MISCELLANEOUS PREVIOUS YEAR QUESTIONS

1. To 500 cm^3 of water, 3×10^{-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. **[JEE 2000]**

Ans. 0.23 K

2. Match the boiling point with K_b for x, y and z, if molecular weight of x, y and z are same. **[JEE 2003]**

	b.pt.	**K_b**
x	100	0.68
y	27	0.53
z	253	0.98

Ans. K_b(x) = 0.68, K_b(y) = 0.53, K_b(z) = 0.98

3. During depression of freezing point in a solution, the following are in equilibrium **[JEE 2003]**

(A) liquid solvent-solid solvent
(B) liquid solvent-solid solute
(C) liquid solute-solid solute
(D) liquid solute-solid solvent

Ans. (A)

Sol. Equilibrium exists between liquid solvent & solid solvent.

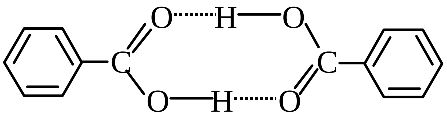
4. 1.22 g of benzoic acid is dissolved in (i) 100 g acetone (K_b for acetone = 1.7) and (ii)100 g benzene (K_b for benzene = 2.6). The elevation in boiling points T_b is 0.17°C and 0.13°C respectively.

(a) What are the molecular weights of benzoic acid in both the solutions?

(b) What do you deduce out of it in terms of structure of benzoic acid? **[JEE 2004]**

Ans. (a)122, (b) It means that benzoic acid remains as it is in acetone while it dimerises in benzene

as



Sol. (a)

(i) $\Delta T_b = i\ K_b\ .\ m$

$$0.17 = i \times 1.7 \times \frac{1.22/122}{0.1}$$

$$i = 1 = \frac{(\text{mol wt})_{Th}}{(\text{mol wt})_{ACt}}$$

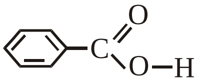
$$(\text{mol wt})_{ACt} = \frac{122}{1}\ \text{gm/mol}$$

(ii) $\Delta T_b = i \times K_b\ .\ m$

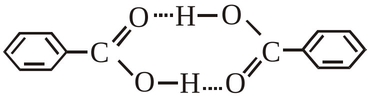
$$0.13 = i \times 2.6 \times \frac{1.22/122}{0.1}$$

$$i = 0.5 = \frac{(\text{mol wt})_{Th}}{(\text{mol wt})_{ACt}} \Rightarrow (\text{mol ut})_{ACl} = \frac{122}{0.5}$$

$$= 244\ \text{gm/mol}$$

(b) In Acetone its normal ie. 

but in benzene it is in dimenc form



5. A 0.004 M solution of Na_2SO_4 is isotonic with a 0.010 M solution of glucose at same temperature. The apparent degree of dissociation of Na_2SO_4 is

(A) 25% (B) 50% (C) 75% (D) 85% **[JEE 2004]**

Ans. (C)

Sol. $\pi_{Na_2So_4} = \pi_{g10C^\circ}$

$i \times 0.004 = 0.010$

$i = 2.5 = 1+2\propto \Rightarrow \propto = 0.75$ or 75%

6. The elevation in boiling point, when 13.44 g of freshly prepared $CuCl_2$ are added to one kilogram of water, is [Some useful data, K_b (H_2O) = 0.52 kg K mol^{-1}, mol. wt. of $CuCl_2$ = 134.4 gm]

(A) 0.05 (B) 0.1 (C) 0.16 (D) 0.21 **[JEE 2005]**

Ans.(C)

Sol. $\Delta T_b = i\ K_b\ .\ m$

$= 3 \times 0.52 \times \frac{13.44/134.4}{1}$

$= 0.156$ K

$\simeq 0.16$ K

7. 72.5 g of phenol is dissolved in 1 kg of a solvent ($k_f = 14$) which leads to dimerization of phenol and freezing point is lowered by 7 kelvin. What percent of total phenol is present in dimeric form? **[JEE 2006]**

Ans. 35% (degree of asso = 70%)

Sol. $\underset{0.77\ \text{mol}}{2\ PhOH} \rightleftharpoons \underset{—}{(PhOH)_2}$

$0.77(1-\propto) \qquad 0.77\propto/2$

$i = 1-\propto/2$

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

$7 = (1-\propto) \times 14 \times \frac{72.5/94}{1}$

$0.649 = 1-\propto/2$

$\propto/2 = 0.35$

$\propto = 0.70$

% of phenol in dimeric form

$= \frac{0.77\propto/2}{0.77} \times 100 = \frac{\propto}{2} \times 100 = 35\%$

8. When 20 g of naphtholic acid ($C_{11}H_8O_2$) is dissolved in 50 g of benzene (K_f = 1.72 K kg mol^{-1}), a freezing point depression of 2 K is observed. The van't Hoff factor (*i*) is **[JEE 2007]**

(A) 0.5 (B) 1 (C) 2 (D) 3

Ans. **(A)**

Sol. $\Delta T_f = i\ K_f \cdot \dfrac{n}{W/1000}$

$2 = i \times 1.72 \times \dfrac{20/172}{50/1000}$

$i = 0.5$

Paragraph for Question No. Q.9 to Q.11

Properties such as boiling point, freezing point and vapour pressure of a pure solvent change when solute molecules are added to get homogeneous solution. These are called colligative properties. Applications of colligative properties are very useful in day-to-day life. One of its examples is the use of ethylene glycol and water mixture as anti-freezing liquid in the radiator of automobiles.

A solution **M** is prepared by mixing ethanol and water. The mole fraction of ethanol in the mixture is 0.9.

Given : Freezing point depression constant of water $\left(K_f^{water}\right)$ = 1.86 K kg mol^{-1}
Freezing point depression constant of ethanol $\left(K_f^{ethanol}\right)$ = 2.0 K kg mol^{-1}
Boiling point elevation constant of water $\left(K_b^{water}\right)$ = 0.52 K kg mol^{-1}
Boiling point elevation constant of ethanol $\left(K_b^{ethanol}\right)$ = 1.2 K kg mol^{-1}
Standard freezing point of water = 273 K
Standard freezing point of ethanol = 155.7 K
Standard boiling point of water = 373 K
Standard boiling point of ethanol = 351.5 K
Vapour pressure of pure water = 32.8 mm Hg
Vapour pressure of pure ethanol = 40 mm Hg
Molecular weight of water = 18 g mol^{-1}
Molecular weight of ethanol = 46 g mol^{-1}

In answering the following questions, consider the solutions to be ideal dilute solutions and solutes to be non-volatile and non-dissociative.

9. The freezing point of the solution **M** is **[JEE 2008]**

(A) 268.7 K (B) 268.5 K (C) 234.2 K (D) 150.9 K

Ans. **(D)**

$(T_f')_{Alc.sol^n} = (T_f)_{EtoH} - (K_f)_{etoh}.m$

$= 115.7 - 2 \times \dfrac{0.1}{0.9 \times 46/1000}$

$= 155.7 - 2 \times 2.415$

$= 150.9$ K

10. The vapour pressure of the solution **M** is **[JEE 2008]**

(A) 39.3 mm Hg (B) 36.0 mm Hg (C) 29.5 mm Hg (D) 28.8 mm Hg

Ans. **(B)**

Sol. $P^s = (P^\circ)_{solvent} . X_{solvent}$

$= 40 \times 0.9$

$= 36.0$ mm Hg

11. Water is added to the solution **M** such that the mole fraction of water in the solution becomes 0.9. The boiling point of this solution is **[JEE 2008]**

(A) 380.4 K (B) 376.2 K (C) 375.5 K (D) 354.7 K

Ans. **(B)**

Sol. $(T_b')_{Aqsol^n} = (T_b)_{solvent H_2O} + K_b . m$

$$= 373 + 0.52 \times \frac{0.1}{0.9 \times 18/1000}$$

$= 373 + 0.52 \times 6.173$

$= 376.2$ K

12. The Henry's law constant for the solubility of N_2 gas in water at 298 K is 1.0×10^5 atm. The mole fraction of N_2 in air is 0.8. The number of moles of N_2 from air dissolved in 10 moles of water at 298 K and 5 atm pressure is- **[JEE 2009]**

(A) 4.0×10^{-4} (B) 4.0×10^{-5} (C) 5.0×10^{-4} (D) 4.0×10^{-5}

Ans. **(A)**

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

$Y_{N_2}.P_T = K_H \times N_2$

$$0.8 \times 5 = 1 \times 10^5 \times \frac{n}{n+10}$$

$$4 = 10^5 \times \frac{n}{10}$$

$n = 4 \times 10^{-4}$

EXERCISE # S-I

(Raoult's law)

1. At 25°C, the vapour pressure of methyl alcohol is 96.0 torr. What is the mole fraction of CH_3OH in a solution in which the (partial) vapor pressure of CH_3OH is 24.0 torr at 25°C?

LS0001

2. The vapour pressure of ethanol and methanol are 44.0 mm and 88.0 mm Hg respectively. An ideal solution is prepared at the same temperature by mixing 69 g of ethanol with 40 g of methanol. Calculate total vapour pressure of the solution.

LS0002

3. Liquide 'A' and 'B' form an ideal solution. The vapour pressure of solution containing equal moles of both liquids is 80 cm Hg. At the same temperature, the vapour pressure of solution containing 25 mole percent of liquid 'A' is 70 cm Hg. Calculate P_A^0 and P_B^0.

LS0003

4. Liquids 'A" and 'B' form an ideal solution. Calculate the mole-fraction of 'A' in the vapours above the liquid solution containing the liquids 'A' and 'B' in 2 : 3 mole ratio, at equilibrium.

[Given : P_A^0 = 0.4 atm, P_B^0 = 0.8 atm]

LS0004

5. Liquids 'P' and 'Q' form an ideal solution. At equilibrium, the vapours contain 40% molecules of 'P'. Calculate the vapour presure of solution.

[Given : P_P^0 = 0.4 bar, P_Q^0 = 0.6 bar]

LS0005

6. Liquids 'X' and 'Y' form an ideal solution. The vapour pressure of solution may be expressed as : **P[/cmHg] = (80 – 25x)**, where 'x' is the mole-fraction of liquid 'X' in the liquid solution at equilibrium. Calculate the vapour pressures of pure liquids 'X' and 'Y'.

LS0006

7. Liquid 'R' and 'S" form an ideal solution. The mole-fraction of 'R' in liquid and vapour phases at equilibrium are 0.25 and 0.40, respectively. If the vapour pressure of solution is 0.50 bar, calculate P_R^0 and P_S^0

LS0007

Colligative properties

8. The vapour pressure of pure liquid solvent A is 0.80 atm. When a nonvolatile substance B is added to the solvent its vapour pressure drops to 0.60 atm. What is the mole fraction of component B in the solution?

LS0008

9. Calculate the relative lowering in vapour pressure if 100 g of a nonvolatile solute (mol.wt.100) are dissolved in 432 g water.

LS0009

10. The vapour pressure of pure benzene at 30° C is 640 mm of Hg and the vapour pressure of a solution of a solute in C_6H_6 at the same temperature is 624 mm of Hg. Calculate molality of solution.

LS0010

11. The vapour pressure of pure benzene at a certain temperature is 640 mm of Hg. A nonvolatile nonelectrolyte solid weighing 2.175 g is added to 39.0 of benzene. The vapour pressure of the solution is 600 mm of Hg. What is molecular weight of solid substance?

LS0011

12. The vapour pressure of water is 17.54 mm Hg at 293 K. Calculate vapour pressure of 0.5 molal solution of a solute in it.

LS0012

13. When 10.5 g of a nonvolatile substance is dissolved in 742 g of ether, its boiling point is raised 0.25°C. What is the molecular weight of the substance? Molal boiling point constant for ether is 2.12°C·kg/mol.

LS0013

14. Calculate the molal elevation constant, K_b for water and the boiling point of 0.1 molal urea solution. Latent heat of vaporisation of water is 9.72 kcal mol^{-1} at 373.15 K. $[(373.15)^2 = 258 \times 540]$

LS0014

15. Pure benzene freeze at 5.45°C. A solution containing 6.72 g of $C_2H_2Cl_4$ in 120 g of benzene was observed to freeze at 3.75°C. What is the molal freezing point constant of benzene?

LS0015

16. The freezing point of a solution containing 2.40 g of a compound in 60.0 g of benzene is 0.10°C lower than that of pure benzene. What is the molecular weight of the compound? (K_f is 5.12°C/m for benzene)

LS0016

17. Normal boiling point of diethyl ether is 327° and at 190 mmHg boiling points in 27°C. What is the value of $\Delta H^{\circ}_{vap.}$ in kJ/mole.

(Use : R = 8.3 J/K-mole, ln2 = 0.7)

LS0017

18. A 6.84% solution (w/v) of cane-sugar (Mol. weight = 342) is isotonic with 0.8%(w/v) solution of non-volatile solute. Find molecular weight of solute.

LS0018

19. Calculate the osmotic pressure of 12% (w/v) aq. urea solution at 27°C.

LS0019

20. Calculate the osmotic pressure of a solution containing 18 gm glucose and 17.1 gm canesugar ($C_{12}H_{22}O_{11}$) per litre, at 27°C.

LS0020

21. A storage battery contains a solution of H_2SO_4 38% by weight. What will be the Van't Hoff factor if the $\Delta T_{f(experiment)}$ is 22.8K. [Given $K_f = 1.86\ mol^{-1}\ Kg$]

LS0021

22. A certain mass of a substance, when dissolved in 100 g C_6H_6, lowers the freezing point by 1.28°C. The same mass of solute dissolved in 100g water lowers the freezing point by 1.40°C. If the substance has normal molecular weight in benzene and is completely ionized in water, into how many ions does it dissociate in water? K_f for H_2O and C_6H_6 are 1.86 and 5.12K kg mol^{-1}.

LS0022

23. **2.0** g of benzoic acid dissolved in 25.0g of benzene shows a depression in freezing point equal to 1.96K. Molal depression constant (K_f) of benzene is 4.9 K.kg.mol^{-1}. What is the percentage association of the acid?

LS0023

24. **A d**ecimolar solution of potassium ferrocyanide is 50% (w/v) dissociated at 300K. Calculate the osmotic pressure of the solution. $\left(R=8.314\ JK^{-1}\ mol^{-1}\right)$

LS0024

25. **A 1**.2% solution (w/v) of NaCl is isotonic with 7.2% solution (w/v) of glucose. Calculate degree of ionization and Van’t Hoff factor of NaCl.

LS0025

Henry's law

26. **How** many gm O_2 gas will disolve in 100 gm water at 9 bar and 27°C? (K_H = 40 Kbar)

LS0026

27. The Henry law constant for dissolution of a gas in aqueous medium is 3×10^2 atm. At what partial pressure of the gas (in atm), the molality of gas in aqueous solution will be $\frac{5}{9}$m.

LS0027

EXERCISE # S-II

1. At 90°C, the vapour pressure of toluene is 400 torr and that of σ-xylene is 150 torr. What is the composition of the liquid mixture that boils at 90°C, when the pressure is 0.50 atm? What is the composition of vapour produced?

LS0028

2. The vapour pressure of an aqueous solution of glucose is 750 mm Hg at 373 K. Calculate molality and mole fraction of solute.

LS0029

3. Calculate the amount of ice that will separate out of cooling a solution containing 50g of ethylene glycol in 200 g water to –9.3°C. (K_f for water = 1.86 K mol^{-1} kg)

LS0030

4. A solution of crab hemocyanin, a pigmented protein extracted from crabs, was prepared by dissolving 0.750 g in 125 cm^3 of an aqueous medium. At 4°C an osmotic pressure rise of 2.77 mm of the solution was observed. The solution had a density of 1.013 g/cm^3. Determine the molecular weight of the protein. ($g = 10\ m/s^2$), (R = 0.08 l-atm/K-mol)

LS0031

5. The vapour pressure of an aqueous solution is found to be 750 torr at certain temperature 'T'. If 'T' is the temperature at which pure water boils under atmospheric pressure, calculate the atmospheric pressure. The boiling point of solution is 101.04°C. (K_b = 0.52 K kg mol^{-1}).

LS0032

6. How many grams of sucrose (mol.wt. = 342) should be dissolved in 100 gm water in order to produce a solution with 105°C difference between the freezing point & boiling point temperature at 1 atm? **(Unit: K_f = 2 K.kg mol^{-1} ; k_b = 0.5 K.kg mol^{-1})**

LS0033

7. An aqueous solution containing 288 gm of a non-volatile compound having the stoichiometric composition $C_xH_{2x}O_x$ in 90 gm water boils at 101.38°C at 1.00 atmospheric pressure. What is the molecular formula? $K_b(H_2O)$ = 0.52 K mol^{-1} kg

LS0034

8. A complex is represented as $CoCl_3 \cdot xNH_3$. It's 0.1 molal solution in a solution shows ΔT_f = 0.558°C. K_f for H_2O is 1.86 K mol^{-1} kg . Assuming 100% ionisation of complex and coordination no. of Co is six, calculate formula of complex.

LS0035

9. Phenol associates in benzene to a certain extent to form a dimer. A solution containing 18.8×10^{-3} kg phenol in 1 kg of benzene has its freezing point depressed by 0.768 K. Calculate the fraction of phenol that has dimerised. K_f for benzene = 5.12 kg mol^{-1}K.

LS0036

10. The molar volume of liquid benzene (density = 0.877 g ml^{-1}) increases by a factor of 2750 as it vaporizes at 20°C and that of liquid toluene (density = 0.867gml^{-1}) increases by a factor of 7720 at 20°C. A Solution of benzene & toluene has a vapour pressure of 46.0 torr. Find the mole fraction of benzene in the vapour above the solution.

LS0037

11. The cryoscopic constant for acetic acid is 3.6 K kg/mol. A solution of 1 g of a hydrocarbon in 100 g of acetic acid freezes at 16.14°C instead of the usual 16.60°C. The hydrocarbon contains 92.3% carbon. What is the molecular formula?

LS0038

12. Cane sugar underoges the inversion as follow

$$C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6 + C_6H_{12}O_6$$

If solution of 0.025 moles of sugar in 200 gm of water show depresion in freezing point 0.372ºC, then what % sucrose has inverted. ($K_f(H_2O) = 1.86$ K kg mol^{-1})

LS0039

13. When 0.1 M $Pb(NO_3)_2$ solution is titrated with 0.1 M KI solution then what will be the osmotic pressure (in atm) of solution when equivalence point is reached at 300 K .

(Take : R = 0.08 atm L/mol-k)

LS0040

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

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

LS0041

EXERCISE # O-I

Single correct :

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 :

(A) C_6H_6 (B) CH_3OH (C) $C_6H_5NH_2$ (D) $C_6H_5NO_2$

LS0042

2. Mole fraction of A vapours above the solution in mixture of A and B ($X_A = 0.4$) will be

[Given : $P_A^\circ = 100$ mm Hg and $P_B^\circ = 200$ mm Hg]

(A) 0.4 (B) 0.8 (C) 0.25 (D) none of these

LS0043

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

$$P_{Total} = 120 - 75\ X_B$$

hence, vapour pressure of pure A and B respectively (in Torr) are

(A) 120, 75 (B) 120, 195 (C) 120, 45 (D) 75, 45

LS0044

4. Two liquids A & B form an ideal solution. What is the vapour pressure of solution containing 2 moles of A and 3 moles of B at 300 K? [Given : At 300 K, Vapour pr. of pure liquid A (P_A^o) = 100 torr, Vapour pr. of pure liquid B (P_B^o) = 300 torr]

(A) 200 torr (B) 140 torr (C) 180 torr (D) None of these

LS0045

5. If Raoult's law is obeyed, the vapour pressure of the solvent in a solution is directly proportional to

(A) Mole fraction of the solvent (B) Mole fraction of the solute

(C) Mole fraction of the solvent and solute (D) The volume of the solution

LS0046

6. 1 mole of heptane (V. P. = 92 mm of Hg) was mixed with 4 moles of octane (V. P. = 31mm of Hg). The vapour pressure of resulting ideal solution is :

(A) 46.2 mm of Hg (B) 40.0 mm of Hg (C) 43.2 mm of Hg (D) 38.4 mm of Hg

LS0047

7. Mole fraction of A vapours above solution in mixture of A and B ($X_A = 0.4$) will be :-

($P_A^\circ = 100$mm, $P_B^\circ = 200$mm)

(A) 0.4 (B) 0.8 (C) 0.25 (D) None

LS0048

8. The vapour pressure of a pure liquid 'A' is 70 torr at 27^0C. 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 27^0C. The vapour pressure of pure liquid B at 27^0C is

(A) 14 (B) 56 (C) 140 (D) 70

LS0049

9. 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 will boil at 88 °C at 1 atm. pressure, benzene - toluence form an ideal solution:

(A) 0.416 (B) 0.588 (C) 0.688 (D) 0.740

LS0050

10. The exact mathematical expression of Raoult's law is (n = moles of solute ; N = moles of solvent)

(A) $\frac{P^0 - P_s}{P^0} = \frac{n}{N}$ (B) $\frac{P^0 - P_s}{P^0} = \frac{N}{n}$ (C) $\frac{P^0 - P_s}{P_s} = \frac{n}{N}$ (D) $\frac{P^0 - P_s}{P^0} = n \times N$

LS0051

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

(A) 0.2 (B) 0.4 (C) 0.6 (D) 0.8

LS0052

12. The vapour pressure of a solution having solid as solute and liquid as solvent is :

(A) Directly proportional to mole fraction of the solvent

(B) Inversely proportional to mole fraction of the solvent

(C) Directly proportional to mole fraction of the solute

(D) Inversely propartional to mole fraction of the solute

LS0053

13. 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

(A) $\frac{2}{3}$ (B) $\frac{1}{3}$ (C) $\frac{1}{2}$ (D) $\frac{3}{2}$

LS0054

14. The vapour pressure of pure A is 10 torr and at the same temperature when 1 g 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 :

(A) 100 amu (B) 90 amu (C) 75 amu (D) 120 amu

LS0055

15. The vapour pressure of a pure liquid solvent (X) is decreased to 0.60 atm. from 0.80 atm on addition of a non volatile substance (Y). The mole fraction of (Y) in the solution is:-

(A) 0.20 (B) 0.25 (C) 0.5 (D) 0.75

LS0056

16. Among the following, that does not form an ideal solution is :

(A) C_6H_6 and $C_6H_5CH_3$ (B) C_2H_5Cl and C_6H_5OH

(C) C_6H_5Cl and C_6H_5Br (D) C_2H_5Br and C_2H_5I

LS0057

17. Colligative properties of the solution depend upon

(A) Nature of the solution (B) Nature of the solvent

(C) Number of solute particles (D) Number of moles of solvent

LS0058

18. Elevation of boiling point of 1 molar aqueous glucose solution (density = 1.2 g/ml) is

(A) K_b (B) 1.20 K_b (C) 1.02 K_b (D) 0.98 K_b

LS0059

19. When common salt is dissolved in water

(A) Melting point of the solution increases (B) Boiling point of the solution increases

(C) Boiling point of the solution decreases (D) Both Melting point and Boiling point is decreases

LS0060

20. What should be the freezing point of aqueous solution containing 17 gm of C_2H_5OH in 1000 gm of water (water K_f = 1.86 deg – kg mol^{-1})

(A) – 0.69°C (B) – 0.34°C (C) 0.0°C (D) 0.34°C

LS0061

21. If mole fraction of the solvent in solution decreases then :

(A) Vapour pressure of solution increases (B) B. P. decreases

(C) Osmotic pressure increases (D) All are correct

LS0062

22. 5% (w/v) solution of sucrose is isotonic with 1% (w/v) solution of a compound 'A' then the molecular weight of compound 'A' is -

(A) 32.4 (B) 68.4 (C) 121.6 (D) 34.2

LS0063

23. Osmotic pressure of a sugar solution at 24^0C is 2.5 atmosphere. The concentration of the solution in mole per litre is :

(A) 10.25 (B) 1.025 (C) 1025 (D) 0.1025

LS0064

24. A solution containing 4 g of a non volatile organic solute per 100 ml was found to have an osmotic pressure equal to 500 cm of mercury at 27^0C. The molecular weight of solute is :

(A) 14.97 (B) 149.7 (C) 1697 (D) 1.497

LS0065

25. 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 wight of thiocarbamide is :

(A) 152 (B) 76 (C) 60 (D) 180

LS0066

26. Which of the following aqueous solution will show maximum vapour pressure at 300 K?

(A) 1 M NaCl (B) 1 M $CaCl_2$ (C) 1 M $AlCl_3$ (D) 1 M $C_{12}H_{22}O_{11}$

LS0067

27. The correct relationship between the boiling points of very dilute solution of $AlCl_3$ (T_1K) and $CaCl_2$ (T_2K) having the same molar concentration is

(A) $T_1 = T_2$ (B) $T_1 > T_2$ (C) $T_2 > T_1$ (D) $T_2 \leq T_1$

LS0068

28. 1.0 molal aqueous solution of an electrolyte A_2B_3 is 60% ionised. The boiling point of the solution at 1 atm is $(K_{b(H_2O)} = 0.52 \text{ K kg mol}^{-1})$

(A) 274.76 K (B) 377 K (C) 376.4 K (D) 374.76 K

LS0069

29. The freezing point depression of a 0.1 M a solution of weak acid (HX) is –0.20°C.
What is the value of equilibrium constant for the reaction?

$$HX\,(aq) \rightleftharpoons H^+(aq) + X^-(aq)$$

[Given : K_f for water = 1.8 kg mol^{-1} K. & Molality = Molarity]

(A) 1.46×10^{-4} (B) 1.35×10^{-3} (C) 1.21×10^{-2} (D) 1.35×10^{-4}

LS0070

30. The Vant Hoff factor (i) for a dilute solution of $K_3[Fe(CN)_6]$ is (Asuming 100% ionsation) :

(A) 10 (B) 4 (C) 5 (D) 0.25

LS0071

31. The substance A when dissolved in solvent B shows the molecular mass corresponding to A_3. The vant Hoff's factor will be -

(A) 1 (B) 2 (C) 3 (D) 1/3

LS0072

32. The value of observed and calcutated molecular wieght of silver nitrate are 92.64 and 170 respectively. The degree of dissociation of silver nitrate is :

(A) 60% (B) 83.5 % (C) 46.7% (D) 60.23%

LS0073

33. The freezing point of 1 molal NaCl solution assuming NaCl to be 100% dissociated in water is : (K_f = 1.86 K Molality^{-1})

(A) –1.86 °C (B) –3.72 °C (C) +1.86 °C (D) + 3.72 °C

LS0074

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

(A) 0.85°C (B) –3.53°C (C) 0°C (D) –0.35°C

LS0075

35. If a ground water contains H_2S at concentration of 2 mg/l, determine the pressure of H_2S in head space of a closed tank containing the ground water at 20ºC. Given that for H_2S, Henry's constant is equal to 6.8×10^3 bar at 20ºC.

(A) 720 Pa (B) 77×10^2 Pa (C) 553 Pa (D) 55×10^2 Pa

LS0076

36. A pressure cooker reduces cooking time for food because -

(A) The higher pressure inside the cooker crushes the food material

(B) Cooking involves chemical changes helped by a rise in temperature

(C) Heat is more evenly distributed in the cooking space

(D) Boiling point of water involved in cooking is increased

LS0077

EXERCISE # O-II

Single correct :

1. An ideal solution was obtained by mixing (MeOH) methanol and (EtOH) 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 -

(A) 0.635 MeOH, 0.365 EtOH
(B) 0.365 MeOH, 0.635 EtOH
(C) 0.574 MeOH, 0.326 EtOH
(D) 0.173 MeOH, 0.827 EtOH

LS0078

2. Molar volume of liquid A(d = 0.8gm/ml) increase by factor of 2000 when it vapourises at 200K. Vapour pressure of liquid A at 200K is [R = 0.08 L-atm/mol-K]

(Molar mass of A = 80g/mol)

(A) 0.4 atm
(B) 8 atm
(C) 0.8 atm
(D) 0.08 atm

LS0079

3. Assuming each salt to be 90 % dissociated, which of the following will have highest boiling point?

(A) Decimolar $Al_2(SO_4)_3$
(B) Decimolar $BaCl_2$
(C) Decimolar Na_2SO_4
(D) A solution obtained by mixing equal volumes of (B) and (C)

LS0080

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

(A) 4.04×10^{-2}
(B) 8.08×10^{-2}
(C) 2.02×10^{-2}
(D) 4.04×10^{-3}

LS0081

5. 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 :-

(A) 0.200
(B) 0.478
(C) 0.549
(D) 0.786

LS0082

6. For which of the following vant' Hoff's factor is not correctly matched -

	Salt	**Degree of dissociation (α)**	***i***
(A)	Na_2SO_4	50 %	2
(B)	$K_3[Fe(CN)_6]$	75%	3.25
(C)	$[Ag(NH_3)_2]Cl$	80 %	1.8
(D)	$[Cr(NH_3)_5Cl]SO_4$	90 %	2.8

LS0083

7. In the depression of freezing point experiment, it is found that

(I) The vapour pressure of the solution is less than that of pure solvent.

(II) The vapour pressure of the solution is more than that of pure solvent.

(III) Only solute molecules solidify at the freezing point.

(IV) Only solvent molecules solidify at the freezing point.

(A) I, II (B) II, III (C) I, IV (D) I, II, III

LS0084

8. **Statement-1** :Additon of ethylene glycol (non-volatile) to water lowers the freezing point of water hence used as antifreeze.

Statement-2 : Addition of any substance to water lowers its freezings point of water.

(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.

(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.

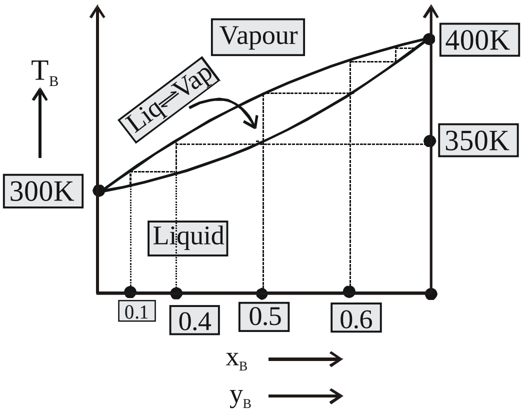
(C) Statement-1 is true, statement-2 is false.

(D) Statement-1 is false, statement-2 is true.

LS0085

More than one may be correct

9. For an ideal solution having two liquid A(P_A^0 and liquid B(P_B^0) boiling point versus composition graph is given below, then select incorrect statement (s) :



(A) B is less volatile than A

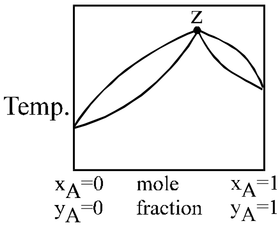
(B) If mole percent of A in liquid phase is 40% then mole percent of A in vapour phase is 50%

(C) If mole percent of B in liquid phase is 10% then mole percent of B in vapour phase is 40%

(D) If the mole percent of A in solution is 50% then its boiling point is 350K

LS0086

10 A liquid mixture having composition corresponding to point z in the figure shown is subjected to distillation at constant pressure.



Which of the following statement is correct about the process

(A) The composition of distillate differs from the mixture

(B) The boiling point goes on changing

(C) The mixture has lowest vapour pressure than for any other composition.

(D) Composition of an azeotrope alters on changing the external pressure.

LS0087

11. Which of the following is correct for a non-ideal solution of liquids A and B, showing negative deviation?

(A) ΔH_{mix} = –ve (B) ΔV_{mix} = –ve

(C) ΔS_{mix} = +ve (D) ΔG_{mix} = –ve

LS0088

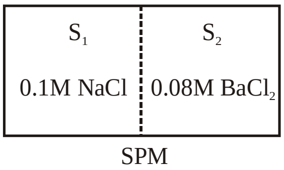
12. Two solutions S_1 and S_2 containing 0.1M NaCl(aq.) and 0.08M $BaCl_2$(aq.) are separated by semipermeable membrane. Which among the following statement(s) is/are correct -

(A) S_1 and S_2 are isotonic

(B) S_1 is hypertonic and S_2 is hypotonic

(C) S_1 is hypotonic and S_2 is hypertonic

(D) Osmosis will take place to from S_1 to S_2



LS0089

13. For an ideal binary liquid solution with $P_A^\circ > P_B^\circ$, which relation between X_A (mole fraction of A in liquid phase) and Y_A(mole fraction of A in vapour phase) is correct?

(A) $Y_A < Y_B$ (B) $X_A > X_B$ (C) $\frac{Y_A}{Y_B} > \frac{X_A}{X_B}$ (D) $\frac{Y_A}{Y_B} < \frac{X_A}{X_B}$

LS0090

14. Which of the following plots represents an ideal binary mixture?

(A) Plot of P_{total} v/s $1/X_B$ is linear (X_B = mole fraction of 'B' in liquid phase).

(B) Plot of P_{total} v/s Y_A is linear (Y_B = mole fraction of 'A' in vapour phase)

(C) Plot of $\frac{1}{P_{total}}$ v/s Y_A is linear

(D) Plot of $\frac{1}{P_{total}}$ v/s Y_B is non linear

LS0091

Paragraph for Q.15 to Q.17

An ideal solution is obtained by mixing a non-volatile solute B with a volatile solvent A (molar mass = 60). If the mass ratio of A : B in solution is 10 : 1 and vapour pressure of pure A is 400 mm and vapour pressure decreases by 4% on forming the above solution at 300K.

15. The mole fraction of solute in the solution is -

(A) 0.96 (B) 0.04 (C) 0.16 (D) 0.84

LS0092

16. The molality the solution is -

(A) 1 (B) $\frac{36}{25}$ (C) $\frac{25}{36}$ (D) $\frac{36}{25}$

LS0092

17. The molar mass of B in the solution is -

(A) 1440 (B) 14400 (C) 4 (D) 144

LS0092

Table type question :

	Column-I		**Column-II**		**Column-III**
(1)	$C_6H_6 + C_6H_5{-}CH_3$	(a)	$DH = 0$	(P)	$DG = -ve$
(2)	$CHCl_3 + CH_3COCH_3$	(b)	$DH = +ve$	(Q)	Form minimum boiling azerotrope
(3)	$CCl_4 + CH_3COCH_3$	(c)	$DH = -ve$	(R)	Form maximum boiling azerotrope
(4)	$C_2H_5OH + H_2O$	(d)	$DS = +ve$	(S)	No azeotrope

18. Select the correct match -

(A) 1 , a, R (B) 2, b, P (C) 3, b, Q (D) 4, d, R

LS0093

19. Select the correct match -

(A) 1 , d, S (B) 3, b, S (C) 2, b, S (D) 4, c, P

LS0093

20. Select the incorrect match -

(A) 1 , d, P (B) 2, c, R (C) 3, d, S (D) 3, b, P

LS0093

Match the column :

21.

	Column–I **(Colligative properties)**		**Column–II** **(Aqueous solution)** **(Assume m = M)**
(A)	$\Delta T_f = 0.3 \times K_f$	(P)	$0.1\ m - Ca(NO_3)_2$
(B)	$\Delta T_b = 0.28 \times K_b$	(Q)	$0.14\ m - NaBr$
(C)	$\pi = 0.19 \times RT$	(R)	$0.1\ m - MgCl_2(\alpha = 0.9)$
(D)	$\frac{P^0 - P}{P^0} = \frac{\left(\frac{\Delta T_f}{K_f}\right)}{\left(\frac{1000}{18}\right) + \left(\frac{\Delta T_f}{K_f}\right)}$	(S)	$0.28\ m$ – Urea
		(T)	$0.1\ m$ – HA (monobasic acid, $K_a = 0.81$)

LS0094

EXERCISE # (J-MAIN)

1. 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) $\alpha = \frac{x+y-1}{i-1}$ (2) $\alpha = \frac{x+y+1}{i-1}$ (3) $\alpha = \frac{i-1}{(x+y-1)}$ (4) $\alpha = \frac{i-1}{x+y+1}$

LS0095

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

LS0096

3. A solution containing 0.85 g of $ZnCl_2$ in 125.0 g of water freezes at –0.23ºC. The apparent degree of dissociation of the salt is : **[JEE (MAIN)-2012 ONLINE]**

(k_f for water = 1.86 K kg mol^{-1}, atomic mass ; Zn = 65.3 and Cl = 35.5)

(1) 1.36% (2) 2.47% (3) 73.5% (4) 7.35%

LS0097

4. Liquids A and B form an ideal solution. At 30ºC, the total vapour pressure of a solution containing 1 mol of A and 2 moles of B is 250 mm Hg. The total vapour pressure becomes 300 mm Hg when 1 more mol of A is added to the first solution. The vapour pressures of pure A and B at the same temperature are :- **[JEE (MAIN)-2012 ONLINE]**

(1) 450, 150 mm Hg (2) 250, 300 mm Hg (3) 125, 150 mm Hg (4) 150, 450 mm Hg

LS0098

5. The freezing point of a 1.00 m aqueous solution of HF is found to be –1.91°C. The freezing point constant of water, K_f, is 1.86 K kg mol^{-1}. The percentage dissociation of HF at this concentration is **[JEE (MAIN)-2012 ONLINE]**

(1) 2.7% (2) 30% (3) 10% (4) 5.2%

LS0099

6. How many grams of methyl alcohol should be added to 10 litre tank of water to prevent its freezing at 268 K ? **[JEE (MAIN)-2013 ONLINE]**

(K_f for water is 1.86 K kg mol^{-1}, Normal freezing point of water = 273.15K)

(1) 899.04 g (2) 886.02 g (3) 868.06 g (4) 880.07 g

LS0100

7. Vapour pressure of pure benzene is 119 torr and that of toluene is 37.0 torr at the same temperature. Mole fraction of toluene in vapour phase which is in equilibrium with a solution of benzene and toluene having a mole fraction of toluene 0.50, will be : **[JEE (MAIN)-2013 ONLINE]**

(1) 0.137 (2) 0.205 (3) 0.237 (4) 0.435

LS0101

8. A molecule M associates in a given solvent according to the equation $M \rightleftharpoons (M)_n$. For a certain concentration of M, the van't Hoff factor was found to be 0.9 and the fraction of associated molecules was 0.2. The value of n is : **[JEE (MAIN)-2013 ONLINE]**

(1) 2 (2) 4 (3) 5 (4) 3

LS0102

9. 12g of a nonvolatile solute dissolved in 108g of water produces the relative lowering of vapour pressure of 0.1. The molecular mass of the solute is : **[JEE (MAIN)-2013 ONLINE]**

(1) 60 (2) 80 (3) 40 (4) 20

LS0103

10. 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) 0.875 M (2) 1.00 M (3) 1.75 M (4) 0.975 M

LS0104

11. The observed osmotic pressure for a 0.10 M solution of $Fe(NH_4)_2(SO_4)_2$ at 25°C is 10.8 atm. The expected and experimental (observed) values of Van't Hoff factor (i) will be respectively :

(R= 0.082 L atm k^{-} mol^{-1}) **[JEE (MAIN)-2014 ONLINE]**

(1)3 and 5.42 (2) 5 and 3.42 (3) 4 and 4.00 (4) 5 and 4.42

LS0105

12. For an ideal Solution of two components A and B, which of the following is true ?

(1) $\Delta H_{mixing} < 0$ (zero) **[JEE(MAIN)-2014 ONLINE]**

(2) A – A, B – B and A – B interactions are identical

(3) A – B interaction is stronger than A – A and B – B interactions

(4) $\Delta H_{mixing} > 0$ (zero)

LS0106

13. Consider separate solution of 0.500 M C_2H_5OH(aq), 0.100 M $Mg_3(PO_4)_2$(aq), 0.250 M KBr(aq) and 0.125 M Na_3PO_4(aq) at 25°C. Which statement is true about these solutions, assuming all salts to be strong electrolytes ? **[JEE (MAIN)-2014]**

(1) 0.125 M Na_3PO_4 (aq) has the highest osmotic pressure.

(2) 0.500 M C_2H_5OH (aq) has the highest osmotic pressure.

(3) They all have the same osmotic pressure.

(4) 0.100 M $Mg_3(PO_4)_2$ (aq) has the highest osmotic pressure.

LS0107

14. Determination of the molar mass of acetic acid in benzene using freezing point depression is affected by : **[JEE (MAIN)-2015 ONLINE]**

(1) association (2) dissociation (3) complex formation (4) partial ionization

LS0108

15. A solution at 20°C is composed of 1.5 mol of benzene and 3.5 mol of toluene. If the vapour pressure of pure benzene and pure toluene at this temperature are 74.7 torr and 22.3 torr, respectively, then the total vapour pressure of the solution and the benzene mole fraction in equilibrium with it will be, respectively : **[JEE (MAIN)-2015 ONLINE]**

(1) 38.0 torr and 0.589 (2) 30.5 torr and 0.389

(3) 35.8 torr and 0.280 (4) 35.0 torr and 0.480

LS0109

16. The vapour pressure of acetone at 20°C is 185 torr. When 1.2 g of non-volatile substance was dissolved in 100 g of acetone at 20°C, its vapour pressure was 183 torr. The molar mass (g mol^{-1}) of the substance is : **[JEE (MAIN)-2015]**

(1) 128 (2) 488 (3) 32 (4) 64

LS0110

17. An aqueous solution of a salt MX_2 at certain temperature has a van't Hoff factor of 2. The degree of dissociation for this solution of the salt is : **[JEE (MAIN--2016-ONLINE]**

(1) 0.50 (2) 0.80 (3) 0.67 (4) 0.33

LS0111

18. The solubility of N_2 in water at 300 K and 500 torr partial pressure is 0.01 g L^{-1}. The solubility (in g L^{-1}) at 750 torr partial pressure is : **[JEE (MAIN--2016-ONLINE]**

(1) 0.02 (2) 0.005 (3) 0.015 (4) 0.0075

LS0112

19. 18 g glucose ($C_6H_{12}O_6$) is added to 178.2g at 100°C water. The vapour pressure of water (in torr) for this aqueous solution is : **[JEE (MAIN)-2016]**

(1) 759.0 (2) 7.6 (3) 76.0 (4) 752.4

LS0113

20. 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 :- **[JEE (MAIN)-2017]**

(K_f for benzene = 5.12 K kg mol^{-1})

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

LS0114

21. 5 g of Na_2SO_4 was dissolved in x g of H_2O. The change in freezing point was found to be 3.82°C. If Na_2SO_4 is 81.5% ionised, the value of x **[JEE (MAIN--2017-ONLINE]**

(K_f for water = 1.86°C kg mol^{-1}) is approximately.

(Molar mass of S = 32 g mol^{-1} and that of Na = 23 g mol^{-1})

(1) 45 g (2) 65 g (3) 15 g (4) 25 g

LS0115

22. A solution is prepared by mixing 8.5 g of CH_2Cl_2 and 11.95 g of $CHCl_3$. If vapour pressure of CH_2Cl_2 and $CHCl_3$ at 298 K are 415 and 200 mmHg respectively, the mole fraction of $CHCl_3$ in vapour form is: (Molar mass of Cl = 35.5 g mol^{-1}) **[JEE (MAIN-2017-ONLINE]**

(1) 0.486 (2) 0.325 (3) 0.162 (4) 0.675

LS0116

23. For 1 molal aqueous solution of the following compounds, which one will show the highest freezing point ? **[JEE (MAIN)-2018]**

(1) $[Co(H_2O)_5Cl]Cl_2.H_2O$ (2) $[Co(H_2O)_4Cl_2]Cl.2H_2O$

(3) $[Co(H_2O)_3Cl_3].3H_2O$ (4) $[Co(H_2O)_6]Cl_3$

LS0117

24. Two 5 molal solutions are prepared by dissolving a non-electrolyte non-volatile solute separately in the solvents X and Y. The molecular weights of the solvents are M_X and M_Y, respectively where $M_X = \frac{3}{4} M_Y$. The relative lowering of vapour pressure of the solution in X is "m" times that of the solution in Y. Given that the number of moles of solute is very small in comparison to that of solvent, the value of "m" is - **[JEE (MAIN-2018-ONLINE]**

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

LS0118

25. The mass of a non-volatile, non-electrolyte solute (molar mass = 50 g mol^{-1}) needed to be dissolved in 114 g octane to reduce its vapour pressure by 75%, is :- **[JEE (MAIN-2018-ONLINE]**

(1) 50 g (2) 37.5 g (3) 75 g (4) 150 g

LS0119

26. Freezing point of a 4% aqueous solution of X is equal to freezing point of 12% aqueous solution of Y. If molecular weight of X is A, then molecular weight of Y is :- **[JEE (MAIN-2019-(JAN.)ONLINE]**

(1) A (2) 3A (3) 4A (4) 2A

LS0120

27. Molecules of benzoic acid (C_6H_5COOH) dimerise in benzene. 'w' g of the acid dissolved in 30 g of benzene shows a depression in freezing point equal to 2K. If the percentage association of the acid to form dimer in the solution is 80, then w is : **[JEE (MAIN-2019-(JAN.)ONLINE]**

(Given that K_f = 5 K kg mol^{-1}, Molar mass of benzoic acid = 122 g mol^{-1})

(1) 1.8 g (2) 2.4 g (3) 1.0 g (4) 1.5 g

LS0121

28 . The freezing point of a diluted milk sample is found to be –0.2°C, while it should have been –0.5°C for pure milk. How much water has been added to pure milk to make the diluted sample ?

(1) 2 cups of water to 3 cups of pure milk **[JEE (MAIN-2019-(JAN.)ONLINE]**

(2) 1 cup of water to 3 cups of pure milk

(3) 3 cups of water to 2 cups of pure milk

(4) 1 cup of water to 2 cups of pure milk

LS0122

29. K_2HgI_4 is 40% ionised in aqueous solution. The value of its van't Hoff factor (i) is :-

(1) 1.8 (2) 2.2 **[JEE (MAIN-2019-(JAN.)ONLINE]**

(3) 2.0 (4) 1.6

LS0123

30. Liquids A and B form an ideal solution in the entire composition range. At 350 K, the vapor pressures of pure A and pure B are 7×10^3 Pa and 12×10^3 Pa, respectively. The composition of the vapor in equilibrium with a solution containing 40 mole percent of A at this temperature is :

(1) $y_A = 0.37; y_B = 0.63$ (2) $y_A = 0.28; y_B = 0.72$

(3) $y_A = 0.76; y_B = 0.24$ (4) $y_A = 0.4; y_B = 0.6$

[JEE (MAIN-2019-(JAN.)ONLINE]

LS0124

31. A solution containing 62 g ethylene glycol in 250 g water is cooled to –10°C. If K_f for water is 1.86 K kg mol^{-1}, the amount of water (in g) separated as ice is : **[JEE (MAIN-2019-(JAN.)ONLINE]**

(1) 32 (2) 48 (3) 16 (4) 64

LS0125

32. Which one of the following statements regarding Henry's law is not correct ?

(1) The value of K_H increases with increase of temperatrue and K_H is function of the nature of the gas **[JEE (MAIN-2019-(JAN.)ONLINE]**

(2) Higher the value of K_H at a given pressure, higher is the solubility of the gas in the liquids.

(3) The partial pressure of the gas in vapour phase is proportional to the mole fraction of the gas in the solution.

(4) Different gases have different K_H (Henry's law constant) values at the same temperature.

LS0126

33. Elevation in the boiling point for 1 molal solution of glucose is 2 K. The depression in the freezing point of 2 molal solutions of glucose in the same solvent is 2 K. The relation between K_b and K_f is:

(1) $K_b = 0.5\ K_f$ (2) $K_b = 2\ K_f$ **[JEE(MAIN-2019-(JAN.)ONLINE]**

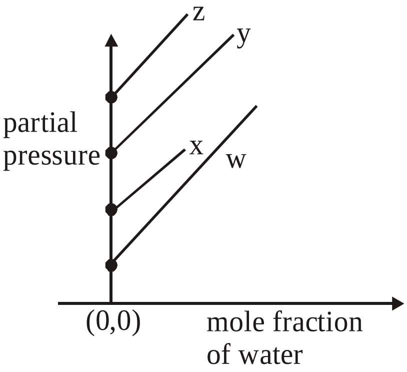
(3) $K_b = 1.5\ K_f$ (4) $K_b = K_f$

LS0127

34. For the solution of the gases w, x, y and z in water at 298K, the Henrys law constants (K_H) are 0.5, 2, 35 and 40 kbar, respectively. The correct plot for the given data is :-

[JEE (MAIN-2019-(APRIL)ONLINE]

(1)



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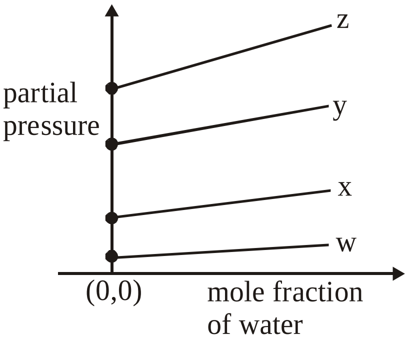

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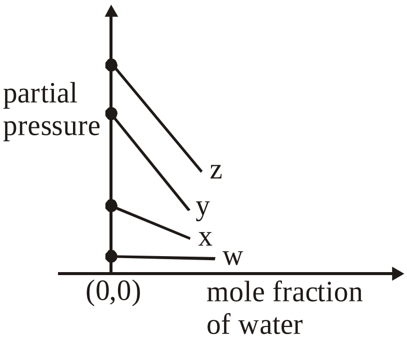

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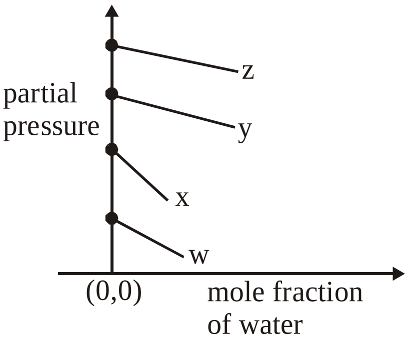


LS0128

35. The vapour pressures of pure liquids A and B are 400 and 600 mmHg, respectively at 298K. On mixing the two liquids, the sum of their initial volumes is equal to the volume of the final mixture. The mole fraction of liquid B is 0.5 in the mixture. The vapour pressure of the final solution, the mole fraction of components A and B in vapour phase, respectively are **[JEE (MAIN-2019-(APRIL)ONLINE]**

(1) 500 mmHg, 0.5, 0.5 (2) 450 mmHg, 0.4, 0.6

(3) 450 mmHg, 0.5, 0.5 (4) 500 mmHg, 0.4, 0.6

LS0129

36. Molal depression constant for a solvent is 4.0 kg mol^{-1}. The depression in the freezing point of the solvent for 0.03 mol kg^{-1} solution of K_2SO_4 is : **[JEE (MAIN-2019-(APRIL)ONLINE]**

(Assume complete dissociation of the electrolyte)

(1) 0.12 K (2) 0.36 K (3) 0.18 K (4) 0.24 K

LS0130

37. The osmotic pressure of a dilute solution of an ionic compound XY in water is four times that of a solution of 0.01 M $BaCl_2$ in water. Assuming complete dissociation of the given ionic compounds in water, the concentration of XY (in mol L^{-1}) in solution is : **[JEE (MAIN-2019-(APRIL)ONLINE]**

(1) 6×10^{-2} (2) 4×10^{-4} (3) 16×10^{-4} (4) 4×10^{-2}

LS0131

38. Liquid 'M' and liquid 'N' form an ideal solution. The vapour pressures of pure liquids 'M' and 'N' are 450 and 700 mmHg, respectively, at the same temperature. Then correct statement is:

(x_M = Mole fraction of 'M' in solution ; **[JEE (MAIN-2019-(APRIL)ONLINE]**

x_N = Mole fraction of 'N' in solution ;

y_M = Mole fraction of 'M' in vapour phase ;

y_N = Mole fraction of 'N' in vapour phase)

(1) $(x_M - y_M) < (x_N - y_N)$ (2) $\frac{x_M}{x_N} < \frac{y_M}{y_N}$

(3) $\frac{x_M}{x_N} > \frac{y_M}{y_N}$ (4) $\frac{x_M}{x_N} = \frac{y_M}{y_N}$

LS0132

39. A solution is prepared by dissolving 0.6 g of urea (molar mass = 60 g mol^{-1}) and 1.8 g of glucose (molar mass = 180 g mol^{-1}) in 100 mL of water at 27ºC. The osmotic pressure of the solution is :

(R = 0.08206 L atm K^{-1} mol^{-1}) **[JEE (MAIN-2019-(APRIL)ONLINE]**

(1) 4.92 atm (2) 1.64 atm (3)2.46 atm (4) 8.2 atm

LS0133

40. At room temperature, a dilute soluton of urea is prepared by dissolving 0.60 g of urea in 360 g of water. If the vapour pressure of pure water at this temperature is 35 mmHg, lowering of vapour pressure will be (molar mass of urea = 60 g mol^{-1}):-

[[JEE (MAIN-2019-(APRIL)ONLINE]

(1) 0.027 mmHg (2) 0.028 mmHg (3) 0.017 mmHg (4) 0.031 mmHg

LS0134

41. 1 g of non-volatile non-electrolyte solute is dissolved in 100g of two different solvents A and B whose ebullioscopic constants are in the ratio of 1 : 5. The ratio of the elevation in their boiling points, $\frac{\Delta T_b(A)}{\Delta T_b(B)}$, is : **[JEE (MAIN-2019-(APRIL)ONLINE]**

(1) 5 : 1 (2) 10 : 1 (3) 1 : 5 (4) 1 : 0.2

LS0135

EXERCISE # (J-ADVANCED)

1. The freezing point (in °C) of a solution containing 0.1 g of $K_3[Fe(CN)_6]$ (Mol. Wt. 329) in 100 g of water ($K_f = 1.86$ K kg mol^{-1}) is - **[JEE 2011]**

(A) -2.3×10^{-2} (B) -5.7×10^{-2} (C) -5.7×10^{-3} (D) -1.2×10^{-2}

LS0136

2. For a dilute solution containing 2.5 g of a non-volatile non-electrolyte solute in 100 g of water, the elevation in boiling point at 1 atm pressure is 2°C. Assuming concentration of solute is much lower than the concentration of solvent, the vapour pressure (mm of Hg) of the solution is

(take K_b=0.76 K kg mol^{-1}) **[JEE 2012]**

(A) 724 (B) 740 (C) 736 (D) 718

LS0137

3. Benzene and naphthalene form an ideal solution at room temperature. For this process, the true statement(s) is(are) **[J-Adv. 2013]**

(A) ΔG is positive (B) ΔS_{system} is positive (C) $\Delta S_{surroundings} = 0$ (D) $\Delta H = 0$

LS0138

4. If the freezing point of a 0.01 molal aqueous solution of a cobalt (III) chloride-ammonia complex (which behaves as a strong eletrolyte) is – 0.0558°C, the number of chloride (s) in the coordination sphere of the complex is- [K_f of water = 1.86 K kg mol^{-1}] **\[JEE-Adv. 2015]**

LS0139

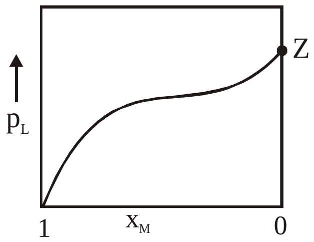
5. Mixture(s) showing positive deviation from Raoult's law at 35°C is (are) **[JEE-Adv. 2016]**

(A) carbon tetrachloride + methanol (B) carbon disulphide + acetone

(C) benzene + toluene (D) phenol + aniline

LS0140

6. For a solution formed by mixing liquids L and M, the vapour pressure of L plotted against the mole fraction of M in solution is shown in the following figure, Here x_L and x_M represent mole fractions of L and M, respectively, in the solution. the correct statement(s) applicable to this system is(are)



(A) Attractive intramolecular interactions between L–L in pure liquid L and M–M in pure liquid M are stronger than those between L–M when mixed in solution **[JEE-Adv. 2017]**

(B) The point Z represents vapour pressure of pure liquid M and Raoult's law is obeyed when $x_L \to 0$

(C) The point Z represents vapour pressure of pure liquid L and Raoult's law is obeyed when $x_L \to 1$

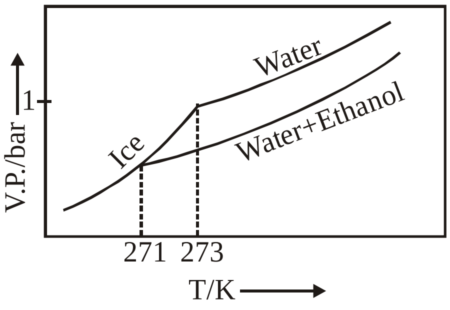
(D) The point Z represents vapour pressure of pure liquid M and Raoult's law is obeyed from $x_L = 0$ to $x_L = 1$

LS0141

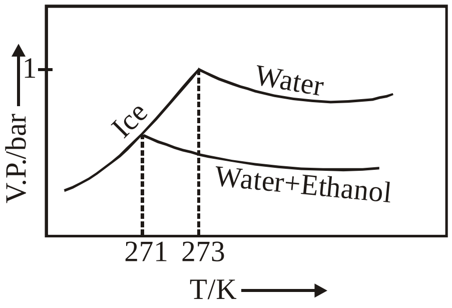
7. Pure water freezes at 273 K and 1 bar. The addition of 34.5 g of ethanol to 500 g of water changes the freezing point of the solution. Use the freezing point depression constant of water as 2 K kg mol^{-1}. The figures shown below represents plots of vapour pressure (V.P.) versus temperature (T). [Molecular weight of ethanol is 46 g mol^{-1}]

Among the following, the option representing change in the freezing point is -**[JEE-Adv. 2017]**

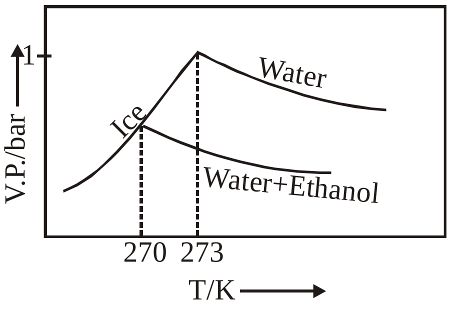
(A)



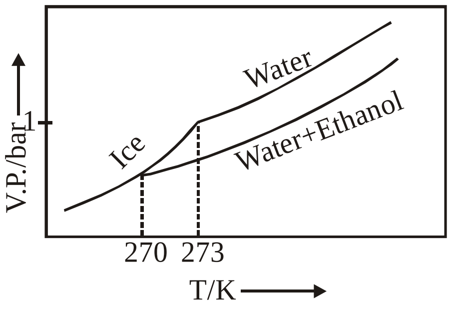
(B)



(C)



(D)



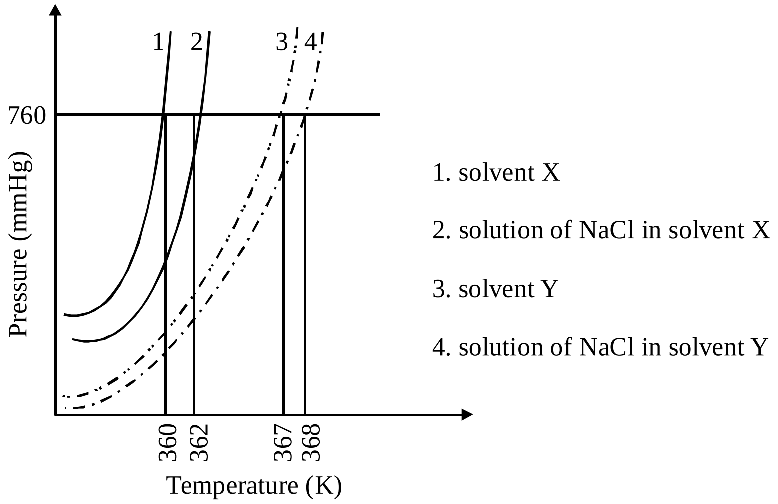
LS0142

8. Liquids A and B form ideal solution over the entire range of composition. At temperature T, equimolar binary solution of liquids A and B has vapour pressure 45 Torr. At the same temperature, a new solution of A and B having mole fractions x_A and x_B, respectively, has vapour pressure of 22.5 Torr. The value of x_A/x_B in the new solution is____. **[JEE-Adv. 2018]**

(Given that the vapour pressure of pure liquid A is 20 Torr at temperature T)

LS0143

9. The plot given below shows P–T curves (where P is the pressure and T is the temperature) for two solvents X and Y and isomolal solutions of NaCl in these solvents. NaCl completely dissociates in both the solvents.



On addition of equal number of moles a non-volatile solute S in equal amount (in kg) of these solvents, the elevation of boiling point of solvent X is three times that of solvent Y. Solute S is known to undergo dimerization in these solvents. If the degree of dimerization is 0.7 in solvent Y, the degree of dimerization in solvent X is ___. **[JEE-Adv. 2018]**

LS0144

10. On dissolving 0.5 g of a non-volatile non-ionic solute to 39 g of benzene, its vapor pressure decreases from 650 mm Hg to 640 mm Hg. The depression of freezing point of benzene (in K) upon addition of the solute is ______ .

(Given data : Molar mass and the molal freezing point depression constant of benzene are 78 g mol^{-1} and 5.12 K kg mol^{-1}, respectively) **[JEE-Adv. 2019]**

LS0145

ANSWER-KEY

EXERCISE # S-I

1. **Ans.0.25**
2. **Ans. 64.0 mm Hg**
3. **Ans.** P_A^0 **= 100 cmHg ,** P_B^0 **= 60 cmHg.**
4. **Ans. 0.25**
5. **Ans. 0.5 bar**
6. **Ans.** P_X^0 **= 55 cmHg ,** P_Y^0 **= 80 cmHg**
7. **Ans.** P_R^0 **= 0.8 bar,** P_S^0 **= 0.4 bar**
8. **Ans.0.25**
9. **Ans.0.04**
10. **Ans.0.32 m**
11. **Ans.65.25**
12. **Ans.17.38 mm Hg**
13. **Ans.120 g/mol**
14. **Ans.**K_b**= 0.516kg mol** K^{-1}**,** T_b **= 373.20 K**
15. **Ans.5.1 K-kg/mol**
16. **Ans.2048 g/mol**
17. **Ans.(6.972)**
18. **Ans.40 g/mol**
19. **Ans. 49.26 atm**
20. **Ans.3.69 atm**
21. **Ans.1.96**
22. **Ans.3 ions**
23. **Ans.78 %**
24. **Ans.** 7.482×10^5 Nm^{-2}
25. **Ans.0.95; 1.95**
26. **Ans. 0.04**
27. **Ans.(3)**

EXERCISE # S-II

1. **Ans.92 mol% toluene; 96.8 mol % toluene**
2. **Ans.0.741 m, 0.0136**
3. **Ans.38.71 g**
4. **Ans.**4.8×10^5 **g/mol**
5. **Ans.(777)**
6. **Ans(68.4)**
7. **Ans.**$C_{40}H_{80}O_{40}$
8. **Ans.**$[Co(NH_3)_5Cl]Cl_2$
9. **Ans.a = 0.50**
10. **Ans.0.73**
11. **Ans.**C_6H_6
12. **Ans (60%)**
13. **Ans.(3.2)**
14. **Ans. (100°C)**

EXERCISE # O-I

1. **Ans.(B)**
2. **Ans.(C)**
3. **Ans.(C)**
4. **Ans.(D)**
5. **Ans.(A)**
6. **Ans.(C)**
7. **Ans.(C)**
8. **Ans.(C)**
9. **Ans.(D)**
10. **Ans.(C)**
11. **Ans.(C)**
12. **Ans.(A)**
13. **Ans.(A)**
14. **Ans.(B)**
15. **Ans.(B)**
16. **Ans.(B)**
17. **Ans.(C)**
18. **Ans.(D)**
19. **Ans.(B)**
20. **Ans.(A)**
21. **Ans.(C)**
22. **Ans.(B)**
23. **Ans.(D)**
24. **Ans.(B)**
25. **Ans.(B)**
26. **Ans.(D)**
27. **Ans.B**
28. **Ans.(D)**
29. **Ans.(B)**
30. **Ans.(B)**
31. **Ans.(D)**
32. **Ans.(B)**
33. **Ans.(B)**
34. **Ans.(B)**
35. **Ans.(A)**
36. **Ans.(D)**

EXERCISE # O-II

1.	**Ans.(B)**	**2.**	**Ans.(D)**	**3.**	**Ans.(A)**	**4.**	**Ans.(A)**
5.	**Ans.(B)**	**6.**	**Ans.(D)**	**7.**	**Ans.(C)**	**8.**	**Ans.(C)**
9.	**Ans.(C)**	**10.**	**Ans.(C, D)**	**11.**	**Ans.(A, B, C, D)**	**12.**	**Ans.(C, D)**
13	**Ans.(C)**	**14.**	**Ans.(C)**	**15.**	**Ans.(B)**	**16.**	**Ans. (C)**
17.	**Ans.(D)**	18.	Ans.(C)	19.	Ans.(A)	20.	Ans.(C)

21. Ans.(A) → P ; (B) → Q, R, S ; (C) → T ; (D) → P, Q, R, S, T

EXERCISE # J-MAIN

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

EXERCISE # J-ADVANCED

1.	**Ans.(A)**	**2.**	**Ans.(A)**	**3.**	**Ans.(B,C,D)**	**4.**	**Ans.(1)**
5.	**Ans.(A,B)**	**6.**	**Ans.(A,C)**	**7.**	**Ans.(D)**	**8.**	**Ans.(19)**
9.	**Ans.(0.05)**	**10.**	**Ans.(1.02 or 1.03)**				