 1 + \frac{x}{n}$

(c) $i = \frac{1 - x + \frac{x}{n}}{1}$ (d) $i = 1$

45. The molecular weight of benzoic acid in benzene as determined by depression in freezing point method corresponds to

(a) Ionization of benzoic acid

(b) Dimerization of benzoic acid

(c) Trimerization of benzoic acid

(d) Solvation of benzoic acid

46. What is the freezing point of a solution containing 8.1 g HBr in 100 g water assuming the acid to be 90 % ionised? (K_f for water = 1.86 K mole^{-1})

(a) 0.85°C (b) – 3.53°C (c) 0°C (d) – 0.35°C

Prabal (JEE Main Level)

1. Mole fraction of $C_3H_5(OH)_3$ (glycerine) in a solution of 36 g of water and 46 g of glycerine is

(a) 0.46 (b) 0.36

(c) 0.20 (d) 0.40

2. An aqueous solution of urea containing 18 g urea in 1500 cm^3 of solution has a density of 1.052 g/cm^3. If the molecular weight of urea is 60, then the molality of solution is

(a) 0.2 (b) 0.192

(c) 0.064 (d) 1.2

3. What is the molarity of H_2SO_4 solution that has a density of 1.84 g/cc at 35°C and contains 98% by weight?

(a) 4.18 M (b) 8.14 M

(c) 18.4 M (d) 18 M

4. When 5.0 gram of $BaCl_2$ is dissolved in water to have 10^6 gram of solution. The concentration of solution is

(a) 2.5 ppm (b) 5 ppm

(c) 5 M (d) 5 gm L^{-1}

5. A mixture contains 1 mole of volatile liquid A $\left(P_A^O = 100 \text{ Hg}\right)$ and 3 moles of volatile liquid B $\left(P_B^O = 80 \text{ mm Hg}\right)$. If solution behaves ideally, the total vapour pressure of the distillate is

(a) 80 mm Hg (b) 85.88 mm Hg

(c) 90 mm Hg (d) 92 mm Hg

6. Mixture of volatile components A and B has total vapour pressure (in Torr) P = 254 –119 X_A where X_A is mole fraction of A in mixture. Hence, P_A^O and P_B^O are (in Torr)

(a) 254, 119 (b) 119, 254

(c) 135, 254 (d) 119, 373

7. What is ratio of mole fraction of benzene (P_B^o = 150 torr) and toluene (P_T^o = 50 torr) in vapour phase if the given solution has a vapour pressure of 120 torr?

(a) 7 : 1 (b) 7 : 3

(c) 8 : 1 (d) 7 : 8

8. At 300 K. the vapour pressure of an ideal solution containing 3 mole of A and 2 mole of B is 600 torr. At the same temperature, if 1.5 mole of A and 0.5 mole of C (non-volatile) are added to this solution, the vapour pressure of solution increases by 30 torr. What is the value of P_B^O?

(a) 940 torr (b) 405 torr

(c) 90 torr (d) None of these

9. At a constant temperature, ΔS will be maximum for which of the following processes?

(a) Vaporisation of a pure solvent

(b) Vaporisation of solvent from a solution containing non-volatile and non electrolyte solute in it.

(c) Vaporisation of solvent from a solution containing non-volatile but electrolyte solute in it.

(d) Entropy change will be same in all the above cases.

10. Which of the following is less than zero for ideal solutions?

(a) ΔH_{mix} (b) ΔG_{mix} (c) ΔV_{mix} (d) ΔS_{mix}

11. The vapour pressures of pure liquids 'A' and 'B' are 300 and 800 torr respectively at 25°C. When these two liquids are mixed at this temperature to form a solution in which mole percentage of "B" is 92, then the total vapour pressure is observed to be 0.95 atm. Which of the following is true for this solution?

(a) $\Delta V_{mix} > 0$ (b) $\Delta H_{mix} < 0$

(c) $\Delta V_{mix} = 0$ (d) $\Delta H_{mix} = 0$

12. Consider a binary mixture of volatile liquids. If at $X_A = 0.4$, the vapour pressure of solution is 580 torr then the mixture could be [P_A^O = 300 torr, P_B^O = 800 torr]

(a) $H_2O - HNO_3$ (b) $C_6H_5Cl - C_6H_5Br$

(c) $C_6H_6 - C_6H_5CH_3$ (d) $nC_6H_{14} - nC_7H_{16}$

13. Which of the following mixture of liquids will form an ideal solution?

(a) C_2H_5OH and water

(b) HNO_3 and water

(c) $CHCl_3$ and CH_3COCH_3

(d) C_6H_6 and $C_6H_5CH_3$

14. Which of the following mixture shows negative deviation from Raoult's law?

(*a*) $CHCl_3$ and acetone

(*b*) $CHCl_3$ and C_2H_5OH

(*c*) $C_6H_5CH_3$ and C_6H_6

(*d*) C_6H_6 and CCl_4

15. Assuming each salt to be completely dissociated, which of the following will have the highest osmotic pressure?

(*a*) Decimolar $Al_2(SO_4)_3$

(*b*) Decimolar $BaCl_2$

(*c*) Decimolar Na_2SO_4

(*d*) A solution obtained by mixing equal volumes of (*b*) and (*c*) and filtering

16. A complex containing K^+, Pt(IV) and Cl^- is 100% ionised giving i = 3. Thus, complex is

(*a*) $K_2[PtCl_4]$ (*b*) $K_2[PtCl_6]$

(*c*) $K_3[PtCl_5]$ (*d*) $K[PtCl_3]$

17. pH of 1 M HA (weak acid) is 2. Hence, van't Hoff factor of HA is

(*a*) 1.2 (*b*) 1.02

(*c*) 1.1 (*d*) 1.01

18. In which case, van't Hoff factor is maximum?

(*a*) KCl, 50% ionised (*b*) K_2SO_4 40% ionised

(*c*) $FeCl_3$ 30% ionised (*d*) $SnCl_4$ 20% ionised

19. The vapour pressure of water at room temperature is lowered by 5% by dissolving a solute in it, then the approximate molality of solution is

(*a*) 2 (*b*) 1 (*c*) 4 (*d*) 3

20. The van't Hoff factor for 0.1 M $Ba(NO_3)_2$ solution is 2.74. The degree of dissociation is

(*a*) 91.3% (*b*) 87% (*c*) 100% (*d*) 74%

21. The vapour pressure of pure liquid A is 10 torr and at the same temperature when 1 g of B solid is dissolved in 20 g 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

(*a*) 100 amu (*b*) 90 amu

(*c*) 75 amu (*d*) 120 amu

22. The vapour pressure of a solution of a non-volatile solute B in a solvent A is 95% of the vapour pressure of the pure solvent at the same temperature. If the molecular weight of the solvent is 0.3 times the molecular weight of the solute, what is the ratio of weight of solvent to solute?

(*a*) 0.15 (*b*) 5.7

(*c*) 0.2 (*d*) None of these

23. The vapour pressure of a dilute aqueous solution of glucose is 750 mm of mercury at 373 K. The mole fraction of solute is

(*a*) $\frac{1}{10}$ (*b*) $\frac{1}{7.6}$

(*c*) $\frac{1}{35}$ (*d*) $\frac{1}{76}$

24. 1 mol each of following solutes are taken in 5 mol water.

(A) NaCl (B) K_2SO_4

(C) Na_3PO_4 (D) Glucose

Assuming 100% ionisation of each electrolyte, vapour pressure of solutions will be in the order

(*a*) D < A < B < C (*b*) D < C < B < A

(*c*) C < B < A < D (*d*) Equal for all

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

(*a*) 0.2 (*b*) 0.4 (*c*) 0.6 (*d*) 0.8

26. The vapour pressure of a saturated solution of sparingly soluble salt (XCl_3) was 17.20 mm Hg at 27°C. If the vapour pressure of pure H_2O is 17.25 mm Hg at 300 K. What is the solubility of sparingly soluble salt XCl_3 in mole/Litre?

(*a*) 4.04×10^{-2} (*b*) 8.08×10^{-2}

(*c*) 2.02×10^{-2} (*d*) 4.04×10^{-3}

27. 0.5 M, 100 mL A and 0.2 M, 500 mL B are mixed at 27°C. Vapour pressure of pure A and pure B is 200 mm Hg and 50 mm Hg respectively at 27°C. The ratio of partial pressures of A and B (in vapour phase) after mixing is

(*a*) 2 : 1 (*b*) 1 : 2 (*c*) 2 : 3 (*d*) 4 : 1

28. Which of the solutions have equal elevation in boiling point?

A. 0.1 M Na_2SO_4

B. 0.1 M $MgCl_2$

C. 0.1 M $C_6H_{12}O_6$ (glucose)

D. 0.1 M $Al(NO_3)_3$

(*a*) A and B (*b*) B and C

(*c*) C and D (*d*) None of these

29. Aluminium phosphate is 100% ionised in 0.01 molal aqueous solution. Hence, $\Delta T_b/K_b$ is

(*a*) 0.01 (*b*) 0.015

(*c*) 0.0175 (*d*) 0.02

30. A 0.001 molal solution of a complex MA_8 in water has the freezing point of – 0.0054°C. Assuming 100% ionization of the complex salt and K_r for H_2O = 1.86 K m^{-1}, what is the correct representation for the complex?

(*a*) $[MA_5]$ (*b*) $[MA_7]A$

(*c*) $[MA_6]A_2$ (*d*) $[MA_5]A_3$

31. Which of the following option has been arranged in the order of decreasing freezing point?

(*a*) 0.05 M KNO_3 > 0.04 M $BaCl_2$ > 0.140 M sucrose > 0.075 M $CuSO_4$

(*b*) 0.04 M $BaCl_2$ > 0.140 M sucrose > 0.075 M $CuSO_4$ > 0.05 M KNO_3

(*c*) 0.075 M $CuSO_4$ > 0.140 M sucrose > 0.04 M $BaCl_2$ > 0.05 M KNO_3

(*d*) 0.075 M $CuSO_4$ > 0.05 M KNO_3 > 0.140 M sucrose > 0.04 M $BaCl_2$

47. For 1 molal aqueous solution of the following compounds, which one will show the highest freezing point?

(*a*) $[Co(H_2O)_5Cl]Cl_2 \cdot H_2O$ (*b*) $[Co(H_2O)_4Cl_2]Cl \cdot 2H_2O$

(*c*) $[Co(H_2O)_3Cl_3] \cdot 3H_2O$ (*d*) $[Co(H_2O)_6]Cl_3$

48. A solution at 20°C is composed of 1.5 mol of benzene and 3.5 mol of toluene. If the vapour pressure of pure benzene and pure toluene at this temperature are 74.7 torr and 22.3 torr, respectively, then the total vapour pressure of the solution and the benzene mole fraction in equilibrium (in vapor phase) with it will be, respectively

(*a*) 38.0 torr and 0.589 (*b*) 30.5 torr and 0.389

(*c*) 35.8 torr and 0.280 (*d*) 35.0 torr and 0.480

INTEGER TYPE QUESTION

49. At 10°C, the osmotic pressure of urea solution is 500 mm of Hg. The solution is diluted and the temperature is raised to 25°C, when the osmotic pressure is found to be 105.3 mm of Hg. Determine the extent of dilution done with original solution.

50. Three particles of a solute 'A' associate in benzene to form species $(A)_3$. Calculate the freezing point (in °C) of 0.25 molal solution. The degree of association of solute 'A' is found to be 0.80. The freezing point of benzene is 5.5°C and its cryoscopic constant is 5.12 K m^{-1}.

51. Two liquids A and B have $P_A^0 : P_B^0 = 1 : 3$ at a certain temperature. If the mole fraction ratio of $X_A : X_B = 1:3$, the mole percentage of A in vapour in equilibrium with the solution at a given temperature is _____.

52. 500 mL of 6% (w/V) urea solution is mixed with 500 mL of 18% (w/V) glucose solution and final volume of mixture becomes 2 L after addition of water. The osmotic pressure of final 2 L solution at 27°C is 5yR. The value of y is [R → universal gas constant]

53. The molal freezing point depression constant of benzene (C_6H_6) is 4.90 K kg mol^{-1}. Selenium exists as a polymer of the type Se_X. When 3.26 g of selenium is dissolved in 226 g of benzene, the observed freezing point is 0.112°C lower than that of pure benzene. What is the value of X. (Atomic mass of Se = 78.8 mol^{-1}).

54. A radiator was filled with 10L of water to which 2.5 L of methanol (density = 0.8g.ml^{-1}) were added. The vehicle is parked outdoors where the temperature is 0°C. The temperature is decreasing at a uniform rate of 0.50C/min. Upto what time (in min) will there be no danger to the radiator of the car? K_f(water) = 1.86 kg.mol^{-1}.K. Assume methanol to be non-volatile. Multiply final answer by four.

55. 24.6 litre dry N_2 gas is slowly passed over a liquid at 27°C and 1 atm. The pressure of gaseous sample coming out increases due to saturation of gas with vapours of the liquid. If the mass ratio of N_2 gas and the liquid vapour in the gaseous sample coming out is 25 : 4 and the vapour pressure of the liquid at 27°C is 0.04 atm, the molar mass (gm/mol) of liquid is.

56. H_2S, a toxic gas with rotten egg like smell, is used for the quantitative analysis. If the solubility of H_2S in water at STP is 0.2m, Henry's law constant (in bar) for H_2S in water at 273K is ___ .

57. A $CaCl_2$ aqueous solution at 27°C has an osmotic pressure 16 atm and density of 1.2 gm/ml. What is depression of freezing point (in °C) of this solution? [K_f of water = 1.8 K Kg mol^{-1}, R = 0.08 atm litre / mole - K] (multiply final answer by 100)

58. Calculate solubility (in moles/litre) of a saturated aqueous solution of Ag_3PO_4 if the vapour pressure of the solution becomes 750 torr at 373 K. (multiply final answer by 54)

Parikshit (JEE Advanced Level)

SINGLE CORRECT TYPE QUESTIONS

1. A very small amount of non-volatile solute (that does not dissociate) is dissolved is 56.8 cm^3 of benzene (density 0.889 g cm^{-3}). At room temperature, vapour pressure of this solution is 100 mm Hg while that of benzene is 102 mm Hg. If the freezing temperature of this solution is 1.3 degree lower than that of benzene, then what is the value of molal freezing point depression constant of benzene?

(*a*) 5.07 deg/molal (*b*) 1.3 deg/molal

(*c*) 3.9 deg/molal (*d*) 4.97 deg/molal

2. Using the following information determine the boiling point of a mixture containing 1560 gm benzene and 1125 gm chlorobenzene, when the external pressure is 1000 torr. Assume the solution is ideal.

Given: Molar mass of benzene = 78

Molar mass of chlorobenzene = 112.5

Temperature (0°C)	Vapour pressure of benzene (torr)	Vapour pressure of chlorobenzene (torr)
80	750	120
90	1000	200
100	1350	300
110	1800	400
120	2200	540

(*a*) 120 °C (*b*) 110 °C

(*c*) 100 °C (*d*) 90 °C

EXPRESSING CONCENTRATIONS OF SOLUTIONS

1. The quantity which changes with temperature is:
[27 Jan, 2024 (Shift-II)]
(*a*) Molarity (*b*) Mass percentage
(*c*) Molality (*d*) Mole fraction

2. Volume of 3M NaOH (formula weight 40 g mol^{-1}) which can be prepared from 84 g of NaOH is _____ $\times 10^{-1}$ dm^3.
[27 Jan, 2024 (Shift-II)]

3. A solution of H_2SO_4 is 31.4% H_2SO_4 by mass and has a density of 1.25g/mL.The molarity of the H_2SO_4 solution is____M (nearest integer)
[Given molar mass of H_2SO_4 = 98g mol^{-1}]
[29 Jan, 2024 (Shift-I)]

4. Molality of 0.8 M H_2SO_4 solution (density 1.06 g cm^{-3}) is _____ $\times 10^{-3}$ m. **[29 Jan, 2024 (Shift-II)]**

5. The mass of sodium acetate (CH_3COONa) required to prepare 250 mL of 0.35 M aqueous solution is _____ g. (Molar mass of CH_3COONa is 82.02 g mol^{-1})
[30 Jan, 2024 (Shift-I)]

6. If a substance 'A' dissolves in solution of a mixture of 'B' and 'C' with their respective number of moles as n_A, n_B and n_C, mole fraction of C in the solution is:
[30 Jan, 2024 (Shift-II)]
(*a*) $\frac{n_C}{n_A \times n_B \times n_C}$ (*b*) $\frac{n_C}{n_A + n_B + n_C}$
(*c*) $\frac{n_C}{n_A - n_B - n_C}$ (*d*) $\frac{n_B}{n_A + n_B}$

7. The molarity of 1L orthophosphoric acid (H_3PO_4) having 70% purity by weight (specific gravity 1.54 g cm^{-3}) is _____M. (Molar mass of H_3PO_4 = 98 g mol^{-1})
[31 Jan, 2024 (Shift-II)]

8. The Molarity (M) of an aqueous solution containing 5.85 g of NaCl in 500 mL water is: **[04 April, 2024 (Shift-I)]**
(Given: Molar Mass Na : 23 and Cl : 35.5 $gmol^{-1}$)
(*a*) 20 (*b*) 0.2 (*c*) 2 (*d*) 4

9. The density of 'x' M solution ('x' molar) of NaOH is 1.12 g mL^{-1}. while in molality, the concentration of the solution is 3 m (3 molal). Then x is **[06 April, 2024 (Shift-I)]**
(Given: Molar mass of NaOH is 40 g/mol)
(*a*) 3.5 (*b*) 3.0
(*c*) 3.8 (*d*) 2.8

10. Molality (m) of 3M aqueous solution of NaCl is: (Given: Density of solution = 1.25 g mL^{-1}, Molar mass in g mol^{-1} : Na-23,Cl-35.5) **[06 April, 2024 (Shift-II)]**
(*a*) 2.90 m (*b*) 2.79 m
(*c*) 1.90 m (*d*) 3.85 m

11. Molality of an aqueous solution of urea is 4.44 m. Mole fraction of urea in solution is x $\times 10^{-3}$.
Value of *x* is _____. (integer answer)
[08 April, 2024 (Shift-II)]

12. A solution is prepared by adding 1 mole ethyl alcohol in 9 mole water. The mass percent of solute in the solution is _____ (Integer Answer)
(Given: Molar mass in g mol^{-1} Ethyl alcohol: 46, water: 18)
[08 April, 2024 (Shift-II)]

13. Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A): 3.1500g of hydrated oxalic acid dissolved in water to make 250.0 mL solution will result in 0.1 M oxalic acid solution.

Reason (R): Molar mass of hydrated oxalic acid is 126 g mol^{-1}. **[10 April, 2023 (Shift-II)]**

In the light of the above statements, choose the correct answer from the options given below:
(*a*) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).
(*b*) (A) is false but (R) is true.
(*c*) (A) is true but (R) is false.
(*d*) Both (A) and (R) are true and (R) is the correct explanation of (A).

14. The molality of a 10%(V/V) solution of di-bromine solution in CCl_4 (carbon tetrachloride) is 'x'. x = _____ $\times 10^{-2}$ M. (Nearest Integer)
[Given: molar mass of Br_2 = 160 g mol^{-1}
atomic mass of C = 12 g mol^{-1}
atomic mass of Cl = 35.5 g mol^{-1}
density of dibromine 3.2 g cm^{-3}
density of CCl_4 = 1.6 g cm^{-3}] **[1 Feb, 2023 (Shift-II)]**

15. A solution of sugar is obtained by mixing 200 g of its 25% solution and 500 g of its 40% solution (both by mass). The mass percentage of the resulting sugar solution is. (Nearest Integer) **[11 April, 2023 (Shift-I)]**

16. When 800 mL of 0.5 M nitric acid is heated in a beaker, its volume is reduced to half and 11.5 g of nitric acid is evaporated. The molarity of the remaining nitric acid solution is x $\times 10^{-2}$M. (Nearest Integer)
(Molar mass of nitric acid is 63 g mol^{-1})
[26 July, 2022 (Shift-I)]

17. The molarity of the solution prepared by dissolving 6.3 g of oxalic acid ($H_2C_2O_4 \cdot 2H_2O$) in 250 mL of water in mol L^{-1} is x $\times 10^{-2}$. The value of x is _____. (Nearest Integer)
[Atomic mass : H : 1.0, C : 12.0, O : 16.0]
[31Aug, 2021 (Shift-I)]

INTEGER TYPE QUESTIONS

1. The molecular weight of a newly synthesized organic compound was determined by the method of isothermal distillation. In this procedure two solutions, each in an open calibrated vial, are placed side by side in a closed chamber. One of the solutions contained 9.3 mg of the new compound, the other 13.2 mg of azobenzene (MW = 182). Both were dissolved in portions of the same solvent. During a period of 3 days of equilibration, solvent distilled from one vial into the other until the same partial pressure of solvent was reached in the two vials. At this point the distillation of solvent stopped. Neither of the solutes distilled at all. The volume of the two solutions at equilibrium were then read on the calibration marks of the vials. The solution containing the new compound occupied 1.72 mL and the azobenzene solution occupied 1.02 mL. What is the molecular weight (in g/mol) of the new compound? The mass of solvent in solution may be assumed to be proportional to the volume of the solution.

2. In water at 20°C, the Henry's law constant for oxygen is 4.6×10^4 atm, and for nitrogen it is 8.2×10^4 atm, where the concentration are expressed as mole fractions. If we are to prepare 90 mole % pure oxygen from air (successive treatments by partially dissolving in water and then all the gas is removed under vacuum the water), how many cycles would be necessary to achieve this result?

3. When cells of the skeletal vacuole of a frog wee placed in series of NaCl solution of different concentrations at 6°C, it was observed microscopically that they remained unchanged in x% NaCl solution, it shrank in more concentrated solution and swells in more dilute solutions. Water freezes from the x% salt solution at –0.40°C. If the osmotic pressure of the cell cytoplasm at 6°C is 'y'× 0.0821 atm, then the value of 'y' is (K_f = 1.86 K mol^{-1} kg)

4. Consider the following arrangements, in which a solution containing 20 g of haemoglobin in 1 dm^3 of the solution is placed in right compartment and pure water is placed in left compartment, separated by SPM. At equilibrium, the height of liquid in the right compartment is 74.5 mm in excess of that in the left compartment. The temperature of the system is maintained at 298K. The number of millimoles in 320 g of haemoglobin is (Given: The density of final solution is 1.013 g/ml, g = 10 m/s^2, R = 0.08 L-atm / K-mol)

NUMERICAL TYPE QUESTIONS

5. Two solutions of non-volatile solutes A and B are prepared. The molar mass ratio, $\frac{M_A}{M_B} = \frac{1}{3}$. Both are prepared as 5% solutions by weight in water. If the two solutions are mixed to prepare two new solution S_1 and S_2, the mixing ratio being 2 : 3 and 3 : 2 by volume for S_1 and S_2 respectively what would be the value of $\frac{(\Delta T_f)_{S_1}}{(\Delta T_f)_{S_2}}$?

(Answer upto two decimal place)

SINGLE CHOICE TYPE QUESTIONS

6. A dilute solution contains m mol of solute A in 1 kg of a solvent with molal elevation constant K_b; The solute dimerises in solution as $2A \rightleftharpoons A_2$. What is correct expression for the equilibrium constant for this dimer formation? (ΔT_b is the elevation in boiling point for the given solution)

(*a*) $K = \frac{K_b(K_b m + \Delta T_b)}{(2\Delta T_b + K_b m)^2}$ (*b*) $K = \frac{K_b(K_b m + \Delta T_b)}{(\Delta T_b + K_b m)^2}$

(*c*) $K = \frac{K_b(K_b m + \Delta T_b)}{(\Delta T_b - 2K_b m)^2}$ (*d*) $K = \frac{K_b(K_b m - \Delta T_b)}{(2\Delta T_b - K_b m)^2}$

7. The partial molar volumes of propanone (CH_3COCH_3) and butanone ($CH_3COCH_2CH_3$) in a mixture in which mole fraction of propanone is 0.4 are 75 cm^3 mol^{-1} and 80 cm^3 mol^{-1}. Thus, the total volume of solution of total mass 1 kg, is

(*a*) 1175 cm^3 (*b*) 1000 cm^3

(*c*) 1200 cm^3 (*d*) 972 cm^3

COMPREHENSION BASED QUESTIONS

Comprehension I

10 mole of liquid 'A' and 20 mole of liquid 'B' is mixed in a cylindrical vessel containing a piston arrangement. Initially a pressure of 2 atm is maintained on the solution. Now, the piston is raised slowly and isothermally. Assume ideal behaviour of solution and A and B are completely miscible.

P_A° = 0.6 atm and P_B° = 0.9 atm

8. The pressure below which the evaporation of liquid solution will start, is

(*a*) 0.6 atm (*b*) 0.8 atm

(*c*) 0.77 atm (*d*) 0.9 atm

9. The pressure at which $\frac{1}{3}$ th of the total amount (by mol) of liquid solution taken initially, will be present in the vapour form, is

(*a*) 0.283 (*b*) 0.791 (*c*) 0.600 (*d*) 0.652

ANSWER KEY

CONCEPT APPLICATION

1. (*d*) **2.** (*b*) **3.** (*a*) **4.** (*b*) **5.** [P_B° = 600 mm Hg , P_A° = 400 mm Hg] **6.** [< 80 mL]
7. [65.25 g/mol]
8. vapour pressure of pure water = 20.22 Torr.
Mol. weight of non-volatile solute = 54 g/mol. **9.** [0.33] **10.** [5.08 K kg mole^{-1}] **11.** [π = 8.35 atm]
12. [34.89 g/mol.] **13.** [i = 1.0753, $K_a = 3.07 \times 10^{-3}$]

BOARD LEVEL PROBLEMS

1. (*b*) **2.** (*b*) **3.** (*c*) **4.** (*d*) **5.** (*d*) **6.** (*b*) **7.** (*b*) **8.** (*c*) **9.** (*d*) **10.** (*a*)
11. (*c*) **12.** (*a*) **13.** (*d*) **14.** (*a*) **25.** (I)-(*d*), (II)-(*d*), (III)-(*a*), (IV)-(*c*)

PRARAMBH (TOPICWISE)

1. (*d*) **2.** (*c*) **3.** (*d*) **4.** (*b*) **5.** (*c*) **6.** (*a*) **7.** (*b*) **8.** (*d*) **9.** (*c*) **10.** (*d*)
11. (*a*) **12.** (*c*) **13.** (*d*) **14.** (*c*) **15.** (*b*) **16.** (*d*) **17.** (*d*) **18.** (*c*) **19.** (*d*) **20.** (*c*)
21. (*b*) **22.** (*a*) **23.** (*b*) **24.** (*b*) **25.** (*b*) **26.** (*a*) **27.** (*d*) **28.** (*b*) **29.** (*a*) **30.** (*b*)
31. (*a*) **32.** (*b*) **33.** (*c*) **34.** (*c*) **35.** (*c*) **36.** (*c*) **37.** (*a*) **38.** (*a*) **39.** (*c*) **40.** (*d*)
41. (*a*) **42.** (*a*) **43.** (*a*) **44.** (*c*) **45.** (*b*) **46.** (*b*)

PRABAL (JEE MAIN LEVEL)

1. (*c*) **2.** (*b*) **3.** (*c*) **4.** (*b*) **5.** (*b*) **6.** (*c*) **7.** (*a*) **8.** (*c*) **9.** (*a*) **10.** (*b*)
11. (*b*) **12.** (*a*) **13.** (*d*) **14.** (*a*) **15.** (*a*) **16.** (*b*) **17.** (*d*) **18.** (*c*) **19.** (*d*) **20.** (*b*)
21. (*b*) **22.** (*b*) **23.** (*d*) **24.** (*c*) **25.** (*c*) **26.** (*a*) **27.** (*a*) **28.** (*a*) **29.** (*d*) **30.** (*c*)
31. (*a*) **32.** (*a*) **33.** (*a*) **34.** (*b*) **35.** (*d*) **36.** (*a*) **37.** (*c*) **38.** (*d*) **39.** (*c*) **40.** (*d*)
41. (*d*) **42.** (*c*) **43.** (*d*) **44.** (*a*) **45.** (*c*) **46.** (*d*) **47.** (*c*) **48.** (*a*) **49.** [5] **50.** [5]
51. [10] **52.** [30] **53.** [8] **54.** [93] **55.** [112] **56.** [278] **57.** [102] **58.** [10]

PARIKSHIT (JEE ADVANCED LEVEL)

1. (*a*) **2.** (*c*) **3.** (*d*) **4.** (*d*) **5.** (*a*) **6.** (*c*) **7.** (*a*) **8.** (*b*) **9.** (*a*) **10.** (*b,c,d*)
11. (*a,c*) **12.** (*a,c,d*) **13.** (*b,d*) **14.** (*b,d*) **15.** (*a,b*) **16.** (*a,c*) **17.** (*a,b,c,d*) **18.** (*a,c,d*) **19.** (*a,b,c*) **20.** (*a,b,c*)
21. (*c,d*) **22.** (*c,d*) **23.** (*a,b,c*) **24.** (*b*) **25.** (*a*) **26.** (*b*) **27.** (*b*) **28.** (*c*) **29.** (*a*) **30.** (*b*)
31. (*a*) **32.** (*c*) **33.** (*b*) **34.** (*d*) **35.** (*c*) **36.** (*d*) **37.** (*a*) **38.** (*d*) **39.** [98] **40.** [20]
41. [80] **42.** [78] **43.** [380] **44.** [160] **45.** [366] **46.** [4] **47.** [5] **48.** [85] **49.** [71.42] **50.** [0.23]
51. [0.67] **52.** [52.5] **53.** [0.56] **54.** [1.04] **55.** [0.20]

PYQ's (PAST YEAR QUESTIONS)

1. (*a*) **2.** [7] **3.** [4] **4.** [815] **5.** [7] **6.** (*b*) **7.** [11] **8.** (*b*) **9.** (*b*) **10.** (*b*)
11. [74] **12.** [22] **13.** (*d*) **14.** [139] **15.** [36] **16.** [54] **17.** [20] **18.** [50] **19.** [47]
20. [2.8-3.05] **21.** [23] **22.** [1] **23.** [25] **24.** (*d*) **25.** [0.20] **26.** (*c*) **27.** (*d*) **28.** (*d*)
29. (*d*) **30.** (*b*) **31.** [73] **32.** (*d*) **33.** (*a*) **34.** (*a*) **35.** [15] **36.** [707] **37.** [31] **38.** [25]
39. [19] **40.** [76] **41.** [543] **42.** [5] **43.** (*d*) **44.** [13] **45.** (*d*) **46.** (*d*) **47.** [100] **48.** [6]
49. [415] **50.** (*b*) **51.** [271] **52.** [100.1] **53.** [2.5] **54.** [0.97 to 1.06] **55.** (*c*) **56.** [167] **57.** (*b*)

PW CHALLENGERS

1. [76] **2.** [7] **3.** [60] **4.** [5] **5.** [0.82] **6.** (*d*) **7.** (*a*) **8.** (*b*) **9.** (*b*) **10.** (*c*)
11. (*b*) **12.** (*c*) **13.** [0.010] **14.** [0.095] **15.** [0.0045] **16** [67.52] **17.** [76] **18.** [49] **19.** [76] **20.** (*d*)

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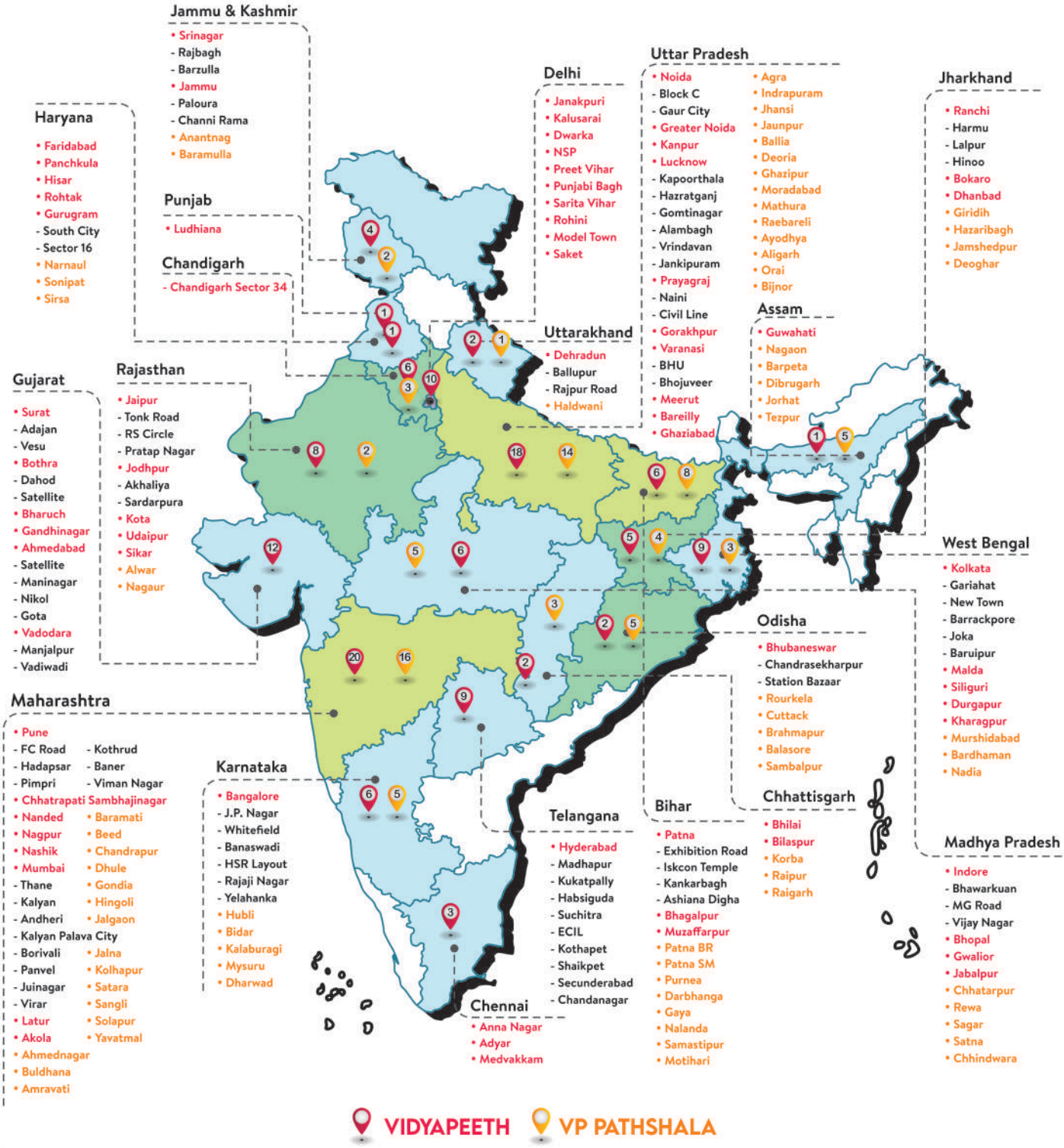

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