Additional Problems for Self Practice (APSP)

✍ **Marked questions are recommended for Revision.**

This Section is not meant for classroom discussion. It is being given to promote self-study and self testing amongst the Resonance students.

PART - I : PRACTICE TEST-1 (IIT-JEE (MAIN Pattern))

Max. Marks : 120 **Max. Time : 1 Hr.**

Important Instructions :

1. The test is of **1 hour** duration.
2. The Test Booklet consists of **30** questions. The maximum marks are **120.**
3. Each question is allotted **4 (four)** marks for correct response.
4. Candidates will be awarded marks as stated above in Instructions No. 3 for correct response of each question.
¼ **(one fourth)** marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
5. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instructions 4 above.

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1. Mole fraction of $C_3H_5(OH)_3$ 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

2.✍ Colligative properties have many practical uses, some of them may be :
I : Melting of snow by salt
II : Desalination of sea water
III : Determination of molar mass
IV : Determination of melting point and boiling point of solvent
Actual practical uses are :
(1) I, II (2) III, IV (3) I, II, III (4) II, III, IV

3. Select correct statement(s) :
(1) When solid $CaCl_2$ is added to liquid water, the boiling temperature rises
(2) When solid $CaCl_2$ is added to ice at 0°C, the freezing temperature falls
(3) Both (1) and (2)
(4) None of the above

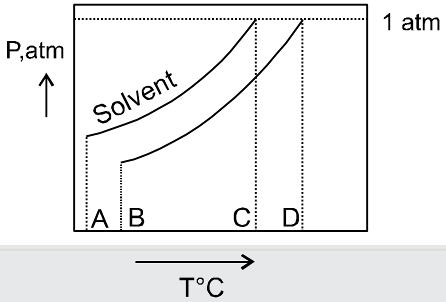
4.✍ If $pK_a = -\log K_a = 4$, and $K_a = Cx^2$ then Van't Hoff factor for weak monobasic acid when C = 0.01 M is :
(1) 1.01 (2) 1.02 (3) 1.10 (4) 1.20

5. Consider following terms (m = molality) :
I : mK_b ; II : mK_bi III : $\frac{\Delta T_b}{i}$ IV : K_b
Terms which can be expressed in degree (temperature) are
(1) III, IV (2) I, II (3) I, II, IIII (4) I, III

6. Elevation in b.p. of an aqueous urea solution is 0.52°. (K_b = 0.52° mol^{-1} kg) Hence, mole-fraction of urea in this solution is :
(1) 0.982 (2) 0.567 (3) 0.943 (4) 0.018

7.✍ Insulin $(C_2H_{10}O_5)_n$ is dissolved in a suitable solvent and the osmotic pressure π of the solution of various concentration (in kg/m^3) is measured at 20ºC. The slope of a plot of π against c is found to be 8.134×10^{-3} (SI units) The molecular weight of the insulin (in kg/mol) is :
(1) 4.8×10^5 (2) 9×10^5 (3) 293×10^3 (4) 8.314×10^5

8.✍ What is the normal boiling point of the solution represented by the phase diagram ?



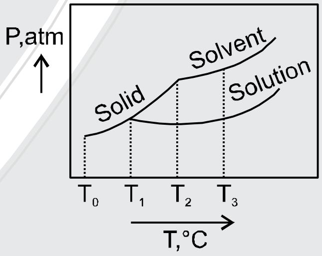
(1) A (2) B (3) C (4) D

9.✍ An aqueous solution of a solute AB has b.p. of 101.08°C (AB is 100% ionised at boiling point of the solution) and freezes at – 1.80°C. Hence, AB (K_b / K_f = 0.3)
(1) is 100% ionised at the f.p. of the solution
(2) behaves as non-electrolyte at the f.p. of the solution
(3) forms dimer
(4) none of the above

10.✍ Density of 1M solution of a non-electrolyte $C_6H_{12}O_6$ is 1.18 g/mL. If K_f (H_2O) is 1.86° mol^{-1} kg, solution freezes at :
(1) – 1.58°C (2) – 1.86°C (3) – 3.16°C (4) 1.86°C

11.✍ Mole fraction of a non-electrolyte in aqueous solution is 0.07. If K_f is 1.86° mol^{-1} kg, depression in f.p., ΔT_f, is:
(1) 0.26° (2) 1.86° (3) 0.13° (4) 7.78°

12.✍ What is the normal freezing point of the solution represented by the phase diagram ?



(1) T_1 (2) T_2 (3) T_3 (4) T_0

13. Total vapour pressure of mixture of 1 mol of volatile component A ($p_A°$ = 100 mmHg) and 3 mol of volatile component B ($p_B°$ = 60 mmHg) is 75 mm. For such case :
(1) there is positive devitation from Raoult's low
(2) boiling point has been lowered
(3) force of attraction between A and B is smaller than that between A and A or between B and B
(4) all the above statements are correct

14.✍ A colligative property of a solution depends on the :
(1) arrangement of atoms in solute molecule (2) total number of molecules of solute and solvent
(3) number of molecules of solute in solution (4) mass of the solute molecules

15. Which has maximum freezing point ?
(1) 6g urea solution in 100 g H_2O (2) 6g acetic acid solution in 100g H_2O
(3) 6g sodium chloride in 100 g H_2O (4) All have equal freezing point

16. Select correct statements :
(1) The fundamental cause of all colligative properties is the higher entropy of the solution relative to that of the pure solvent
(2) The freezing point of hydrofluoride solution is larger than that of equimolal hydrogen chloride solution
(3) 1M glucose solution and 0.5 M NaCl solution are isotonic at a given temperature
(4) All are correct statements

17.✍ The vapour pressure of a pure liquid A is 40 mmHg at 310 K. The vapour pressure of this liquid in a solution with liquid B is 32 mmHg. Mole fraction of A in the solution, if it obeys Raoult's law is :
(1) 0.8 (2) 0.5 (3) 0.2 (4) 0.4

18. Mole fraction of the toluene in the vapour phase which is in equilibrium with a solution of benzene (p° = 120 Torr) and toluene (p° = 80 Torr) having 2.0 mol of each is
(1) 0.50 (2) 0.25 (3) 0.60 (4) 0.40

19. An azeotropic solution of two liquids has a boiling point lower than either of them when it :
(1) shows negative deviation from Raoult's law (2) shows positive deviation from Raoult's low
(3) shows ideal behaviour (4) is saturated

20.✍ Depression of freezing point of 0.01 molal aq. CH_3COOH solution is 0.02046°. 1 molal urea solution freezes at – 1.86°C. Assuming molality equal to molarity, pH of CH_3COOH solution is :
(1) 2 (2) 3 (3) 3.2 (4) 4.2

21. Which of the following azeotropic solutions has the boiling point more than boiling point of the constituents A and B ?
(1) CH_3CH_2OH and CH_3COCH_3 (2) CS_2 and CH_3COCH_3
(3) $CHCl_3$ and CH_3COCH_3 (4) CH_3CHO and CS_2

22.✍ A 0.50 molal solution of ethylene glycol in water is used as coolant in a car. If the freezing point constant of water is 1.86° per molal, at which temperature will the mixture freeze ?
(1) 1.56°C (2) – 0.93°C (3) – 1.86°C (4) 0.93°C

23.✍ The depression of freezing points of 0.05 molal aqueous solution of the following compounds are measured.
1. NaCl 2. K_2SO_4 3. $C_6H_{12}O_6$ 4. $Al_2(SO_4)_3$
Which one of the above compounds will exhibit the maximum depression of freezing point ?
(1) 3 (2) 2 (3) 4 (4) 1

24. On mixing 10 mL of acetone with 40 mL of chloroform , the total volume of the solution is :
(1) < 50 mL (2) > 50 mL (3) = 50 mL (4) Cannot be predicted

25.✍ Select correct statement ?
(1) Heats of vaporisation for a pure solvent and for a solution are similar because similar intermolecular forces between solvent molecules must be overcome in both cases
(2) Entropy change between solution and vapour is smaller than the entropy change between pure solvent and vapour
(3) Boiling point of the solution is larger than that of the pure solvent
(4) All are correct statements

26.✍ What will be the molecular weight of NaCl determined experimentally from elevation in the boiling point or depression in freezing point method ?
(1) < 58.5 (2) > 58.5 (3) = 58.5 (4) None of these

27. Which characterises the weak intermolecular forces of attraction in a liquid ?
(1) High boiling point (2) High vapour pressure
(3) High critical temperature (4) High heat of vaporization

28.✍ On the basis of intermolecular forces predict the correct order of decreasing boiling points of the compounds:
(1) $CH_3OH > H_2 > CH_4$ (2) $CH_3OH > CH_4 > H_2$ (3) $CH_4 > CH_3OH > H_2$ (4) $H_2 > CH_4 > CH_3OH$

29.✍ During depression of freezing point in a solution the following are in equilibrium :
(1) Liquid solvent, solid solvent (2) Liquid solvent, solid solute
(3) Liquid solute, solid solute (4) Liquid solute, solid solvent

30. Which of the following liquid pairs shows a positive deviation from Raoult's law ?
(1) Acetone – chloroform (2) Benzene – methanol
(3) Water – nitric acid (4) Water – hydrochloric acid

Practice Test-1 (IIT-JEE (Main Pattern))

OBJECTIVE RESPONSE SHEET (ORS)

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.										
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.										
Que.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.										

PART - II : NATIONAL STANDARD EXAMINATION IN CHEMISTRY (NSEC) STAGE-I

1. Solutions having the same osmotic pressure are called **[NSEC-2000]**
(A) isotonic solutions (B) molar solutions
(C) hypotonic solutions (D) ideal solutions

2. A colligative property of a solution depends on the **[NSEC-2000]**
(A) arrangement of atoms in solute molecule. (B) total number of molecules of solute and solvent
(C) number of molecules of solute in solution. (D) mass of the solute molecules.

3. Consider 1 M solutions of the following salts. State which solution will have the lowest freezing point. **[NSEC-2000]**
(A) Na_2SO_4 (B) $BaCl_2$ (C) NaCl (D) $Al(NO_3)_3$

4. When 0.6 g of urea dissolved in 100 g of water, the water will boil at (K_b for water = 0.52 kJ. mol^{-1} and normal boiling point of water = 100ºC) : **[NSEC-2001]**
(A) 373.052 K (B) 273.52 K (C) 372.48 K (D) 273.052 K

5. The osmotic pressure of a solution is given by the equation : **[NSEC-2001]**
(A) $p = \frac{CR}{T}$ (B) $\frac{\pi}{C} = RT$ (C) $p = \frac{CT}{R}$ (D) $p = \sqrt{C} . \frac{R}{T}$

6. The relative lowering of vapour pressure is equal to the mole fraction of the solute. This is the statement of: **[NSEC-2001]**
(A) Raoult's law (B) Boyle's law
(C) Osmotic pressure law (D) Graham's law

7. Azeotropes are : **[NSEC-2002]**
(A) liquid mixtures which distil unchanged in composition
(B) liquids which can mix with each other in all proportions
(C) solids which form solid solutions of definite compositions
(D) gases which can be separated.

8. Which gas is mixed with oxygen by sea-divers at the high underwater pressure ? **[NSEC-2002]**
(A) Nitrogen (B) Neon (C) Helium (D) Argon.

9. A 2% solution of glucose has the same elevation in the boiling point as that of a 5% solution of a non-volatile solute. The molar mass of the solute is : **[NSEC-2003]**
(A) 180 (B) 450 (C) 72 (D) 18

10. For water, the maximum number of phases that can be in equilibrium is **[NSEC-2004]**
(A) 1 (B) 2 (C) 3 (D) 4.

11. The boiling point of a glucose solution is higher than that of water because **[NSEC-2004]**
(A) glucose forms extensive hydrogen bonding with water
(B) glucose does not dissociate in water
(C) its vapour pressure is higher than that of water at a given temperature
(D) its vapour pressure is lower than that of water at a given temperature.

12. A 1.0 molal solution with the lowest freezing point is that of : **[NSEC-2004]**
(A) $FeCl_3$ (B) HCl (C) KCl (D) $MgCl_2$.

13. From among the following, the aqueous solution which has the highest freezing point depression is : **[NSEC-2005]**
(A) 0.1 M $Sr(NO_3)_2$ (B) 0.1 M KCl (C) 0.1 M HNO_3 (D) 0.1 M glucose.

14. In chemical industries, the preferred method of purification of liquids is : **[NSEC-2006]**
(A) differential extraction (B) fractional distillation
(C) chromatography (D) leaching.

15. The solubility of a gas in a liquid is driectly proportional to the partial pressure of the gas over the solution. This statement is known as: **[NSEC-2007]**
(A) Raoult's law (B) Henry's law
(C) Boyle's law (D) Charles' and Gay Lussac's Law

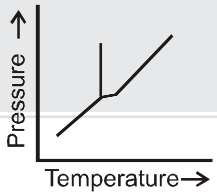
16. Which of the following is not a colligative property ? **[NSEC-2007]**
(A) solubility. (B) vapor pressure lowering.
(C) boiling point elevation. (D) osmotic pressure.

17. Which of the following has the lowest freezing point and the highest boiling point? **[NSEC-2007]**
(A) 1.5 m magnesium phosphate (B) 1.0 m sodium chloride
(C) 1.5 m aluminum nitrate (D) 1.5 m calcium chloride

18. A solution of urea was found to be isotonic with a solution of salt XY of molecular weight 74.6. If 0.15 moles of urea are dissolved in a certain volume V mL of the isotonic solution, the amount of salt in the solution will be : **[NSEC-2008]**
(A) 22.4g (B) 5.6 g (C) 11.2 g (D) 7.46 g

19. The desalination of sea water involves the phenomenon of : **[NSEC-2008]**
(A) Sedimentation (B) Distillation (C) Precipitation (D) Reverse osmosis

20. According to this phase diagram, which phases can exist at pressures lower than the triple point pressure ?



(A) gas only (B) solid and gas only
(C) liquid only (D) solid and liquid only

21. For a dilute solution, Raoult's law states that : **[NSEC-2009]**
(A) the lowering of vapour pressure is equal to the mole fraction of the solute.
(B) the relative lowering of vapour pressure is equal to the mole fraction of the solute
(C) the vapour pressure of solution is equal to the mole fraction of solution.
(D) the relative lowering of vapour pressure is proportional to the amount of solute in the solution.

22. 20 g of Compound X are dissolved in 500 mL of water and the osmotic pressure of the resulting solution is 500mm of Hg of 10°C. The average molecular mass of X is **[NSEC-2010]**
(A) 1115.42 (B) 1150.70 (C) 1412.84 (D) 1163.88

23. A mixture of two liquids which boils without change in composition is called **[NSEC-2010]**
(A) Stable mix ture (B) Binary liquid mixture
(C) Azeotropic mixture (D) Zerotropic mixture

24. The aqueous solution having osmotic pressure nearest to that of an equimolar solution of $K_4[Fe(CN)_6]$ is **[NSEC-2010]**

(A) K_2SO_4 (B) Na_3PO_4 (C) $Al_2(SO_4)_3$ (D) $C_6H_{12}O_6$

25. The elevation in boiling point of a solution containing 13.44 g of $CuCl_2$ in 1 kg of water is (K_b = 0.52 K kg mol^{-1}) **[NSEC-2011]**

(A) 0.05 (B) 0.10 (C) 0.16 (D) 0.21

26. The freezing point of a solution containing 8.1 g of HBr in 100 g of water, assuming the acid to be 90% ionized is [H = 1, Br = 80, K_f for water = 1.86 K kg mol^{-1}] **[NSEC-2011]**

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

27. The inorganic precipitate which acts as a semipermeable membrane is **[NSEC-2012]**

(A) Calcium phosphate (B) Nickel phosphate (C) Plaster of paris (D) Copper ferrocyanide

28. Which of the following observation indicates colligative properties ? **[NSEC-2012]**

I. A 0.5 M NaBr solution has a higher vapour pressure than 0.5 M $BaCl_2$.
II. A 0.5 M NaOH solution freezes at a lower temperature than pure water.
III. Pure water freezes at a higher temperature than pure ethanol.

(A) Only I (B) Only II (C) Only III (D) I and II

29. Osmotic pressure of a 2 % w/v solution of glucose is same as 5% w/v solution of a nonvolatile non-electrolyte solute. The molar mass of the solute is : **[NSEC-2014]**

(A) 180 (B) 450 (C) 72 (D) 45

30. The colligative property used in the determination of molar mass of a polymer is : **[NSEC-2014]**

(A) lowering of the vapour pressure (B) elevation in the boiling point
(C) depression in the freezing point (D) osmotic pressure.

31. The vapor pressure of benzene is 53.3 kPa at 60.3ºC, but it fall to 51.5 kPa when 19 g of a nonvolatile organic compound is dissolved in 500g benzene. The molar mass of the nonvolatile compound is **[NSEC-2015]**

(A) 82 (B) 85 (C) 88 (D) 92

32. The vapor pressure of two pure isomeric liquids X and Y are 200 torr and 100 torr respectively at a given temperature. Assuming a solution of these components to obey Raoult's law, the mole fraction of component X in vapor phase in equilibrium with the solution containing equal amounts of X and Y, at the same temperature, is **[NSEC-2015]**

(A) 0.33 (B) 0.50 (C) 0.66 (D) 0.80

33. In cold climate, the water in a radiator of car gets frozen causing damage to the radiator. Ethylene glycol is used as an antifreezing agent. The amount of ethylene glycol that should be added to 5 kg of water to prevent it from freezing at –7ºC is : **[NSEC-2016]**

(Given : K_f for water = 1.86 K mol^{-1} kg ; Molar mass of ethylene gycol = 62 g mol^{-1})

(A) 1165 g (B) 46.7 g (C) 116.7 g (D) 93.4 g

34. Which of the following is correct ? **[NSEC-2017]**

A liquid with

(A) low vapour pressure will have a low surface tension and high boiling point
(B) high vapour pressure will have high intermolecular forces and high boiling point
(C) low vapour pressure will have high surface tension and high boiling point
(D) low vapour pressure will have low surface tension and low boiling point

35. The mass (g) of NaCl that has to the dissolved to reduce the vapour pressure of 100 g of water by 10% (Molar mass of NaCl = 58.5 g mol^{-1}) is: **[NSEC-2019]**
(A) 36.11 g (B) 17.54 g (C) 81.25 g (D) 3.61 g

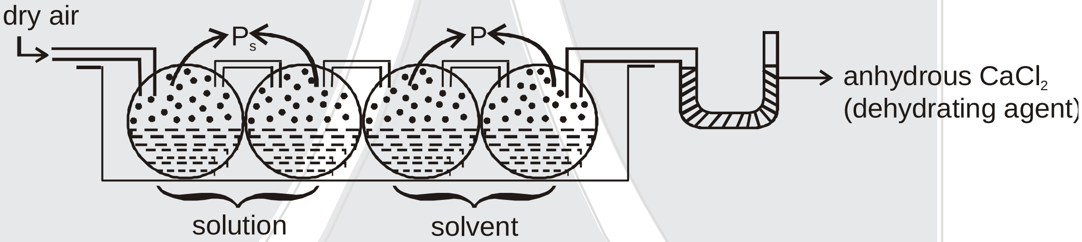
36. About sea water, which of the following statement/s is/are correct? **[NSEC-2019]**
I. Frozen sea water melts at a lower temperature than pure ice
II. Boiling point of sea water increases as it evaporates
III. Sea water boils at a lower temperature than fresh water
IV. Density of sea water at STP is same as that of fresh water
(A) I only (B) I and II (C) I, II and III (D) III only

PART - III : HIGH LEVEL PROBLEM (HLP)

THEORY

Ostwald–Walker Method :

Experimental or lab determination of relative lowering of vapoure pressure i.e. $\frac{\Delta P}{P^0}$ or $\frac{\Delta P}{P_s}$.



(i) Initially note down the weights of the solution set, solvent set containers & of dehydrating agent before start of experiment.

(ii) Note down the same weights after the experiment is complete.

Loss of weight of solution containers ∝ P$_s$.

Loss of in weight of solvent containers ∝ (P^o – P$_s$)

gain in weight of dehydriating agent ∝ P^o.

$$\frac{P^o - P_s}{P^o} = \frac{\text{loss in weight of solvent}}{\text{loss in weight of solution}}$$

$$\frac{P^o - P_s}{P_s} = \frac{\text{loss is weight of solvent}}{\text{gain is weight of dehydrating agent}} = \frac{w}{m} \times \frac{M}{W} = (\text{molality}) \times \frac{M}{1000}$$

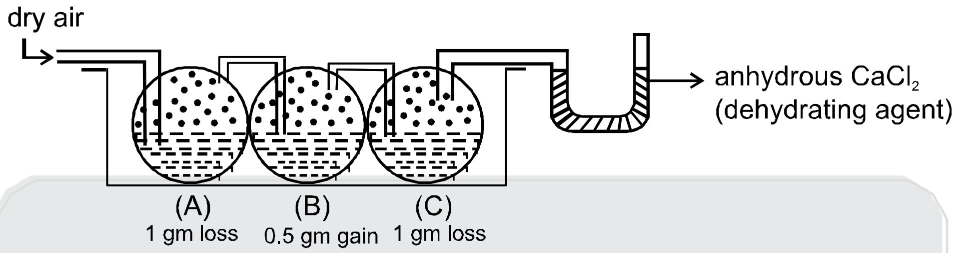
Suppose, dry air was passed through a solution of 5 g of a solute in 80 g of water & then it is passed through pure water. Loss in weight of solution was 2.50 g & loss in weight of pure water was 0.04 g. Then, to find molecular weight of the solute, we have

$$\frac{P^o - P_s}{P_s} = \frac{\text{loss in wt. of solvent}}{\text{loss in wt. of solution}}$$

$$\frac{P^o - P_s}{P_s} = \frac{0.04}{2.50} = \frac{w}{m} \times \frac{M}{W} = \frac{5}{m} \times \frac{18}{80}$$. Thus. m = molecular weight of the solute = 70 g/mol.

Solved Examples

Example-1 :



If same volume solution of different solute is used then what is order of (a) vapour pressure (b) moles of solute (c) molar mass of solute.

Solution : $P_A \propto 1$ g. ; $P_A - P_B \propto 0.5$ g, $P_B \propto 0.5$ g.

$P_C - P_B \propto 1$ g ; $P_C \propto 1.5$ g.

$P_C > P_A > P_B$; $n_C < n_A < n_B$. ; $M_C > M_A > M_B$.

SUBJECTIVE QUESTIONS

1.✍ Dry air was passed through bulbs containing a solution of 40 grams of non-volatile electrolytic solute in 360 grams of water, then through bulbs containing pure water at the same temperature and finally through a tube in which pumice moistened with strong H_2SO_4 was kept. The water bulbs lost 0.0870 grams and the sulphuric acid tube gained 2.175 grams. Calculate the molecular weight of solute.

2.✍ Calculate the freezing point of a solution of a non-volatile solute in a unknown solvent of molar mass 30 g/mole having mole fraction of solvent equal to 0.8. Given that latent heat of fusion of solid solvent = 2.7 kcal mol^{-1}, freezing point of solvent = 27°C and R = 2 cal mol^{-1} k^{-1}.

ONLY ONE OPTION CORRECT TYPE

3.✍ The vapour pressure of two pure liquids A and B, that form an ideal solution are 100 and 900 torr respectively at temperature T. This liquid solution of A and B is composed of 1 mole of A and 1 mole of B. What will be the pressure, when 1 mole of mixture has been vapourized ?
(A) 800 torr (B) 500 torr (C) 300 torr (D) None of these

4.✍ A maxima or minima obtained in the temperature composition curve of a mixture of two liquids indicates
(A) an azeotropic mixture
(B) an eutectic formation
(C) that the liquids are immiscible with one another
(D) that the liquids are partially miscible at the maximum or minimum

5.✍ At a constant temperature, ΔS will be maximum for which of the following processes :
(A) Vaporisation of a pure solvent
(B) Vaporisation of solvent from a solution containing nonvolatile and nonelectrolytic solute in it
(C) Vaporisation of solvent from a solution containing nonvolatile but electrolytic solute in it
(D) Entropy change will be same in all the above cases

6. The freezing point of aqueous solution that contains 3% urea, 7.45% KCl and 9% of glucose is (given K_f of water = 1.86 and asume molarity = molality).
(A) 290 K (B) 285.5 K (C) 267.42 K (D) 250 K

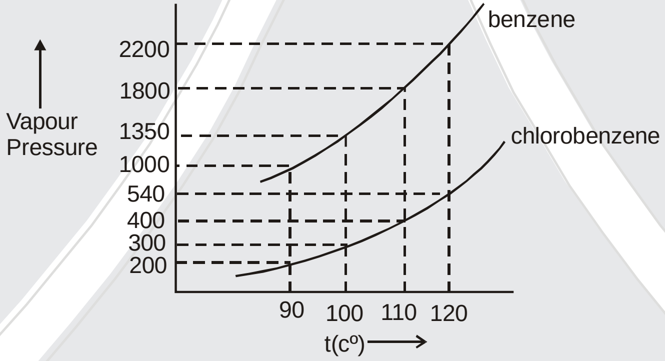
7.✍ Select correct statement :
(A) Osmosis produced by semipermeable membrane.
(B) Desalination of sea-water is done by reverse osmosis
(C) Both are correct statements
(D) None is correct statement

8. Osmotic pressure of a solution of glucose is 1.20 atm and that of a solution of cane sugar is 2.5 atm. The osmotic pressure of the mixture containing equal volumes of the two solutions will be
(A) 2.5 atm (B) 3.7 atm (C) 1.85 atm (D) 1.3 atm.

9. Pressure cooker reduces cooking time because
(A) the heat is more evenly distributed inside the cooker.
(B) a large flame is used.
(C) boiling point of water is elevated.
(D) whole matter is converted into steam.

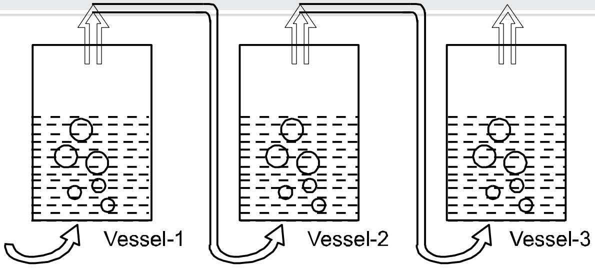
10. Consider two liquids A & B having pure vapour pressures P_A° & P_B° forming an ideal solution. The plot of $\frac{1}{X_A}$ v/s $\frac{1}{Y_A}$ (where X_A and Y_A are the mole fraction of liquid A in liquid and vapour phase respectively) is linear with slope and Y intercepts respectively :
(A) $\frac{P_A^\circ}{P_B^\circ}$ and $\frac{(P_A^\circ - P_B^\circ)}{P_B^\circ}$ (B) $\frac{P_A^\circ}{P_B^\circ}$ and $\frac{(P_B^\circ - P_A^\circ)}{P_B^\circ}$
(C) $\frac{P_B^\circ}{P_A^\circ}$ and $\frac{(P_A^\circ - P_B^\circ)}{P_B^\circ}$ (D) $\frac{P_B^\circ}{P_A^\circ}$ and $\frac{(P_B^\circ - P_A^\circ)}{P_B^\circ}$

11. Assuming the formation of an ideal solution, determine the boiling point of a mixture containing 1560 g benzene (molar mass = 78) and 1125 g chlorobenzene (molar mass = 112.5) using the following against an external pressure of 1000 Torr.



(A) 90ºC (B) 100ºC (C) 110º (D) 120ºC

12. Dry air is slowly passed through three solutions of different concentrations, c_1, c_2 and c_3 ; each containing (non volatile) NaCl as solute and water as solvent, as shown in the Fig. If the vessel 2 gains weight and the vessel 3 loses weight, then



(A) $c_2 > c_3$ (B) $c_1 < c_2$ (C) $c_1 < c_3$ (D) Both (A) and (B)

13. For a solution of 0.849 g of mercurous chloride in 50 g of $HgCl_2(\ell)$ the freezing point depression is 1.24ºC. K_f for $HgCl_2$ is 34.3. What is the state of mercurous chloride in $HgCl_2$? (Hg – 200, Cl – 35.5)
(A) as Hg_2Cl_2 molecules (B) as HgCl molecules
(C) as Hg^+ and Cl^- ions (D) as Hg_2^{2+} and Cl^- ions

14.✍ The vapor pressures of chlorobenzene and water at different temperatures are

t/ºC	90	100	110
Pº(ϕCl)/mm Hg	204	289	402
Pº(H_2O)/mm Hg	526	760	1075

At what temperature will ϕCl steam-distillation under a total pressure of 800 mmHg?
(A) ≈ 95ºC (B) ≈ 92ºC (C) ≈ 94ºC (D) ≈ 89ºC

MATCH THE COLUMN

15.✍ Assuming all the solutes are non volatile and all solutions are ideal and neglect the hydrolysis of cation and anion.

	Column – I		**Column – II**
(A)	10 ml 0.1 M NaOH aqueous solution is added to 10 ml 0.1 M HCl aqueous solution	(p)	Osmotic pressure of solution increases
(B)	10 ml 0.1 M NaOH aqueous solution is added to 10 ml 0.1 M CH_3COOH aqueous solution	(q)	Vapour pressure of solution increases
(C)	10 ml 0.1 M HCl aqueous solution is added to 10 ml 0.1 M NH_3 aqueous solution	(r)	Boiling point of solution increases
(D)	10 ml 0.1 M HCl aqueous solution is added to 10 ml 0.1 M KOH aqueous solution	(s)	Freezing point of solution increases

SINGLE AND DOUBLE VALUE INTEGER TYPE

16.✍ The vapour pressure of fluorobenzene at t°C is given by the equation

$$\log p\ (\text{mm Hg}) = 7.0 - \frac{1250}{t + 220}$$

Calculate the boiling point of the liquid in ºC if the external (applied) pressure is 5.26% more than required for normal boiling point. (log 2 = 0.3)

17.✍ Calculate the concentration of CO_2 in a soft drink that is bottled with a partial pressure of CO_2 of 4 atm over the liquid at 25ºC. The Henry's law constant for CO_2 in water at 25^0C is 3.1×10^{-2} mol/litre–atm. Write answer after multiplying by 100.

18.✍ Two liquids A and B are miscible over the whole range of composition and may be treated as ideal (obeying Raoult's law.) At 350 K the vapour pressure of pure A is 24.0 kPa and of pure B is 12.0 kPa. A mixture of 60% A and 40% B is distilled at this temperature. A small amount of the distillate is collected and and redistilled at 350 K; what is the mole percent of B in the second distillate ?

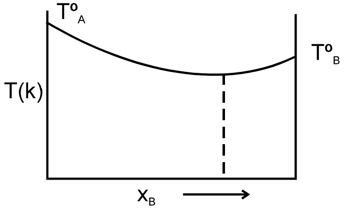
19.✍ Determine i (vant-Hoff factor) for a tribasic acid H_3A. Assuming first dissociation to be 100%, second dissociation 50%, third dissociation 20%. (Round off your answer to nearest integer).

20.✍ Dry air was successively passed through a solution of 5g solute in 80 g water and then through pure water. The loss in weight of solution was 2.5 g and that of pure water was 0.04 g. What is mol. wt of solute ?

ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

21.✍ Which of the following is/are correct for an ideal binary solution of two volatile liquids (eg. benzene & toluene) ?
(A) Its vapor is always richer in the more volatile component (compared to the liquid).
(B) The liquid will gradually become richer in the less volatile component if such a mixture is boiled (distilled).
(C) The P_T (ie. the total pressure) above the solution will be the sum of the vapor pressures of the two pure components.
(D) The boiling point of the solution will be less than the boiling points of the two components.

22. The diagram given below represents boiling point composition diagram of solution of components A and B, which is/are incorrect among the following?



(A) The solution shows negative deviation
(B) A-B-interactions are stronger than A-A and B-B
(C) The solution is ideal solution
(D) The solution shows positive deviation.

23. For a dilute solution having molality m of a given solute in a solvent of mol.wt. M, b.pt. T_b and heat of vaporisation per mole ΔH; $\left[\frac{\partial \quad T_b}{\partial \quad m}\right]_{m\to 0}$ is equal to :

(A) Molal elevation constant of solvent

(B) $\frac{RT_b^2 \quad M}{\Delta_{vap} \quad H}$; where M in kg Δ_{vap} H and R in J mol^{-1}

(C) $\frac{RT_b^2 \quad M}{\Delta_{vap} \quad S}$; where M in kg ; Δ_{vap}S and R in J mol^{-1}

(D) $\frac{RT_b^2 \quad M}{1000 \quad \Delta_{vap} \quad H}$; where M in g ; R and Δ_{vap}H expressed in same unit of heat.

PART - IV : PRACTICE TEST-2 (IIT-JEE (ADVANCED Pattern))

Max. Time : 1 Hr. **Max. Marks : 66**

Important Instructions

A. General :

1. The test is of 1 hour duration.
2. The Test Booklet consists of 22 questions. The maximum marks are 66.

B. Question Paper Format :

3. Each part consists of five sections.
4. Section 1 contains 7 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE is correct.
5. Section 2 contains 5 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE OR MORE THAN ONE are correct.
6. Section 3 contains 6 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9 (both inclusive).
7. Section 4 contains 1 paragraphs each describing theory, experiment and data etc. 3 questions relate to paragraph. Each question pertaining to a partcular passage should have only one correct answer among the four given choices (A), (B), (C) and (D).
8. Section 5 contains 1 multiple choice questions. Question has two lists (list-1 : P, Q, R and S; List-2 : 1, 2, 3 and 4). The options for the correct match are provided as (A), (B), (C) and (D) out of which ONLY ONE is correct.

C. Marking Scheme :

9. For each question in Section 1, 4 and 5 you will be awarded 3 marks if you darken the bubble corresponding to the correct answer and zero mark if no bubble is darkened. In all other cases, minus one (– 1) mark will be awarded.
10. For each question in Section 2, you will be awarded 3 marks. If you darken all the bubble(s) corresponding to the correct answer(s) and zero mark. If no bubbles are darkened. No negative marks will be answered for incorrect answer in this section.
11. For each question in Section 3, you will be awarded 3 marks if you darken only the bubble corresponding to the correct answer and zero mark if no bubble is darkened. No negative marks will be awarded for incorrect answer in this section.

SECTION-1 : (Only One option correct Type)

This section contains 7 multiple choice questions. Each questions has four choices (A), (B), (C) and (D) out of which Only ONE option is correct.

1. Assuming each salt to be 90% dissociated which of the following will have highest osmotic pressure ?

(A) Decimolar $Al_2(SO_4)_3$ (B) Decimolar $BaCl_2$

(C) Decimolar Na_2SO_4

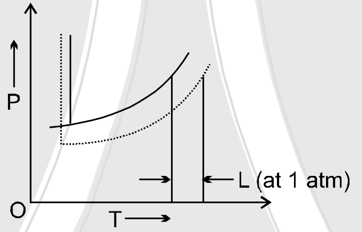
(D) A solution obtained by mixing equal volumes of (A), (B) and (C) and filtering.

2.✍ The melting points of most of the solid substances increases with an increase of pressure acting on them. However, ice melts at a temperature lower than its usual melting point , when the pressure increases. This is because :

(A) Ice is less dense than water (B) Pressure generates heat

(C) The bonds break under pressure (D) Ice is not a true solid

3. The phase diagrams for the pure solvent (solid lines) and the solution (non-volatile solute, dashed line) are recorded below : The quantity indicated by L in the figure is :



(A) Δp (B) ΔT_f (C) K_bm (D) K_fm

4.✍ Available are 1L of 0.1 M NaCl and 2L of 0.2 M $CaCl_2$ solutions. Using **only these two solutions** what maximum volume of a solution can be prepared having $[Cl^-] = 0.34$ M exactly. Both electrolytes are strong

(A) 2.5 L (B) 2.4 L (C) 2.3 L (D) None of these

5. A teacher one day pointed out to his students the peculiar fact that water is unique liquid which freezes exactly at 0^0 C and boils exactly at 100^0 C. He asked the students to find the correct statement based on this fact :

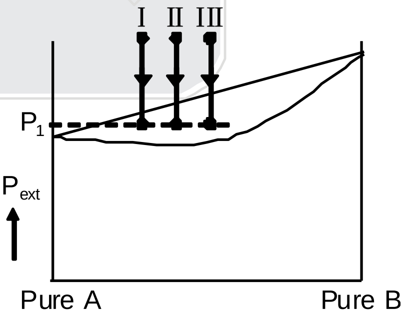
(A) Water dissolves anything however sparingly the dissolution may be

(B) Water is a polar molecule

(C) Boiling and freezing temperatures of water were used to define a temperature scale

(D) Liquid water is denser than ice

6.✍ Three different ideal solutions (I, II, III) each containing total 10 moles of A & B in different composition are taken as shown in figure and pressure over the solutions is gradually reduced.



Initially external pressure is same for all three solutions. At a particular external pressure (P_1), II solution is found to have

$X_A = 0.4$ & $Y_A = 0.8$

(liq composition) (Vap. composition)

Then select correct statement :

(A) At the same external pressure, for solution I, $X_A < 0.4$, $Y_A < 0.8$.

(B) At the same external pressure, for solution III, $X_A > 0.4$, $Y_A > 0.8$.

(C) For all three solutions at same external pressure (P_1) liquid & vapour composition will be same

(D) None of these.

7.✍ For an ideal binary solution with P^o_A / P^o_B which relation between X_A (mole fraction of A in liquid phase) and Y_A (mole fraction of A in vapour phase) is correct , X_B and Y_B are mole fraction of B in liquid and vapour phase respectively : (Given : $P^o_A > P^o_B$)

(A) $X_A = Y_A$ (B) $X_A > Y_A$

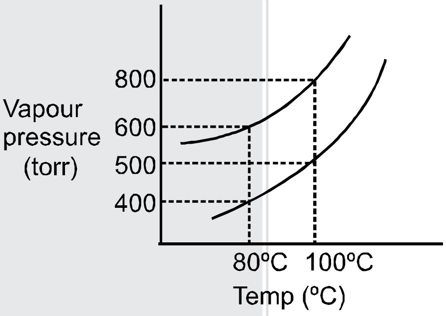
(C) $\frac{X_A}{X_B} < \frac{Y_A}{Y_B}$ (D) X_A, Y_A, X_B and Y_B cannot be correlated

Section-2 : (One or More than one options correct Type)

This section contains 5 multiple choice questions. Each questions has four choices (A), (B), (C) and (D) out of which ONE or MORE THAN ONE are correct.

8.✍ For K_H, Henry's constant, which are correct ?
(A) K_H is characteristic constant for a given gas–solvent system.
(B) Higher is the value of K_H, lower is solubility of gas for a given partial pressure of gas.
(C) K_H has temperature dependence.
(D) K_H increases with temperature.

9.✍ The vapour pressure of ideal solution of benzene and toluene is 550 torr at 80ºC then what would be correct statement about same solution at 100ºC.



(A) Vapour pressure of solution = 725 torr.
(B) at 725 torr pressure at 90ºC, no vapour form
(C) Composition of vapour is $\frac{2}{11}$ and $\frac{9}{11}$
(D) Composition of liquid remain same at equilibrium condition at any temp.

10. Select incorrect statement :
(A) Na^+ and K^+ ions are responsible for maintaining isotonic property inside and outside of the cell of organism.
(B) Aquatic species are more comfortable in lakes present at sea level in comparison to lakes present at high altitude.
(C) Solubility of N_2 decreases, in presence of He when oxygen cylinder is utilised by Scuba divers.
(D) The K_H value of CO_2 is higher than K_H of N_2.

11.✍ Following is false when in a volatile solvent A and a non volatile solute B is mixed (where symbols have their usual meaning) :
(A) $\frac{P_A^0 - P_B^0}{P_A} = \frac{n_B}{n_A}$ (B) $\frac{P_A^0 - P_B^0}{P_A} = \frac{n_B}{n_A + n_B}$ (C) $P_A^0 = \frac{P_A}{1 - X_B}$ (D) $\frac{P_A^0 - P_A}{P_A} = \frac{n_B}{n_A}$

12. 0.2 moles of A and 0.3 moles of B are taken in separate beakers and enclosed in chamber I. Another 0.2 moles of A and 0.3 moles of B are mixed in a beaker and enclosed in chamber II. At equilibrium. Which of the following are not true. (A and B are volatile liquids and they form ideal solution on mixing)
(A) The vapour pressure in chamber I is greater than vapour pressure in chamber II.
(B) The vapour pressure in chamber I is less than vapour pressure in chamber II.
(C) The vapour pressure in both chambers are equal.
(D) The vapour pressure in chamber II can not be determined.

Section-3 : (One Integer Value Correct Type.)

This section contains 6 questions. Each question, when worked out will result in one integer from 0 to 9 (both inclusive)

13. A very small amount of a non-volatile solute (non-associative, non-dissociative) is dissolved in 100 cm^3 of a solvent. At room temperature, vapour pressure of this solution is 98.7 mm of Hg while that of pure solvent is 100 mm of Hg. If the freezing temperature of this solution is 0.72 K lower than that of pure solvent, what is the value of cryoscopic constant of solvent (in K Kg/mol) ? Round off your answer to the nearest whole number. Report your answer as 0 (zero) if you find data insufficient.
Given : Molar mass of solvent = 78 g/mol.

14. At 10ºC the osmotic pressure of urea solution is 500 mm. The solution is diluted and the temperature is raised to 25ºC, when the osmotic pressure is found to be 105.3 mm. Determine extent of dilution.

15.✍ In aqueous solution of 1×10^{-3} molal $K_x[Fe(CN)_6]$ depression in freezing point is 7.2×10^{-3} K. Determine sum of primary and secondary valency of complex (K_f of H_2O = 1.8 K Kg/mole). (Assume that % ionisation of complex is 100%)

16.✍ Calculate molarity of final solution obtained by mixing I and II HNO_3 solution.

	I	II
$\% \frac{w}{w}$	12.6	6.3
d (in g/mL)	1.5	1
Volume (in L)	5	5

17.✍ 8×10^{-x} moles of gas A is dissolved in 36 mL of water when pressure of gaseous mixture above water is 4 atm. Mole percentage of gas A in mixture is 25. Henry constant for gas A in water is 2.5×10^3 atm. Find x.

18.✍ A solution containing 0.1 g of a non volatile organic substance P(Molecular mass 100) in 100 g of benzene raises the boiling point of benzene by 0.2ºC while a solution containing 0.1 g of another non volatile substance Q in same amount of benzene raises the boiling point of benzene by 0.4ºC. If ratio of molecular masses of P and Q is $\frac{x}{y}$ then. Find minimum value of x + y.

SECTION-4 : Comprehension Type (Only One options correct)

This section contains 1 paragraphs, each describing theory, experiments, data etc. 3 questions relate to the paragraph. Each question has only one correct answer among the four given options (A), (B), (C) and (D)

Paragraph for Questions 19 to 21

A solution is made by mixing 1 mole benzene (P_B° = 100 mm Hg) & 1 mole toluene (P_T° = 40 mm Hg).Suppose, initially the pressure over the solution is very high so that no vapour exist above the liquid. As we gradually decrease the pressure, a point (bubble point) comes when we aross the bubble point curve & first bubble of vapour starts forming (hence called bubble point curve). Now we have entered the vapour-liquid equilibrium region. On further decreasing the pressure, a point (dew point) comes when we cross the dew point curve then almost all the liquid has evaporated into vapour i.e. only the last drop of liquid (dew) remains. Beyond this point no liquid exist in the system. Then answer the following questions :

19.✍ If the pressure over the mixture at 300 K is reduced, at what pressure does the first bubble form :
(A) 140 mm Hg (B) 90 mm Hg (C) 65 mm Hg (D) 70 mm Hg

20.✍ What is the composition of first bubble formed ?
(A) $Y_A = 2/7, Y_B = 5/7$ (B) $Y_A = 3/7, Y_B = 4/7$
(C) $Y_A = 1/7, Y_B = 6/7$ (D) none of these

21.✍ What will be the pressure when 1 mole of mixture has been vapourised ?
(A) 70 mm Hg (B) 63.25 mm Hg (C) 100 mm Hg (D) 40 mm Hg

SECTION-5 : Matching List Type (Only One options correct)

This section contains 1 questions, each having two matching lists. Choices for the correct combination of elements from List-I and List-II are given as options (A), (B), (C) and (D) out of which one is correct

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22. Match each List-I with an appropriate pair of characteristics from List-II and select the correct answer using the code given below the lists.
0.1 mol of each solute in the list-I are dissolved in 10 mole water separately.

	List-I		**List-II**
P.	$AlCl_3$ if $\alpha = 0.8$	1.	$i = 3.4$
Q.	$BaCl_2$ if $\alpha = 0.9$	2.	has minimum osmotic pressure among the given solutions.
R.	Na_3PO_4 if $\alpha = 0.9$	3.	has minimum freezing point among the given solutions.
S.	$K_4[Fe(CN)_6]$ if $\alpha = 0.7$	4.	has RLVP = 37/1037.

Code :

	P	Q	R	S		P	Q	R	S
(A)	4	2	3	1	(B)	1	2	4	3
(C)	2	1	3	4	(D)	1	2	3	4

Practice Test-2 ((IIT-JEE (ADVANCED Pattern))

OBJECTIVE RESPONSE SHEET (ORS)

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.										
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.										
Que.	**21**	**22**								
Ans.										

APSP Answers

PART - I

1.	(3)	**2.**	(3)	**3.**	(3)	**4.**	(3)	**5.**	(3)
6.	(4)	**7.**	(3)	**8.**	(4)	**9.**	(2)	**10.**	(2)
11.	(4)	**12.**	(1)	**13.**	(4)	**14.**	(3)	**15.**	(1)
16.	(4)	**17.**	(1)	**18.**	(4)	**19.**	(2)	**20.**	(2)
21.	(3)	**22.**	(2)	**23.**	(3)	**24.**	(1)	**25.**	(4)
26.	(1)	**27.**	(2)	**28.**	(2)	**29.**	(1)	**30.**	(2)

PART - II

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

PART - III

1.	M = 48	**2.**	10.33°C	**3.**	(C)	**4.**	(A)	**5.**	(A)
6.	(C)	**7.**	(C)	**8.**	(C)	**9.**	(C)	**10.**	(B)
11.	(B)	**12.**	(D)	**13.**	(A)	**14.**	(B)		
15.	(A) – q, s; (B) – q, s; (C) – q, s; (D) – q, s					**16.**	85		
17.	12 mol/litre.	**18.**	14	**19.**	3	**20.**	70	**21.**	(AB)
22.	(ABC)	**23.**	(ABD)						

PART - IV

1.	(A)	**2.**	(A)	**3.**	(C)	**4.**	(A)	**5.**	(C)
6.	(C)	**7.**	(C)	**8.**	(ABCD)	**9.**	(AB)	**10.**	(CD)
11.	(AB)	**12.**	(ABD)	**13.**	4	**14.**	5	**15.**	9
16.	2	**17.**	4	**18.**	$\frac{x}{y} = \frac{2}{1}$ Hence $x + y = 3$				**19.**	(D)
20.	(A)	**21.**	(B)	**22.**	(B)					

APSP Solutions

PART - I

1. Mole of $H_2O = \frac{36}{18} = 2$; Mole of glycerine = $\frac{46}{92} = 0.5$

total mole = 2 + 0.5 = 2.5 ; Mole fractions of glycerine = $\frac{n_1}{n_1 + n_2} = \frac{0.5}{2.5}$ $X_0 = 0.2$ Ans.

2. I. Melting of snow by salt : Depression in freezing point
II. Desalination of sea water : Reverse osmosis
III. Osmosis is used to determine the molar mass.

3. When non volatile solute added to solvent. Due to elevation in boiling point $\uparrow$ boiling pointand due to dispression in freezing point, freezing temperature $\downarrow$

4. $HA \rightleftharpoons H^+ + A^-$
$i = [1 + (y - 1) x] = 1 + x$
$pK_a = 4 = -\log K_a$
$\therefore$ $K_a = 10^{-4} = Cx^2$
$1 \times 10^{-4} = 0.01 \times x^2 \Rightarrow x = 0.1 \quad \therefore \quad i = 1 + x = 1.1$

5. As $\Delta T_b = i K_b m$
so $iK_b\ m$ can be expressed in degree (Unit of temperature)
and $K_b\ m$ can be expressed in degree (Unit of temperature)
and $\frac{\Delta T_b}{i}$ can be expressed in degree (Unit of temperature)
But unit of K_b is mol^{-1} kg K

6. As ΔT_b = molality × K_b
0.52 = m × 0.52
molality = 1 mol kg^{-1}
$\therefore$ urea = 1 mol
moles of water = $\frac{1000}{18}$ = 55.55 ; mole fraction of urea = $\frac{1}{1 + 55.55}$ = **0.018**

7. $\pi = CRT$

$\pi = \frac{c}{M}RT$ C = moles/liter, c = kg/m^3

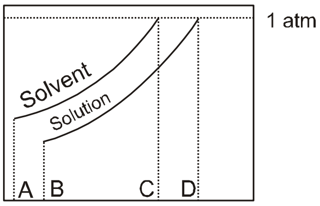
$\frac{\pi}{c} = \frac{RT}{M}$

$M = \frac{RT}{\pi / c}$ $[\pi/c = 8.314 \times 10^{-3}]$

[T = 293 k]

$M = \frac{8.314 \times 293}{8.314 \times 10^{-3}} = 293 \times 10^3$

8.



Normal boiling point of the solution is that temperature at which vapour pressure of solution equals to 1 atm.

9. Given ΔT_b = 1.08ºC, i = 2 at boiling pt. of solution.

and ΔT_f = 1.80ºC, and $\frac{k_b}{k_f} = 0.3$ so $\frac{\Delta T_b}{\Delta T_f} = \frac{i_b k_b m}{i_f k_f m}$ so $i_f = 1$

i.e., AB behaves as non–electrolyte at the f.p of the solution.

10. 1M $C_6H_{12}O_6$ (molar mass = 180 g mol^{-1})

1000 mL solution has = 180 g solute

1180 g solution has = 180 g solute

1000 g solvent has = 180 g solute

Thus, molality = 1 molal

$\therefore$ $\Delta T_f = K_f$ molality = 1.86 × 1 = 1.86º $\therefore$ F.P. = – 1.86ºC

11. Firstly we have to convert mole fraction into molality.

$$\text{Molality} = \frac{x_{solute}}{x_{solvent}\ \ M_{solvent}/1000} = \frac{0.07 \times 1000}{0.93 \times 18} = 4.18$$

Now, $\Delta T_f = k_f m$ = 1.86 × 4.18 = 7.78º.

12. From given graph, we can say T_1 is that temp at which solid state and liquid (solution) are in equilibrium.

13. $P = P_A°X_A + P_B°X_B$

$$\frac{100}{4} + \frac{60 \quad \times \quad 3}{4} = 70 \text{ mm} < 75 \text{ mm (experimental)}$$

Thus, there is positive deviation (1) is true, mixture is more volatile due to decrease in b.p. Thus, (2) is true also force of attraction is decreased thus (3) is true.

14. Colligative property of a solution depends on no. of particles of solute in solution.

15. Value of van't Hoff factor is least for urea solution, so there will be least depression in freezing point i.e., maximum freezing point.

16. In HF hydrogen bonding is present so there is association of molecules due to this van't hoff factor is less, so depression in f.p decreases therefore f.p. value is larger than HCl. Similarly value of i = 2 for NaCl and i = 1 for Glucose.

17. $p_A = X_A\, p^o_A$; 32 = X_A 40 $\therefore$ $X_A = \frac{32}{40}$ = 0.8.

18. $P_T = X_A\, p^o_A + X_B\, p^o_B = \left(\frac{2}{4}\right) \times 80 + \left(\frac{2}{4}\right) \times 120 = 100$ Torr

Now mole fraction in vapour phase = $\frac{X_A P^0_A}{P_T} = \frac{40}{100} = 0.4$.

19. Boiling point get lowered when vapour pr. increases and it happens when there is a positive deviation from Raoult's law.

20. For urea, $\Delta T_f = k_f \times m$ or $k_f = \frac{\Delta T_f}{m} = \frac{1.86}{1} = 1.86$

Now for CH_3COOH

$\Delta T_f = i\, k_f\, m$

so $i = \ = 1.1$ Now $i = 1 + \alpha$ so $\alpha = 1.1 - 1 = 0.1$

Now $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$

$C \quad 0 \quad 0$

$C - C\alpha \quad C\alpha \quad C\alpha$

$[H^+] = C\alpha = 0.01 \times 0.1 = 0.001$ so $pH = 3$.

21. Mixtures of $CHCl_3$ and CH_3COCH_3 shows negative deviation from Raoult's law, so vapour pressure decreases and boiling point increases.

22. $\Delta T_f = k_f\, m.$; $\Delta T_f = 1.86 \times 0.5 = 0.93.$ so $T_f = -0.93^0C.$

23. More the value of van't hoff factor, more will be the depression in freezing point.

24. Acetone and chloroform forms hydrogen bonding so volume decreases.

25. All are facts.
We should remember that, Entropy of solution is more than entropy of pure solvent. So the difference in entropy change will be less in case of solution.

26. $M_{observed} = \frac{58.5}{i}$; $i > 1.$

27. Due to weak force of attraction more vapour will be forrmed so vapour pressure will be high.

28. The order of force attraction and boiling point is $CH_3OH > CH_4 > H_2$.

29. At freezing point liquid solvent and solid solvent are in equilibrium.

30. There is very weak attraction between benzene and methanol as compare to attraction between molecules of methanol.

PART - III

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1. $$\frac{P - P_S}{P} = \frac{0.087}{2.175} = \frac{\frac{40}{M}}{\frac{40}{M} + \frac{360}{18}} \Rightarrow \frac{2.175}{0.087} = 1 + \frac{360}{18} \times \frac{M}{40} \Rightarrow 25 = 1 + \frac{M}{2}$$ **Ans.** $M = 48$

2. $\because$ $K_f = \frac{MRT_f^2}{1000\ \ \Delta H_f} = \frac{2 \times 300 \times 300 \times 30}{1000 \times\ \ 2700} = 2.00\ K\ kg\ mol^{-1}$

$\because$ mole fraction of water = 0.8 $\therefore$ mole fraction of solute = 0.2

or $0.2 = \frac{n}{n + N}$ and $0.8 = \frac{N}{n + N}$

$\therefore$ $\frac{n}{N} = \frac{0.2}{0.8} = \frac{1}{4} = \frac{wM}{mW}$

or $\frac{1}{4} = \frac{w \times 30}{mW}$ ∴ $\frac{w}{mW} = \frac{1}{4 \times 30}$

∴ $\Delta T_f = \frac{1000 \times w \times K_f}{m \times W} = \frac{1000 \times 2.0}{4 \times 30} = 16.67$ ∴ F.P. of solution. = **10.33°C.**

3. Let n_B mole of B present in 1 mole of mixture that has been vaporized. Thus, $y_B = \frac{n_B}{1}$

Mole fraction of B in the remaining liquid phase will be $x_B = \frac{1 - n_B}{1}$

$x_B = \frac{P - P_T^o}{P_B^o - P_T^o}$ .... (1) [$\because P = P^o_T + (P^o_B - P^o_T)\, x_B$]

and $y_B = \frac{P_B}{P} \Rightarrow \frac{P_B^o x_B}{P}$ .... (2)

After substitution of values of x_B and y_B in (1) and (2)

we get $1 - n_B = \frac{P - P_T^o}{P_B^o - P_T^o}$ .... (3)

and $n_B = \frac{(1 - n_B) P_B^o}{P}$ .... (4)

or $n_B = \frac{P_B^o}{P + P_B}$

so $1 - \frac{P_B^o}{P + P_B} = \frac{P - P_T^o}{P_B^o - P_T^o}$ ⇒ $P = \sqrt{P_B^o .\ P_T^o} = \sqrt{100 \times 900}$ ⇒ 300 torr

4. (a) An azeotropic mixture boil at perticular temperture without changing its composition.

5. Entropy of solvent is less than that of solution.

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

$\Delta T_f = i_1 m_1 K_f + i_2\ m_2\ K_f + i_3\ m_3\ K_f = (m_1 + 2m_2 + m_3)\ K_f$

$$\Delta T_f = \frac{\frac{3}{60} + \frac{7.45 \times 2}{74.5} + \frac{9}{180}}{100} \times 1000 \times 1.86$$

$\Delta T_f = 3 \times 1.86 \quad = 5.58$

T_f of solution = 273 – 5.58 = 267.42 K Ans.

7. Desalination is an application of reverse osmosis.

8. $\pi_f V_f = \pi_1 V_1 + \pi_2 V_2$; $\pi_f = \frac{1.2V + 2.5V}{2V} = \frac{3.7V}{2V}$; $\pi_f = 1.85$ atm.

9. (C) B.P. of water is elevated.

10. $P'_A = P_A^o X_A$ and $P'_B = P^o_B X_B$

$P'_A = P_M .\ Y_A$ and $P'_B = P_M . Y_B$

∴ $\frac{P'_A}{Y_A} = \frac{P'_B}{Y_B}$

or $\frac{P_A^\circ X_A}{Y_A} = \frac{P_B^\circ X_B}{Y_B} = \frac{P_B^\circ(1-X_A)}{(1-Y_A)}$ or $\frac{P_A^\circ X_A}{Y_A}(1-Y_A) = P_B^\circ - P_B^\circ X_A$

or $\frac{P_B^\circ}{X_A} = \frac{P_A^\circ}{Y_A} + (P^o_B - P^o_A)$ or $\frac{1}{X_A} = \frac{1}{Y_A}\cdot\frac{P_A^\circ}{P_B^\circ} + \frac{(P_B^\circ - P_A^\circ)}{P_B^\circ}$

or $y = mx + C$ ∴ Slope = m = $\frac{P_A^\circ}{P_B^\circ}$ and intercept C = $\frac{(P_B^\circ - P_A^\circ)}{P_B^\circ}$.

11. 20 mole C_6H_6, 10 mole C_6H_5Cl ⇒ $X_B = \frac{2}{3}$, $X_C = \frac{1}{3}$

at t = 100°C ⇒ $p_s = 300 \times \frac{1}{3} + 1350 \times \frac{2}{3} = 100 + 900$ (=1000).

12. Wt gain means weight loss means

$V.P_{incoming} > V.P_{outgoing}$ $V.P_{incoming} < V.P_{outgoing}$ So $p_1 > p_2 < p_3$ and $c_1 < c_2 > c_3$

13. $1.24 = 34.3 \left[\frac{0.849/M}{0.05}\right] \Rightarrow M = 469.68$ ∴ as Hg_2Cl_2 molecules.

14. At 90ºC, Total P_T = 730 mm Hg

At 100ºC total P_T = 289 + 760 = 1049 mm Hg

so for 800 mm Hg, temperature will lie in between 90º –100ºC

Using extrapolation method, Temperature = $90 + \frac{(800-730)}{(1049-730)} \times (100 - 90) = 92.19$ºC.

15. No of particles ↓, so vapour pressure ↑, i ↓

$\Delta T_f = mK_f i$; ΔT_f ↓ , freezing point ↑.

16. $1.0526 \times 760 = p_{ext}$; $p_{ext} = 799.976 \simeq 800$ Torr

∴ $\log 800 = 7 - \frac{1250}{t+220}$ ⇒ $2.9 = 7 - \frac{1250}{t+220}$ ⇒ t = 84.878 °**C** **Ans. 85**

17. According to Henry's law, $\frac{a}{P} = K_H$ ∴ $a = 3.1 \times 10^{-2} \times 4 = 0.12$ mol/litre.

18. $P_T = \frac{6}{10} \times 24 + \frac{0.4}{10} \times 12 = \frac{16 \times 12}{10} = \frac{192}{10} = 19.2$ kPa

$P_A' = X_A P_A = \frac{6}{10} \times 24 = \frac{144}{10} = 14.4 = X_A' \times 19.2$

so $X_A' = \frac{144}{192} = 75\%$ $X_B' = 25\%$

so $P_T = \frac{3}{4} \times 24 + \frac{1}{4} \times 12 = 18 + 3 = 21$ k Pa & $P_A = \frac{3}{4} \times 24 = 18 = X_A'(21)$

so $X_A' = \frac{18}{21} = \frac{6}{7} = 85.7\%$ of A ⇒ $X_B' = 14.3\%$

19. $H_3A \longrightarrow H^+ + H_2A^-$

Initial mole $1 \quad 0 \quad 0$

$0 \quad 1 \quad 1–0.5$

$H_2A^- \rightleftharpoons H^+ + HA^{2-}$

$1–0.5 \quad 1+0.5 \quad 0.5$

$0.5–0.1$

$HA^{2-} \rightleftharpoons H^+ + A^{3-}$

$0.5–0.1 \quad 1+0.5 \quad 0.1$

$+0.1$

$$i = \frac{\text{observed mole of all the species}}{\text{Theoretical moles}} = \frac{\text{moles of }\left(H^+ + H_2A^- + HA^{2-} + A^{3-}\right)}{1} = \frac{1.6+0.5+0.4+0.1}{1} = 2.6 \quad 3$$

20. Loss in weight of solution $\propto P_S$; Loss in weight of solution $\propto P^0 – P_S$

Also, $\frac{P^0 - P_s}{P_s} = \frac{w \times M}{m \times W}$ By. eq (1) and (2) we get $\frac{0.04}{2.5} \times \frac{5 \times 18}{80 \times m} \Rightarrow m = 70.31$

21. $P_T = P_A + P_B \neq P_A^0 + P_B^0$

boiling point of the solution will be in between the boiling point of two liquids.

22. For – ve deviation A – – B > A – – A

A – – B > B – – B

– ve deviation solution are non ideal solution.

23. $\Delta T_b = mK_b\, i$; $K_b = \frac{RT^2}{1000\,\Delta H_{vapour}}$

PART - IV

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1. $\pi = MRT\, i$: $y\uparrow, i\uparrow, \pi\uparrow$

2. This is due to cage like structure ice.

3. L indicates elevation in boiling pt. i.e., $k_b m$.

4. Let volumes taken by ‘x’ & ‘y’ litres, so $\frac{0.1x + 0.4y}{x+y} = 0.34$ & $V_g = (x + y)$ (to be maximised) so $y = 4x$ so

for maximum volume $y = 2L$ & $x = \frac{1}{2}L$

5. Freezing point and boiling point are used in temperature scale.

6. On the same tie line liquid & vapour composition will be same.

7. Mole fraction of more volatile substance is greater in vapour phase.

9. $P = P_A^\circ X_A + \frac{500}{760} X_B$ (X_B = mole fraction of benzene)

$550 = 400 \times (1 \times X_B) + 600(X_B)$

$150 = (600 – 400)\, X_B$

$= \frac{150}{200} = \frac{3}{4}\, X_B$

$X_A = \frac{1}{4}$

At 100ºC mole fraction will be same initially but get change at equilibrium.

$P = \frac{1}{4} \times 500 + \frac{3}{4} \times 800 = 125 + 600 = 725$ torr

$X_A P_A^{\circ} = Y_A P$

$\frac{1}{4} \times 500 = Y_A = 725$

$\frac{125}{725} = Y_A$

So $Y_A = \frac{5}{29}$ $Y_B = \frac{24}{29}$

At 90ºC mole fraction will be same initially but get change at equilibrium.

$550 < P < 725$

So at P = 725 only liquid state exist.

11. $\frac{P_A^0}{P_A^0 - P_A} = \frac{n_A}{n_B} + 1$ or $\frac{P_A^0 - P_A}{P_A} = \frac{n_B}{n_A}$

12. In both chamber vapour compositions are same so vapour pressure are equal.

13. $\frac{P_o - P_s}{P_o} = X_{solute}$

$\therefore$ $\frac{100 - 98.7}{100} = X_{solute} = 0.013$

Now, $\Delta T_f = K_f \times m$

$0.72 = K_f \times \frac{0.013 \times 1000}{0.978 \times 78}$

$\therefore$ $K_f \approx 4.2$ K Kg/mol

$\therefore$ Reported answer = 4

14. Initially $P = \frac{500}{760}$ atm, T = 283 K

Let $V = V_1$ $\therefore$ $pV = nRT$

Or $\left(\frac{500}{760}\right) \times V_1 = R \times 5 \times 283$ ...(1)

Let on dilution the volume becomes V_2 and temp is raised to 25ºC i.e. 298 K

$\pi = \left(\frac{105.3}{760}\right)$ atm

$\therefore$ $\left(\frac{105.3}{760}\right) \times V_2 = n \times R \times 298$ ...(2)

(1)/(2)

$\frac{V_1}{V_2} = \frac{283}{298} \times \frac{105.3}{500}$ Or $V_2 = 5V_1$

15. $\Delta T_f = iK_fm$

$7.2 \times 10^{-3} = i \times 1 \times 10^{-3} \times 1.8$

$i = \dfrac{7.2}{1.8} = 4$

now , $i = 1 + (x + 1 - 1)\,\alpha = 1 + x$

$4 - 1 = x$

$x = 3$

So oxidation number of Fe $3 + y - 6 = 0,\ y = +3$

Sum of primary and sec valency = 3 + 6 = 9

16. Molarity of I solution $= \dfrac{12.6 \times 1.5 \times 10}{63} = 3$

Molarity of II solution $= \dfrac{6.3 \times 10 \times 10}{63} = 10$

$M = \dfrac{M_1V_1 + M_2V_2}{V_1 + V_2} = \dfrac{3 \times 5 + 1 \times 5}{5 + 5} = \dfrac{4}{2} = 2$

17. $P_A = K_HX_A$

$4 \times \dfrac{25}{100} = 2.5 \times 10^3\ X_A \Rightarrow \quad X_A = \dfrac{2}{5000}$; Number of moles of water $= \dfrac{2}{1} = 2$

Number of moles of gas A dissolved $\approx \dfrac{2}{5000} \times 2 = 0.8 \times 10^{-3} = 8 \times 10^{-4}$

19. $P = X_AP_A^0 + X_BP_B^0 = 0.5 \text{ x } 40 + 0.5 \text{ x } 100 = 70$

20. $Y_A = \dfrac{0.5 \text{ x } 40}{70} = \dfrac{2}{7}$; $Y_B = \dfrac{5}{7}$

21.

1– x	x
B = x	T = 1 – x

$P = 40\,(1 - x) + 100\,x$

$\dfrac{1}{P} = \dfrac{Y_A}{P_A^0} + \dfrac{Y_A}{P_B} \Rightarrow \dfrac{1}{P} = \dfrac{x}{40} + \dfrac{1-x}{100} = \dfrac{100x + (1-x)40}{40 \text{ x } 100}$

So $p^2 = 40 \text{ x } 100$

$p = 20\sqrt{10} = 63.25$

22. P. $AlCl_3 \rightarrow i = 1 + (4 - 1) \times 0.8 = 1 + 2.4 = 3.4$

Q. $BaCl_2 \rightarrow i = 1 + (3 - 1) \times 0.9 = 1 + 1.8 = 2.8$

R. $Na_3PO_4 \rightarrow i = 1 + (4 - 1) \times 0.9 = 1 + 2.7 = 3.7$

S. $K_4[Fe(CN)_6] \rightarrow i = 1 + (5 - 1) \times 0.7 = 1 + 2.8 = 3.8$

so, $K_4[Fe(CN)_6]$ has highest colligative property and hence minimum freezing point and $BaCl_2$ has lowest colligative property, so lowest osmotic pressure.

$RLVP = \dfrac{0.1 \times i}{0.1 \times i + 10} = \dfrac{0.1 \times 3.7}{0.1 \times 3.7 + 10} = \dfrac{3.7}{10.37} = \dfrac{37}{1037}$