CHEMISTRY

Study Material for NEET preparation

Prepared by Career Point Kota Experts

CAREER POINT

CONTENTS OF THE PACKAGE AT A GLANCE

CHEMISTRY

Class 11

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- Atomic Structure
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- Redox & Volumetric Analysis
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Physical/Inorganic Chemistry (II)

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Class 12

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Inorganic Chemistry

- p-Block Elements [Nitrogen, Oxygen, Halogen & Noble gas]
- d & f Block
- Coordination compound
- Principles related to practical Chemistry

Features of The Product

This study material is especially designed for NEET aspirants. The entire study material is arranged in such a way so that the learning process progresses gradually from the basic to advanced stages. This easy-to-grasp material enables students to apply the fundamentals they have learned and boost their confidence to tackle the problems asked in the NEET and other medical competitive examinations.

Key Features of the Chapter

Theory & Concepts

Theory provides all the basic concepts in clear and precise manner. It comprises all the related and required diagrams, tables, graphs, real life examples, info graphics, conceptual questions that makes it more comprehensive. It also highlights tips and tricks, facts, notes, misconceptions, key points, and problem solving tactics.

SOLUTION

KEY CONCEPT

1. Solution

A solution is a homogeneous mixture of a solute, the substance that dissolves and a solvent, the substance in which the solute dissolves.

(a) The component of solution which is in lesser amount (Which is dissolved) is called **solute.**

(b) The component of solution in which solute is dissolved is called **solvent.**

Solution = Solute + Solvent

2. Concentration of Solution

It is calculated by following two methods

(a) Weight % : Weight of solute per 100 gram of solution.

(b) Volume % :

(i) Weight of solute per 100 ml of solution

(ii) Volume of solute per 100 ml of solution

(c) Concentration of a solution expressed in following terms.

2.1 MOLARITY (M)

It is the number of moles of solute in one litre of solution

$$\text{Molarity} = \frac{\text{No. of moles of solute}}{\text{Volume of solution (litre)}}$$

(a) Molarity is expressed by putting a suffix 'M' after a number, say 'X'. It means if concentration of a solution is given to be XM, it means X moles of solute are there per litre of solution.

(b) Some times amount of solute is given in grams. So,

$$\text{Moles of solute} = \frac{\text{amount (gram)}}{\text{mol.wt. in (gram)}}$$

(c) We Should be careful about unit of volume taken. We have to use volume in litre in the formula for molarity. So, if volume is given in ml (mili litre) convert it into litre as-

volume in litre = volume in ml × 10^{-3}

(d) Some times we get confused when volume is given in cm^3. A cm^3 is nothing but a milliliter. So, volume in litre = volume (cm^3) × 10^{-3}

(e) Unit of molarity is mole L^{-1}.

(f) $\text{Millimoles} = M \times V(ml) = \frac{\text{wt.} \times 1000}{\text{mol. wt.}}$

(g) $\text{Strength of solution} = \frac{\text{wt. of solute} \times 1000}{\text{volume of solution (ml)}}$

(h) Molarity is a temperature dependent unit.

$$\text{Molarity} \propto \frac{1}{\text{temp.}}$$

2.2 MOLALITY (m)

It is the number of moles of solute per kilogram of solvent.

$$\text{Molality} = \frac{\text{moles of solute}}{\text{mass of solvent (kg)}}$$

(a) Unit of molality is mole kg^{-1}

(b) Sometimes mass of solution is given instead of solvent, so subtract the mass of solute to get mass of solvent

(c) Represented by a suffix 'm' after a number x. xm means x moles of solute are there per kg of solvent.

(d) Molality does not change with increase of temperature.

(e) Relation between molarity and molality-

$$m = \frac{1000M}{1000d - MM_B}$$

Where,

m = Molality

M = Molarity

d = density of solution in gm/litre

M_B = Molecular wt. of solute

Derivation :–

$$\frac{M}{m} = \frac{\text{wt. of solvent}}{\text{volume of solution}}$$

$$\frac{M}{m} = \frac{W_A}{V(\text{litre})}$$

Since, wt. of solvent = wt. of solution – wt. of solute

$= V \times d - MM_B$

Therefore, $\frac{M}{m} = \frac{Vd - MM_B}{V}$

$$m = \frac{MV}{Vd - MM_B}$$

2.3 MOLE FRACTION (X)

(a) Mole fraction of a component in solution is equal to the ratio of number of moles of that component to the total number of moles of all the components in the solution. Mole fraction of component A is represented by x_A.

(b) Let, there be two components A (solvent) & B (solute)

$X_A = \frac{n_A}{n_A + n_B}$ and $X_B = \frac{n_B}{n_A + n_B}$ where,

X_A = Mole fraction of solvent and

X_B = Mole fraction of solute.

Here, $n_A = \frac{w_A}{M_A}$

(wt. of A in grams/mol.wt. of A, $x_A + x_B = 1$)

In Chapter Examples

To clarify the application of theory & concept accurately & correctly, there is number of solved in-chapter questions follpowng each topic. It proves practically very effective to understand and correct application of related theory.

Questions based on **Raoult's Law**

Ex.1 At 300 K, the vapour pressure of an ideal solution containing one mole of A and 3 moles of B is 550 mm of Hg. At the same temperature, if one mole of B is added to this solution, the vapour pressure of solution increases by 10mm of Hg. Calculate the vapour pressure of A and B in their pure state.

(1) 400 mm, 600 mm

(2) 600 mm, 400 mm

(3) 200 mm, 300 mm

(4) 300 mm, 200 mm **(Ans. 1)**

Sol. Initially,

$P_M = P^o_A \cdot X_A + P^o_B \cdot X_B$

$550 = P^o_A\left(\frac{1}{1+3}\right) + P^o_B\left(\frac{3}{1+3}\right)$

$P^o_A + 3P^o_B = 2200$

When 1 mole of B is further added to it

$P_M = P^o_A \cdot X_A + P^o_B \cdot X_B$

$560 = P^o_A\left(\frac{1}{1+4}\right) + P^o_B\left(\frac{4}{1+4}\right)$

or $P^o_A + 4P^o_B = 2800$

By (i) and (ii)

P^o_A **= 400 mm** ; P^o_B **= 600 mm**

Solved Examples

To understand the concept application, in end of the each chapter there is suffiecient number of solved examples.

SOLVED EXAMPLES

Ex.1 A 6.90 M solution of KOH in water has 30% by weight of KOH. Calculate density of solution.

(A) 1.288 g mL^{-1} (B) 12.88 g mL^{-1}

(C) 24.88 g mL^{-1} (D) 2.488 g mL^{-1}

(Ans. A)

Sol. KOH solution is 30% by weight.

$\therefore$ wt. of KOH = 30 g

and Wt. of solution = 100 g

$\therefore$ Volume of solution $= \frac{100}{d}$

$$\therefore \quad \text{Molarity} = 6.90 = \left(\frac{30}{56 \times \frac{100}{1000 \times d}}\right)$$

$= \mathbf{1.288\ g\ mL^{-1}}$

Ex.2 What is mole fraction in its one molal aqueous solution-

(A) 0.108 (B) 0.018

(C) 0.008 (D) None **(Ans. B)**

Sol. Mole fraction $= \frac{n_A}{n_A + n_B}$

$n_A = 1$ and $n_B = \frac{1000}{18} = 55.4$

$= \frac{1}{1+55.4} = \frac{1}{56.4} = \mathbf{0.018}$

Ex.4 Calculate the molality and mole fraction of the solute in aqueous solution containing 3.0 gm of urea per 250 gm of water (Mol. wt. of urea = 60).

(A) 0.2 m, 0.00357 (B) 0.4 m, 0.00357

(C) 0.5 m, 0.00357 (D) 0.7m, 0.00357

(Ans. A)

Sol. Wt. of solute (urea) dissolved = 3.0 gm

Wt. of the solvent (water) = 250 gm

Mol. wt. of the solute = 60

3.0 gm of the solute $= \frac{3.0}{60}$ moles = 0.05 moles

Thus 250 gm of the solvent contain = 0.05 moles of solute

$\therefore$ 1000 gm of the solvent contain

$= \frac{0.05 \times 100}{250} = 0.2$ moles

Hence molality of the solution = 0.2 m

In short,

Molality = No. of moles of solute/1000 g of solvent

$\therefore$ Molality $= \frac{3/60}{250} \times 1000 = \mathbf{0.2\ m}$

Calculation of mole fraction

3.0 gm of solute = 3/60 moles = 0.05 moles

250 gm of water $= \frac{250}{18}$ moles

= 13.94 moles

$\therefore$ Mole fraction of the solute

$= \frac{0.05}{0.05 + 13.94} = \frac{0.05}{13.99}$

= 0.00357

Ex.5 15 gram of methyl alcohol is dissolved in 35 gram of water. What is the mass percentage of methyl alcohol

Practice Exercises

Exercise Level -1 : It contains TOPIC WISE single objective correct (SCQ) type concept building questions.

Exercise Level -2: It contains single objective type good quality questions on all the concepts of the chapter in mixed manner.

EXERCISE # 2

Q.1 Select correct statement -
(1) b.p. of 1 molal NaCl solution is twice that of 1 molal sucrose solution
(2) b.p. elevation of 1 molal glucose solution is half of the 1 molal KCl solution
(3) b.p. is a colligative property
(4) All of the above

Q.2 At a given temperature, total vapour pressure in Torr of a mixture of volatile components A and B is given by
$$P = 120 - 75 X_B$$
hence, vapour pressure of pure A and B respectively (in Torr) are -
(1) 120, 75 (2) 120, 195
(3) 120, 45 (4) 75, 45

Q.3 Decimolar solution of potassium ferricyanide, $K_3[Fe(CN)_6]$ has osmotic pressure of 3.94 atm at 27ºC. Hence percent ionisation of the solute is -
(1) 10% (2) 20%
(3) 30% (4) 40%

Q.4 A complex containing K^+, Pt (IV) and Cl^- is 100% ionised giving i = 3. Thus, complex is -
(1) $K_2[PtCl_4]$ (2) $K_2[PtCl_6]$
(3) $K_3[PtCl_5]$ (4) $K[PtCl_3]$

Q.5 If $pK_a = -\log K_a = 4$, and $K_a = C\alpha^2$ then van't Hoff factor for weak monobasic acid when C = 0.01 M is -
(1) 0.01 (2) 1.02 (3) 1.10 (4) 1.20

Q.6 In which case van't Hoff factor is maximum ?
(1) KCl, 50% ionised (2) K_2SO_4 40% ionised
(3) $FeCl_3$, 30% ionised (4) $SnCl_4$, 20% ionised

Q.10 The value of K_b for water is 1.86, calculated from Glucose solution. The value of K_b for water calculated for NaCl solution will be -
(1) = 1.86 (2) < 1.86 (3) > 1.86 (4) Zero

Q.11 As a result of osmosis the volume of the concentrated solution -
(1) Gradually decreases (2) Gradually increases
(3) Suddenly increases (4) None

Q.12 If a thin slice of sugar beet is placed in concentrated solution of NaCl then -
(1) Sugar beet will lose water from its cells
(2) Sugar beet will absorb water from solution
(3) Sugar beet will neither absorb nor lose water
(4) Sugar beet will dissolve in solution

Q.13 If mole fraction of the solvent in solution decreases then -
(1) Vapour pressure of solution increases
(2) B. P. decreases
(3) Osmotic pressure increases
(4) All are correct

Q.14 A solution containing 4g of a non volatile organic solute per 100 ml was found to have an osmotic pressure equal to 500 cm of mercury at 27°C. The molecular weight of solute is -
(1) 14.97 (2) 149.7
(3) 1697 (4) 1.497

Q.15 If a 6.84% (wt./ vol.) solution of cane-sugar (mol. wt. 342) is isotonic with 1.52% (wt./vol.) solution of thiocarbamide, then the molecular weight of thiocarbamide is -
(1) 152 (2) 76 (3) 60 (4) 180

Exercise Level -3 : It contains previous years NEET exam quesiotns from 2005 to upto to present year.

Q.56 For an ideal solution, the correct option is - **[NEET-2019]**
(1) $\Delta_{mix} H = 0$ at constant T and P
(2) $\Delta_{min} G = 0$ at constant T and P
(3) $\Delta_{mix} S = 0$ at constant T and P
(4) $\Delta_{mix} V \neq 0$ at constant T and P

Q.57 The mixture which shows positive devation form Raoult's law is : **[NEET 2020]**
(1) Benzene + Toluene
(2) Acetone + Chloroform
(3) Chloroethane + Bromoethane
(4) Ethanol + Acetone

Q.58 The freezing point depression constant (K_f) of benzene is 5.12 K kg mol^{-1}. The freezing point depression for the solution of molality 0.078 m containing a non – electrolyte solute in benzene is (rounded off upto two decimal places) **[NEET 2020]**
(1) 0.80 K (2) 0.40 K
(3) 0.90 K (4) 0.20 K

Q.62 K_H value for some gases at the same temperature 'T' are given :

Gas	K_H/k bar
Ar	40.3
CO_2	1.67
HCHO	1.83×10^{-5}
CH_4	0.413

where K_H is Henry's Law constant in water. The order of their solubility in water is : **[Re-NEET-2022**
(1) HCHO < CH_4 < CO_2 < Ar
(2) Ar < CO_2 < CH_4 < HCHO
(3) Ar < CO_2 < CH_4 < HCHO
(4) HCHO < CO_2 < CH_4 < Ar

Exercise Level -4 : It contains previous years JEE Mains exam quesiotns from 2005 to upto to present year.

$\left[K_{f(H_2O)} = 1.86 \text{kgmol}^{-1}\right]$ **[Main - 2021]**

Q.32 4.5 g of compound A (MW = 90) was used to make 250 mL of its aqueous solution. The molarity of the solution in M is $x \times 10^{-1}$. The value of x is ________. (Rounded off to the nearest integer) **[Main - 2021]**

Q.33 15 mL of aqueous solution of Fe^{2+} in acidic medium completely reacted with 20mL of 0.03 M aqueous $Cr_2O_7^{2-}$. The molarity of the Fe^{2+} solution is —— $\times 10^{-2}$ M (Round off the Nearest Integer). **[Main - 2021]**

Q.34 The K_{sp} for bismuth sulphide (Bi_2S_3) is 1.08×10^{-73}. The solubility of Bi_2S_3 in mol L^{-1} at 298 K is **[Main - 2022]**

(1) 1.0×10^{-15} (2) 2.7×10^{-12}
(3) 3.2×10^{-10} (4) 4.2×10^{-8}

Q.35 The depression in freezing point observed for a formic acid solution of concentration 0.5 mL L^{-1} is 0.0405°C. Density of formic acid is 1.05 g mL^{-1}. The Van't Hoff factor of the formic acid solution is nearly
(Given for water k_f = 1.86 k kg mol^{-1}) **[Main - 2022]**

(1) 0.8 (2) 1.1 (3) 1.9 (4) 2.4

Q.36 Two solutions A and B are prepared by dissolving 1 g of non-volatile solutes X and Y, respectively in 1 kg of water. The ratio of depression in freezing points for A and B is found to be 1 : 4. The ratio of molar masses of X and Y is **[Main - 2022]**

(1) 1 : 4 (2) 1 : 0.25 (3) 1 : 0.20 (4) 1 : 5

Q.37 Boiling point of a 2% aqueous solution of a non-volatile solute A is equal to the boiling point of 8% aqueous solution of a non-volatile solute B. The relation between molecular weights of A and B is **[Main - 2022]**

(1) $M_A = 4M_B$ (2) $M_B = 4M_A$
(3) $M_A = 8M_B$ (4) $M_B = 8M_A$

Q.40 Match List-I with List-II.

	List-I		List-II
A.	van't Hoff factor, i	I.	Cryoscopic constant
B.	k_f	II.	Isotonic solutions
C.	Solutions with same ostomic pressure	III.	$\dfrac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$
D.	Azeotropes	IV.	Solutions with same composition of vapour above it

Choose the correct answer from the options given below ? **[Main - 2023]**

(1) A-III, B-I, C-II, D-IV (2) A-III, B-I, C-IV, D-II
(3) A-III, B-II, C-I, D-IV (4) A-I, B-III, C-II, D-IV

Q.41 What weight of glucose must be dissolved in 100 g of water to lower the vapour pressure by 0.20 mm Hg? (Assume dilute solution is being formed)
Given : Vapour pressure of pure water is 54.2 mm Hg at room temperature. Molar mass of glucose is 180 g mol^{-1} **[Main - 2023]**

(1) 3.59 g (2) 3.69 g
(3) 4.69 g (4S) 2.59 g

Q.42 A solution containing 2 g of a non-volatile solute in 20 g of water boils at 373.52 K. The molecular mass of the solute is ________ g mol^{-1}. (Nearest integer)
Given, water boils at 373 K, K_b for water = 0.52 K kg mol^{-1}) **[Main - 2023]**

Q.43 The vapour pressure of 30% (w/v) aqueous solution of glucose is ________ mm Hg at 25°C.
[Given: The density of 30% (w/v), aqueous solution of glucose is 1.2 g cm^{-3} and vapour pressure of pure water is 24 mm Hg.] (Molar mass of glucose is 180 g mol^{-1}) **[Main - 2023]**

Answer key

Above mentioned all exercises provided with answer key

EXERCISE # 1

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	1	1	3	1	2	3	1	4	3	4	2	3	3	4	1	2	1	3	1
Q.No.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	1	4	2	1	4	4	2	1	2	1	4	2	3	3	1	3	2	3	3
Q.No.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	2	4	1	1	4	2	2	2	3	2	2	2	3	2	3	3	2	1	2
Q.No.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	4	3	1	3	4	3	3	4	3	4	3	1	2	4	3	4	1	3	1
Q.No.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	1	3	2	1	2	3	3	2	4	4	4	3	1	3	4	4	3	3	4
Q.No.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115					
Ans.	3	1	3	2	2	4	3	4	1	1	2	4	2	2	2					

Revision Plan

We emphasis that every student should prepare his/her own revision plan. For this purpose there is Revision Plan Section in each chapter which student should prepare while going thorugh the study material. This will be useful at the time of final revision before final exam for quick & effective revision.

Revision Plan

Prepare Your Revision plan today!

After attempting Exercise Sheet, please fill below table as per the instruction given.

A. Write Question Number (QN) which you are unable to solve at your own in **column A**.

B. After discussing the Questions written in **column A** with faculty, strike off them in the manner so that you can see at the time question number during Revision, to solve such questions again.

C. Write down the Question Number you feel are important or good in the **column B**.

EXERCISE	COLUMN A	COLUMN B
	Questions unable to solve in first attempt	Good or Important questions
Exercise-1		
Exercise-2		
Exercise-3		
Exercise-4		

Online Solutions

Self explanatory and detailed soltuion of all excercises mentioned above are available on Career Point website **www.careerpoint.ac.in**

SOLUTION

EXERCISE-1

Answer Key & Solution

Question Number	Solution	Question Number	Solution	Question Number	Solution	Question Number	Solution
1	Click Here	30	Click Here	59	Click Here	88	Click Here
2	Click Here	31	Click Here	60	Click Here	89	Click Here
3	Click Here	32	Click Here	61	Click Here	90	Click Here
4	Click Here	33	Click Here	62	Click Here	91	Click Here
5	Click Here	34	Click Here	63	Click Here	92	Click Here
6	Click Here	35	Click Here	64	Click Here	93	Click Here
7	Click Here	36	Click Here	65	Click Here	94	Click Here
8	Click Here	37	Click Here	66	Click Here	95	Click Here
9	Click Here	38	Click Here	67	Click Here	96	Click Here
10	Click Here	39	Click Here	68	Click Here	97	Click Here
11	Click Here	40	Click Here	69	Click Here	98	Click Here
12	Click Here	41	Click Here	70	Click Here	99	Click Here
13	Click Here	42	Click Here	71	Click Here	100	Click Here
14	Click Here	43	Click Here	72	Click Here	101	Click Here
15	Click Here	44	Click Here	73	Click Here	102	Click Here
16	Click Here	45	Click Here	74	Click Here	103	Click Here
17	Click Here	46	Click Here	75	Click Here	104	Click Here
18	Click Here	47	Click Here	76	Click Here	105	Click Here
19	Click Here	48	Click Here	77	Click Here	106	Click Here
20	Click Here	49	Click Here	78	Click Here	107	Click Here
21	Click Here	50	Click Here	79	Click Here	108	Click Here
22	Click Here	51	Click Here	80	Click Here	109	Click Here
23	Click Here	52	Click Here	81	Click Here	110	Click Here
24	Click Here	53	Click Here	82	Click Here	111	Click Here
25	Click Here	54	Click Here	83	Click Here	112	Click Here
26	Click Here	55	Click Here	84	Click Here	113	Click Here
27	Click Here	56	Click Here	85	Click Here	114	Click Here
28	Click Here	57	Click Here	86	Click Here	115	Click Here
29	Click Here	58	Click Here	87	Click Here		

SOLUTION

NEET SYLLABUS

1. ***Types of solution***
2. ***Units of concentration***
3. ***Mole fraction***
4. ***Percentage [Volume & mass]***
5. ***Vapour pressure, Roult's law.***
6. ***Colligative properties [lowering of V.P., depression of F.P., elevation of B.P. & O.P.]***
7. ***Determination of molecular masses, abnormal values of molecular masses.***
8. ***Van't Hoff factor.***

Revision Plan

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B. After discussing the Questions written in **column A** with faculty, strike off them in the manner so that you can see at the time question number during Revision, to solve such questions again.

C. Write down the Question Number you feel are important or good in the **column B**.

EXERCISE	COLUMN A	COLUMN B
	Questions unable to solve in first attempt	Good or Important questions
Exercise-1		
Exercise-2		
Exercise-3		
Exercise-4		
Exercise-5		

Revision Strategy:

Whenever you wish to revision this chapter, follow the following steps-

Step-1: Review your theory notes.

Step-2: Solve Questions of column A

Step-3: Solve Questions of Column B

Step-4: Solve questions from other Question Bank, Problem book etc.

SOLUTION

KEY CONCEPT

1. Solution

A solution is a homogeneous mixture of a solute, the substance that dissolves and a solvent, the substance in which the solute dissolves.

(a) The component of solution which is in lesser amount (Which is dissolved) is called **solute.**

(b) The component of solution in which solute is dissolved is called **solvent.**

Solution = Solute + Solvent

2. Concentration of Solution

It is calculated by following two methods

(a) Weight % : Weight of solute per 100 gram of solution.

(b) Volume % :

(i) Weight of solute per 100 ml of solution

(ii) Volume of solute per 100 ml of solution

(c) Concentration of a solution expressed in following terms.

2.1 MOLARITY (M)

It is the number of moles of solute in one litre of solution

$$\text{Molarity} = \frac{\text{No. of moles of solute}}{\text{Volume of solution (litre)}}$$

(a) Molarity is expressed by putting a suffix 'M' after a number, say 'X'. It means if concentration of a solution is given to be XM, it means X moles of solute are there per litre of solution.

(b) Some times amount of solute is given in grams. So,

$$\text{Moles of solute} = \frac{\text{amount (gram)}}{\text{mol.wt.in (gram)}}$$

(c) We Should be careful about unit of volume taken. We have to use volume in litre in the formula for molarity. So, if volume is given in ml (mili litre) convert it into litre as-

volume in litre = volume in ml × 10^{-3}

(d) Some times we get confused when volume is given in cm^3. A cm^3 is nothing but a milliliter. So, volume in litre = volume (cm^3) × 10^{-3}

(e) Unit of molarity is mole L^{-1}.

(f) $\text{Millimoles} = M \times V(ml) = \frac{\text{wt.} \times 1000}{\text{mol. wt.}}$

(g) $\text{Strength of solution} = \frac{\text{wt. of solute} \times 1000}{\text{volume of solution (ml)}}$

(h) Molarity is a temperature dependent unit.

$$\text{Molarity} \propto \frac{1}{\text{temp.}}$$

2.2 MOLALITY (m)

It is the number of moles of solute per kilogram of solvent.

$$\text{Molality} = \frac{\text{moles of solute}}{\text{mass of solvent (kg)}}$$

(a) Unit of molality is mole kg^{-1}

(b) Sometimes mass of solution is given instead of solvent, so subtract the mass of solute to get mass of solvent

(c) Represented by a suffix 'm' after a number x. xm means x moles of solute are there per kg of solvent.

(d) Molality does not change with increase of temperature.

(e) Relation between molarity and molality-

$$m = \frac{1000\,M}{1000d - MM_B}$$

Where,

m = Molality

M = Molarity

d = density of solution in gm/litre

M_B = Molecular wt. of solute

Derivation :–

$$\frac{M}{m} = \frac{\text{wt. of solvent}}{\text{volume of solution}}$$

$$\frac{M}{m} = \frac{W_A}{V(\text{litre})}$$

Since, wt. of solvent = wt. of solution – wt. of solute

$= V \times d - MM_B$

Therefore, $$\frac{M}{m} = \frac{Vd - MM_B}{V}$$

$$m = \frac{MV}{Vd - MM_B}$$

2.3 MOLE FRACTION (X)

(a) Mole fraction of a component in solution is equal to the ratio of number of moles of that component to the total number of moles of all the components in the solution. Mole fraction of component A is represented by x_A.

(b) Let, there be two components A (solvent) & B (solute)

$X_A = \frac{n_A}{n_A + n_B}$ and $X_B = \frac{n_B}{n_A + n_B}$ where,

X_A = Mole fraction of solvent and

X_B = Mole fraction of solute.

Here, $n_A = \frac{w_A}{M_A}$

(wt. of A in grams/mol.wt. of A, $x_A + x_B = 1$)

(c) It is temperature independent unit.

(d) Relation between mole fraction and molality -

Mole fraction of solvent

$$X_A = \frac{n_A}{n_A + n_B}$$

Mole fraction of solute

$$X_B = \frac{n_B}{n_A + n_B}$$

$$\frac{X_A}{X_B} = \frac{n_A}{n_B}$$

On multiplying 1000 in both side

$$\frac{X_A}{X_B} \times 1000 = 1000 \times \frac{n_A}{n_B}$$

$$\frac{X_A}{X_B} = \frac{m \times M_A}{1000}$$

2.4 <u>MASS FRACTION</u> :

Ratio of mass of component to the total mass of components

mass fraction of A = $\frac{w_A}{w_A + w_B}$

where, w_A = weight of A, and w_B = weight of B.

2.5 <u>MOLE PERCENT</u> :

number of moles of a component in 100 moles

Mole percent = mass fraction × 100

2.6 <u>PARTS PER MILLION</u> (PPM) :

(a) amount of component in mg in 1 kg of solution.

$$\text{ppm} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 10^6$$

$$\text{ppm} = \frac{\text{wt. of solute}}{\text{wt. of solute} + \text{wt. of solvent}} \times 10^6$$

(b) Generally, it is used for very-very little concentrations.

3. Colligative properties

Certain properties of dilute solutions containing nonvolatile solute do not depend upon the nature of the solute dissolved but depend only upon the concentration. i.e the number of the particles of the solute present in the solution. Such properties are called colligative properties. The four well known examples of the colligative properties are -

(a) Lowering of vapour pressure of the solvent

(b) Osmotic pressure of the solution

(c) Elevation in boiling point of the solvent

(d) Depression in freezing point of the solvent

4. Vapour Pressure of a Liquid

It is the pressure that its vapours exert when in equilibrium with the liquid at a given temperature. It depends upon the following factors :

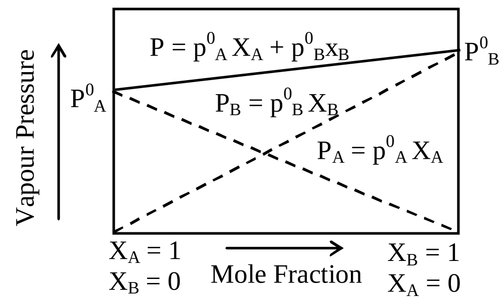
(a) Nature of solvent

(b) Temperature

5. Raoult's Law

(a) Raoult proposed a law which states that at a given temperature, the vapour pressure of a solvent in a solution containing non-volatile solute is directly proportional to its mole fraction.

Mathematically, $p = p^0 x \times$ solvent



(b) In the case of binary solutions of two volatile liquids, Raoult's law states that at a given temperature, the partial vapour pressure of any component of the solution is equal to the product of the vapour pressure of the pure component and its mole fraction in the solution i.e.

$$p_A = p^0_A X_A \text{ and } p_B = p^0_B X_B$$

(c) The total vapour pressure P of such a solution containing two components A and B is,

$$P = p_A + p_B = p^0_A X_A + p^0_B X_B$$

$$= (1 - X_B)\, p^0_A + p^0_B X_B$$

$$= (p^0_B - p^0_A)\, X_B + p^0_A$$

where, p_A and p_B are vapour pressures (of pure component) and X_A and X_B are mole fractions of components A and B respectively.

Plot of P should be a straight line which is true for ideal solution. Thus the addition of a solute may raise or lower the vapour pressure of solvent depending upon which one is more volatile.

(d) Raoult's Law mathematically expressed as

$$\frac{P_0 - P_S}{P_0} = \frac{n}{n + N} \qquad \text{..... (i)}$$

where, P_0 = Vapour pressure of pure solvent

P_S = Vapour pressure of solution

n = moles of non-volatile solute

N = moles of solvent

If the solution is very dilute, then

$n << N$

So, $\frac{P_0 - P_S}{P_0} = \frac{n}{N}$ ….. (ii)

or $\frac{P_0 - P_S}{P_0} = \frac{w/m}{W/M}$

where,w = wt. of solute dissolved in grams

W = wt. of solvent in grams

m = molecular mass of solute

M = molecular weight of solvent

$$\frac{P_0 - P_S}{P_0} = \frac{w.M}{W.m} \quad ..... (iii)$$

This expression (iii) can be used for calculating the molecular weight of solutes.

5.1 Limitations of Raoult's law

(i) As described earlier, Raoult's law is applicable only to very dilute solutions.

(ii) Raoult's law is applicable to solutions containing non-volatile solute only.

(iii) Raoult's law is not applicable to solutes which dissociate or associate in the particular solution

Questions based on **Raoult's Law**

Ex.1 At 300 K, the vapour pressure of an ideal solution containing one mole of A and 3 moles of B is 550 mm of Hg. At the same temperature, if one mole of B is added to this solution, the vapour pressure of solution increases by 10mm of Hg. Calculate the vapour pressure of A and B in their pure state.

(1) 400 mm, 600 mm

(2) 600 mm, 400 mm

(3) 200 mm, 300 mm

(4) 300 mm, 200 mm **(Ans. 1)**

Sol. Initially,

$P_M = P^o_A \cdot X_A + P^o_B \cdot X_B$

$550 = P^o_A\left(\frac{1}{1+3}\right) + P^o_B\left(\frac{3}{1+3}\right)$

$P^o_A + 3P^o_B = 2200$

When 1 mole of B is further added to it

$P_M = P^o_A \cdot X_A + P^o_B \cdot X_B$

$560 = P^o_A\left(\frac{1}{1+4}\right) + P^o_B\left(\frac{4}{1+4}\right)$

or $P^o_A + 4P^o_B = 2800$

By (i) and (ii)

P^o_A = **400 mm** ; P^o_B = **600 mm**

6. Ideal Solution

These are the solutions in which solute-solute and solvent-solvent interactions are almost similar to solute-solvent interactions. Ideal solutions obey Raoult's law for all range of concentrations and temperature.

$\Delta H_{mix} = 0$ $\quad \Delta V_{mix} = 0$

eg. Hexane + Heptane, ethyl chloride + ethyl bromide, chlorobenzene + Bromobenzene etc.

7. Non Ideal Solutions

(a) These are the solutions in which solute-solvent interactions are different than solute-solute and solvent-solvent interactions. The non-ideal solutions do not obey Raoult's law for all concentrations

$\Delta H_{mix} \neq 0$ $\quad \Delta V_{mix} \neq 0$

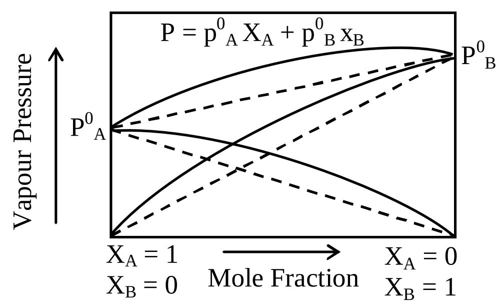
(b) These non-ideal solutions show two types of deviations from the ideal behaviour.

- If $\Delta V_{mix} > 0$ and $\Delta H_{mix} > 0$, then non-ideal solutions show positive deviations.
- If $\Delta V_{mix} < 0$ and $\Delta H_{mix} < 0$, then non-ideal solutions show negative deviations

7.1 Types of non-ideal solutions

7.1.1 Non-ideal solutions showing positive deviations : In such a case, the observed vapour pressure of each component and the total vapour pressure are greater than predicted by Raoult's law i.e.

$p_A > p^0_A X_A$, $\quad p_B > p^0_B x_B$, $\quad P > p_A + p_B$



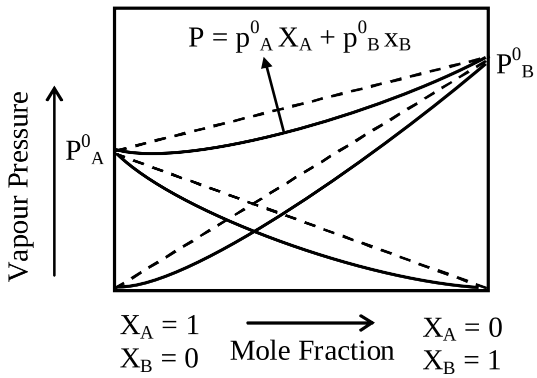
This is because the new interactions are weaker than those in the pure components.

eg. Acetone + Ethyl alcohol, Water + Ethyl alcohol, $CCl_4 + CHCl_3$

Ethanol + $CHCl_3$

Positive deviation (solid lines) from Raoult's law (dotted lines).

7.1.2 Non-ideal solutions showing negative deviations: In such a case the observed vapour pressure of each component and the total vapour pressure are less than predicted by Raoult's law i.e.



$p_A < p^0_A X_A$, $p_B < P^0_B X_B$, $P < p_A + p_B$

This is because the new interactions are stronger than those in the pure components.

eg. Acetone + Aniline, HCl + water,

HNO_3 + water,

water + H_2SO_4 etc

Negative deviations (solid lines) from Raoult's law (dotted lines)

8. Azeotropic Mixture

Azeotropic mixtures of two liquids which boil at a constant temperature and can be distilled unchanged in their composition. They are formed by non-ideal solutions.

8.1 TYPES OF AZEOTROPIC MIXTURES

8.1.1 **"Minimum boiling azeotropes"** are the mixture of two liquids, whose boiling points is less than either of the two pure components. They are formed by non-ideal solution showing positive deviation.

eg. ethanol (95.5%) + water (4.5%) mixture boiling at 351.15 K.

8.1.2 **"Maximum boiling azeotropes"** are the mixtures of two liquids, whose boiling points are more than either of the two components. They are formed by non-ideal solution showing negative deviation.

eg. HNO_3(68%) + water (32%) mixture boiling at 393.5 K

9. Colligative Properties of Dilute Solution

(a) A dilute solution is one in which the amount of the solute is very small in comparison to the amount of the solvent.

(b) Dilute solutions containing non-volatile solute exhibit some special properties which depend only upon the number of solute particles present in the solution irrespective of their nature. These properties are termed as colligative properties.

(c) The colligative properties are-
- Relative lowering of vapour pressure
- Elevation in boiling point
- Depression in freezing point
- Osmotic pressure

9.1 Expression for different colligative properties

(i) Osmotic pressure $(\pi) = \frac{n}{V}$ RT = CRT

when w gram of solute are dissolved in V litres of solutions and M is the molar mass of the solute, then

$$\pi = \frac{WRT}{MV} \left[\because n = \frac{W}{M}\right]$$

when height is involved π = hdg

(h = height, d = density, g = gravitational acceleration)

For isotonic or isosmotic solutions

$$\left[\frac{n_1}{V_1} = \frac{n_2}{V_2}\right] \quad [\because \pi_1 = \pi_2]$$

or $\frac{W_1}{M_1V_1} = \frac{W_2}{M_2V_2}$

(ii) Relative lowering in vapour pressure :

$$\frac{p^0_A - p_A}{p^0_A} = X_B = \frac{n}{n+N}$$

[n = moles of solute, N = moles of solvent]

(iii) Elevation in boiling point :

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

(iv) Depression in freezing point :

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

Here, A = refers to solvent, B = refers to solute

* Molal elevation constant (K_b)

$$K_b = \frac{RT_b^2}{1000\ell_v}$$

[ℓ_v = latent heat of vapourisation]

* Molal depression constant (K_f)

$$K_f = \frac{RT_f^2}{1000\ell_f}$$

[ℓ_f = latent heat of fusion]

Questions based on Colligative properties of Dilute Solution

Ex.2 What will be the temperature at which a solution containing 6 g of glucose per 1000 g water will boil, if molal elevation constant for water is 0.52 / 1000 g.

(1) 1000.173ºC (2) 100.0173ºC
(3) 100.173ºC (4) None **(Ans. 2)**

Sol. w = 6g, W = 1000 g,

Mol. wt. of glucose = 180

$$\Delta T_b = \frac{1000 \times k_b \times w}{m \times W}$$

$$= \frac{1000 \times 0.52 \times 6}{180 \times 1000}$$

= 0.0173ºC

Hence boiling point of solution

= b.p. of water + ΔT_b

= 100 + 0.0173 = **100.0173ºC**

10. Osmotic Pressure

(a) Osmotic pressure may be defined as the excess pressure which must be applied to a solution in order to prevent flow of solvent into the solution through the semipermeable membrane.

Osmotic pressure may also be defined in several other ways.

(b) Osmotic pressure is the excess pressure which must be applied to a given solution in order to increase its vapour pressure until it becomes equal to that of the solution

(c) Osmotic pressure is the negative pressure which must be applied to (i.e. the pressure which must be withdrawn from) the pure solvent in order to decrease its vapour pressure until it becomes equal to that of the solution

(d) Osmotic pressure is the hydrostatic pressure produced when a solution is separated from the solvent by a semipermeable membrane.

Measurements of Osmotic Pressure :

Following methods are used for the measurement of osmotic pressure

(a) Pfeffer's Method

(b) Morse and Frazer's method

(c) Bekeley and Hartley's method

(d) Townsend's negative pressure method

(e) De Vries plasmolytic method

11. Reverse Osmosis

If a pressure higher than osmotic pressure is applied on the solution , the solvent will flow from the solution into the pure solvent through the semipermeable membrane. Since here the flow of solvent is in the reverse direction to that observed in the usual osmosis, the process is called reverse osmosis.

12. Isotonic Solution

(a) A pair of solutions having the same osmotic pressure are known as isosmotic solutions. If two such solutions are separated by a semipermeable membrane there will be no transference of solvent from one solution to the other.

(b) Isotonic solutions have the same molar concentration. eg. 0.85% NaCl solutions is found to be isotonic with blood.

(c) A solution having lower or higher osmotic pressure than the other is said to be hypotonic or hypertonic respectively in respect to other solution.

(d) When cells are placed in hypotonic solutions, cells swell and burst (haemolysis)

(e) When placed in hypertonic solutions , cells contract in size (plasmolysis). When excess of fertilizers (like urea) are applied , plasmolysis takes place and plants dry up (wilt).

13. Colligative properties of Electrolytes

The colligative properties of solutions, viz, lowering of vapour pressure, osmotic pressure, elevation in b.p. and depression in freezing point, depend solely on the total number of solute particles present in solution. Since the electrolytes ionise and give more than one particle per formula unit in solution, the colligative effect of an electrolyte solution is always greater than that of a nonelectrolyte of the same molar concentration.

(a) Colligative properties $\propto$ Number of particles

$\propto$ Number of molecules (in case of nonelectrolytes)

$\propto$ Number of ions (In case of electrolytes)

$\propto$ Number of moles of solute

$\propto$ Mole fraction of solute

(b) For different solutes of same molar concentration, the magnitude of the colligative properties is more for that solution which gives more number of particles on ionisation.

(c) For different solutions of same molar concentration of different nonelectrolytes solutes, the magnitude of the colligative properties will be same for all.

(d) For different molar concentrations of the same solute, the magnitude of colligative properties is more for the more concentrated solution.

(e) For solutions of different solutes but of same percent strength, the magnitude of colligative property is more for the solute with least molecular weight.

(f) For solutions of different solutes of the same percent strength, the magnitude of colligative property is more for that solute which gives more number of particles which can be known by the knowledge of molecular weight and its ionisation behaviour.

eg. Among the 0.1M solutions of urea, NaCl, $BaCl_2$, Na_3PO_4 and $Al_2(SO_4)_3$ solutions

➢ Vapour pressure and freezing point will be lowest while b.p. will be highest for $Al_2(SO_4)_3$ solution

➢ The values of the four colligative properties will be highest for $Al_2(SO_4)_3$ solution

eg. Among 1% solution of urea, glucose and sucrose

➢ Vapour pressure and freezing point area lowest while boiling point is highest for urea solution

➢ The four colligative properties are highest for urea solution

eg. Among 0.1M glucose, 0.15M urea and 0.2M sucrose solutions

- Vapour pressure and freezing point is lowest, while boiling point is highest for sucrose solution
- The four colligative properties are highest for sucrose solution.

14. Van't Hoff Factor

Certain solutes which undergo dissociation or association in solutions are found to show abnormal molecular mass. Thus, in order to know about the extent of association or dissociation of solutes in solution Vant Hoff introduced a factor (*i*). It is defined as the ratio of the normal mass to the observed molecular mass of the solute i.e.

$$i = \frac{\text{Normal molar mass}}{\text{Observed molar mass}};$$

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

$$i = \frac{\text{Observed osmotic pressure}}{\text{Normal osmotic pressure}};$$

$$i = \frac{\text{Actual number of particles}}{\text{No. of particles for no ionisation}}$$

14.1 Van’t Hoff factor and degree of association :

If a solute A forms associated molecules A_n and α is the degree of association then,

$$nA \rightleftharpoons A_n$$

	nA	A_n
Initial mole	1 mole	0
Associated change	– α mole	+ α/n mole
Equilibrium mole	(1-α) mole	α/n mole

Total number of moles after association

1 mole of A = $[1 - \alpha + (\alpha/n)]$ mole

$= [1 - \alpha (1 - \frac{1}{n})]$ mole

Van't Hoff factor (*i*)

$$= \frac{\text{Number of moles after association}}{\text{Normal number of mole taken}}$$

$$= \frac{[1-\alpha(1-1/n)]}{1} = 1 - \alpha\left(1-\frac{1}{n}\right)$$

$$= 1 - \alpha + \frac{\alpha}{n}$$

$\therefore$ degree of association $\boxed{\alpha = (1-i)\frac{n}{n-1}}$

14.2 Van't Hoff factor and degree of dissociation:

If a molecule of solute on dissociation gives n ions and α is the degree of dissociation then,

$$(A)_n \rightleftharpoons nA$$

	$(A)_n$	nA
Initial mole	1 mole	0
dissociation change	–α mole	+ nα mole
Equilibrium mole	(1 – α) mole	nα mole

Total number of moles after dissociation of 1 mole of A

$= [(1 - \alpha) + n\alpha]$ mole

$= 1 + \alpha (n - 1)$ mole

$\therefore$ Van't Hoff factor (*i*)

$$= \frac{\text{Number of moles after dissociation}}{\text{Number of moles taken (normal)}}$$

$$= \frac{1+\alpha(n-1)}{1} = 1 + \alpha (n - 1)$$

$= 1 + n\alpha - \alpha$

$\therefore$ degree of dissociation $\boxed{(\alpha) = \frac{i-1}{n-1}}$

Questions based on Van't Hoff factor

Ex.3 The freezing point fo a solution containing 0.2g of acetic acid in 20.0 g benzene is lowered by 0.45ºC. Calculate the degree of association of acetic acid in benzene. Assume acetic acid dimerizes in benzene. K_f for benzene = 5.12 K mol^{-1} kg.

(1) 49.5 % (2) 94.5%
(3) 85.5% (4) 58.5% **(Ans. 2)**

Sol. Given, w = 0.2 g, W = 20 g, ΔT = 0.45ºC

$$\Delta T = \frac{1000 \times K \times w}{m \times W}$$

or $$0.45 = \frac{1000 \times 5.12 \times 0.2}{20 \times m}$$

$\therefore$ m (observed) = 113.78

Now for 1 $CH_3COOH \rightleftharpoons (CHCOOH)_2$

	CH_3COOH	$(CHCOOH)_2$
Before association	1	0
After association	1 – α	α / 2

Where α is degree of association

$$\therefore \frac{M_{normal}}{M_{observed}} = 1 - \alpha + \alpha / 2$$

or $$\frac{60}{113.78} = 1 - \alpha + \alpha / 2$$

or **α = 0.945** or **94.5 %**

Table : 1 Example of ideal solution

Benzene + toluene, n-hexane + nheptane, $CCl_4 + SiCl_4$, $C_2H_5Br + C_2H_5I$ n-butyl chloride + n butyl bromide	Chlorobenzene + bromo – Benzene

Table : 2 Example of Non ideal solution -

Positive deviation from Raoult's law	Negative Deviation from Raoult's law
1. $(CH_3)_2CO + CS_2$	1. $(CH_3)_2CO + C_6H_5NH_2$
2. $(CH_3)_2CO + C_2H_5OH$	2. $(CH_3)_2\ CO + CHCl_3$
3. $CH_3CHO + CS_2$	3. $CHCl_3 + C_6H_6$
4. $C_6H_6 + (CH_3)_2CO$	4. $CHCl_3 + CH_3COOH$
5. $CCl_4 + C_6H_6$	5. $CH_3OH + CH_3COOH$
6. $CCl_4 + C_6H_5CH_3$	6. $CHCl_3 + (C_2H_5)_2O$
7. $CCl_4 + CHCl_3$	7. $CH_3COOH + C_5H_5N$
8. $CCl_4 + CH_3OH$	8. $H_2O + HCl$
9. $C_6H_6 + C_2H_5OH$	9. $H_2O + HNO_3$
10. $CH_3OH + H_2O$	
11. $C_2H_5OH + H_2O$	

Table : 3. **(Molal elevation constants of some solvents)**

Solvent	B.Pt. (°C)	Molal elevation constant (K_b) (K kg mol^{-1})
Water	100.0	0.52
Acetone	56.0	1.70
Chloroform	61.2	3.67
Carbon tetrachloride	76.8	5.02
Benzene	80.0	2.70
Ethyl alcohol	78.4	1.15

Table : 4. **(Molal depression constant of some solvents)**

Solvent	E.P.(°C)	Molal depression constant (K_f) (K kg mol^{-1})
Water	0.0	1.86
Ehtyl alcohol	– 114.6	1.99
Chloroform	– 63.5	4.70
Carbon tetrachloride	– 22.8	29.80
Benzene	5.5	5.12
Camphor	179.0	39.70

SOLVED EXAMPLES

Ex.1 A 6.90 M solution of KOH in water has 30% by weight of KOH. Calculate density of solution.

(A) 1.288 g mL^{-1} (B) 12.88 g mL^{-1}

(C) 24.88 g mL^{-1} (D) 2.488 g mL^{-1}

(Ans. A)

Sol. KOH solution is 30% by weight.

$\therefore$ wt. of KOH = 30 g

and Wt. of solution = 100 g

$\therefore$ Volume of solution = $\frac{100}{d}$

$$\therefore \quad \text{Molarity} = 6.90 = \left(\frac{30}{56 \times \frac{100}{1000 \times d}}\right)$$

= **1.288 g mL^{-1}**

Ex.2 What is mole fraction in its one molal aqueous solution-

(A) 0.108 (B) 0.018

(C) 0.008 (D) None **(Ans. B)**

Sol. Mole fraction = $\frac{n_A}{n_A + n_B}$

$n_A = 1$ and $n_B = \frac{1000}{18} = 55.4$

$= \frac{1}{1+55.4} = \frac{1}{56.4}$ **= 0.018**

Ex.3 The density of a solution containing 13% by mass of sulphuric acid is 1.09 g/mL. Calculate the molarity and normality of the solution-

(A) 1.445 M (B) 14.45 M

(C) 144.5 M (D) 0.1445 M

(Ans. A)

Sol. Volume of 100 gram of the solution = $\frac{100}{d}$

$= \frac{100}{1.09}$ mL $= \frac{100}{1.09 \times 1000}$ litre

$= \frac{1}{1.09 \times 10}$ litre

Number of moles of H_2SO_4 in 100 gram of the solution

$= \frac{13}{98}$

Molarity = $\frac{\text{No. of moles of } H_2SO_4}{\text{Volume of solution in litre}}$

$= \frac{13}{98} \times \frac{1.09 \times 10}{1}$ **= 1.445 M**

Ex.4 Calculate the molality and mole fraction of the solute in aqueous solution containing 3.0 gm of urea per 250 gm of water (Mol. wt. of urea = 60).

(A) 0.2 m, 0.00357 (B) 0.4 m, 0.00357

(C) 0.5 m, 0.00357 (D) 0.7m, 0.00357

(Ans. A)

Sol. Wt. of solute (urea) dissolved = 3.0 gm

Wt. of the solvent (water) = 250 gm

Mol. wt. of the solute = 60

3.0 gm of the solute = $\frac{3.0}{60}$ moles = 0.05 moles

Thus 250 gm of the solvent contain = 0.05 moles of solute

$\therefore$ 1000 gm of the solvent contain

$= \frac{0.05 \times 100}{250}$ = 0.2 moles

Hence molality of the solution = 0.2 m

In short,

Molality = No. of moles of solute/1000 g of solvent

$\therefore$ Molality = $\frac{3/60}{250} \times 1000$ = **0.2 m**

Calculation of mole fraction

3.0 gm of solute = 3/60 moles = 0.05 moles

250 gm of water = $\frac{250}{18}$ moles

= 13.94 moles

$\therefore$ Mole fraction of the solute

$= \frac{0.05}{0.05+13.94} = \frac{0.05}{13.99}$

= **0.00357**

Ex.5 15 gram of methyl alcohol is dissolved in 35 gram of water. What is the mass percentage of methyl alcohol in solution ?

(A) 30% (B) 50%

(C) 70% (D) 75% **(Ans. A)**

Sol. Total mass of solution = (15 + 35) gram = 50 gram

mass percentage of methyl alcohol

$= \frac{\text{Mass of methyl alcohol}}{\text{Mass of solution}} \times 100$

$= \frac{15}{50} \times 100$ = **30%**

Ex.6 214.2 g of sugar syrup contains 34.2 g of sugar. Calculate (i) molality of the solution and (ii) mole fraction of sugar in the syrup.

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Sol. (i) Mass of sugar = 34.2

moles of sugar = $\frac{34.2}{342}$ = 0.1

Mass of water = (214.2 – 34.2) = 180 gm

No. of moles of water = $\frac{180}{18}$ = 10

molality = $\frac{0.1}{180} \times 1000$ = 0.555m

(ii) Mole fraction of sugar = $\frac{0.1}{10+0.1}$ = 0.0099

Ex.7 At 300 K, the vapour pressure of an ideal solution containing one mole of A and 3 moles of B is 550 mm of Hg. At the same temperature, if one mole of B is added to this solution, the vapour pressure of solution increases by 10mm of Hg. Calculate the vapour pressure of A and B in their pure state.

(A) 400 mm, 600 mm (B) 600 mm, 400 mm

(C) 200 mm, 300 mm (D) 300 mm, 200 mm

(Ans. A)

Sol. Initially, $P_M = P^o_A . X_A + P^o_B . X_B$

$$550 = P^o_A\left(\frac{1}{1+3}\right) + P^o_B\left(\frac{3}{1+3}\right)$$

or $P^o_A + 3P^o_B = 2200$

When 1 mole of B is further added to it

$$P_M = P^o_A . X_A + P^o_B . X_B$$

$$560 = P^o_A\left(\frac{1}{1+4}\right) + P^o_B\left(\frac{1}{1+4}\right)$$

or $P^o_A + 4P^o_B = 2800$

By (i) and (ii)

P^o_A = **400 mm**;

P^o_B = **600 mm**

Ex.8 The vapour pressure of pure liquid 'A' at 310ºC is 120 torr. The vapour pressure of this liquid in solution with liquid B is 72 torr. Calculate the mole fraction of 'A' in solution if the mixture obeys Raoult's law.

(A) 0.06 (B) 0.9

(C) 0.3 (D) 0.6 **(Ans. D)**

Sol. Given is vapour pressure of pure component 'A', P^o_A = 120 torr

Partial vapour pressure of 'A', P_A = 72 torr

Suppose, its mole fraction in solution is x_A, then according to Raoult's law

$$P_A = P^o_A . x_A$$

$$72 = 120 \times x_A$$

or $x_A = \frac{72}{120}$ = **0.6**

Ex.9 What will be the temperature at which a solution containing 6 g of glucose per 1000 g water will boil, if molal elevation constant for water is 0.52/1000 g.

(A) 1000.173ºC (B) 100.0173ºC

(C) 100.173ºC (D) None **(Ans. B)**

Sol. w = 6g, W = 1000g, Mol. wt. of glucose =180

$$\Delta T_b = \frac{1000 \times K_b \times w}{m \times W}$$

$$= \frac{1000 \times 0.52 \times 6}{180 \times 1000}$$

= 0.0173ºC

Hence boiling point of solution = b.p. of water + ΔT_b = 100 + 0.0173 = **100.0173ºC**.

Ex.10 Calculate the molal elevation constant of water evaporates at 100ºC with the absorption of 536 calories per gm (R = 2 cals).

(A) 0.519ºC (B) 0.0519ºC

(C) 1.519ºC (D) 2.519ºC **(Ans. A)**

Sol. Molal elevation constant of the solvent.

$$K_b = \frac{RT^2_b}{\ell_v \times 1000} = \frac{2 \times 373 \times 373}{536 \times 1000} = \mathbf{0.519^oC}$$

Ex.11 The vapour pressure of CCl_4 (density = 1.58 g cm^{-3}) at 30ºC is 143 mm. A 0.5 g of a non-volatile solute of molecular weight 65 is dissolved in 100 ml of CCl_4. Calculate the vapour pressure of the solution-

(A) 141.93 mm (B) 14.193 mm

(C) 1.4193 mm (D) None **(Ans. A)**

Sol. Here w = 0.5 g, W = 100 × 1.58 = 158 g (since d = W / V), m = 65,

M of CCl_4 = 154. $\frac{p^o - p}{p^o} = \frac{wM}{mW}$

or $\frac{143 - p}{143} = \frac{0.5 \times 154}{65 \times 158}$

or p = **141.93 mm**

Ex.12 The freezing point of a solution containing 0.2g of acetic acid in 20.0 g benzene is lowered by 0.45ºC. Calculate the degree of association of acetic acid in benzene. Assume acetic acid dimerizes in benzene. K_f for benzene = 5.12 K mol^{-1} kg.

(A) 49.5 % (B) 94.5%

(C) 85.5% (D) 58.5% **(Ans. B)**

Sol. Given, w = 0.2 g, W = 20 g,

$$\Delta T = 0.45^oC$$

$$\Delta T = \frac{1000 \times K \times w}{m \times W}$$

or $0.45 = \frac{1000 \times 5.12 \times 0.2}{20 \times m}$

∴ m(observed) = 113.78

Now for $2CH_3COOH \rightleftharpoons (CH_3COOH)_2$

Before association 1 0

After association $1 - \alpha$ $\alpha/2$

Where α is degree of association

∴ $\frac{m_{normal}}{m_{observed}} = 1 - \alpha + \alpha/2$

or $\frac{60}{113.78} = 1 - \alpha + \alpha / 2$

or α **= 0.945**

or **94.5 %**

Ex.13 An aqueous solution containing 28% by mass of a liquid A(mol. mass = 140) has a vapour pressure of 160 mm at 37^0C. Find the vapour pressure of the pure liquid A. (The vapour pressure of water at 37^0C is 150 mm).

(A) 360 mm (B) 150 mm

(C) 160 mm (D) None **(Ans. A)**

Sol. For two miscible liquids,

P_{total} = mol. fraction A x p^0_A mol. fraction B x p^0_B

No. of moles of A = $\frac{28}{140}$ = 0.2

Liquid B is water. Its mass is (100 - 28) = i.e. 72

No. of moles of B = $\frac{72}{18}$ = 4.0

Total number of moles = 0.2 + 4.0 = 4.2

Given P_{total} = 160 mm

p^0_B = 150 mm

So, $160 = \frac{0.2}{4.2} \times p^0_A + \frac{4.0}{4.2} \times 150$

$p^0_A = \frac{17.15 \times 4.2}{0.2}$

= 360.15 mm ≈ 360 mm

Ex.14 Twenty grams of a substance were dissolved in 500 ml. of water and the osmotic pressure of the solution was found to be 600 mm of mercury at 15^0C. Determine the molecular weight of the substance-

(A) 1120 (B) 1198

(C) 1200 (D) None of these

(Ans. B)

Sol. Here it is given that

w = 20 gm ; V = 500 ml .

$= \frac{500}{1000}$ = 0.5 litre

π = 600 mm = $\frac{600}{760}$ atm ;

T = 15 + 273 = 288^0A

m = ?

According to Van't Hoff equation ,

$\pi V = nST$

$\pi V = \frac{w}{m} ST$

$\therefore m = \frac{wST}{\pi V} = \frac{20 \times 0.0821 \times 288 \times 760}{600 \times 0.5}$

= 1198

Ex.15 Blood plasma has the following composition (milli-equivalents per litre). Calculate its osmotic pressure at 37^0C.

Na^+ = 138 , Ca^{2+} = 5.2, K^+ = 4.5,

Mg^{2+} = 2.0 , Cl^- = 105, HCO_3^- = 25,

PO_4^{3-} = 2.2 , SO_4^{2---} = 0.5,

Proteins = 16, Others = 1.0

(A) 7.47 atm (B) 7.30 atm

(C) 7.29 atm (D) 7.40 atm

(Ans. A)

Sol. Since for calculating osmotic pressure we require millimoles/litre therefore

Na^+ = 138 $Ca^{2+} = \frac{5.2}{2}$ = 2.6 , K^+ = 4.5, Mg^{2+}

$= \frac{2.0}{2}$ = 1.0 , Cl^- = 105 ,

HCO_3^- = 24,$PO_4^{3-} = \frac{22}{3}$ = 0.73,

$SO_4^{2-} = \frac{0.5}{2}$ = 0.25 , Proteins = 16 ,

others = 1.0

Total = 294.18 millimoles/litre = $\frac{294.18}{1000}$

= 0.294 moles/litre

Now since π = CST

= 0.294 x 0.0821 x .310 = 7.47 atm

Ex.16 0.15g of a substance dissolved in 15g of solvent boiled at a temperature higher by 0.216^0C than that of the pure solvent. Calculate the molecular weight of the substance. Molal elevation constant for the solvent is 2.16^0C.

(A) 216 (B) 100 (C) 178 (D) None of these

(Ans. B)

Sol. Here it is given that

w = 0.15 g,

ΔT_b = = 0.216^0C

W = 15g K_b = 2.16^0C

m = ?

Substituting values in the expression ,

$m = \frac{1000 \times K_b \times w}{\Delta T_b \times W}$

$m = \frac{1000 \times 2.16 \times 0.15}{0.216 \times 15}$ = 100

Ex.17 The freezing point of 0.2 molal K_2SO_4 is –1.1ºC. Calculate Van't Haff factor and percentage degree of dissociation of K_2SO_4. K_f for water is 1.86º

(A) 97.5 (B) 90.75

(C) 105.5 (D) 85.75 **(Ans. A)**

Sol. ΔT_f = freezing point of water – freezing point of solution = 0º C – (–1.1º C) = 1.1º

We know that,

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

$1.1 = i \times 1.86 \times 0.2$

$\therefore \quad i = \frac{1.1}{1.86 \times 0.2}$ = 2.95

But we know

$i = 1 + (n - 1)\alpha$

$2.95 = 1 + (3 - 1)\alpha = 1 + 2\alpha$

α = 0.975

Van't Haff factor (i) = 2.95

Degree of dissociation = 0.975

Percentage degree of dissociation = **97.5**

Ex.18 Pure benzene boiled at 80°C. The boiling point of a solution containing 1 g of substance dissolved in 83.4 g of benzene is 80.175°C. If latent heat of vaporization of benzene is 90 cal per g, calculate the molecular weight of solute .

Sol. Boiling point of $C_6H_6 = 80 + 273 = 353$ k
Latent heat $(1_v) = 90$ cal/g
$\Delta T = 80.175 - 80 = 0.175$, w = 1 g, W = 83.4 g

$$\because \quad K_b = \frac{RT^2}{10001_v}$$

$$\text{or} \quad k_b = \frac{2\times353\times353}{1000\times90} = 2.769 \text{ K mol}^{-1}\text{ kg}$$

$$\text{Now} \quad \Delta T = \frac{k_b\times1000\times w}{m\times W}$$

$$0.175 = \frac{2.769\times1000\times1}{m\times83.4}$$

$$\therefore \quad m = 189.79$$

Ex.19 At 27°C, 36 g of glucose per litre has an O.P. of 4.92 atm. If the osmotic pressure of solution is 1.5 atm at the same temperature, what should be its concentration ?

Sol. Given that, $\pi_1 = 4.92$ atm, $\pi_2 = 1.5$ atm

$$C_1 = \frac{36}{180\times1} \quad \left(\because C = \frac{w}{m\times V}\right) \quad C_2 = ?$$

$\pi_1V_1 = n_1S_1T_1$ and $\pi_2V_2 = n_2ST_2$
At same temperature

$$\frac{\pi_1}{\pi_2} = \frac{n_1}{n_2}\times\frac{V_2}{V_1} = \frac{C_1}{C_2} \quad \text{or} \quad \frac{4.92}{1.5} = \frac{36}{180\times C_2}$$

$$C_2 = 0.061 \text{ mol/litre}$$

Ex.20 How many g of glucose must be present in 0.5 litre of a solution for its osmotic pressure to be same as that of solution of 9.2 g glucose per litre ?

Sol. For isotonic solutions, $C_1 = C_2$

$$\text{or} \quad \frac{w_1}{m_1V_1} = \frac{w_2}{m_2V_2}$$

$$\text{or} \quad \frac{w_1}{180\times0.5} = \frac{9.2}{180\times1}$$

$$\therefore \quad w_1 = 4.60 \text{ g}$$

Ex.21 Two liquids A and B form an ideal solution at temperature T. When the total vapour pressure above the solution is 400 torr, the mol fraction of A in the vapour phase is 0.4 and in the liquid phase 0.75. What are the vapour pressure of pure A and pure B at temperature T ?

Sol. Mole fraction of A in vapour phase $Y_A = 0.4$ & in liquid phase $X_A = 0.75$
$P_{total} = 400$ torr
Let V.P. of pure A and B are P_A^0 & P_B^0.
$\because X_AP_A^0 = Y_A P_{total}$

$$P_A^0 = \frac{Y_AP_{Total}}{x_A} = \frac{0.4\times400}{0.75} = \frac{160}{0.75}$$

$P_A^0 = 213.33$ torr
$P_{total} = X_AP_A^0 + (1 - X_A)P_B^0$

$$400 = 0.75\left(\frac{160}{0.75}\right) + (1 - 0.75)P_B^0$$

$P_B^0 = 960$ torr

Ex.22 Vapour pressure of solution containing 6g of a non-volatile solute in 180 g water is 20.0 torr. If 1 mol water is further added vapour pressure increases by 0.02 torr. Calculate vapour pressure of water and molecular weight of non-volatile solute temperature remaining constant

Sol. Let moelcualr wt. of solute = m
and V.P. of water (solvent) = P^0
$P_{solution} = 20$ torr

$$\text{moles of solute } n = \frac{6}{m}$$

$$\text{moles of solvent } N = \frac{180}{18} = 10$$

$$\because \quad P_S = \left(\frac{N}{n+N}\right)P^0$$

$$20 = \left(\frac{10}{\frac{6}{m}+10}\right)P^0$$

$$20 = \left(\frac{10m}{6+10m}\right)P^0 \quad ....(1)$$

If 1 mol water is further added moles of solvent
N = 10 + 1 = 11 mol
& V.P. of solution becomes

$$P_S = 20 + 0.02 = 20.02 \text{ torr}$$

$$P_S = \frac{N}{n+N}P^0$$

$$20.02 = \left(\frac{11}{\frac{6}{m}+11}\right)P^0$$

$$20.02 = \left(\frac{11m}{6+11m}\right)P^0 \quad ....(2)$$

divide eqn. (2) by (1)

$$\frac{20.02}{20} = \frac{11(6+10m)}{10(6+11m)}$$

m = 54 gm
Put this value of m in equation. (1) or (2)
$P^0 = 22.22$ torr

Ex.23 Phenol associates in benzene to a certain extent to form dimmer. A solution containing 20×10^{-3} kg of phenol in 1.0 kg of benzene has its freezing point decreased by 0.69 K. Calculate the fraction of the phenol that has dimerised. (K_f of benzene is 5.12ºKmol^{-1}).
[Roorkee 1998]

Sol. Given
w = 20 × 10^{-3} kg. = 20 gm
W = 1 kg = 10^3 gm
Observed

$$\Delta T_f = i\left(\frac{w\times1000}{m\times W}\times K_f\right)$$

$$0.69 = i\left(\frac{20\times1000\times5.12}{94\times10^3}\right)$$

$$i = 1 - \alpha + \frac{\alpha}{n} \quad \text{or} \quad \alpha = \frac{(i-1)}{\left(\frac{1}{n}-1\right)}$$

α = 0.733 or 73.3

Ex.24 Calculate the freezing point of an aqueous solution of a non-electrolyte having an osmotic pressure of 0.2 atmosphere at 300 K. **[Roorkee 1993]**

Sol. π = CST

$$C = \frac{\pi}{ST} = \frac{2}{0.0821\times300} \text{ mol lit}^{-1}$$

In dilute solution, the density fo water can be taken as 1.0 gm cm^{-3}.

Hence molality ≈ molarity

ΔT_f = (molality × K_f)

$$= \frac{2}{0.0821\times300} \times 1.86$$

ΔT_f = 0.151 K

∴ $(T_f)_{solution}$ = (T_f)solvent – ΔT_f

= (273 – 0.151)

$(T_f)_{solution}$ = 272.749 K or – 0.151°C

Ex.25 x g of a non-electrolytic compound (molar mass = 200) is dissolved in 1.0 litre of 0.05 M NaCl solution. The osmotic pressure of this solution is found to be 4.92 atm at 27ºC. Calculate the value 'x'. Assume complete dissociation of NaCl and ideal behaviour of this solution. **[Roorkee 1998]**

Sol. (i) For NaCl : π_1 = i (CST)

π_1 = 2 × 0.05 × 0.0821 × 300

π_1 = 2.463 atm

(ii) for unknown compound :

π_2 = CST

$$\pi_2 = \frac{x}{200\times1} \times 0.0821 \times 300$$

π_2 = 0.1231 x atm

Total osmotic pressure $\pi = \pi_1 + \pi_2$

4.92 = 2.463 + 0.1231x

x = 19.959 gm

Ex.26 To 500 cm^3 of water, 3.0 × 10^{-3} kg of acetic acid is added. If 23% of acetic acid is dissociated, what will be the depression in freezing point ? K_f and density of water are 1.86 K kg^{-1} mol^{-1} and 0.997 g cm^{-3} respectively. **[IIT 2000]**

Sol. Mass of solute = 3 × 10^{-3} Kg = 3gm

Mass of solvent = 500 × 0.997 = 498.5 gm

α = 23% = 0.23

i = 1 – α + nα

= 1 – 0.23 + 2 × 0.23

i = 1.23

ΔT_f = i (molality × k_f)

$$= 1.23 \times \left(\frac{3\times1000}{60\times498.5}\right) \times 1.86$$

ΔT_f = 0.229

Ex. 27 0.1 formal solution of NaCl is found to be isotonic with 1.10% solution urea. Calculate the apparent degree of ionization of NaCl.

Sol. 0.1 formal = 0.1 M solu. of NaCl

1.1% solution of urea means ⟶

100 ml solu. contains 1.1 gm urea

$\pi_{NaCl} = \pi_{urea}$

$$i(0.4 \times ST) = \frac{1.1\times1000}{60\times100}\times ST$$

i = 1.83

$$\alpha = \frac{(i-1)}{(n-1)}$$

$$\Rightarrow \frac{1.83-1}{2-1} = 0.83 \quad \alpha = 83\%$$

EXERCISE # 1

Q.1 The boiling point of C_6H_6, CH_3OH, $C_6H_5NH_2$ and $C_6H_5NO_2$ are 80^0C, 65^0C, 184^0C and 212^0C respectively. Which will show highest vapour pressure at room temperature-

(1) C_6H_6 (2) CH_3OH

(3) $C_6H_5NH_2$ (4) $C_6H_5NO_2$

Q.2 The relative lowering of vaour pressure is equal to the mole fraction of the nonvolatile solute, This statement was given by -

(1) Raoult (2) Henry

(3) Joule (4) Dalton

Q.3 If Raoult's law is obeyed, the vapour pressure of the solvent in a solution is directly proportinal to -

(1) Mole fraction of the solvent

(2) Moe fraction of the solute

(3) Mole fraction of the solvent and solute

(4) The volume of the solution

Q.4 Which one of the following is the incorrect form of Raoult's law

(1) $\frac{P_s}{P^0} = \frac{N}{n+N}$ (2) $\frac{P^0}{p^0 - P_s} = 1 + \frac{N}{n}$

(3) $\frac{P^0 - P_s}{P_s} = \frac{n}{n+N}$ (4) $\frac{P_s}{P^\circ - P_s} = \frac{N}{n}$

Q.5 The vapour pressure of a solution having solid as solute and liquid as solvent is -

(1) Directly proportional to mole fraction of the solvent

(2) Inversely proportional to mole fraction of the solvent

(3) Directly proportional to mole fraction of the solute

(4) Inversely proportional to mole fraction of the solute

Q.6 If P_0 and P_S are the vapour pressure of solvent and its solution respectively. N_1 and N_2 are the mole fraction of solvent and solute respectively then -

(1) $P_S = \frac{P_0}{N_2}$

(2) $P_0 - P_S = P_0N_2$

(3) $P_S = P_0N_2$

(4) $\frac{(P_0 - P_S)}{P_S} = \frac{N_1}{(N_1 + N_2)}$

Q.7 1 mole of heptane (V.P. = 92 mm of Hg) was mixed with 4 moles of octane (V.P. = 31 mm of Hg). The vapour pressure of resulting ideal solution is -

(1) 46.2 mm of Hg (2) 40.0 mm of Hg

(3) 43.2 mm of Hg (4) 38.4 mm of Hg

Q.8 One mole of non volatile solute is dissolved in two moles of water. The vapour pressure of the solution relative to that of water is -

(1) $\frac{2}{3}$ (2) $\frac{1}{3}$ (3) $\frac{1}{2}$ (4) $\frac{3}{2}$

Q.9 The vapour pressure of a dilute aqueous solution of Glucose is 750 mm of mercury at 373 K. The mole fraction of solute is -

(1) $\frac{1}{10}$ (2) $\frac{1}{7.6}$ (3) $\frac{1}{35}$ (4) $\frac{1}{76}$

Q.10 The vapour pressure of water at room temperature is 23.8 mm of Hg. The vapour pressure of an aqueous solution of sucrose with mole fraction 0.1 is equal to -

(1) 23.9 mm Hg (2) 24.2 mm Hg

(3) 21.42 mm Hg (4) 31.44 mm Hg

Q.11 At 88 °C benzene has a vapour pressure of 900 torr and toluene has a vapour pressure of 360 torr. What is the mole fraction of benzene in the mixture with toluene that wil boil at 88 °C at 1 atm. pressure, benzene - toluence form an ideal solution -

(1) 0.416 (2) 0.588

(3) 0.688 (4) 0.740

Q.12 Among the following, that does not form an ideal solution is -

(1) C_6H_6 and $C_6H_5CH_3$ (2) C_2H_5Cl and C_6H_5OH

(3) C_6H_5Cl and C_6H_5Br (4) C_2H_5Br and C_2H_5I

Q.13 Which condition is not satisfied by an ideal solution

(1) ΔH mixing = 0 (2) ΔV mixing = 0

(3) ΔS mixing = 0 (4) Obeyance of Raoult's law

Q.14 Colligative properties of the solution depend upon

(1) Nature of the solution

(2) Nature of the solvent

(3) Number of solute particles

(4) Number of moles of solvent

Q.15 Which is not a colligative property ?

(1) Osmotic pressure

(2) Lowering in vapour pressure

(3) Depression in freezing point

(4) Refractive index

Q.16 The lowering of vapour pressure of a solvent by addition of a non-volatile solute to it is directly proportional to -

(1) The strength of the solution

(2) The nature of the solute in the solution

(3) The atmospheric pressure

(4) All

Q.17 The molal elevation constant is the ratio of the elevation in B.P. to -
(1) Molarity
(2) Molality
(3) Mole fraction of solute
(4) Mole fraction of solvent

Q.18 The molal cryoscopic constant for water is -
(1) 1.86 K $molality^{-1}$ (2) 5.26 K $molality^{-1}$
(3) 55.5 K $molality^{-1}$ (4) 0.52 K $molality^{-1}$

Q.19 The freezing point of a 0.05 molal solution of a non electrolyte in water is -
(K_f = 1.86 K $molality^{-1}$)
(1) – 1.86 °C (2) – 0.93°C
(3) – 0.093°C (4) 0.093°C

Q.20 The molal freezing point constant of water is 1.86 K $molality^{-1}$. If 342 g of cane sugar ($C_{12}H_{22}O_{11}$) are dissolved in 1000g of water, the solution will freeze at -
(1) –1.86 °C (2) 1.86 °C
(3) –3.92 °C (4) 2.42 °C

Q.21 Molal depression of freezing point of water is 1.86° per 1000g of water. 0.02 mole of urea dissolved in 100g of water will produce a lowering of temperature of -
(1) 0.186°C (2) 0.372°C
(3) 1.86°C (4) 3.72°C

Q.22 What would be the freezing point of aqueous solution containing 17 g of C_2H_5OH in 1000g of water K_f = 1.86 K $molality^{-1}$
(1) – 0.69°C (2) – 0.34°C
(3) 0.0°C (4) 0.34°C

Q.23 A solution of 1.25 g of a non-electrolyte in 20 g of water freezes at 271.94 K. If K_f = 1.86 K $molality^{-1}$ then the molecular wt. of the solute is -
(1) 207.8 g/mol (2) 179.79 g/mol
(3) 209.6 g/mol (4) 109.6 g/mol

Q.24 Elevation in boiling point was 0.52 °C when 6 g of a compound x was dissolved in 100 g of water. Molecular weight of x is : (K = 5.2 mol^{-1} 100 g H_2O)
(1) 120 (2) 60 (3) 100 (4) 342

Q.25 Pure benzene freezes at 5.45 °C at a certain place but a 0.374 m solution of tetrachloroethane in benzene freezes at 3.55 °C. The K_f for benzene is -
(1) 5.08 K Kg mol^{-1} (2) 508 K Kg mol^{-1}
(3) 0.508 K Kg mol^{-1} (4) 50.8 °C Kg mol^{-1}

Q.26 An aqueous solution containing 1g of urea boils at 100.25 °C. The aqueous solution containing 3g of glucose in the same volume will boil at -
(1) 100.75 °C (2) 100.5 °C
(3) 100 °C (4) 100.25 °C

Q.27 An aqueous solution freezes at - 0.186 °C (K_f 1.86° ; K_b = 0.512°). What is the elevation in boiling point ?
(1) 0.186 (2) 0.512
(3) $\frac{0.512}{1.86}$ (4) 0.0512

Q.28 The osmotic pressure of a dilute solution is directly proportional to the -
(1) Diffusion rate of the solute
(2) Ionic concentration
(3) Boiling point
(4) Flow of solvent from a concentrated solution

Q.29 Which can pass through semipermeable membrane ?
(1) Molecules of solvent (2) Molecules of solute
(3) Simple ion (4) Complex ion

Q.30 In osmosis phenomenon -
(1) Solvent molecules move from higher concentration to lower concentration
(2) Solvent molecules move from lower concentration to higher concentration
(3) Solvent molecules move from higher concentration to lower concentration
(4) Solute molecules move from lower concentration to higher concentration

Q.31 At constant temperature the osmotic pressure of a solution is -
(1) Directly proportional to the concentration
(2) Inversely proportional to the concentration
(3) Directly proportional to the square of concentration
(4) Directly proportional to the square root of concentration

Q.32 Which inorganic precipitate acts as semipermeable membrane ?
(1) Calcium sulphate (2) Barium oxalate
(3) Nickel phosphate (4) Copper ferrocyanide

Q.33 The correct expression for the determination of molecular mass of the solute by osmotic pressure measurement is -
(1) $m = \frac{WPV}{RT}$ (2) $m = \frac{WRT}{PV}$
(3) $m = \frac{RT}{WPV}$ (4) $m = \frac{PRT}{WV}$

Q.34 Osmotic pressure of aqueous solution is determined by -
(1) Haeber's method
(2) Solvay method
(3) Berkeley and Hartley's method
(4) Ostwalds method

Q.35 The osmotic pressure of solution increases if -
(1) Temperature is decreases
(2) Concentration is decreases
(3) Number of solute particle is increases
(4) Volume is increased

Q.36 If 0.1 M solution of glucose and 0.1 M urea solution are placed on two sides of a semipermeable membrane to equal heights. Then it will be correct to say that -
(1) There will be not movement across the membrane
(2) Glucose will flow towards urea solution
(3) Urea will flow towards glucose solution
(4) Water will flow from urea solution towards glucose solution

Q.37 The plant cell will shrink when placed in -
(1) Water
(2) A hypotonic solution
(3) A hypertonic solution
(4) An isotonic solution

Q.38 The best colligative property used for the determination of molecular masses of polymers is
(1) Relative lowering in vapour pressure
(2) Osmotic pressure
(3) Elevation in boiling point
(4) Depression in freezing point

Q.39 The osmotic pressure of a solution increases if -
(1) Temperature is lowered
(2) Volume is increases
(3) Number of solute molecules is increases
(4) None

Q.40 Osmotic pressure of a solution (density is 1g/ml) containing 3 g of glucose (molecular weight = 180) in 60 g of water at 15°C is -
(1) 0.34 atm (2) 0.65 atm
(3) 6.25 atm (4) 5.57 atm

Q.41 Osmotic pressure of a sugar solution at 24°C is 2.5 atmosphere. The concentration of the solution in mole per litre is -
(1) 10.25 (2) 1.025
(3) 1025 (4) 0.1025

Q.42 A solution containing 8.6 g urea in one litre was found to be isotonic with 0.5% (wt./vol) solution of an organic, non volatile solute. The molecular weight of latter is -
(1) 348.9 (2) 34.89
(3) 3489 (4) 861.2

Q.43 A solution containing 500 g of a protein per litre is isotonic with a solution containing 3.42 g of sucrose per litre. The molecular mass of protein is
(1) 5 (2) 146
(3) 34200 (4) 50000

Q.44 Which method cannot be used to find out the molecular weight of non-volatile solute -
(1) Victor Meyer's method
(2) Osmotic pressure method
(3) Cryoscopic method
(4) Ebullioscopic method

Q.45 Camphor is used as solvent to determine the molecular weight of nonvolatile solute by Rast method because for camphor -
(1) Molal depresion constant is high
(2) Melting point is high
(3) Being cheap
(4) All

Q.46 Van't Hoff factor is -
(1) Less than one in case of dissociation
(2) More than one in case of association
(3) Always less than one
(4) Less than one in case of association

Q.47 The Vant Hoff factor (i) for a dilute solution of $K_3[Fe(CN)_6]$ is -
(1) 10 (2) 4 (3) 5 (4) 0.25

Q.48 The experimental molecular weight of an electrolyte will always be less than its calculated value because the value of vant Hoff factor, 'i' is
(1) Less than 1 (2) Greater than 1
(3) One (4) Zero

Q.49 The Vant Hoff factor (i) for a dilute aqueous solution of Glucose is -
(1) Zero (2) 1.0 (3) 1.5 (4) 2.0

Q.50 The ratio of the value of any colligative property for KCl solution to that for sugar solution is nearly................time -
(1) 1 (2) 0.5 (3) 2 (4) 2.5

Q.51 The lowering of vapour pressure of 0.1 M aqueous solution of NaCl, $CuSO_4$ and K_2SO_4 are
(1) All equal
(2) In the ratio of 1 : 1 : 1.5
(3) In the ratio of 3 : 2 : 1
(4) In the ratio of 1.5 : 1 : 2.5

Q.52 The molal elevation constant of water is 0.51. The boiling point of 0.1 molal aqueous NaCl solution is nearly -
(1) 100.05 °C (2) 100.1 °C
(3) 100.2 °C (4) 101.0 °C

Q.53 The value of observed and calculated molecular weight of silver nitrate are 92.64 and 170 respectively. The degree of dissociation of silver nitrate is -
(1) 60% (2) 83.5%
(3) 46.7 % (4) 60.23%

Q.54 A 0.004M solution of Na_2SO_4 is isotonic with a 0.010M solution of glucose at the 25°C temperature The apparent degree of dissociation of Na_2SO_4 is -
(1) 25% (2) 50%
(3) 75% (4) 85%

Q.55 Which of the following solutions at the same temperature will be isotonic -
(1) 3.42 g of cane sugar in one litre water and 0.18 g of glucose in one litre water
(2) 3.42 g of cane sugar in one litre water and 0.18 g of glucose in 0.1 litre water
(3) 3.42 g of cane sugar in one litre water and 0.585g of NaCl in one litre water
(4) 3.42 g of cane sugar in one litre water and 1.17 g of NaCl in one litre water

Q.56 Which salt shows maximum osmotic pressure in its 1 M solution -
(1) $AgNO_3$ (2) Na_2SO_4
(3) $(NH_4)_3PO_4$ (4) $MgCl_2$

Q.57 Which solution will exert highest osmotic pressure ?
(1) 1 M glucose solution
(2) 1M urea solution
(3) 1M Alum solution
(4) 1M NaCl solution

Q.58 Which is the correct relation between osmotic pressure of 0.1M NaCl solution and 0.1M Na_2SO_4 solution ?
(1) The osmotic pressure of Na_2SO_4 is less than NaCl solution
(2) The osmotic pressure Na_2SO_4 is more than NaCl solution
(3) Both have same osmotic pressure
(4) None of the above

Q.59 Which one of the following solutions will have highest osmotic pressure ? (Assume that all the salts are equally dissociated) -
(1) 0.1M $Al_2(SO_4)_3$
(2) 0.1M $BaCl_2$
(3) 0.1M Na_2SO_4
(4) The solution obtained by mixing equal volumes of (2) and (3)

Q.60 The following solutions have equal concentration. Which one will show minimum osmotic pressure ?
(1) $BaCl_2$ (2) $AgNO_3$
(3) Na_2SO_4 (4) $(NH_4)_3PO_4$

Q.61 The osmotic pressure of equimolor solutions of $BaCl_2$,NaCl, and glucose will be in the order -
(1) Glucose > NaCl > $BaCl_2$
(2) $BaCl_2$ > NaCl > Glucose
(3) NaCl > $BaCl_2$ > Glucose
(4) NaCl > Glucose > $BaCl_2$

Q.62 Which one of the following pairs of solutions will be expected to be isotonic under the same temperature -
(1) 0.1M urea and 0.1M NaCl
(2) 0.1M urea and 0.2M $MgCl_2$
(3) 0.1M NaCl and 0.1M Na_2SO_4
(4) 0.1M $Ca(NO_3)_2$ and 0.1M Na_2SO_4

Q.63 Two solution of KNO_3 and CH_3COOH are prepared separately. Molarity of both is 0.1 M and osmotic pressures are P_1 and P_2 respectively. The correct relationship between the osmotic pressures is -
(1) $P_2 > P_1$ (2) $P_1 = P_2$
(3) $P_1 > P_2$ (4) $\frac{P_1}{P_1 + P_2} = \frac{P_2}{P_1 + P_2}$

Q.64 Which of the following 0.1 M aqueous solution will have the lowest freezing point -
(1) Potassium Sulphate
(2) Sodium Chloride
(3) Urea
(4) Glucose

Q.65 Which has the minimum freezing point -
(1) 1 molal NaCl solution
(2) 1 molal KCl solution
(3) 1 molal $CaCl_2$ solution
(4) 1 molal urea solution

Q.66 Which has maximum freezing point -
(1) 1 molar of NaCl solution
(2) 1 molar of KCl solution
(3) 1 molar of $CaCl_2$ solution
(4) 1 molar of urea solution

Q.67 The following aqueous solution in the correct order of decreasing freezing point is -
(1) 0.2M $BaCl_2$, 0.2M KCl, 0.1M Na_2SO_4
(2) 0.2M KCl, 0.1M Na_2SO_4, 0.2M $BaCl_2$
(3) 0.1M Na_2SO_4, 0.2M KCl, 0.2M $BaCl_2$
(4) 0.1M Na_2SO_4, 0.2M $BaCl_2$, 0.2M KCl

Q.68 Which of the following solutions will have highest boiling point ?
(1) 1% Glucose in water
(2) 1% Sucrose in water
(3) 1% NaCl in water
(4) 1% Urea in water

Q.69 The freezing point of equimolal aqueous solution will be highest for -
(1) $C_6H_5NH_3Cl$ (2) $Ca(NO_3)_2$
(3) $La(NO_3)_3$ (4) $C_6H_{12}O_6$(Glucose)

Q.70 Which one has the highest boiling point -
(1) 0.1 N Na_2SO_4 (2) 0.1N $MgSO_4$
(3) 0.1M $Al_2(SO_4)_3$ (4) 0.1M $BaSO_4$

Q.71 Which of the following plots does not represent the behaviour of an ideal binary liquid solution -
(1) Plot of P_A versus X_A (mole fraction of A in liquid phase) is linear
(2) Plot of P_B versus X_B is linear
(3) Plot of P_{total} versus X_A (or X_B) is linear
(4) Plot of P_{total} versus X_A is non linear

Q.72 Arrange the following aqueous solutions in the order of their increasing boiling points -
(i) 10^{-4} M NaCl (ii) 10^{-4}M Urea
(iii) 10^{-3} M $MgCl_2$ (iv) 10^{-2} M NaCl
(1) (i) < (ii) < (iv) < (iii) (2) (ii) < (i) = (iii) < (iv)
(3) (ii) < (i) < (iii) < (iv) (4) (iv) < (iii) < (i) = (ii)

Q.73 A mixture of liquid showing positive deviation in Raoult's law is -
(1) $(CH_3)_2CO + C_2H_5OH$
(2) $(CH_3)_2CO + CHCl_3$
(3) $(C_2H_5)_2O + CHCl_3$
(4) $(CH_3)_2CO + C_6H_5NH_2$

Q.74 The van't Hoff factor for 0.1 M $Ba(NO_3)_2$ solution is 2.74. The degree of dissociation is -
(1) 91.3% (2) 87%
(3) 100% (4) 74%

Q.75 Osmosis of A into solution B will not take place if -
(1) A is hypertonic
(2) A is hypotonic
(3) A is isotonic
(4) Either 1 or 3 may correct

Q.76 Among 0.1M solution of urea, Na_3PO_4 and $Al_2(SO_4)_3$ -
(a) The vapour pressure and freezing point are the lowest for urea
(b) The vapour pressure and freezing point are the highest for urea
(c) The elevation in boiling point is the highest for $Al_2(SO_4)_3$
(d) The depression in freezing point is the highest for $Al_2(SO_4)_3$
(1) Only a (2) b & c both
(3) b, c and d (4) a, b, c and d

Q.77 Glucose is added to 1 litre water to such an extent that $\frac{\Delta T_1}{K_f}$ becomes equal to $\frac{1}{1000}$, the wt. of glucose added is -
(1) 180 g (2) 18 g
(3) 1.8 g (4) 0.18 g

Q.78 The vapour pressure of a solution of 5gm of non electrolyte in 100gm of water at particular temperature is 2985 Nm^{-2}. The vapour pressure of pure water at that temperature is 3000Nm^2. The molecualr weight of the solute is -
(1) 180 (2) 90 (3) 270 (4) 200

Q.79 How many grams of a non volatile solute having a molecular weight of 90 are to be dissolved in 97.5 g water in order to decrease the vapour pressure of water by 2.5 percent -
(1) 25 (2) 18 (3) 12.5 (4) 9

Q.80 Colligative properties depend on the -
(1) Relative no. of solute molecules in soln. and the nature of the solvent
(2) Relative no. of solute molecules in solvent and the nature of solute
(3) Relative no. of solute molecules and the nature of solute and solvent
(4) Relative no. of solute molecules, irrespective of the nature of solvent and solute

Q.81 The vapour pressure of two pure liquids (A) and (B) are 100 and 80 torr respectively. The total pressure of the solution obtained by mixing 2 mol of (A) and 3 mol of (B) would be -
(1) 20 torr (2) 36 torr
(3) 88 torr (4) 180 torr

Q.82 When equimolar aqueous solutions of glucose, sodium chloride and barium nitrate are compared the vapour pressure of the solutions will be in the following order -
(1) Glucose > NaCl > $Ba(NO_3)_2$
(2) Glucose = NaCl = $Ba(NO_3)_2$
(3) $Ba(NO_3)_2$ > NaCl > Glucose
(4) NaCl > $Ba(NO_3)_2$ > Glucose

Q.83 The substance when dissolved in water would decrease the vapour pressure of water to the greatest extent is -
(1) 0.1 M KCl (2) 0.1 M urea
(3) 0.1 M $BaCl_2$ (4) 0.1 M NaCl

Q.84 The vapour pressure of a pure liquid solvent (X) is decreased to 0.60 atm. from 0.80 atm on additional of a non volatile substance (Y). The mole fraction of (Y) in the solution is -
(1) 0.20 (2) 0.25 (3) 0.5 (4) 0.75

Q.85 For a solution of two liquids A and B, it was proved that $P = X_A (P_A^0 – P_B^0) + P_B^0$. The solution is -
(1) Ideal (2) Non ideal
(3) Semiideal (4) None of the above

Q.86 The molar mass of NaCl determined by the osmotic pressure method will be -
(1) Higher than the theoretical value
(2) Lower than the theoretical value
(3) The same as the theoretical value
(4) None of these

Q.87 Mole fraction of A vapours above solution in mixture of A and B (X_A = 0.4) will be -
(P_A° = 100mm, P_B° = 200mm)
(1) 0.4 (2) 0.8
(3) 0.25 (4) None

Q.88 The vapour pressure of pure benzene and toluene are 160 and 60 torr respectively. The mole fraction of toluene is vapour phase in contact with equimolar solution of benzene and toluene is -
(1) 0.50 (2) 0.6
(3) 0.27 (4) 0.73

Q.89 Solutions which distil without change in composition or temperature are called -
(1) Amorphous (2) Azeotropic mixture
(3) super saturated (4) ideal

Q.90 Azeotropic mixture are -
(1) Mixture of two solids
(2) Those which boil at different temperatures
(3) Those which can be fractionally distilled
(4) Constant boiling mixtures

Q.91 An azeotropic mixture of two liquids boil at a lower temperature than either of them when
(1) It is saturated
(2) It does not deviate from Raoult's law
(3) It shows negative deviation from Raoult's law
(4) It show positive deviation from Raoult's law

Q.92 The azeotropic mixture of water (B.P 100°C) and HCl (B.P. 85°C) boils at 108.5°C. When this mixture is distilled, it is possible to obtain -
(1) Pure HCl
(2) Pure water
(3) Pure water as well as HCl
(4) Neither HCl nor H_2O in their pure states

Q.93 An azeotropic solution of two liquids has boiling point lower than either of them when it -
(1) Shows a negative deviation from Raoult's law
(2) Shows no deviation from Raoult's law
(3) Shows positive deviation from Raoult's law
(4) Is saturated

Q.94 Dry air was passes successively through a solution of 5g of a solute in 180 g of water and then through pure water. The loss in weight of solution was 2.50g and that of pure solvent 0.04g. The molecular weight of the solute is -
(1) 31.25 (2) 3.125
(3) 312.5 (4) None

Q.95 How many grams of glucose should be dissolved to make one litre solution of 10%(w/v) glucose-
(1) 10 g (2) 180 g (3) 100 g (4) 1.8 g

Q.96 The molality of 15% (wt./vol.) solution of H_2SO_4 of density 1.1 g/cm^3 is approximately-
(1) 1.2 (2) 1.4 (3) 1.8 (4) 1.6

Q.97 1000 gram aqueous solution of $CaCO_3$ contains 10 gram of carbonate. Concentration of solution is-
(1) 10 ppm (2) 100 ppm
(3) 1000 ppm (4) 10,000 ppm

Q.98 All of the water in a 0.20 M solution of NaCl as evaporated and 0.150 mol of NaCl was obtained. What was the original volume of the sample ?
(1) 30 mL (2) 333 mL
(3) 750 mL (4) 1000 mL

Q.99 25 mL of 3.0 M HNO_3 are mixed with 75 mL of 4.0M HNO_3. If the volumes are additive, the molarity of the final mixture would be-
(1) 3.25 M (2) 4.0 M
(3) 3.75 M (4) 3.50 M

Q.100 If 18 g of glucose is present in 1000 g of solvent, the soution is said to be -
(1) 1 molar (2) 0.1 molar
(3) 0.5 molal (4) 0.1 molal

Q.101 Mole fraction of glycerine ($C_3H_5(OH)_3$) in a solution of 36 g of water and 46 g of glycerine is -
(1) 0.46 (2) 0.36
(3) 0.20 (4) 0.40

Q.102 A molal solution is one that contains one mole of a solute in -
(1) 1000 g of the solvent
(2) one litre of the solution
(3) one litre of the solvent
(4) 22.4 litres of the solution

Q.103 Molarity of 720 gm of pure water -
(1) 40 M
(2) 4M
(3) 55.5 M
(4) Can't be determined

Q.104 Which represent percent by strength -
(1) $\frac{\text{Wt. of solute}}{\text{Wt. of solution}} \times 100$
(2) $\frac{\text{Wt. of solute}}{\text{Volume of solution}} \times 100$
(3) $\frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100$
(4) All of them

Q.105 The mole fraction of oxygen in a mixture of 7g of nitrogen and 8g of oxygen is -
(1) $\frac{8}{15}$ (2) 0.5
(3) 0.25 (4) 1.0

Q.106 Which of the following statements is true -
(a) Molarity is the no. of moles of solute dissolved per litre of solvent.
(b) The molarity and normality of a solution of sodium carbonate are same
(c) Molality (m) of a solution is defined as the number of moles of solute dissolved is 1000 gm of solution
(d) The ratio of mole fraction of solute and solvent is in the ratio of there respective moles
(1) a & c (2) a & d
(2) b & c (4) only d

Q.107 Equal weight of NaCl and KCl are dissolved separately in equal volumes of solutions molarity of the two solutions will be -
(1) Equal
(2) That of NaCl will be less than that of KCl
(3) That of NaCl will be more than that of KCl solution
(4) That of NaCl will be half of that of KCl solution

Q.108 Normality of 10% (W\V) H_2SO_4 solution nearly
(1) 0.1 (2) 0.2
(3) 0.5 (4) 2

Q.109 The molarity of 0.04 N $Ba(OH)_2$ as a base is -
(1) 0.02 M (2) 0.08 M
(3) 0.04 M (4) 0.06 M

Q.110 In a solution of 7.8 g benzene (C_6H_6) and 46.0g toluene ($C_6H_5CH_3$) the mole fraction of benzene is -

(1) $\frac{1}{6}$ (2) $\frac{1}{5}$ (3) $\frac{1}{2}$ (4) $\frac{1}{3}$

Q.111 A 500 g tooth paste sample has 0.02 gm fluoride concentration. What is the concentration of fluorine in terms of ppm level -

(1) 250 (2) 40
(3) 400 (4) 1000

Q.112 Molar concentration of a solution in water is -

(1) Always equal to normality
(2) More than molality of the solution
(3) Equal to molality of the solution
(4) Less than the molality of the solution

Q.113 The molarity of 98% H_2SO_4 (d = 1.8 g/ml) by wt. is -

(1) 6 M (2) 18 M
(3) 10 M (4) 4 M

Q.114 An aqueous solution of glucose is 10% in strength. The volume in which 2gm mole of it is dissolved will be -

(1) 18 litre (2) 3.6 litre
(3) 0.9 litre (4) 1.8 litre

Q.115 Increasing the temperature of an aqueous solution will cause -

(1) Decrease in molality
(2) Decrease in molarity
(3) Decrease in mole fraction
(4) Decrease in % w/w

EXERCISE # 2

Q.1 Select correct statement -
(1) b.p. of 1 molal NaCl solution is twice that of 1 molal sucrose solution
(2) b.p. elevation of 1 molal glucose solution is half of the 1 molal KCl solution
(3) b.p. is a colligative property
(4) All of the above

Q.2 At a given temperature, total vapour pressure in Torr of a mixture of volatile components A and B is given by

$$P = 120 - 75\ X_B$$

hence, vapour pressure of pure A and B respectively (in Torr) are -
(1) 120, 75 (2) 120, 195
(3) 120, 45 (4) 75, 45

Q.3 Decimolar solution of potassium ferricyanide, $K_3[Fe(CN)_6]$ has osmotic pressure of 3.94 atm at 27ºC. Hence percent ionisation of the solute is -
(1) 10% (2) 20%
(3) 30% (4) 40%

Q.4 A complex containing K^+, Pt (IV) and Cl^- is 100% ionised giving i = 3. Thus, complex is -
(1) $K_2[PtCl_4]$ (2) $K_2[PtCl_6]$
(3) $K_3[PtCl_5]$ (4) $K[PtCl_3]$

Q.5 If $pK_a = -\log K_a = 4$, and $K_a = C\alpha^2$ then van't Hoff factor for weak monobasic acid when C = 0.01 M is -
(1) 0.01 (2) 1.02 (3) 1.10 (4) 1.20

Q.6 In which case van't Hoff factor is maximum ?
(1) KCl, 50% ionised (2) K_2SO_4 40% ionised
(3) $FeCl_3$, 30% ionised (4) $SnCl_4$, 20% ionised

Q.7 The hard shell of an egg is dissolved in acetic acid and then egg was subsequently placed in saturated solution of NaCl
(1) The egg will shrink
(2) The egg will become harder
(3) The egg will swell
(4) No change in the size of egg

Q.8 The vapour pressure of a pure liquid 'A' is 70 torr at 27°C. It forms an ideal solution with another liquid B. The mole fraction of B is 0.2 and total vapour pressure of the solution is 84 torr at 27°C. The vapour pressure of pure liquid B at 27°C is -
(1) 14 (2) 56 (3) 140 (4) 70

Q.9 The vapour pressure of pure A is 10 torr and at the same temperature when 1g of B is dissolved in 20 gm 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 -
(1) 100 amu (2) 90 amu
(3) 75 amu (4) 120 amu

Q.10 The value of K_b for water is 1.86, calculated from Glucose solution. The value of K_b for water calculated for NaCl solution will be -
(1) = 1.86 (2) < 1.86 (3) > 1.86 (4) Zero

Q.11 As a result of osmosis the volume of the concentrated solution -
(1) Gradually decreases (2) Gradually increases
(3) Suddenly increases (4) None

Q.12 If a thin slice of sugar beet is placed in concentrated solution of NaCl then -
(1) Sugar beet will lose water from its cells
(2) Sugar beet will absorb water from solution
(3) Sugar beet will neither absorb nor lose water
(4) Sugar beet will dissolve in solution

Q.13 If mole fraction of the solvent in solution decreases then -
(1) Vapour pressure of solution increases
(2) B. P. decreases
(3) Osmotic pressure increases
(4) All are correct

Q.14 A solution containing 4g of a non volatile organic solute per 100 ml was found to have an osmotic pressure equal to 500 cm of mercury at 27°C. The molecular weight of solute is -
(1) 14.97 (2) 149.7
(3) 1697 (4) 1.497

Q.15 If a 6.84% (wt./ vol.) solution of cane-sugar (mol. wt. 342) is isotonic with 1.52% (wt./vol.) solution of thiocarbamide, then the molecular weight of thiocarbamide is -
(1) 152 (2) 76 (3) 60 (4) 180

Q.16 The osmotic pressure of blood is 7.65 atm. at 310 K. an aqueous solution of Glucose that will be isotonic with blood is ......wt/vol. -
(1) 5.41% (2) 54.1%
(3) 3.5% (4) 4.53%

Q.17 Equimolal solutions of A and B show depression in freezing point in the ratio of 2 : 1. A remains in normal state in solution. B will be in.......state in solution -
(1) Normal (2) Associated
(3) Hydrolysed (4) Dissociated

Q.18 The substance A when dissolved in solvent B shows the molecular mass corresponding to A_3. The vant Hoff's factor will be -
(1) 1 (2) 2 (3) 3 (4) $\frac{1}{3}$

Q.19 The freezing point of 1 molal NaCl solution assuming NaCl to be 100% dissociated inwater is (K_f = 1.86 K $Molality^{-1}$)
(1) – 1.86 °C (2) –3.72 °C
(3) +1.86 °C (4) +3.72 °C

Q.20 The molal elevation constant of water = 0.52 K molality^{-1}. The boiling point of 1.0 molal aqueous KCl solution (assuming complete dissociation of KCl), should be -
(1) 100.52°C (2) 101.04°C
(3) 99.48°C (4) 98.96°C

Q.21 Solute A is ternary electrolyte and solute B is non-electrolyte. If 0.1 M solution of solute B produces an osmotic pressure of 2P, then 0.05M solution of A at the same temperature will produce an osmotic pressure equal to -
(1) P (2) 1.5 P (3) 2 P (4) 3 P

Q.22 The values of observed and calculated molecular weight of calcium nitrate are respectively 65.6 and 164. The degree of dissociation of calcium nitrate will be -
(1) 25% (2) 50 %
(3) 75% (4) 60 %

Q.23 A 5.8% (wt./vol.) NaCl solution will exert an osmotic pressure closest to which one of the following -
(1) 5.8% (wt./vol) sucrose solution
(2) 5.8% (wt./vol) glucose solution
(3) 2 M sucrose solution
(4) 1 M glucose solution

Q.24 The correct relationship between the boiling points of very dilute solutions of $AlCl_3(t_1)$ and $CaCl_2(t_2)$, having the same molar concentration is
(1) $t_1 = t_2$ (2) $t_1 > t_2$
(3) $t_2 > t_1$ (4) $t_2 \geq t_1$

Q.25 Which aqueous solution has minimum freezing point -
(1) 0.01 M NaCl (2) 0.005 M C_2H_5OH
(3) 0.005 M MgI_2 (4) 0.005 M $MgSO_4$

Q.26 Which solution will have least vapour pressure -
(1) 0.1 M $BaCl_2$ (2) 0.1 M urea
(3) 0.1 M Na_2SO_4 (4) 0.1 M Na_3PO_4

Q.27 The freezing point of 1% aqueous solution of calcium nitrate will be -
(1) 0°C (2) Above 0°C
(3) 1°C (4) Below 0°C

Q.28 When mercuric Iodide is added to the aqueous solution of potassium iodide ?
(1) The boiling point does not change
(2) Freezing point is raised
(3) The freezing point is lowered
(4) Freezing point does not change

Q.29 The molecular weight of benzoic acid in benzene as determined by depression in freezing point method corresponds to -
(1) Ioniation of benzoic acid
(2) Dimerization of benzoic acid
(3) Trimerization of benzoic acid
(4) Solvation of benzoic acid

Q.30 The vapour pressure of a solvent decreases by 10 mm. of Hg when a non volatile solute was added to the solvent. The mole fraction of the solute in the solution is 0.2. What should be the mole fraction of the solvent if the decrease in vapour pressure is to be 20 mm. of Hg -
(1) 0.2 (2) 0.4 (3) 0.6 (4) 0.8

Q.31 The relationship between the values of osmotic pressure of solutions obtained by dissolving 6.00 gL^{-1} of CH_3COOH (π_1) and 7.45 gL^{-1} of KCl (π_2) is -
(1) $\pi_1 > \pi_2$ (2) $\pi_1 < \pi_2$
(3) $\pi_1 = \pi_2$ (4) None of these

Q.32 What is the freezing point of a solution containing 8.1 gm. of HBr is 100 gm. water assuming the acid to be 90% ionised.
(K_f for water = 1.86 K molality^{-1})
(1) 0.85°C (2) –3.53°C
(3) 0°C (4) – 0.35°C

Q.33 A 0.2 molal aqueous solution of a weak acid (HX) is 20% ionised. The freezing point of this solution is (Given : K_f = 1.86°C/m for water)
(1) – 0.31°C (2) – 0.45°C
(3) – 0.53°C (4) – 0.90°C

Q.34 The vapour pressure of ethanol and methanol are 42.0 mm and 88.5 mm Hg respectively. An ideal solution is formed at the same temperature by mixing 46.0 g of ethanol with 16.0 g of methanol. The mole fraction of methanol in the vapour is -
(1) 0.467 (2) 0.502
(3) 0.513 (4) 0.556

Q.35 An ideal solution was obtained by mixing methanol and ethanol. If the partial vapour pressure of methanol and ethanol are 2.619 K Pa and 4.556 K Pa respectively, the composition of vapour (in terms of mole fraction) will be -
(1) 0.635 MeOH, 0.365 EtOH
(2) 0.365 MeOH, 0.635 EtOH
(3) 0.574 MeOH, 0.326 EtOH
(4) 0.173 MeOH, 0.827 EtOH

Q.36 Insulin $(C_2H_{10}O_5)_n$ is dissolved in a suitable solvent and the osmotic pressure (π) of solutions of various concentrations (g/cm^3) C is measured at 20 °C. The slope of a plot of π against C is found to be 4.65×10^{-3}. The molecular weight of the insulin is -
(1) 4.8×10^5 (2) 9×10^5
(3) 3×10^5 (4) 5.16×10^6

Q.37 The boiling point of an aqueous solution of a non volatile solute is 100.15°C. What is the freezing point of an aqueous solution obtained by diluting the above solution with an equal volume of water ? The values of K_b and K_f for water are 0.512 and 1.86 K molality^{-1}
(1) –0.544 °C (2) –0.512 °C
(3) –0.272 °C (4) –1.86°C

Q.38 In ideal solution of non volatile solute B in solvent A in 2 : 5 molar ratio has vapour pressrue 250 mm. If another solution in ratio 3 : 4 prepared then vapour pressure above this solution
(1) 200 mm (2) 250 mm
(3) 350 mm (4) 400 mm

Q.39 Two liquids having vapour pressures P_1^0 and P_2^0 in pure state in the ratio of 2 : 1 are mixed in the molar ratio of 1 : 2. The ratio of their moles in the vapour state would be -

(1) 1 : 1 (2) 1 2
(3) 2 : 1 (4) 3 : 2

Q.40 3.0 molal NaOH solution has a density of 1.110 g/ml. The molarity of the solution is-

(1) 2.9732 (2) 3.05
(3) 3.64 (4) 3.0504

Q.41 In the aqueous solution of sulphuric acid the mole fraction of water is 0.85. The molality of the solution is-

(1) 8.9 m (2) 0.19 m
(3) 9.8 m (4) 15 m

Q.42 Equal volumes of 0.1 M $AgNO_3$ and 0.2 M NaCl are mixed. The concentration of NO_3^- ions in the mixture will be-

(1) 0.1 M (2) 0.05 M
(3) 0.2 M (4) 0.15 M

Q.43 10 gram of glucose are dissolved in 150 gram of water. The mass % of glucose is-

(1) 5% (2) 6.25%
(3) 93.75% (4) 15%

Q.44 The volume of water added to 500 ml., 0.5 M NaOH so that its strength becomes 10 mg NaOH per ml.

(1) 100 ml (2) 200 ml
(3) 250 ml (4) 500 ml

Q.45 An X molal solution of a compound in benzene has mole fraction of solute eq ual to 0.2. The value of X is -

(1) 14 (2) 3.2
(3) 1.4 (4) 2

Q.46 Mole fraction of ethanol in ethanol water mixture is 0.25. Hence percentage concentration of ethanol by weight of mixture is -

(1) 25 % (2) 75 %
(3) 46 % (4) 54 %

Q.47 Two bottles of A and B contains 1M and 1m aqueous solution (d $\simeq$ 1g/mL) of sulphuric acid respectively -

(1) A is more concentrated than B
(2) B is more concentrated than A
(3) Concentration of A = conc. of B
(4) It is not possible to compare the concentration

EXERCISE # 3

Q.1 Which of the following solutions would have the highest osmotic pressure - **[AIPMT-91]**

(1) $\frac{M}{10}$ NaCl (2) $\frac{M}{10}$ Urea

(3) $\frac{M}{10}$ $BaCl_2$ (4) $\frac{M}{10}$ Glucose

Q.2 Which of the following solution has the highest boiling point - **[AIPMT-91]**

(1) 0.1 M glucose (2) 0.1 M $BaCl_2$

(3) 0.1 M NaCl (4) 0.1 M Urea

Q.3 Which of the following is a colligative property – **[AIPMT-92]**

(1) Viscosity (2) Surface tension

(3) Optical rotation (4) Osmotic pressure

Q.4 The compound whose 0.1 M solution has maximum osmotic pressure at 25°C will be - **[AIPMT-94]**

(1) $CaCl_2$ (2) KCl

(3) Glucose (4) Urea

Q.5 Which of the following salt has the same value of Vont Hoff's factor as that of $K_3[Fe(CN)_6]$ **[AIPMT-94]**

(1) $Al_2(SO_4)_3$ (2) NaCl

(3) $Al(NO_3)_3$ (4) Na_2SO_4

Q.6 Which one of the following modes of expressing concentration of solution is independent of temperature - **[AIPMT-91-95]**

(1) Molarity (2) Molality

(3) Normality (4) Grams per litre

Q.7 According to raoult's law the relative lowering of vapour pressure for a solution is equal to - **[AIPMT-95]**

(1) Moles of solute

(2) Mole fraction of solvent

(3) Moles of solvents

(4) Mole fraction of solute

Q.8 The relationship between osmotic pressure at 273 K when 10 g glucose (P_1) 10 g urea (P_2) and 10 g sucrose (P_3) are dissolved in 250 ml of water is - **[AIPMT-96]**

(1) $P_1 > P_2 > P_3$ (2) $P_3 > P_1 > P_2$

(3) $P_2 > P_1 > P_3$ (4) $P_3 > P_2 > P_1$

Q.9 The vapour pressure of an ideal solution having 0.2 Mole non-volatile solute & 0.8 mole solvent, is 60 mm. The vapour pressure of pure solvent at this temperature will be - **[AIPMT-96]**

(1) 120 mm (2) 150 mm

(3) 60 mm (4) 75 mm

Q.10 What is the molarity of H_2SO_4 solution which is 98% by weight and the density of solution at 35°C is 1.84 gm/cm^3- **[AIPMT-96]**

(1) 4.18 M (2) 8.14 M

(3) 18.4 M (4) 18 M

Q.11 Vapour pressure of CCl_4 at 25°C is 143 mm Hg. 0.5 gm of a non-volatile solute (mol. wt. 65) is dissolved in 100 ml of CCl_4. Find the vapour pressure of the solution. (Density of CCl_4 1.58 gm/cm^3) **[AIPMT-96]**

(1) 141.93 mm (2) 94.39 mm

(3) 199.34 mm (4) 143.9 mm

Q.12 The vapour pressure decreases by 10 mm of Hg when solute's mole fraction in a solution is 0.2. If the vapour pressure decreases is 20 mm of Hg then the mole fraction of solute will be - **[AIPMT-98]**

(1) 0.2 (2) 0.4 (3) 0.6 (4) 0.8

Q.13 5% solution of sucrose is isotonic with 1% solution of a compound 'A' then the molecular weight of compound 'A' is - **[AIPMT-98]**

(1) 32.4 (2) 68.4 (3) 121.6 (4) 34.2

Q.14 The vapour pressure of benzene at a certain temperature is 640 mm of Hg. A non-volatile and electrolytic solid weighting 2.175 g is added to 39.08 g of benzene. If the vapour pressure of the solution is 600 mm of Hg. What is the molecular weight of the solid substance ? **[AIPMT-99]**

(1) 79.82 (2) 65.25

(3) 59.60 (4) 49.50

Q.15 What is false for mole fraction - **[AIPMT-99]**

(1) $x < 1$ (2) $-2 < x \leq 2$

(3) $0 < x \leq 1$ (4) Always non negative

Q.16 From the colligative properties of solution which one is the best method for the determination of mol. wt. of proteins & polymers - **[AIPMT-2001]**

(1) Osmotic pressure

(2) Lowering in freezing point

(3) Lowering in V.P.

(4) Elevation in B.Pt.

Q.17 Pure water can be obtain from sea water by - **[AIPMT-2001]**

(1) Centrifugation (2) Plasmolysis

(3) Reverse osmosis (4) Sedimentation

Q.18 Molarity of liquid HCl if density of liquid HCl is 1.17 gm/cc - **[AIPMT-2001]**

(1) 36.5 (2) 18.25

(3) 32.05 (4) 42.10

Q.19 A solution contains non volatile solute of molecular mass M_2. Which of the following can be used to calculate the molecular mass of solute in terms of osmotic pressure - **[AIPMT-2002]**

(1) $M_2 = \left(\frac{m_2}{\pi}\right) VRT$ (2) $M_2 = \left(\frac{m_2}{V}\right)\frac{RT}{\pi}$

(3) $M_2 = \left(\frac{m_2}{V}\right)\pi RT$ (4) $M_2 = \left(\frac{m_2}{V}\right)\frac{\pi}{RT}$

Note : $m_2 \longrightarrow$ mass of solute

$V \longrightarrow$ Volume of solution

$\pi \longrightarrow$ Osmotic pressure

Q.20 A solution containing components A and B follows Raoult's law **[AIPMT-2002]**
(1) A–B attraction force is greater than A– A and B – B
(2) A–B attraction force is less than A – A and B – B
(3) A – B attraction force remains same as A – A and B – B
(4) Volume of solution is different from sum of volume of solute and solvent

Q.21 Formation of a solution from two components can be considered as - **[AIPMT-2003]**
(i) Pure solvent $\rightarrow$ separated solvent molecules, ΔH_1
(ii) Pure solute $\rightarrow$ separated solute molecules, ΔH_2
(iii) Separated solvent and solute molecules $\rightarrow$ solution, ΔH_3
Solution so formed will be ideal if -
(1) $\Delta H_{soln} = \Delta H_1 + \Delta H_2 + \Delta H_3$
(2) $\Delta H_{soln} = \Delta H_1 + \Delta H_2 - \Delta H_3$
(3) $\Delta H_{soln} = \Delta H_1 - \Delta H_2 - \Delta H_3$
(4) $\Delta H_{soln} = \Delta H_3 - \Delta H_1 - \Delta H_2$

Q.22 Which one of the statements given below concerning properties of solutions, describes a colligative effect - **[AIIMS-2003]**
(1) boiling point of pure water decreases by the addition of ethanol
(2) vapour pressure of pure water decreases by the addition of nitric acid
(3) vapour pressure of pure benzene decreases by the addition of naphthalene
(4) boiling point of pure benzene increases by the addition of toluene

Q.23 The average osmotic pressure of human blood is 7.8 bar at 37°C. What is the concentration of an aqueous NaCl solution that could be used in the blood stream - **[AIIMS-2004]**
(1) 0.16 mol/L (2) 0.32 mol/L
(3) 0.60 mol/L (4) 0.45 mol/L

Q.24 Camphor is often used in molecular mass determination because - **[AIPMT-2004]**
(1) It has a very high cryoscopic constant
(2) It is volatile
(3) It is solvent for organic substances
(4) It is readily available

Q.25 The vapour pressure of two liquids 'P' and 'Q' are 80 and 60 torr, respectively. The total vapour pressure of solution obtained by mixing 3 mole of P and 2 mol of Q would be - **[AIPMT-2005]**
(1) 68 torr (2) 140 torr
(3) 72 torr (4) 20 torr

Q.26 A solution of urea (mol. mass 56 g mol^{-1}) boils at 100.18°C at the atomospheric pressure. If K_f and K_b for water are 1.86 and 0.512K kg mol^{-1} respectively, the above solution will freeze at - **[AIPMT-2005]**
(1) –6.54°C (2) –0.654°C
(3) 6.54°C (4) 0.654°C

Q.27 A solution has a 1 : 4 mole ratio of pentane to hexane. The vapour pressures of the pure hydrocarbons at 20°C are 440 mmHg for pentane and 120 mmHg for hexane. The mole fraction of pentane in the vapour phase would be - **[AIPMT-2005]**
(1) 0.200 (2) 0.478
(3) 0.549 (4) 0.786

Q.28 The mole fraction of the solute in one molal aqueous solution is - **[AIPMT-2005]**
(1) 0.027 (2) 0.036
(3) 0.018 (4) 0.009

Q.29 A solution containing 10g per dm^3 of urea (molecular mass = 60g mol^{-1}) is isotonic with a 5% solution of a nonvolatile solute. The molecular mass of this nonvolatile solute is - **[AIPMT-2006]**
(1) 250g mol^{-1} (2) 300g mol^{-1}
(3) 350g mol^{-1} (4) 200g mol^{-1}

Q.30 1.00g of a non-electrolyte solute (molar mass 250g mol^{-1}) w was dissolved in 51.2g of benzene. If the freezing point depression constant, K_f of benzene is 5.12 K kg mol^{-1}, the freezing point of benzene will be lowered by - **[AIPMT-2006]**
(1) 0.4 K (2) 0.3 K
(3) 0.5 K (4) 0.2 K

Q.31 A solution of acetone in ethanol - **[AIPMT-2006]**
(1) shows a positive deviation from Raoult's law
(2) behaves like a near ideal solution
(3) Obey Raoult's law
(4) shows a negative deviation from Raoult's law

Q.32 During osmosis, flow of water through a semipermeable membrane is - **[AIPMT-2006]**
(1) from both sides of semipermeable membrane with equal flow rates
(2) from both sides of semipermeable membrane with unequal flow rates
(3) from solution having lower concentration only
(4) from solution having higher concentration only

Q.33 A 5% solution (by mass) of cane sugar in water has freezing point of 271 K and freezing point of pure water is 273.15K. The freezing point of a 5% solution (by mass) of glucose in water is - **[AIIMS-2006]**
(1) 271 K (2) 273.15 K
(3) 269.07 K (4) 277.23 K

Q.34 A mixture of ethyl alcohol and propyl alcohol has a vapour pressure of 290 mm at 300 K. the vapour pressure of propyl alcohol is 200 mm. If the mole fraction of ethyl alcohol is 0.6, its vapour pressure (in mm) at the same temperature will be **[AIEEE-2007]**
(1) 300 (2) 700
(3) 360 (4) 350

Q.35 0.5 molal aqueous solution of a weak acid (HX) is 20% ionised. If K_f for water is 1.86 K kg mol^{-1}, the lowering in freezing point of the solution is - **[AIPMT-2007]**
(1) –0.56 K (2) –1.12 K
(3) 0.56 K (4) 1.12 K

Q.36 Concentrated aqueous sulphuric acid is 98% H_2SO_4 by mass and has a density of 1.80 $g.mL^{-1}$. Volume of acid required to make 1 litre of 0.1 M H_2SO_4 solution is - **[AIPMT-2007]**
(1) 5.55 mL (2) 11.10 mL
(3) 16.65 mL (4) 22.20 mL

Q.37 A 0.0020 M aqueous solution of an ionic compound $Co(NH_3)_5(NO_2)Cl$ freezes at – 0.00732ºC. Number of moles of ions which 1 mole of ionic compound produces on being dissolved in water will be : (k_f = – 1.86ºC/m) - **[AIPMT-2009]**
(1) 1 (2) 2 (3) 3 (4) 4

Q.38 An aqueous solution is 1.00 molal in KI. Which change will cause the vapour pressure of the solution to increase? **[AIPMT-2010]**
(1) addition of NaCl
(2) addition of Na_2SO_4
(3) addition of 1.00 molal KI
(4) addition of water

Q.39 A solution of sucrose (molar mass = 342 g mol^{-1}) has been prepared by dissolving 68.5 g of sucrose in 1000 g of water. The freezing point of the solution obtained will be : (K_f for water = 1.86 K kg mol^{-1}) **[AIPMT-2010]**
(1) –0.372°C (2) –0.520°C
(3) + 0.372°C (4) – 0.570°C

Q.40 The freezing point depression constant for water is $-1.86^{\circ}Cm^{-1}$. If 5.00 g Na_2SO_4 is dissolved in 45.0g H_2O, the freezing point is changed by –3.82ºC. Calculate the Van't Hoff factor for Na_2SO_4 **[AIPMT-2011]**
(1) 0.381 (2) 2.05 (3) 2.63 (4) 3.11

Q.41 The Van't Hoff factor i for a compound which undergoes dissociation in one solvent and association in other solvent is respectively : **[AIPMT-2011]**
(1) greater than one and greater than one
(2) less than one and greater than one
(3) less than one and less than one
(4) greater than one and less than one

Q.42 A 0.1 molal aqueous solution of a weak acid is 30% ionized. If K_f for water is 1.86°C/m, the freezing point of the solution will be- **[AIPMT MAINS-2011]**
(1) –0.24°C (2) –0.18°C
(3) –0.54°C (4) –0.36°C

Q.43 200 mL of an aqueous solution of a protein contains its 1.26 g. The Osmotic pressure of this solution at 300 K is found to be 2.57×10^{-3} bar. The molar mass of protein will be (R = 0.083 L bar mol^{-1} K^{-1}): **[AIPMT MAINS-2011]**
(1) 61038 g mol^{-1} (2) 51022 g mol^{-1}
(3) 122044 g mol^{-1} (4) 31011 g mol^{-1}

Q.44 Mole fraction of the solute in a 1.00 molal aqueous solution is : **[AIPMT-2011]**
(1) 1.7700 (2) 0.1770
(3) 0.0177 (4) 0.0344

Q.45 P_A and P_B are the vapour pressure of pure liquid components, A and B, respectively of an ideal binary solution. If x_A represents the mole fraction of component A, the total pressure of the solution will be: **[AIPMT-2012]**
(1) $p_B + x_A(p_B - p_A)$ (2) $p_B + x_A(p_A - p_B)$
(3) $p_A + x_A(p_B - p_A)$ (4) $p_A + x_A(p_A - p_B)$

Q.46 How many grams of concentrated nitric acid solution should be used to prepare 250 mL of 2.0 M HNO_3 ? The concentrated acid is 70 % HNO_3. **[NEET-2013]**
(1) 45.0 g conc. HNO_3 (2) 90.0 g conc. HNO_3
(3) 70.0 conc. HNO_3 (4) 54.0 g conc. HNO_3

Q.47 6.02×10^{20} molecules of urea are present in 100 mL of its solution. The concentration of solution is- **[NEET -2013]**
(1) 0.02 M (2) 0.01 M
(3) 0.001 M (4) 0.1 M

Q.48 Of the following 0.10 m aqueous solutions, which one will exhibit the largest freezing point depression ? **[AIPMT-2014]**
(1) KCl (2) $C_6H_{12}O_6$
(3) $Al_2(SO_4)_3$ (4) K_2SO_4

Q.49 At 100ºC the vapour pressure of a solution of 6.5 g of a solute in 100 g water is 732 mm. If K_b = 0.52, the boiling point of this solution will be : **[NEET-1-2016]**
(1) 100ºC (2) 102ºC
(3) 103ºC (4) 101ºC

Q.50 Which of the following statements about the composition of the vapour over an ideal 1 : 1 molar mixture of benzene and toluene is correct ? Assume that the temperature is constant at 25ºC. (Given, Vapour Pressure Data at 25ºC, benzene = 12.8 kPa, toluene = 3.85 kPa) **[NEET-1-2016]**
(1) The vapour will contain a higher percentage of toluene
(2) The vapour will contain equal amounts of benzene and toluene
(3) Not enough information is given to make a prediction
(4) The vapour will contain a higher percentage of benzene

Q.51 The van't Hoff factor (i) for a dilute aqueous solution of the strong electrolyte barium hydroxide is **[NEET-2-2016]**
(1) 0 (2) 1 (3) 2 (4) 3

Q.52 Which one of the following is **incorrect** for ideal solution ? **[NEET-2-2016]**

(1) $\Delta H_{mix} = 0$
(2) $\Delta U_{mix} = 0$
(3) $\Delta P = P_{obs} - P_{\text{calculated by Raoult's law}} = 0$
(4) $\Delta G_{mix} = 0$

Q.53 If molality of the dilute solution is doubled, the value of molal depression constant (K_f) will be **[NEET -2017]**

(1) unchanged (2) doubled
(3) halved (4) tripled

Q.54 Which of the following is dependent on temperature ? **[NEET-2017]**

(1) Weight percentage (2) Molality
(3) Molarity (4) Mole fraction

Q.55 The mixture that forms maximum boiling azeotrope is : **[NEET -2019]**

(1) Acetone + Carbon disulphide
(2) Heptane + Octane
(3) Water + Nitric acid
(4) Ethanol + Water

Q.56 For an ideal solution, the correct option is - **[NEET-2019]**

(1) Δ_{mix} H = 0 at constant T and P
(2) Δ_{min} G = 0 at constant T and P
(3) Δ_{mix} S = 0 at constant T and P
(4) Δ_{mix} V ≠ 0 at constant T and P

Q.57 The mixture which shows positive devation form Raoult's law is : **[NEET 2020]**

(1) Benzene + Toluene
(2) Acetone + Chloroform
(3) Chloroethane + Bromoethane
(4) Ethanol + Acetone

Q.58 The freezing point depression constant (K_f) of benzene is 5.12 K kg mol^{-1}. The freezing point depression for the solution of molality 0.078 m containing a non – electrolyte solute in benzene is (rounded off upto two decimal places) **[NEET 2020]**

(1) 0.80 K (2) 0.40 K
(3) 0.90 K (4) 0.20 K

Q.59 The following solutions were prepared by dissolving 10g of glucose ($C_6H_{12}O_6$) in 250 ml of water (P_1),10g of urea (CH_4N_2O) in 250 ml of water (P_2) and 10g of sucrose ($C_{12}H_{22}O_{11}$) in 250 ml of water P_3).The right option for the decreasing order of osmotic pressure of these solutions is : **[NEET 2021]**

(1) $P_3 > P_1 > P_2$ (2) $P_2 > P_1 > P_3$
(3) $P_1 > P_2 > P_3$ (4) $P_2 > P_3 > P_1$

Q.60 The correct option for the value of vapour pressure of a solution at 45°C with benzene to octane in molar ratio 3 : 2 is : [At 45°C vapour pressure of benzene is 280 mm Hg and that of octane is 420 mm Hg. Assume Ideal gas] **[NEET 2021]**

(1) 350 mm of Hg (2) 160 mm of Hg
(3) 168 mm of Hg (4) 336 mm of Hg

Q.61 In one molal solution that contains 0.5 mole of a solute, there is **[NEET-2022]**

(1) 500 g of solvent (2) 100 mL of solvent
(3) 1000 g of solvent (4) 500 mL of solvent

Q.62 K_H value for some gases at the same temperature 'T' are given :

Gas	K_H/k bar
Ar	40.3
CO_2	1.67
HCHO	1.83×10^{-5}
CH_4	0.413

where K_H is Henry's Law constant in water. The order of their solubility in water is : **[Re-NEET-2022]**

(1) HCHO < CH_4 < CO_2 < Ar
(2) Ar < CO_2 < CH_4 < HCHO
(3) Ar < CO_2 < CH_4 < HCHO
(4) HCHO < CO_2 < CH_4 < Ar

EXERCISE # 4

Q.1 In a mixture of A and B, components show negative deviation when – **[AIEEE-2002]**
(1) A – B interaction is stronger than A – A and B – B interaction
(2) A – B interaction is weaker than A – A and B – B interaction
(3) $\Delta V_{mix} > 0$, $\Delta S_{mix} > 0$
(4) $\Delta V_{mix} = 0$, $\Delta S_{mix} > 0$

Q.2 Benzene and toluene form nearly ideal solutions. At 20ºC, the vapour pressure of benzene is 75 torr and that of toluene is 22 torr. The partial vapour pressure of benzene at 20ºC for a solution containing 78 g of benzene and 46 g of toluene in torr is– **[AIEEE-2005]**
(1) 25 (2) 50
(3) 53.5 (4) 37.5

Q.3 Equimolal solutions in the same solvent have – **[AIEEE-2005]**
(1) Same freezing point but different boiling point
(2) Same boiling point but different freezing point
(3) Different boiling and different freezing point
(4) Same boiling and same freezing points

Q.4 The vapour pressure of water at 20º C is 17.5 mm Hg. If 18g of glucose ($C_6H_{12}O_6$) is added to 178.2 g of water at 20° C, the vapour pressure of the resulting solution will be - **[AIEEE 2008]**
(1) 15.750 mm Hg (2) 16.500 mm Hg
(3) 17.325 mm Hg (4) 17.675 mm Hg

Q.5 A binary liquid solution is prepared by mixing n-heptane and ethanol. Which one of the following statements is correct regarding the behaviour of the solution ? **[AIEEE 2009]**
(1) The solution is non-ideal, showing +ve deviation form Raoult's Law
(2) The solution is non-ideal, showing –ve deviation from Raoult's Law
(3) n-heptane shows +ve deviation while ethanol shows – ve deviation from Raoult's Law
(4) The solution formed is an ideal solution

Q.6 Two liquids X and Y form an ideal solution At 300 K, vapour pressure of the solution containing 1 mol of X and 3 mol of Y is 550 mmHg. At the same temperature, if 1 mol of Y is further added to this solution, vapour pressure of the solution increases by 10 mmHg. Vapour pressure (in mmHg) of X and Y in their pure states will be, respectively - **[AIEEE 2009]**
(1) 300 and 400 (2) 400 and 600
(3) 500 and 600 (4) 200 and 300

Q.7 Aqueous solutions of 0.004 M Na_2SO_4 and 0.01 M Glucose are isotonic. The degree of dissociation of Na_2SO_4 is - **[IIT-2004]**
(1) 25% (2) 60% (3) 75% (4) 85%

Q.8 In a 0.2 molal aqueous solution of a weak acid HX the degree of ionization is 0.3. Taking k_f for water as 1.85, the freezing point of the solution will be nearest to - **[AIEEE-2003]**
(1) – 0.480°C (2) – 0.360°C
(3) – 0.260°C (4) + 0.480°C

Q.9 If liquids A and B form an ideal solution – **[AIEEE-2003]**
(1) the enthalpy of mixing is zero
(2) the entropy of mixing is zero
(3) the free energy of mixing is zero
(4) the free energy as well as the entropy of mixing are each zero

Q.10 18 g of glucose ($C_6H_{12}O_6$) is added to 178.2g of water. The vapour pressure for this aqueous solution at 100°C is - **[AIEEE-2006]**
(1) 759.00 torr (2) 7.60 torr
(3) 76.00 torr (4) 752.40 torr

Q.11 A 5.25% solution of a substance is isotonic with a 1.5% solution of urea (molar mass = 60g mol^{-1}) in the same solvent. If the densities of both the solutions are assumed to be equal to 1.0 g cm^{-3}, molar mass of the substance will be - **[AIEEE-2007]**
(1) 115.0 g mol^{-1} (2) 105.0 g mol^{-1}
(3) 210.0 g mol^{-1} (4) 90.0 g mol^{-1}

Q.12 The density (in g mL^{-1}) of a 3.60 M sulphuric acid solution that is 29% H_2SO_4 (Molar mass = 98 g mol^{-1}) by mass will be - **[AIEEE-2007]**
(1) 1.88 (2) 1.22
(3) 1.45 (4) 1.64

Q.13 Ethylene glycol is used as an antifreeze in a cold climate. Mass of ethylene glycol which should be added to 4 kg of water to prevent it from freezing at –6º C will be : (K_f for water = 1.86 K kg mol^{-1}, and molar mass of ethylene glycol = 62 g mol^{-1}) **[AIEEE-2011]**
(1) 804.32 g (2) 204.30 g
(3) 400.00 g (4) 304.60 g

Q.14 The degree of dissociation (α) of a weak electrolyte, A_xB_y is related to van't Hoff factor (i) by the expression : **[AIEEE-2011]**
(1) $\alpha = \dfrac{i-1}{(x+y-1)}$ (2) $\alpha = \dfrac{i-1}{(x+y+1)}$
(3) $\alpha = \dfrac{x+y-1}{i-1}$ (4) $\alpha = \dfrac{x+y+1}{i-1}$

Q.15 The molality of a urea solution in which 0.0100g of urea, $[(NH_2)_2CO]$ is added to 0.3000 dm^3 of water at STP is - **[AIEEE-2011]**

(1) 5.55×10^{-4} m (2) 33.3 m
(3) 3.33×10^{-2} m (4) 0.555 m

Q.16 A 5% solution of can sugar (molar mass 342) is isotonic with 1% of a solution of an unknown solute. The molar mass of unknown solute in g/mol is - **[AIEEE-2011]**

(1) 171.2 (2) 68.4
(3) 34.2 (4) 136.2

Q.17 A 5.2 molal aqueous solution of methyl alcohol, CH_3OH, is supplied. What is the mole fraction of methyl alcohol in the solution ? **[AIEEE-2011]**

(1) 0.100 (2) 0.190
(3) 0.086 (4) 0.050

Q.18 The density of a solution prepared by dissolving 120 g of urea (mol. mass = 60 u) in 1000g of water is 1.15 g/mL. The molarity of this solution is : **[AIEEE-2011]**

(1) 1.78 M (2) 1.02 M
(3) 2.05 M (4) 0.50 M

Q.19 K_f for water is 1.86 K kg mol^{-1}. If your automobile radiator holds 1.0 kg of water, how many grams of ethylene glycol ($C_2H_6O_2$) must you add to get the freezing point of the solution lowered to – 2.8°C ? **[AIEEE-2012]**

(1) 93 g (2) 39 g
(3) 27 g (4) 72 g

Q.20 The molarity of a solution obtained by mixing 750 mL of 0.5(M)HCl with 250 ml of 2(M)HCl will be - **[JEE Main-2013]**

(1) 1.75 M (2) 0.975 M
(3) 0.875 M (4) 1.00 M

Q.21 The freezing point of benzene decreases by 0.45°C when 0.2 g of acetic acid is added to 20 g of benzene. If acetic acid associates to form a dimer in benzene, percentage association of acetic acid in benzene will be (K_f for benzene = 5.12 K kg mol^{-1}) **[JEE Main - 2017]**

(1) 74.6% (2) 94.6%
(3) 64.6% (4) 80.4%

Q.22 For 1 molal aqueous solution of the following compounds, which one will show the highest freezing point ? **[JEE Main - 2018]**

(1) $[Co(H_2O)_6]Cl_3$
(2) $[Co(H_2O)_5Cl]Cl_2.H_2O$
(3) $[Co(H_2O)_4Cl_2]Cl.2H_2O$
(4) $[Co(H_2O)_3Cl_3].3H_2O$

Q.23 A mixture of 100 m mol of $Ca(OH)_2$ and 2 g of sodium sulphate was dissolved in water and the volume was made up to 100 mL. The mass of calcium sulphate formed and the concentration of OH^- in resulting solution, respectively, are : (Molar mass of Ca $(OH)_2$, Na_2SO_4 and $CaSO_4$ are 74, 143 and 136 g mol^{-1}, respectively; K_{sp} of $Ca(OH)_2$ is 5.5×10^{-6}) **[JEE Main Online - 2019]**

(1) 13.6g, 0.28 mol L^{-1} (2) 13.6g, 0.14 mol L^{-1}
(3) 1.9g, 0.28 mol L^{-1} (4) 1.9g, 0.14 mol L^{-1}

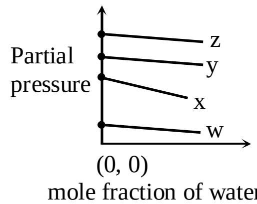
Q.24 Elevation in the boiling point for 1 molar solution of glucose is 2 K. The depression in the freezing point for 2 molal solution of glucose in the same solvent is 2 K. The relation between K_b and K_f is : **[JEE Main Online - 2019]**

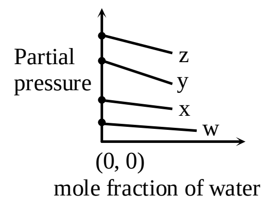
(1) $K_b = K_f$ (2) $K_b = 0.5\ K_f$
(3) $K_b = 1.5\ K_f$ (4) $K_b = 2\ K_f$

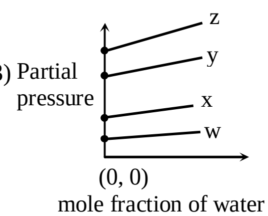
Q.25 25 ml of the given HCl solution requires 30 mL of 0.1 M sodium carbonate solution. What is the volume of this HCl solution required to titrate 30 mL of 0.2 M aqueous NaOH solutions ? **[JEE Main Online - 2019]**

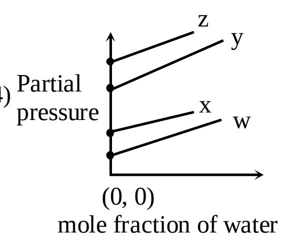
(1) 50 mL (2) 12.5 mL
(3) 25 mL (4) 75 mL

Q.26 For the solution of the gases w, x, y and z in water at 298 K, the Henry law constants (K_H) are 0.5, 2, 35 and 40 kbar, respectively. The correct plot for the given data is - **[JEE Main Online - 2019]**

(1)


(2)


(3)


(4)


Q.27 At 35ºC, the vapour pressure of CS_2 is 512 mm Hg and that of acetone is 344 mm Hg. A solution of CS_2 in acetone has a total vapour pressure of 600 mm Hg. The false statement amongst the following is : **[JEE Main-2020]**

(1) A mixture of 100 mL CS_2 and 100 mL acetone has a volume < 200 mL
(2) Roult's law is not obeyed by this system
(3) CS_2 and acetone are less attracted to each other than to themselves
(4) Heat must be absorbed in order to produce the solution at 35ºC

Q.28 The K_{sp} for the following dissociation is 1.6×10^{-5}

$$PbCl_{2(s)} \rightleftharpoons Pb^{2+}_{(aq)} + 2Cl^-_{(aq)}$$

Which of the following choices is correct for a mixture of 300 mL 0.134 M $Pb(NO_3)_2$ and 100 mL 0.4 M NaCl? **[JEE Main-2020]**

(1) Not enough data provided
(2) $Q > K_{sp}$
(3) $Q < K_{sp}$
(4) $Q = K_{sp}$

Q.29 An open beaker of water in equilibrium with water vapour is in a sealed container. When a few grams of glucose are added to the beaker of water, the rate at which water molecules : **[JEE Main-2020]**

(1) leaves the vapour increases
(2) leaves the solution increases
(3) leaves the solution decreases
(4) leaves the vapour decreases

Q.30 The solubility of AgCN in a buffer solution of pH = 3 is x. The value of x is:
[Assume : No cyano complex is formed; $K_{sp}(AgCN) = 2.2 \times 10^{-16}$ and $K_a(HCN) = 6.2 \times 10^{-10}$] **[Main - 2021]**

(1) 0.625×10^{-6} (2) 1.9×10^{-5}
(3) 2.2×10^{-16} (4) 1.6×10^{-6}

Q.31 When 9.45 g of $ClCH_2COOH$ is added to 500 mL of water, its freezing point drops by 0.5ºC. The dissociation constant of $ClCH_2COOH$ is $x \times 10^{-3}$. The value of x is________.
(Rounded off to the nearest integer)
$\left[K_{f(H_2O)} = 1.86 \text{kgmol}^{-1}\right]$ **[Main - 2021]**

Q.32 4.5 g of compound A (MW = 90) was used to make 250 mL of its aqueous solution. The molarity of the solution in M is $x \times 10^{-1}$. The value of x is ________.
(Rounded off to the nearest integer) **[Main - 2021]**

Q.33 15 mL of aqueous solution of Fe^{2+} in acidic medium completely reacted with 20mL of 0.03 M aqueous $Cr_2O_7^{2-}$. The molarity of the Fe^{2+} solution is ____ $\times 10^{-2}$ M (Round off the Nearest Integer). **[Main - 2021]**

Q.34 The K_{sp} for bismuth sulphide (Bi_2S_3) is 1.08×10^{-73}. The solubility of Bi_2S_3 in mol L^{-1} at 298 K is **[Main - 2022]**

(1) 1.0×10^{-15} (2) 2.7×10^{-12}
(3) 3.2×10^{-10} (4) 4.2×10^{-8}

Q.35 The depression in freezing point observed for a formic acid solution of concentration 0.5 mL L^{-1} is 0.0405°C. Density of formic acid is 1.05 g mL^{-1}. The Van't Hoff factor of the formic acid solution is nearly
(Given for water k_f = 1.86 k kg mol^{-1}) **[Main - 2022]**

(1) 0.8 (2) 1.1 (3) 1.9 (4) 2.4

Q.36 Two solutions A and B are prepared by dissolving 1 g of non-volatile solutes X and Y, respectively in 1 kg of water. The ratio of depression in freezing points for A and B is found to be 1 : 4. The ratio of molar masses of X and Y is **[Main - 2022]**

(1) 1 : 4 (2) 1 : 0.25 (3) 1 : 0.20 (4) 1 : 5

Q.37 Boiling point of a 2% aqueous solution of a non-volatile solute A is equal to the boiling point of 8% aqueous solution of a non-volatile solute B. The relation between molecular weights of A and B is **[Main - 2022]**

(1) $M_A = 4M_B$ (2) $M_B = 4M_A$
(3) $M_A = 8M_B$ (4) $M_B = 8M_A$

Q.38 The vapour pressures of two volatile liquids A and B at 25°C are 50 Torr and 100 Torr, respectively. If the liquid mixture, contains 0.3 mole fraction of A, then the mole fraction of liquid B in the vapour phase is $\frac{x}{17}$. The value of x is **[Main - 2022]**

Q.39 In the depression of freezing point experiment

A. Vapour pressure of the solution is less than that of pure solvent
B. Vapour pressure of the solution is more than that of pure solvent
C. Only solute molecules solidify at the freezing point
D. Only solvent molecules solidify at the freezing point

Choose the most appropriate answer from the options given below: **[Main - 2023]**

(1) A and D only (2) B and C only
(3) A only (4) A and C only

Q.40 Match List-I with List-II.

List-I		List-II	
A.	van't Hoff factor, i	I.	Cryoscopic constant
B.	k_f	II.	Isotonic solutions
C.	Solutions with same ostomic pressure	III.	$\frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$
D.	Azeotropes	IV.	Solutions with same composition of vapour above it

Choose the correct answer from the options given below ? **[Main - 2023]**

(1) A-III, B-I, C-II, D-IV (2) A-III, B-I, C-IV, D-II
(3) A-III, B-II, C-I, D-IV (4) A-I, B-III, C-II, D-IV

Q.41 What weight of glucose must be dissolved in 100 g of water to lower the vapour pressure by 0.20 mm Hg? (Assume dilute solution is being formed)
Given : Vapour pressure of pure water is 54.2 mm Hg at room temperature. Molar mass of glucose is 180 g mol^{-1} **[Main - 2023]**

(1) 3.59 g (2) 3.69 g
(3) 4.69 g (4S) 2.59 g

Q.42 A solution containing 2 g of a non-volatile solute in 20 g of water boils at 373.52 K. The molecular mass of the solute is ________ g mol^{-1}. (Nearest integer)
Given, water boils at 373 K, K_b for water = 0.52 K kg mol^{-1}) **[Main - 2023]**

Q.43 The vapour pressure of 30% (w/v) aqueous solution of glucose is ________ mm Hg at 25°C.
[Given: The density of 30% (w/v), aqueous solution of glucose is 1.2 g cm^{-3} and vapour pressure of pure water is 24 mm Hg.] (Molar mass of glucose is 180 g mol^{-1}) **[Main - 2023]**

EXERCISE # 5
(NCERT QUESTION)

Ex.1 Concentrated nitric acid used in the laboratory work is 68% nitric acid by mass in aqueous solution. What should be the molarity of such a sample of the acid if the density of solution is 1.504g mL^{-1} ?

Sol. 68 % mass of HNO_3 means 100g solution contains 68 g HNO_3

$\therefore$ Volume of solution = $\dfrac{\text{wt.of solution}}{\text{density}}$

$= \dfrac{100}{1.504}$ = 66.49 mL

Molarity (M) = $\dfrac{\text{mole of } HNO_3}{\text{volume of solution in litre}}$

$= \dfrac{68 \times 1000}{63 \times 66.49}$ = 16.23

Ex.2 A solution of glucose in water is labelled as 10 percent (w/W), what would be the molality and mole fraction of each component in the solution ? If the density of the solution is 1.2g mL^{-1}, then what shall be molarity of the solution ?

Sol. 10% (w/w) solution of glucose means 100 g solution contains 10 g glucose (Solute).

$\therefore$ Weight of water = 100 – 10 = 90 g (Solvent)

Molality (m) = $\dfrac{10}{180 \times \dfrac{90}{100}}$ = 0.617 m

volume of solution = $\dfrac{100}{1.2}$ ml

Molarity (M) = $\dfrac{10}{180 \times \dfrac{100}{1.2 \times 1000}}$ = 0.67M

Mole fraction of glucose = $\dfrac{10/180}{\dfrac{10}{180} + \dfrac{90}{18}}$ = 0.011

Mole fraction of water = $\dfrac{90/18}{\dfrac{10}{180} + \dfrac{90}{18}}$ = 0.989

Ex.3 How many mL of a 0.1 M HCl are required to react completely with 1 g mixture of Na_2CO_3 and $NaHCO_3$ containing equimolar amounts of two -

Sol. Let a moles of Na_2CO_3 and a moles of $NaHCO_3$ be present in 1 g mixture

$\therefore$ a × 106 + a × 84 = 1

or a = 5.26 × 10^{-3}

Now for reaction :

Meq. of HCl = Meq. of Na_2CO_3 + Meq. of $NaHCO_3$

0.1 × 1 × V

= 2 × 5.26 × 10^{-3} × 1000 + 1 × 5.26 × 10^{-3} × 1000

V = 157.8 mL

Ex.4 Calculate the percentage composition in terms of mass of a solution obtained by mixing 300 g of a 25% and 400 g of a 40% solution by mass.

Sol. 25% solution means 25 g solute in 100 g solution.

40% solution means 40 g solute in 100 g solution

Mass of solute in 300 g solution = $\dfrac{25 \times 300}{100}$ = 75g

Mass of solute in 400 g solution = $\dfrac{40 \times 400}{100}$ = 160g

$\therefore$ total mass of solute = 75 + 160 = 235 g

$\therefore$ mass % in mixture = $\dfrac{235}{700} \times 100$ = 33.57%

Ex.5 An antifreeze solution is prepared from 222.6 g of ethylene glycol [$C_2H_4(OH)_2$] and 200 g of water. Calculate the molality of the solution. If the density of the solution is 1.072 g mL^{-1} then what shall be the molarity of the solution ?

Sol. Molality of ethylene glycol = $\dfrac{222.6}{62 \times \dfrac{200}{1000}}$ = 17.95 m

weight of solution = weight of glycol + weight of water = 222.6 + 200 = 422.6 g

Volume of solution = $\dfrac{422.6}{1.072}$ mL

Molarity of ethylene glycol = $\dfrac{222.6}{62 \times \dfrac{422.6}{1.072 \times 1000}}$

= 9.11 M

Ex.6 A sample of drinking water was found to be severely contaminated with chloroform, $CHCl_3$,
supposed to be carcinogen. The level of contamination was 15 ppm (by mass)

(i) Express this in percent by mass.

(ii) Determine the molarity of chloroform in the water sample.

Sol. $CHCl_3$ present in 15 ppm or 10^6 g or mL H_2O contains 15 g $CHCl_3$

(i) % by mass = $\dfrac{15}{10^6}$ × 100 = 1.5 × 10^{-3}

(ii) molality = $\dfrac{15/119.5}{10^6 \times 10^{-3}}$ = 1.25 × 10^{-4}m

ANSWER KEY

EXERCISE # 1

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	1	1	3	1	2	3	1	4	3	4	2	3	3	4	1	2	1	3	1
Q.No.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	2	1	4	2	1	4	4	2	1	2	1	4	2	3	3	1	3	2	3	3
Q.No.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	4	2	4	1	1	4	2	2	2	3	2	2	2	3	2	3	3	2	1	2
Q.No.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
Ans.	2	4	3	1	3	4	3	3	4	3	4	3	1	2	4	3	4	1	3	1
Q.No.	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
Ans.	3	1	3	2	1	2	3	3	2	4	4	4	3	1	3	4	4	3	3	4
Q.No.	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**					
Ans.	3	1	3	2	2	4	3	4	1	1	2	4	2	2	2					

EXERCISE # 2

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	3	2	2	3	3	1	3	2	1	2	1	3	2	2	1	2	4	2	2
Q.No.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	4	3	3	2	1	4	4	2	2	3	2	2	2	3	2	4	3	1	1	1
Q.No.	**41**	**42**	**43**	**44**	**45**	**46**	**47**													
Ans.	3	2	2	4	2	3	1													

EXERCISE # 3

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	2	4	1	3	2	4	3	4	3	1	2	2	2	2	1	3	3	2	3
Q.No.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	1	3	1	1	3	2	2	3	2	1	1	2	3	4	4	1	2	4	1	3
Q.No.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	4	1	1	3	2	1	2	3	4	4	4	4	1	3	3	1	4	2	2	4
Q.No.	**61**	**62**																		
Ans.	1	2																		

EXERCISE # 4

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	2	4	3	1	2	3	1	1	4	3	2	1	1	1	2	3	3	1	3
Q.No.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	2	1	3	4	3	2	1	2	1	2	36.00	2.00	24.00	1	3	2	2	14.00	1	1
Q.No.	**41**	**42**	**43**																	
Ans.	2	100	23.00																	