SELECT THE CORRECT ALTERNATIVE (ONLY ONE CORRECT ANSWER)

1. The molarity of a glucose solution containing 36 g of glucose per 400 mL of the solution is:
(A) 1.0 (B) 0.5 (C) 2.0 (4) 0.05

2. 1 kg of NaOH solution contains 4g of NaOH. The approximate concentration of the solution is:
(A) 0.1 molar (B) 0.1 molal (C) Decinormal (D) About 0.1 N

3. To prepare 0.1 M $KMnO_4$ solution in 250 mL flask, the weight of $KMnO_4$ required is:
(A) 4.80g (B) 3.95g (C) 39.5g (D) 0.48 g

4. The number of moles present in 2 litre of 0.5 M NaOH is:
(A) 2 (B) 1 (C) 0.1 (D) 0.5

5. The weight of solute present in 200 mL of 0.1 M H_2SO_4 :
(A) 2.45g (B) 4.9g (C) 1.96g (D) 3.92 g

6. The nature of mixture obtained by mixing 50 mL of 0.1 M H_2SO_4 and 50 mL of 0.1 M NaOH is:
(A) Acidic (B) Basic (C) Neutral (D) Amphoteric

7. If 250 mL of a solution contains 24.5g H_2SO_4 the molarity and normality respectively are:
(A) 1M, 2N (B) 1M,0.5M (C) 0.5M, 1N (D) 2M,1N

8. The volume strength of H_2O_2 solution is 10. What does it mean :
(A) at S.T.P. 10 g solution of H_2O_2 gives 10 mL of O_2
(B) at S.T.P. 1 g equivalent of H_2O_2 gives 10 mL of O_2
(C) at ST.P. 10 litre solution of H_2O_2 gives 10 mL of O_2
(D) at S.T.P. 1 mL solution of H_2O_2 gives 10 mL of O_2

9. The normality of 0.3 M phosphorus acid (H_3PO_3) is:
(A) 0.1 (B) 0.9 (C) 0.3 (D) 0.6

10. The normality of 4% (wt./vol.) NaOH is:
(A) 0.1 (B)1.0 (C) 0.05 (D) 0.01

11. The density of NH_4OH solution is 0.6 g/mL. It contains 34% by weight of NH_4OH. Calculate the normality of the solution :
(A) 4.8 N (B) 10 N (C) 0.5 N (D) 5.8 N

12. A molal solution is one that contains one mole of a solute in :
(A) 1000 g of the solution (B) 1000 c.c. of the solution
(C) 1000 c.c of the solvent(D) 1000 g of the solvent

13. Out of molarity (M), molality (m), formality (F) and mole fraction (x) those independent of temperature are :
(A) M,m (B) F, x (C) m,x (D) M,x

14. 3.0 molal NaOH solution has a density of 1.110 g/mL. The molarity of the solution is:
(A) 2.9732 (B) 3.05 (C) 3.64 (D) 3.0504

15. 1000 gram aqueous solution of $CaCO_3$ contains 10 gram of carbonate. Concentration of solution is:
(A) 10ppm (B) 100ppm (C) 1000ppm (D) 10,000 ppm

16. When 5.0 gram of $BaCl_2$ is dissolved in water to have 10^6 gram of solution. The concentration of solution is :
(A) 2.5 ppm (B) 5 ppm (C) 5M (D) 5 g L^{-1}

17. How many grams of glucose be dissolved to make one litre solution of 10% glucose :
(A) 10g (B) 180g (C) 100g (D) 1.8g

18. Vapour pressure of a solvent containing nonvolatile solute is :

(A) more than the vapour pressure of a solvent (B) less than the vapour pressure of solvent

(C) equal to the vapour pressure of solvent (D) none

19. The relative lowering in vapour pressure is:

(A) $\propto X_{solute}$ (B) $\propto \frac{1}{X_{solute}}$ (C) $= X_{solute}$ (D) $\propto m$

20. The vapour pressure of a dilute solution of a solute is not influenced by :

(A) temperature of solution (B) melting point of solute

(C) mole fraction of solute (D) degree of dissociation of solute

21. An aqueous solution of methanol in water has vapour pressure :

(A) equal to that of water (B) equal to that of methanol

(C) more than that of water (D) less than that of water

22. When a substance is dissolved in a solvent, the vapour pressure of solvent decreases. This brings:

(A) an increase in b.pt. of the solution (B) a decrease in b.pt of a solution

(C) an increase in f.pt of the solvent (D) none

23. Solute when dissolved in water:

(A) increases the vapour pressure of water (B) decreases the boiling point of water

(C) decreases the freezing point of water (D) all of the above

24. If the vapour pressure of solutions of two liquids are less than those expected from ideal solution they are said to have :

(A) negative deviation from ideal behaviour

(B) positive deviations from ideal behaviour

(C) ideal behaviour

(D) positive deviation for lower concentration and negative deviations for higher concentration

25. A 5.8% solution of NaCl has vapour pressure closest to :

(A) 5.8 % solution of urea (B) 2 m solution of glucose

(C) 1 m solution of urea (D) 5.8 % solution of glucose

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

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

27. Boiling point of water is defined as the temperature at which :

(A) vapour pressure of water equal to that of atmospheric pressure

(B) bubbles are formed

(C) steam comes out

(D) none of the above

28. Which solution will show maximum elevation in b.pt:

(A) 0.1 M KCl (B) 0.1 M $BaCl_2$ (C) 0.1 M $FeCl_3$ (D) 0.1 M $Fe_2(SO_4)_3$

29. The correct relationship between the boiling points of very dilute solutions of $AICI_3$ (t_1) and $CaCI_2$(t_2) having the same molar concentration is :

(A) $t_1 = t_2$ (B) $t_1 > t_2$ (C) $t_2 > t_1$ (D) $t_2 \geq t_1$

30. Cryoscopic constant of a liquid is:

(A) decrease in freezing point when 1 gram of solute is dissolved per kg of the solvent

(B) decrease in the freezing point when 1 mole of solute is dissolved per kg of the solvent

(C) the elevation for 1 molar solution

(D) a factor used for calculation of elevation in boiling point

31. At certain Hill-station pure water boils at 99.725 C. If K_b for water is 0.513 C kg mol^{-1}, the boiling point of 0.69 m solution of urea will be :

(A) 100.079 C (B) 103 C (C) 100. 359 C (D) un predictable

32. The freezing point of 1 molal NaCl solution assuming NaCI to be 100% dissociated in water is :

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

33. 10 gram of solute with molecular mass 100 gram mol^{-1} is dissolved in 100 gram solvent to show 0.3 C elevation in boiling point. The value of molal ebullioscopic constant will be :

(A) 10 (B) 3 (C) 0.3 (D) un predictable

34. Depression in freezing point of solution of electrolytes are generally:

(A) lower

(B) higher than what should be normally

(C) low or high depending upon nature of electrolyte

(D) what it should be normally

35. A liquid is in equilibrium with its vapour at its boiling point. On the average the molecules in the two phase have equal:

(A) inter-molecular forces (B) potential energy (C) total energy (D) kinetic energy

36. Which salt may show the same value of vant Hoff factor (i) as that of $K_4Fe(CN)_6$ in very dilute solution state :

(A) $Al_2(SO_4)_3$ (B) NaCl (C) $Al(NO_3)_3$ (D) Na_2SO_4

37. Which compound corresponds vant Hoff factor (i) to be equal to 2 in dilute solution:

(A) K_2SO_4 (B) $NaHSO_4$ (C) Sugar (D) $MgSO_4$

38. In which of the following, the vant Hoff factor (i) is equal to one:

(A) NaCl (B) KNO_3 (C) Urea (D) all

39. If the observed and theoretical molecular mass of NaCl is found to be 31.80 and 58.50, then the degree of dissociation of NaCl is :

(A) 83.96% (B) 8.39% (C) 90% (D) 100%

40. The substance A when dissolved in solvent B shows the molecular mass corresponding to A_3. The vant Hoffs factor will be:

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

41. Which of the following conditions is not correct for ideal solution :

(A) no change in volume on mixing (B) no change in enthalpy on mixing

(C) it obey's Raoult's law

(D) lonisation of solute should occurs to a small extent

42. Solutions distilled without change in composition at a temperature are called :

(A) Amorphous (B) Azeotropic mixture

(C) Ideal solution (D) Super saturated solution

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

(A) vapour pressure of solution increases (B) b.pt decreases

(C) osmotic pressure increases (D) all are correct

44. An azeotropic solution of two liquids has boiling point lower than either of them when it:

(A) shows a negative deviation from Raoult's law (B) shows no deviation from Raoult's law

(C) shows positive deviation from Raoult's law (D) is saturated

45. The passing of particles through semipermeable membrane is called :

(A) osmosis (B) electrodialysis (C) electrophrosis (D) electroplating

46. From the colligative properties of solution which one is the best method for the determination of mol. wt of proteins & polymers :

(A) osmotic pressure (B) lowering in vapour pressure

(C) lowering in freezing point (D) elevation in B.Pt

47. As a result of osmosis, the volume of the concentrated solution :

(A) gradually decreases (B) gradually increases

(C) suddenly increases (D) none

48. The osmotic pressure of a solution of benzoic acid dissolved in benzene is less than expected because:

(A) benzoic acid is an organic solute (B) benzene is a non-polar solvent

(C) benzoic acid dissociates in benzene (D) benzoic acid gets associated in benzene

49. Two solutions have different osmotic pressures. The solution of higher osmotic pressure is called:

(A) isotonic solution (B) hypotonic solution

(C) isotopic solution (D) hypertonic solution

50. Blood is isotonic with :

(A) 0.16 M NaCl (B) Conc.NaCl (C) 30% NaCl (D) 50% NaCl

51. Which one of the following pairs of solution can we expect to be isotonic at the same temperature:

(A) 0.1 M urea and 0.1 M NaCl (B) 0.1 M urea and 0.2 M $MgCl_2$

(C) 0.1 M NaCl and 0.1 M Na_2SO_4 (D) 0.1 M $Ca(NO_3)_2$ and 0.1 M Na_2SO_4

52. A 5% solution of cane sugar is isotonic with 0.877 % of X. The molecular weight of substance X is:

(A) 58.98 (B) 119.96 (C) 95.58 (D) 126.98

53. Which statement is incorrect about osmotic pressure (π), volume (V) and temperature (T):

(A) $\pi \propto \frac{1}{V}$ if T is constant (B) $\pi \propto T$ if V is constant

(C) $\pi \propto V$ if T is constant (D) π V is constant if T is constant

54. The osmotic pressure of equimolar solutions of urea, $BaCI_2$ and $AlCI_3$ will be in the order:

(A) $AlCl_3 > BaCl_2 >$ Urea (B) $BaCl_2 > AlCl_3 >$ Urea

(C) Urea > $BaCl_2 > AlCl_3$ (D) $BaCl_2 >$ Urea > $AlCl_3$

CHECK YOUR GRASP						ANSWER KEY						EXERCISE -1				
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Ans.	B	B	B	B	C	A	A	D	D	B	D	D	C	A	D
Que.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	B	C	B	C	B	C	A	C	A	B	B	A	D	B	B
Que.	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
Ans.	A	B	C	C	D	A	D	C	A	D	D	B	C	C	A
Que.	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**						
Ans.	A	B	D	D	A	D	A	C	A						

SELECT THE CORRECT ALTERNATIVES (ONE OR MORE THEN ONE CORRECT ANSWERS)

1. 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 = 100 C) :

(A) 373.052 K (B) 273.52 K (C) 372.48 K (D) 273.052 K

2. Solutions having the same osmotic pressure are called :

(A) isotonic solution (B) molar solutions (C) hypotonic solutions (D) ideal solutions

3. Consider 1 M solutions of the following salts. State which solution will have the lowest freezing point.

(A) Na_2SO_4 (B) $BaCl_2$ (C) NaCl (D) $Al_2(SO_4)_3$

4. A solution prepared by dissolving a 2.50 g sample of an unknown compound dissolved in 34.0 g of benzene, C_6H_6 boils at 1.38 C higher than pure benzene. Which expression gives the molar mass of the unknown compound ?

Compound	K_b
C_6H_6	2.53 $C.m^{-1}$

(A) 2.53 $\dfrac{2.50}{1.38}$ (B) 1.38 $\dfrac{34.0}{2.53}\times 2.50$

(C) 2.50 10^3 $\dfrac{2.53}{34.0}\times\dfrac{1}{1.38}$ (D) 2.50 10^3 $\dfrac{1.38}{34.0}$ 2.53

5. When 1.20 g of sulphur is melted with 15.00 g of naphthalene, the solution freezes at 77.2 C. What is the molar mass of this from of sulphur. Data for Napthalene

Melting point, m.p 80 C

Freezing point depression constant, k_f = 6.80 C m^{-1}

(A) 180 g mol^{-1} (B) 194 g mol^{-1} (C) 260 g mol^{-1} (D) 450 g mol^{-1}

6. 12.2 gm benzoic acid (M = 122) in 100 g H_2O has elevation of boiling point of 0.27 C, K_b = 0.54 K kg/ mole. If there is 100% dimerization, the no. of molecules of benzoic acid in associated state is :

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

7. The Van't Hoff factor 0.1 M La $(NO_3)_3$ solution is found to be 2.74 the percentage dissociation of the salt is :

(A) 85 % (B) 58 % (C) 65.8% (D) 56.8%

8. Maximum freezing point will be for 1 molal solution of (assuming equal ionisation in each case) :

(A) $[Fe(H_2O)_6\ Cl_3]$ (B) $[Fe(H_2O)_5Cl]\ Cl_2.H_2O$ (C) $[Fe(H_2O)_4Cl_2]Cl.2H_2O$ (D) $[Fe(H_2O)_3Cl_3].3H_2O$

9. 1.0 molal aqueous solution of an electrolyte X_3Y_2 is 25% ionized. The boiling point of the solution is (K_b for H_2O = 0.52 K kg / mol) :

(A) 375.5 K (B) 374.04 K (C) 377.12 K (D) 373.25 K

10. Which one of the following aqueous solution has the highest freezing point at 1 atm :

(A) 0.1 M urea (B) 0.1 M acetic acid (C) 0.1 M NaCl (D) 0.1 M $BaCl_2$

11. If in solvent, n simple molecules of solute combine to form an associated molecule, X is degree of association the Van't Hoff's factor 'i' is equal to :

(A) $\dfrac{1}{1-nx}$ (B) $\dfrac{1-x+nx}{1}$ (C) $\dfrac{1-x+\frac{x}{n}}{1}$ (D) $\dfrac{\frac{x}{n}-1+x}{1}$

12. The decrease in the freezing point of an aqueous solution of a substance is 1.395 K and that in the freezing point of benzene solution of the same substance is 1.280 K. Explain the difference in ΔT. The substance :

(A) dissociates in the aqueous solution as well as in the benzene solution

(B) forms complexes in solution

(C) associates in the benzene solution

(D) dissociates in the aqueous solution and not in the benzene solution

13. The molal boiling point constant of water is 0.573 C kg mole^{-1}. When 0.1 mole of glucose is dissolved in 1000 g of water, the solution boils under atmospheric pressure at :

(A) 100.513 C (B) 100.0573 C (C) 100.256 C (D) 101.025 C

14. A 0.2 molal aqueous solution of a weak acid HX is 20% ionized. The freezing point of the solutions is (k_f = 1.86 K kg mole^{-1} for water) :

(A) –0.45 C (B) –0.9 C (C) –0.31 C (D) –0.53 C

15. The boiling point of an azeotropic mixture of water and ethyl alcohol is less than that of theoretical value of water and alcohol mixture. Hence the mixture shows :

(A) that solution is highly saturated (B) positive deviation from Raoult's law

(C) negative deviation from Raoult's law (D) none of these

16. The boiling point of an aqueous solution of a non-volatile solute is 100.15 C. What is the freezing point of an aqueous solution obtained by diluting the above solution with an equal volume of water. The values of K_b and K_f for water are 0.512 and 1.86 C mol^{-1}:

(A) –0.544 C (B) –0.512 C (C) –0.272 C (D) –1.86 C

17. An aqueous solution of NaCl freezes at –0.186 C. Given that $K_{b(H_2O)} = 0.512K$ kg mol^{-1} and $K_{f(H_2O)} = 1.86K$ kg mol^{-1}, the elevation in boiling point of this solution is :

(A) 0.0585 K (B) 0.0512 K (C) 1.864 K (D) 0.0265 K

18. The Van't Hoff factors i for an electrolyte which undergoes dissociation and association in solvents are respectively :

(A) greater than one and less than one (B) less than one and greater than one

(C) less than one and less than one (D) greater than one and greater than one

19. A solution of 0.450 g of urea (mol. wt. 60) in 22.5 g of water showed 0.170 C of elevation in boiling point, the molal elevation constant of water :

(A) 0.51 (B) 0.95 (C) 0.25 (D) 2.25

20. Colligative properties of the solution depend on :

(A) Nature of solute (B) Nature of solvent

(C) Number of particles present in the solution (D) Number of moles of solvent only

21. Which of the following solutions will have highest boiling point :

(A) 1% glucose in water (B) 1% sucrose in water (C) 1% NaCl in water (D) 1% urea in water

22. In cold countries, ethylene glycol is added to water in the radiators of cars during winters. It results in :

(A) reducing viscosity (B) reducing specific heat

(C) reducing freezing point (D) reducing boiling point

23. An azeotropic solution of two liquids has a boiling point lower than either of them when it :

(A) shows negative deviation from Raoult's law (B) shows no deviation from Raoult's law

(C) shows positive deviation from Raoult's law (D) is saturated

24. When mercuric iodide is added to an aqueous solution of potassium iodide the :

(A) freezing point is raised (B) freezing point is lowered

(C) freezing point does not change (D) boiling point does not change

25. For an ideal solution containing a nonvolatile solute, which of the following expressions represents the vapour pressure of the solution? ($x_1 \rightarrow$ mole fraction of solvent)

(A) $p = x_2\, p_2^*$ (B) $p = x_1\, p_2^*$ (C) $p = x_1\, p_1^*$ (D) $p_1^* - p = x_2$

26. For a dilute solution containing a nonvolatile solute, the molar mass of solute evaluated from the elevation of boiling point is given by the expression :

(A) $M_2 = \dfrac{\Delta T_b}{K_b}\dfrac{m_1}{m_2}$ (B) $M_2 = \dfrac{\Delta T_b}{K_b}\dfrac{m_2}{m_1}$ (C) $M_2 = \dfrac{K_b}{\Delta T_b}\dfrac{m_2}{m_1}$ (D) $M_2 = \dfrac{K_b}{\Delta T_b}\dfrac{m_1}{m_2}$

27. For a dilute solution containing a nonvolatile solute, the molar mass of solute evaluated from the osmotic pressure measurement is given as :

(A) $M_2 = \frac{m_2}{V}\frac{RT}{\pi}$ (B) $M_2 = \frac{m_2}{V}\frac{\pi}{RT}$ (C) $M_2 = m_2\frac{RT}{\pi}$ (D) $M_2 = m_2\frac{\pi}{RT}$

28. An aqueous solution of acetone, CH_3COCH_3, is 10.00% acetone by weight. What is the mole percentage of acetone in this solution :

(A) 3.332 % (B) 5.000 % (C) 10.00 % (D) 11.11 %

29. The freezing point of an aqueous solution of a non-electrolyte is –0.14 C. The molarity of this solution is $[K_f(H_2O) = 1.86\ K\ kg\ mol^{-1}]$:

(A) 1.86 m (B) 1.00 m (C) 0.15 m (D) 0.075 m

30. The boiling point of a 0.1 M solution of $CaCl_2$ should be elevated by :

(A) exactly 0.51 (B) somewhat less than 1.02

(C) exactly 1.02 (D) some what less than 1.53

31. Of the following measurements the one most suitable for the determination of the molecular weight of oxyhaemoglobin, a molecule with a molecular weight of many thousand, is :

(A) the vapour pressure lowering (B) the elevation of the boiling point

(C) the depression of the freezing point (D) the osmotic pressure

32. The vapour pressure of pure benzene at 50 C is 268 torr. How many mol of non-volatile solute per mol of benzene is required to prepare a solution of benzene having a vapour pressure of 167 torr at 50 C:

(A) 0.377 (B) 0.605 (C) 0.623 (D) 0.395

33. If P the vapour pressure of a pure solvent and P is the vapour pressure of the solution prepared by dissolving a non volatile solute in it. The mole fraction of the solvent X_A is given by :

(A) $\frac{P^\circ - P}{P^\circ} = X_A$ (B) $\frac{P^\circ - P}{P} = X_A$ (C) $\frac{P}{P^\circ} = X_A$ (D) $P - P = X_A$

34. Dry air was passed successively through a solution of 5 g of a solute in 180 g of water and then through pure water. The loss in weight of solution was 2.5 g and that of pure solvent 0.04 g. The molecular weight of the solute is :

(A) 31.25 (B) 3.125 (C) 312.5 (D) None of these

35. The relative lowering of the vapour pressure is equal to the ratio between the number :

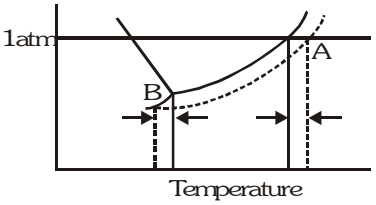
(A) solute molecules to the solvent molecules

(B) solute molecules to the total molecules in the solution

(C) solvent molecules to the total molecules in the solution

(D) solvent molecules to the total number of ions of the solute

36. The vapour pressure of pure liquid solvent A is 0.80 atm when a non volatile solute B is added to the solvent its vapours pressure falls to 0.60 atm. Mole fraction of solute B in the solution is :



(A) 0.50 (B) 0.25

(C) 0.75 (D) given data is not sufficient

37. 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)

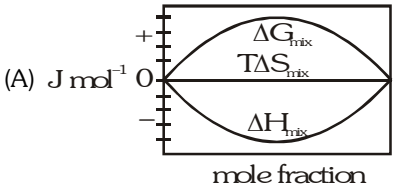
(C) plot of $\frac{1}{P_{total}}$ v/s Y_A is linear

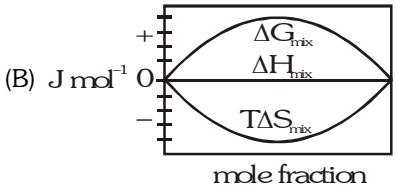
(D) plot of $\frac{1}{P_{total}}$ v/s Y_B is non linear

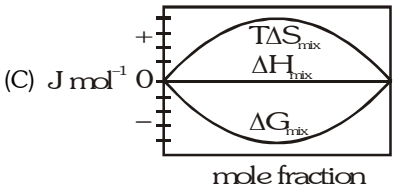
38. The lowering of vapour pressure in a saturated aq. solution of salt AB is found to be 0.108 torr. If vapour pressure of pure solvent at the same temperatuare is 300 torr, find the solubility product of salt AB:

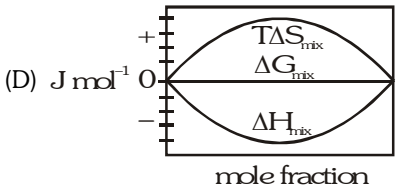
(A) 10^{-8} (B) 10^{-6} (C) 10^{-4} (D) 10^{-5}

39. Which of the following represents correctly the changes in thermodynamic properties during the formation of 1 mol of an ideal binary solution :

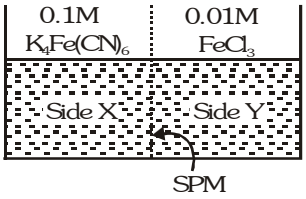
(A) 

(B) 

(C) 

(D) 

40. $FeCl_3$ on reaction with $K_4[Fe(CN)_6]$ in aqueous solution gives blue colour. These are separated by a semipermeable membrane AB as shown. Due to osmosis there is :



(A) blue colour formation in side X.

(B) blue colour formation in side Y.

(C) blue colour formation in both of the sides X and Y.

(D) no blue colour formation.

41. P_A = (235 y – 125 xy) mm of Hg. P_A is partial pressure of A, x is mole fraction of B in liquid phase in the mixture of two liquids A and B and y is the mole fraction of A in vapour phase, then P_B in mm of Hg is :

(A) 235 (B) 0 (C) 110 (D) 125

BRAIN TEASERS					ANSWER KEY							EXERCISE -2			
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Ans.	A	A	D	C	B	B	B	D	B	A	C	D	B	A	B
Que.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	C	B	A	A	C	C	C	C	A	C	C	A	A	D	D
Que.	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**				
Ans.	D	B	C	A	B	B	C	C	C	D	C				

EXERCISE–03 MISCELLANEOUS TYPE QUESTIONS

TRUE / FALSE

1. Relative lowering of vapour pressure is a colligative property.
2. The components of an azeotropic solution can be separated by simple distillation.
3. Addition of non-volatile solute to water always lowers its vapour pressure.
4. Reverse osmosis is generally used to make saline water fit for domestic use.
5. A 6% solution of NaCl should be isotonic with 6% solution of sucrose.
6. On diluting solution, its normality and molarity changes but molality remains constant.
7. The unit of k_b is kg K^{-1} mol^{-1}.
8. The value of K_b or K_f depends only on the type of solvent & not solute dissolved in it.
9. Limiting value of van't Hoff factor of $[K_4Fe(CN)_6]$ is 11.
10. The increasing order of osmotic pressure of 0.1 M aqueous solution containing different electrolyte is as follows 0.1 M Glucose < 0.1 M sodium chloride < 0.1 M magnesium chloride.

FILL IN THE BLANKS

1. Lowering of vapour pressure is ..... to the mole fraction of the solute.
2. The ratio of the value of any colligative property for NaCl solution of that of equimolal solution of sugar is nearly ..... .
3. Semipermeable membrane allows the passage of ..... through it.
4. A binary solution which has same composition in liquid as well as vapour phase is called ..... .
5. The number of urea molecules in 1 litre of 0.5 M solution ..... .
6. 0.1 M solution of urea would be ..... with 0.1 M solution of NaCl. (hypotonic / hypertonic / isotonic)
7. The value of k_f depends on nature of ..... .
8. Among 0.1 M solution of NaCl, $CaCl_2$ and $Al_2(SO_4)_3$ the one with highest vapour ..... .
9. For a non-ideal solution exhibiting positive deviation from Raoult's law, Δ_{mix} H has a ..... (nonzero) value.
10. If in a binary solution, forces of attraction between like molecules are weaker than those prevailing between unlike molecules, the solution is expected to exhibit ..... deviations from Raoult's law.
11. The van't Hoff factor of a weak electrolyte AB in a solution is 1.1. Its degree of dissociation would be ..... .
12. The density of a solution expressed in g cm^{-3} and kg dm^{-3} have ..... values.

MATCH THE COLUMN

1.

Column-I (Properties)		Column-II (Affecting factors)	
(A)	Relative lowering of vapour pressure	(p)	Directly proportional to van't Hoff factor, i
(B)	Elevation in boiling point	(q)	Directly proportional to molality
(C)	Freezing point	(r)	Directly proportional to molarity
(D)	Osmotic pressure	(s)	Indirectly proportional to lowering of vapour pressure

ASSERTION & REASON

These questions contains, Statement I (assertion) and Statement II (reason).

(A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.

(B) Statement-I is true, Statement-II is true ; Statement-II is NOT a correct explanation for statement-I

(C) Statement-I is true, Statement-II is false

(D) Statement-I is false, Statement-II is true

1. **Statement-I :** 0.1 M solution of NaCl has greater osmotic pressure than 0.1 M solution of glucose at same temperature.

   Because

   Statement-II : In solution, NaCl dissociates to produce more number of particles.

2. **Statement-I :** Relative lowering of vapour pressure is equal to mole fraction of the solvent.

   Because

   Statement-II : Relative lowering of vapour pressure is a colligative property.

3. **Statement-I :** Molal elevation constant depends on the nature of solvent.

   Because

   Statement-II : Molal elevation constant is the elevation in boiling point when 1 mole of the solute is dissolved in 1 kg of solvent.

4. **Statement-I :** 0.02 m solutions of urea and sucrose will freeze at same temperature.

   Because

   Statement-II : Freezing point of a solution is inversely proportional to the conc. of solution.

5. **Statement-I :** When mercuric iodide is added to the aqueous solution of KI, the freezing point is raised.

   Because

   Statement-II : HgI_2 reacts with KI forming complex ion $[HgI_4]^{2-}$.

6. **Statement-I :** 1 M solution of Glauber's salt is isotonic with 1 M solution of KNO_3.

   Because

   Statement-II : Solutions having same molar concentration of solute may or may not have same osmotic pressure.

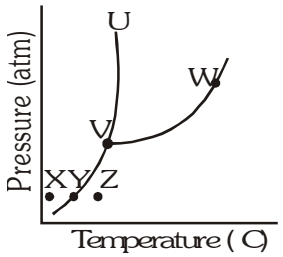
7. **Statement-I :** If decimolal solution of sodium chloride boils at 101.2 C, then decimolal solution of calcium chloride will also boil at the same temperature.

   Because

   Statement-II : For same molal concentration of aqueous solutions of electrolytes, the elevation of boiling point may not be same.

COMPREHENSION BASED QUESTIONS

Comprehension # 1



The phase diagram for a pure substance is shown above. Use this diagram and your knowledge about changes of phase to answer the following questions.

1. What does point V represent :

   (A) point of equilibrium (B) point of fusion (C) point of vaporisation (D) Triple point

2. What characteristics are specific to the system only at point V?

   (A) Liquid $\rightleftharpoons$ Solid (B) Solid $\rightleftharpoons$ Vapour

   (C) Liquid $\rightleftharpoons$ Vapour (D) Solid $\rightleftharpoons$ Liquid $\rightleftharpoons$ Vapour

3. What happens if temperature is increased from X to Y at 1.0 atm ?

(A) solid is competely vaporised (B) solid and vapour are in equilibrium

(C) solid and liquid are in equilibrium (D) liquid and vapour are in equilibrium

4. Select correct statement (s) :

(A) curve VU is solid-liquid equilibrium curve

(B) curve VU has a positive slope

(C) curve VW is vapour pressure curve for liquid substance

(D) In the solid - liquid mixture of the substance, solid will float

5. If the given substance is water then :

(A) curve VU would have negative slope

(B) in ice $\rightleftharpoons$ water liquid mixture, ice will float

(C) as the temperature increases, pressure at which solid and liquid are in equilibrium, decreases

(D) increase in pressure at constant temperature causes ice to be converted to liquid water

6. If the triple point pressure of a substance is greater than 1 atm, we expect :

(A) the solid to sublime without melting

(B) the boiling point temperature to be lower than the triple point temperature

(C) the melting point of the solid to come at a lower temperature than the triple point

(D) that the substance cannot exist as a liquid

7. In a phase change (say solid to liquid or liquid to solid) $\Delta G = \Delta H - T\Delta S$ where :

(A) ΔH is the enthalpy change associated with making or breaking the intermolecular attractions that hold solid and liquid together and ΔS is associated with change in disorder between the various phases.

(B) ΔH is associated with change in disorder while ΔS is associated with energy change

(C) both are associated with change in disorder

(D) both are associated with change in energy

Comprehension # 2

Following passage explains effect of temperature on the vapour pressure of liquid. Answer the questions given at the end.

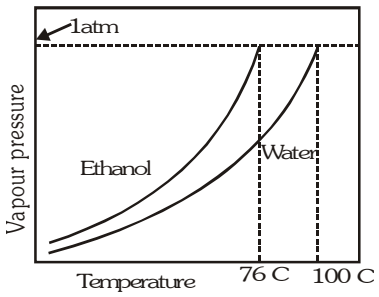
Effect of temperature on Vapour pressure

The quantity of heat required to evaporate a given liquid at constant temperature is defined as the heat of vaporisation. Variation of vapour pressure with temperature is given by

Clausius-Clapeyron equation.

$$\log_e P = -\frac{\Delta H_{vap}}{RT} + \log_e A$$

A liquid is said to be at its boiling temperature if its vapour pressure is equal to external pressure. Therefore, the boiling point of water in particular and of liquids in general decreases as altitude of a place increases where the external pressure is less than 1 atmosphere (normal b.p. of water is 373.15 K at 1 atmosphere)



On top of Mount Everest, for example, where the atmospheric pressure is only about 260 mm Hg, water boils at approximately 71 C. Conversely, if the external pressure on a liquid is greater than 1 atm., the vapour pressure necessary for boiling than normal boiling is reached later, and the liquid boils at a temperature greater than normal boiling point.

1. Clausius-Clapeyron equation can be written in the following form :

(A) $P = Ae^{-\Delta H_{vap}/RT}$ (B) $\frac{d\log_{10} P}{dT} = \frac{\Delta H_{vap}}{2.303RT^2}$

(C) $\frac{d\log_e P}{dT} = -\frac{\Delta H_{vap}}{RT^2}$ (D) $P = Ae^{\Delta H_{vap}/RT}$

2. For a given liquid at a given temperature vapour pressure is given by :

$$\log_{10} P \text{ (mm)} = -\frac{400(K)}{T} + 10$$

Vapour pressure of the liquid at 400 K is :

(A) 9 mm (B) –9 mm (C) 10^9 mm (D) 10^{-9} mm

3. Latent heat of vaporisation of the above case in the given temperature range is :

(A) –400 R (B) 400 R

(C) –400 2.303 R (D) 400 2.303 R

MISCELLANEOUS TYPE QUESTION — ANSWER KEY — EXERCISE -3

- ***True / False***

1. T **2.** F **3.** T **4.** T **5.** F **6.** F **7.** F
8. T **9.** F **10.** T

- ***Fill in the Blanks***

1. proportional **2.** 2 : 1 **3.** solvent molecule **4.** azeotropic mixture **5.** 3.01 10^{23}
6. hypotonic **7.** solvent **8.** 0.1 M NaCl **9.** positive **10.** negative
11. 0.1 **12.** same

- ***Match the Column***

1. (A) → p ; (B) → p, q ; (C) → s ; (D) → p, r

- ***Assertion - Reason Questions***

1. A **2.** D **3.** B **4.** B **5.** A **6.** D **7.** D

- ***Comprehension Based Questions***

Comprehension #1 : **1.** (D) **2.** (D) **3.** (B) **4.** (A,B,C) **5.** (A,B,C,D) **6.** (A) **7.** (A)
Comprehension #2 : **1.** (A,B) **2.** (C) **3.** (D)

1. The vapour pressure of ethanol and methanol are 44.5 mm Hg and 88.7 mm Hg, respectively. An ideal solution is formed at the same temperature by mixing 60 g of ethanol and 40 g of methanol. Calculate the total vapour pressure of the solution and the mole fraction of methanol in the vapour.

2. The vapour pressure of pure benzene at a certain temperature is 640 mm Hg. A non-volatile solid weighing 2.175 g is added to 39.0 g of benzene. The vapour pressure of the solution is 600 mm Hg. What is the molar mass of the solid substance?

3. Addition of 0.643 g of a compound to 50 mL of benzene (density : 0.879 g mL^{-1}) lower the freezing point from 5.51 C to 5.03 C. If K_f for benzene is 5.12 K kg mol^{-1}, calculate the molar mass of the compound.

4. (a) The vapour pressure of n-hexane and n-heptane at 273 K are 45.5 mm Hg and 11.4 mm Hg, respectively. What is the composition of a solution of these two liquids if its vapour pressure at 273 K is 37.3 mm Hg.

   (b) The mole fraction of n-hexane in the vapour above a solution of n-hexane and n-heptane is 0.75 at 273 K. What is the composition of the liquid solution.

5. A solution containing 30 g of a nonvolatile solute in exactly 90 g water has a vapour pressure of 21.85 mm Hg at 25 C. Further 18 g of water is then added to the solution. The resulting solution has vapour pressure of 22.18 mm Hg at 25 C. Calculate (a) molar mass of the solute, and (b) vapour pressure of water at 25 C.

6. The freezing point of ether was lowered by 0.60 C on dissolving 2.0 g of phenol in 100 g of ether. Calculate the molar mass of phenol and comment on the result. Given : K_f (ether) = 5.12 K kg mol^{-1}.

7. A solution contains 3.22 g of $HClO_2$ in 47.0 g of water. The freezing point of the solution is 271.10 K. Calculate the fraction of $HClO_2$ that undergoes dissociation to H^+ and ClO_2^-. Given : K_f(water) = 1.86 K kg mol^{-1}.

8. A 0.1 molar solution of NaCl is found to be isotonic with 1% urea solution. Calculate (a) Van't Hoff factor, and (b) degree of dissociation of sodium chloride. Assume density of 1% urea equal to 1 g cm^{-3}.

9. The addition of 3 g of a substance to 100 g CCl_4 (M = 154 g mol^{-1}) raises the boiling point of CCl_4 by 0.60 C. If K_b (CCl_4) is 5 K mol^{-1} kg, calculate (a) the freezing point depression (b) the relative lowering of vapour pressure (c) the osmotic pressure at 298 K and (d) the molar mass of the substance. Given : K_f (CCl_4) = 31.8 K kg mol^{-1} and ρ (solution) = 1.64 g cm^{-3}.

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

11. A 0.01 m aqueous solution of $K_3[Fe(CN)_6]$ freezes at –0.062 C. What is the apparent percentage of dissociation? [K_f for water = 1.86]

12. The degree of dissociation of Ca $(NO_3)_2$ in a dilute aqueous solution containing 7 g of the salt per 100 g of water at 100 C is 70%. If the vapour pressure of water at 100 C is 760 mm, calculate the vapour pressure of the solution.

13. A solution containing 0.122 kg of benzoic acid in 1 kg of benzene (b. pt. 353 K) boils at 354.5 K. Determine the apparent molar mass of benzoic acid (which dimerizes) in the solution and the degree of dimerization. Given : $\Delta_{vap}H_{1m}$ (benzene) = 394.57 J g^{-1}.

14. A solution containing 0.011 kg of barium nitrate in 0.1 kg of water boils at 100.46 C. Calculate the degree of ionization of the salt. K_b (water) = 0.52 K kg mol^{-1}.

15. When 3.24 g of mercuric nitrate $Hg(NO_3)_2$ dissolved in 1 kg of water, the freezing point of the solution is found to be – 0.0558 C. When 10.84 g of mercuric chloride $HgCl_2$ is dissolved in 1 kg of water, the freezing point of the solution is –0.0744 C. K_f = 1.86 mol^{-1} K kg. Will either of these dissociate into ions in an aqueous solution ?

16. The vapour pressure of solution containing 6.69 g of $Mg(NO_3)_2$ dissolved in 100 g of water is 747 Torr at 373 K. Calculate the degree of dissociation of the salt in the solution.

17. At 353 K, the vapour pressure of pure ethylene bromide and propylene bromide are 22.93 and 16.93 k Nm^{-2}, respectively, and these compounds form a nearly ideal solution. 3 mol of ethylene bromide and 2 mole of propylene bromide are equilibrated at 553 K and a total pressure of 20.4 k Nm^{-2}.

(a) What is the composition of the liquid phase?

(b) What amount of each compound is present in the vapour phase?

18. The vapour pressure of two pure liquids, A and B, that form an ideal solution are 300 and 800 torr, respectively, at temperature T. A mixture of the vapour of A and B for which the amount fraction of A is 0.25 is slowly compressed at temperature T. Calculate :

(a) The composition of the first drop of the condensate,

(b) The total pressure when this drop is formed,

(c) The composition of the solution whose normal boiling point is T.

(d) The pressure when only the last bubble of vapour remains.

(e) The composition of the last bubble.

19. Sea water is found to contain 5.85% NaCl and 9.50% $MgCl_2$ by weight of solution. Calculate its normal boiling point assuming 80% ionisation for NaCl and 50% ionisation of $MgCl_2$ [K_b (H_2O) = 0.51 kg mol^{-1} K].

20. Find the freezing point of a glucose solution whose osmotic pressure at 25 C is found to be 30 atm. K_f (water) = 1.86 $kg.mol^{-1}$. K.

21. The latent heat of fusion of ice is 80 calories per gram at 0 C. What is the freezing point of a solution of KCℓ in water containing 7.45 grams of solute 500 grams of water, assuming that the salt is dissociated to the extent of 95%?

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 100 g water lowers the freezing point by 1.40 C. If the substance has normal molecular weight in benzene and is completely ionised in water, into how many ions does it dissociate in water? K_f for H_2O and C_6H_6 are 1.86 and 5.12 K kg mol^{-1}.

23. 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?

24. A radiator was filled with 10 L of water to which 2.5 L of methanol (density = 0.8 $g.mL^{-1}$) were added. At 9 : 00 pm, the vehicle is parked outdoors where the temperature is 0 C. The temperature is decreasing at a uniform rate of 0.5 C / min. Upto what time will there be no danger to the radiator of the car. K_f (water) = 1.86 $kg.mol^{-1}$ K. Assume methanol to be non-volatile.

25. At 300 K, two solutions of glucose in water of concentration 0.01 M and 0.001 M are separated by semipermeable membrane. Pressure needs to be applied on which solution, to prevent osmosis? Calculate the magnitude of this applied pressure?

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

27. When cells of the skeletal vacuole of a frog were placed in a series of NaCl solutions of different concentration at 25 C, it was observed microscopically that they remained unchanged in 0.7% NaCl solution, shrank in more cocentrated solutions, and swelled in more dilute solutions. Water freezes from the 0.7% salt solution at –0.406 C. What is the osmotic pressure of the cell cytoplasm at 25 C ? K_f = 1.86 kg mol^{-1} K.

28. A 0.1 M solution of potassium ferrocyanide is 46% dissociated at 18 C. What will be its osmotic pressure?

29. At 100 C, benzene & toluene have vapour pressure of 1375 & 558 Torr respectively. Assuming these two form an ideal binary solution that boils at 1 atm & 100 C. What is the composition of vapour issuing at these conditions?

30. An ideal solution of two volatile liquid A and B has a vapour pressure of 402.5 mmHg, the mole fraction of A in vapour & liquid state being 0.35 & 0.65 respectively. What are the vapour pressure of the two liquid at this temperature.

31. Dry air was drawn through bulbs containing a solution of 40 grams of urea in 300 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 2.036 grams. Calculate the molecular weight of urea.

CONCEPTUAL SUBJECTIVE EXERCISE — ANSWER KEY — EXERCISE-4(A)

1. 66.11mmHg, 0.656 **2.** 69.6 g/mole **3.** 156.06 g/mol

4. (a) 0.76, 0.34, (b) 0.61 **5.** (a) 61.21 g mol^{-1}, (b) 23.99 mmHg **6.** 170.7 g mol^{-1}

7. α = 0.102 **8.** (a) 1.667, (b) 0.667

9. (a) 3.816 k (b) .01814 (c) 4.669 atm (d) 250 g mol^{-1} **10.** 0.23 k

11. 0.78 % **12.** 746.10 mm **13.** 0.214 kg mol^{-1}, 0.86

14. 0.55 **16.** 0.56 **17.** (a) 0.578, 0.422, (b) 0.9967 mol, 0.5374 mol

18. (a) 0.4706 (b) 564.7 Torr (c) 0.08, 0.92 (d) 675 Torr (e) .111, .889

19. T_b = 102.3 C **20.** T_f = – 2.28 C **21.** T_f = – 0.73 C **22.** 3 ions

23. C_6H_6 **24.** 23.25 min **25.** P = 0.2217 atm should be applied

26. (V_{final} = 5 $V_{original}$) **27.** 5.34 atm **28.** p = 6.785 atm

29. x_b = 0.2472, y_b = 0.4473 **30.** p_A = 216.7 mm Hg, p_B = 747.5 mm Hg **31.** M = 53.8

1. A one litre solution is prepared by dissolving some solid lead-nitrate in water. The solution was found to boil at 100.15 C. To the resulting solution 0.2 mole NaCl was added. The resulting solution was found to freeze at –0.83 C. Determine solubility product of $PbCl_2$. Given K_b= 0.5 and K_f = 1.86. Assume molality to be equal to molarity in all case.

2. A protein has been isolated as sodium salt with their molecular formula Na_xP (this notation means that xNa^+ ions are associated with a negatively charged protein P^{-x}). A solution of this salt was prepared by dissolving 0.25 g of this sodium salt of protein in 10 g of water and ebulliscopic analysis revealed that solution boils at temperature 5.93 10^{-3} C higher than the normal boiling point of pure water. K_b of water 0.52 kg mol^{-1}. Also elemental analysis revealed that the salt contain 1% sodium metal by weight. Deduce molecular formula and determine molecular weight of acidic form of protein H_xP.

3. The vapour pressure of two miscible liquids (A) and (B) are 300 and 500 mm of Hg respectively. In a flask 10 mole of (A) is mixed with 12 mole of (B). However, as soon as (B) is added, (A) starts polymerising into a completely insoluble solid. The polymerisation follows first-order kinetics. After 100 minute, 0.525 mole of a solute is dissolved which arrests the polymerisation completely. The final vapour pressure of the solution is 400 mm of Hg. Estimate the rate constant of the polymerisation reaction. Assume negligible volume change on mixing and polymerisation, and ideal behaviour for the final solution.

4. Two beaker A and B present in a closed vessel. Beaker A contains 152.4 g aqueous solution of urea, containing 12 g of urea. Beaker B contains 196.2 g glucose solution, containing 18 g of glucose. Both solutions allowed to attain the equilibrium. Determine wt. % of glucose in it's solution at equilibrium :

5. The vapour pressure of two pure liquids A and B, that form an ideal solution are 100 and 900 mm Hg 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 vaporized ?

6. The addition of 3 g of substance to 100 g CCl_4 (M = 154 g mol^{-1}) raises the boiling point of CCl_4 by 0.60 C of K_b (CCl_4) is 5.03 kg mol^{-1} K. Calculate :
   (a) the freezing point depression
   (b) the relative lowering of vapour pressure
   (c) the osmotic pressure at 298 K
   (d) the molar mass of the substance
   Given $K_f(CCl_4)$ = 31.8 kg mol^{-1} K and ρ (density) of solution = 1.64 g/cm^3.

7. If 20 mL of ethanol (density = 0.7893 g/mL) is mixed with 40 mL water (density = 0.9971 g/mL) at 25 C, the final solution has density of 0.9571 g/mL. Calculate the percentage change in total volume of mixing. Also calculate the molality of alcohol in the final solution.

8. Mixture of two liquids A and B is placed in cylinder containing piston. Piston is pulled out isothermally so that volume of liquid decreases but that of vapour increases. When negligibly small amount of liquid was remaining, the mole fraction of A in vapour is 0.4. Given P_A = 0.4 atm and P_B = 1.2 atm at the experimental temperature. Calculate the total pressure at which the liquid has almost evaporated. (Assume ideal behaviour)

9. 1.5 g of monobasic acid when dissolved in 150 g of water lowers the freezing point by 0.165 C. 0.5 g of the same acid when titrated, after dissolution in water, requires 37.5 mL of N/10 alkali. Calculate the degree of dissociation of the acid (K_f for water = 1.86 C mol^{-1}).

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

11. Calculate the boiling point of a solution containing 0.61 g of benzoic acid in 50 g of carbon disulphide assuming 84% dimerization of the acid. The boiling point and K_b of CS_2 are 46.2 C and 2.3 K kg mol^{-1}, respectively.

12. At 25 C, 1 mol of A having a vapour pressure of 100 torr and 1 mol of B having a vapour pressure of 300 torr were mixed. The vapour at equilibrium is removed, condensed and the condensate is heated back to 25 C. The vapour now formed are again removed, recondensed and analyzed. What is the mole fraction of A in this condensate ?

13. 30 mL of CH_3OH (d = 0.7980 g cm^{-3}) and 70 mL of H_2O (d = 0.9984 g cm^{-3}) are mixed at 25 C to form a solution of density 0.9575 g cm^{-3}. Calculate the freezing point of the solution. $K_f(H_2O)$ is 1.86 kg mol^{-1} K. Also calculate its molarity.

14. Vapour pressure of C_6H_6 and C_7H_8 mixture at 50 C is given by P (mm Hg) = 179 X_B + 92, where X_B is the mole fraction of C_6H_6 . A solution is prepared by mixing 936 g benzene and 736 g toluene and if the vapours over this solution are removed and condensed into liquid and again brought to the temperature of 50 C, what would be mole fraction of C_6H_6 in the vapour state ?

15. When the mixture of two immiscible liquids (water and nitrobenzene) boils at 372 K and the vapour pressure at this temperature are 97.7 kPa (H_2O) and 3.6 kPa ($C_6H_5NO_2$). Calculate the weight % of nitrobenzene in the vapour.

16. The vapour pressure of a certain liquid is given by the equation :

$\text{Log}_{10}P = 3.54595 - \frac{313.7}{T} + 1.40655 \log_{10} T$ where P is the vapour pressure in mm and T = Kelvin Temperature. Determine the molar latent heat of vaporisation as a function of temperature. Calculate the its value at 80 K.

17. A very dilute saturated solution of a sparingly soluble salt A_3B_4 has a vapour pressure of 20 mm of Hg at temperature T, while pure water exerts a pressure of 20.0126 mm Hg at the same temperature. Calculate the solubility product constant of A_3B_4 at the same temperature.

18. The molar volume of liquid benzene (density = 0.877 g mL^{-1}) increases by a factor of 2750 as it vaporises at 20 C while in equilibrium with liquid benzene. At 27 C when a non - volatile solute (that does not dissociate) is dissolved in 54.6 cm^3 of benzene vapour pressure of this solution, is found to be 98.88 mm Hg. Calculate the freezing point of the solution.

Given : Enthalpy of vaporization of benzene (l) = 394.57 J/g

Molal depression constant for benzene = 5.12 K kg. mol^{-1}

Freezing point of benzene = 278.5 K.

19. An ideal solution was prepared by dissolving some amount of cane sugar (non-volatile) in 0.9 moles of water. The solution was then cooled just below its freezing temperature (271 K), where some ice get separated out. The remaining aqueous solution registered a vapour pressure of 700 torr at 373 K. Calculate the mass of ice separated out, if the molar heat of fusion of water is 96 kJ.

20. The freezing point depression of a 0.109 M aq. solution of formic acid is –0.21 C. Calculate the equilibrium constant for the reaction,

$$HCOOH\ (aq) \rightleftharpoons H^+\ (aq) + HCOO^{\ominus}\ (aq)$$

K_f for water = 1.86 kg mol^{-1} K

21. 10 g of NH_4Cl (mol. weight = 53.5) when dissolved in 1000 g of water lowered the freezing point by 0.637 C. Calculate the degree of hydrolysis of the salt if its degree of dissociation of 0.75. The molal depression constant of water is 1.86 kg mol^{-1} K.

22. The freezing point of 0.02 mol fraction solution of acetic acid (A) in benzene (B) is 277.4 K. Acetic acid exists partly as a dimer $2A = A_2$. Calculate equilibrium constant for the dimerisation. Freezing point of benzene is 278.4 K and its heat of fusion ΔH_f is 10.042 kJ mol^{-1}.

23. Tritium, T (an isotope of H) combines with fluorine to form weak acid TF, which ionizes to give T^+. Tritium is radioactive and is a β-emitter. A freshly prepared aqueous solution of TF has pT (equivalent of pH) of 1.5 and freezes at –0.372 C. If 600 mL of freshly prepared solution were allowed to stand for 24.8 years, calculate (i) ionization constant of TF. (ii) Number of β-particles emitted.

(Given K_f for water = 1.86 kg mol K^{-1}, $t_{1/2}$ for tritium = 12.4 years.)

BRAIN STORMING SUBJECTIVE EXERCISE — ANSWER KEY — EXERCISE-4(B)

1. 1.46 10^{-5} **2.** $H_{20}P$, 45563 amu **3.** 1.0 10^{-4} **4.** 14.49 %

5. 300 mm Hg **6.** (a) 3.793 C, (b) 0.018, (c) 4.65 atm , (d) 251.5

7. 3.1 %, 8.6 **8.** 0.66 atm **9.** 18.27% **10.** 0.732

11. 46.31 C **12.** 0.1 **13.** –19.91 C, 7.63 M

14. 0.9286 **15.** 20.11%

16. ΔH = 1659.9 Cal. at 80 K, ΔH = R[313.7 2.303 + 1.40655 T] **17.** 5.4 10^{-13}

18. T_f = 277.51 C **19.** 12.54 g **20.** 1.44 10^{-4} **21.** h = 0.109

22. 3.225 **23.** (i) k_a = 7.3 10^{-3} (ii) 3.7 10^{22}

1. Which of the following concentration factor is affected by change in temperature? **[AIEEE-2002]**
(A) Molarity (B) Molality (C) Mol fraction (D) Weight fraction

2. For an aqueous solution, freezing point is – 0.186 C. The boiling point of the same solution is (K_f = 1.86 mol^{-1} kg) and (K_b=0.512 mol^{-1} kg) **[AIEEE-2002]**
(A) 0.186 (B) 100.0512 (C) 1.86 (D) 5.12

3. In a mixture of A and B, components show negative deviation when - **[AIEEE-2003]**
(A) A – B interaction is stronger than A – A and B – B interaction
(B) A – B interaction is weaker than A – A and B – B interaction
(C) $\Delta V_{mix} > 0$, $\Delta S_{miix} > 0$
(D) $\Delta V_{mix} = 0$, $\Delta S_{miix} > 0$

4. A pressure cooker reduces cooking time for food because - **[AIEEE-2003]**
(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

5. If liquids A and B form an ideal solution - **[AIEEE-2003]**
(A) The free energy of mixing is zero
(B) The free energy as well as the entropy of mixing are each zero
(C) The enthalpy of mixing is zero
(D) The entropy of mixing is zero

6. In a 0.2 molal aqueous solution of a weak acid HX the degree of ionization is 0.3. Taking k_f for water as 1.85, the freezing point of the solution will be nearest to – **[AIEEE-2003]**
(A) – 260 C (B) + 0.480 C (C) – 0.480 C (D) – 0.360 C

7. Which one of the following aqueous solutions will exhibit highest boiling point? **[AIEEE-2004]**
(A) 0.01M Na_2SO_4 (B) 0.01M KNO_3 (C) 0.015M urea (D) 0.015M glucose

8. Which of the following liquid pairs shows a positive deviation from Raoult's law ? **[AIEEE-2004]**
(A) Water-hydrochloric acid (B) Benzene-methanol
(C) Water-nitric acid (D) Acetone-chloroform

9. Which one of the following statement is False? **[AIEEE-2004]**
(A) Raoult's law states that the vapour pressure of a component over a solution is proportional to its mole fraction
(B) The osmotic pressure (π) of a solution is given by the equation π = MRT where M is the molarity of the solution
(C) The correct order of osmotic pressure for 0.01M aqueous solution of each compound is $BaCl_2$ > KCl > CH_3COOH > Sucrose
(D) Two sucrose solutions of same molality prepared in different solvent will have the same freezing point depression

10. If α is the degree of dissociation of Na_2SO_4, the vant of Hoff's factor (i) used for calculating the molecular mass is - **[AIEEE-2005]**
(A) 1 – α (B) 1 + α (C) 1 – 2α (D) 1 + 2α

11. Benzene and toluene form nearly ideal solutions. At 20 C, the vapour pressure of benzene is 75 torr and that of toluene is 22 torr. The partial vapour pressure of benzene at 20 C for a solution containing 78 g of benzene and 46 g of toluene in torr is - **[AIEEE-2005]**

(A) 25 (B) 50 (C) 53.5 (D) 37.5

12. Two solutions of a substance (non electrolyte) are mixed in the following manner. 480 ml of 1.5 M first solution + 520 mL of 1.2 M second solution. What is the molarity of the final mixture? **[AIEEE-2005]**

(A) 1.50 M (B) 1.20 M (C) 2.70 M (D) 1.344 M

13. Equimolar solutions in the same solvent have - **[AIEEE-2006]**

(A) Same freezing point but different boiling point
(B) Same boiling point but different freezing point
(C) Different boiling and different freezing point
(D) Same boiling and same freezing points

14. 18 g of glucose ($C_6H_{12}O_6$) is added to 178.2g of water. The vapour pressure of water for this aqueous solution at 100 C is - **[AIEEE-2006]**

(A) 7.60 Torr (B) 76.00 Torr (C) 752.40 Torr (D) 759.00 Torr

15. Density of a 2.05 M solution of acetic acid in water is 1.02 g/mL. The molality of the solution is - **[AIEEE-2006]**

(A) 3.28 mol kg^{-1} (B) 2.28 mol kg^{-1} (C) 0.44 mol kg^{-1} (D) 1.14 mol kg^{-1}

16. A mixture of ethyl alcohol and propyl alcohol has a vapour pressure of 290 mm at 300 K. The vapour pressure of propyl alcohol is 200 mm. If the mole fraction of ethyl alcohol is 0.6, its vapour pressure (in mm) at the same temperature will be **[AIEEE-2007]**

(A) 350 (B) 300 (C) 700 (D) 360

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

(A) 90.0 g mol^{-1} (B) 115.0 g mol^{-1} (C) 105.0 g mol^{-1} (D) 210.0 g mol^{-1}

18. The density (in g mL^{-1}) of a 3.60 M sulphuric acid solution that is 29% H_2SO_4 (Molar mass = 98g mol^{-1}) by mass will be - **[AIEEE-2007]**

(A) 1.64 (B) 1.88 (C) 1.22 (D) 1.45

19. At 80 C, the vapoure pressure of pure liquid 'A' is 520 mm Hg and that of pure liquid 'B' is 1000 mm Hg. If a mixture solution of 'A' and 'B' boils at 80 C and 1 atm pressure, the amount of 'A' in the mixture is (1 atm = 760 mm Hg) **[AIEEE-2008]**

(A) 52 mol % (B) 34 mol % (D) 48 mol % (D) 50 mol %

20. The vapour pressure of water at 20 C is 17.5 mm Hg. If 18 g of glucose ($C_6H_{12}O_6$) is added to 178.2 g of water at 20 C, the vapour pressure of the resulting solution will be **[AIEEE-2008]**

(A) 17.675 mm Hg (B) 15.750 mm Hg (C) 16.500 mm Hg (D) 17.325 mm Hg

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

(A) 400 and 600 (B) 500 and 600 (C) 200 and 300 (D) 300 and 400

22. A binary liquid solution is prepared by mixing n-heptane and ethanol. Which one of the folloowing statements is correct regarding the behaviour of the solution ? **[AIEEE-2009]**

(A) The solution is non-ideal, showing –ve deviation from Raoult's law

(B) n-heptane shows +ve deviation while ethanol shows –ve deviation from Raoult's law

(C) The solution formed is an ideal solution.

(D) The solution is non-ideal, showing +ve deviation from Raoult's law

23. If sodium sulphate is considered to be completely dissociated into cations and anions in aqueous solution, the change in freezing point of water (ΔT_f), when 0.01 mol of sodium sulphate is dissolved in 1 kg of water, is (K_f = 1.86 K kg mol^{-1}) :- **[AIEEE-2010]**

(A) 0.0186 K (B) 0.0372 K (C) 0.0558 K (D) 0.0744 K

24. On mixing, heptane and octane form an ideal solution. At 373 K, the vapour pressures of the two liquid components (heptane and octane) are 105 kPa and 45 kPa respectively. Vapour pressure of the solution obtained by mixing 25.0 of heptane and 35 g of octane will be (molar mass of heptane = 100 g mol^{-1} and of octane = 114 g mol^{-1}) :- **[AIEEE-2010]**

(A) 144.5 kPa (B) 72.0 kPa (C) 36.1 kPa (D) 96.2 kPa

25. 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]**

(A) $\alpha = \frac{x+y-1}{i-1}$ (B) $\alpha = \frac{x+y+1}{i-1}$ (C) $\alpha = \frac{i-1}{(x+y-1)}$ (D) $\alpha = \frac{i-1}{x+y+1}$

26. Ethylene glycol is used as an antifreeze in a cold climate. Mass of ethylene glycol which should be added to 4 kg of water to prevent it from freezing at – 6 C will be :

(K_f for water = 1.86 K $kgmol^{-1}$, and molar mass of ethylene glycol = 62 $gmol^{-1}$) **[AIEEE-2011]**

(A) 400.00 g (B) 304.60 g (C) 804.32 g (D) 204.30 g

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

(A) 136.2 (B) 171.2 (C) 68.4 (D) 34.2

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

(A) 0.555 m (B) 5.55 10^{-4} m (C) 33.3 m (D) 3.33 10^{-2} m

29. 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]**

(A) 27 g (B) 72 g (C) 93 g (D) 39 g

JEE-[MAIN] : PREVIOUS YEAR QUESTIONS **ANSWER KEY** EXERCISE -5[A]

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

EXERCISE - 05 [B] JEE-[ADVANCED] : PREVIOUS YEAR QUESTIONS

1. An azeotropic solution of two liquids has boiling point lower than either of them when it : **[JEE 1981]**
(A) shows negative deviation from Raoult's law (B) shows no deviation from Raoult's law
(C) shows positive deviation from Raoult's law (D) is saturated

2. For a dilute solution, Raoult's law state that : **[JEE 1985]**
(A) the lowering of vapour pressure is equal to mole fraction of solute
(B) the relative lowering of vapour pressure is equal to the mole fraction of solute
(C) the relative lowering of vapour pressure is proportional to the amount of solute in solution
(D) the vapour pressure of the solution is equal to the mole fraction of solvent

3. Which of the following 0.1 M aqueous solutions will have the lowest freezing point ? **[JEE 1989]**
(A) Potassium sulphate (B) Sodium chloride (C) Urea (D) Glucose

4. The freezing point of equimolal aqueous solution is highest for :
(A) $C_6H_5N^+H_3Cl^-$ (aniline hydrochloride) (B) $Ca(NO_3)_2$
(C) $La(NO_3)_3$ (D) $C_6H_{12}O_6$ (glucose)

5. Osmotic pressure of a solution is 0.0821 atm at a temperature of 300 K. The concentration in mole/litre will be : **[REE 1990]**
(A) 0.33 (B) 0.066 (C) 0.3 10^{-2} (D) 3

6. Increasing the temperature of an aqueous solution will cause : **[JEE 1983]**
(A) decrease in molality (B) decrease in molarity
(C) decrease in the mole fraction (D) decrease in % (w/w)

7. How many moles of Fe^{2+} ions are formed when excess iron is treated with 500 mL of 0.4 M HCl under inert atmosphere ? Assume no change in volume : **[JEE 1993]**
(A) 0.4 (B) 0.1 (C) 0.2 (D) 0.8

8. A 0.2 molal aqueous solution of a weak acid (HX) is 20 percent ionised. The freezing point of this solution is (given k_f = 1.86 C kg mol^{-1} for water) : **[JEE 1995]**
(A) –0.45 C (B) –0.90 C (C) –0.31 C (D) –0.53 C

9. The molecular weight of benzoic acid in benzene as determined by depression in freezing point of the solution is : **[JEE 1996]**
(A) ionization of benzoic acid (B) dimerization of benzoic acid
(C) trimerization of benzoic acid (D) solvation of benzoic acid

10. The van't Hoff factor for 0.1 M $Ba(NO_3)_2$ solution is 2.74. The degree of dissociation is : **[JEE 1996]**
(A) 91.3% (B) 87% (C) 100% (D) 74%

11. In the depression of freezing point experiment, it is found that : **[JEE 1999]**
(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)

12. To 500 cm^3 of water, 3.0 10^{-3} kg of acetic acid is added. If 23% of acetic acid is dissociated, what will be the depression in freezing point? k_f and density of water are 1.86 K kg mol^{-1} and 0.997 g cm^{-3} respectively : **[JEE 2000**
(A) 0.186 K (B) 0.228 K (C) 0.372 K (D) 0.556 K

13. An aqueous solution of 6.3 g oxalic acid dihydrate is made up to 250 mL. The volume of 0.1 N NaOH required to completely neutralise 10 mL of this solution is : **[JEE 2001]**
(A) 40 mL (B) 20 mL (C) 10 mL (D) 4 mL

14. 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

15. The elevation in boiling point of a solution of 13.44 g of $CuCl_2$ in 1 kg of water using the following information will be (Molecular weight of $CuCl_2$ = 134.4 and K_b = 0.52 K $molal^{-1}$) : **[JEE 2005]**

(A) 0.16 (B) 0.05 (C) 0.1 (D) 0.2

SUBJECTIVE QUESTIONS :

16. A very small amount of a nonvolatile solute (that does not dissociate) is dissolved in 56.8 cm^3 of benzene (density 0.889 g cm^{-3}), At room temperature, vapour pressure of this solution is 98.88 mm Hg while that of benzene is 100 mm Hg. Find the molality of this solution If the freezing point depression constant of benzene ? **[JEE 1997]**

17. A solution of a nonvolatile solute in water freezes at –0.30 C. The vapour pressure of pure water at 298 K is 23.51 mm Hg and K_f for water is 1.86 degree/molal. Calculate the vapour pressure of this solution at 298 K. **[JEE 1998]**

18. The vapour pressure of two miscible liquids (A) and (B) are 300 and 500 mm of Hg respectively. In a flask 10 mole of (A) is mixed with 12 mole of (B). However, as soon as (B) is added, (A) starts polymerising into a completely insoluble solid. The polymerisation follows first-order kinetics. After 100 minute, 0.525 mole of a solute is dissolved which arrests the polymerisation complete. The final vapour pressure of the solution is 400 mm of Hg. Estimate the rate constant of the polymerisation reaction. Assume negligible volume change on mixing and polymerisation and ideal behaviour for the final solution. **[JEE 2001]**

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

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

20. 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 : **[JEE 2004]**

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

(b) What do you deduce out of it in terms of structure of benzoic acid?

21. 72.5 g of phenol is dissolved in 1 kg of a solvent (k_f = 14) which leads to dimerisation of phenol and freezing point is lowered by 7 kelvin. What percent of total phenol is present in dimeric form: **[JEE 2006]**

22. 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

Paragraph for Question No. Q.23 to Q.24

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.

23. 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

24. 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

25. 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

26. 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}

27. 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}

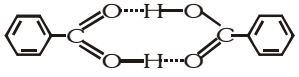
Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	B	A	D	C	B	B	A	B	B	C	B	A	A	A

16. 0.1452, 5.025Km^{-1} **17.** 23.44 mm Hg **18.** 1.0 10^{-4}

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

20. (a) 122, 244

(b) It means that benzoic acid remains as it is in acetone while it dimerises in benzeneas



21. 35% phenol is present in dimeric form.

22. A **23.** D **24.** B **25.** B **26.** A **27.** A