AIM HIGH, TOGETHER WE FLY

THE VILLAGE
INTERNATIONAL SCHOOL
“We Nurture Dreams”

SOLUTIONS

1. Which of the following condition is not satisfied by an ideal solution?

   a. $\Delta\text{Hmixing} = 0$
   b. $\Delta\text{Vmixing} = 0$
   c. Raoult’s Law is obeyed
   d. Formation of an azeotropic mixture

2. People add sodium chloride to water while boiling eggs. This is to

   a. decrease the boiling point
   b. increase the boiling point
   c. prevent the breaking of eggs
   d. make eggs tasty

3. The boiling point of an azeotropic mixture of water and ethanol is less than that of water and ethanol. The mixture shows

   a. no deviation from Raoult’s Law
   b. positive deviation from Raoult’s Law
   c. negative deviation from Raoult’s Law
   d. that the solution is unsaturated

4.The number of moles of NaCl in 3 litres of 3M solution is

   a. 1
   b. 3
   c. 9
   d. 27

5. Low concentration of oxygen in the blood and tissues of people living at high altitude is due to __________

   a. low temperature
   b. low atmospheric pressure
   c. high atmospheric pressure
   d. both low temperature and high atmospheric pressure

6. Considering the formation, breaking and strength of hydrogen bond, predict which of the following mixtures will show a positive deviation from Raoult’s law?

   a. Methanol and acetone.
   b. Chloroform and acetone.
   c Nitric acid and water.
   d. Phenol and aniline.

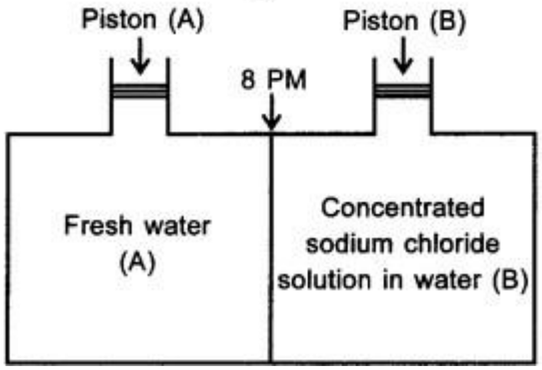
7. Which of the following statements is false?
   a. Two different solutions of sucrose of same molality prepared in different solvents will have the same depression in freezing point.
   b. The osmotic pressure of a solution is given by the equation $\pi = CRT$ (where C is the molarity of the solution).
   c. The value of Henry’s constant K_H is greater for gases with lower solubility.
   d. According to Raoult’s law, the vapour pressure exerted by a volatile component of a solution is directly proportional to its mole fraction in the solution.

8. Which relationship is not correct?

(a) $\Delta T_b = \frac{K_b.1000.W_2}{M_2.W_1}$ (b) $M_2 = \frac{K_f.1000.W_1}{W_2.\Delta T_b}$

(c) $\pi = \frac{n_2}{V}$ (d) $\frac{p^\circ - p_s}{p^\circ} = \frac{W_2}{M_2} \times \frac{M_1}{W_1}$

9. Consider the figure and mark the correct option



   a. water will move from side (B) to side (A) if a pressure lower than osmotic pressure is applied on piston (B).
   b. water will move from side (B) to side (A) if a pressure greater than osmotic, pressure is applied on piston (B).
   c. water will move from side (B) to side (A) if a pressure equal to osmotic pressure is applied on piston (B).
   d. water will move from side (A) to side (B) if pressure equal to osmotic pressure is applied on piston (A).

10. Intermolecular forces between two benzene molecules are nearly of same strength as those between two toluene molecules. For a mixture of benzene and toluene, which of the following are true?
   (i) $\Delta_{mix} H$ = zero
   (ii) $\Delta_{mix} V$ = zero
   (iii) These will form minimum boiling azeotrope.
   (iv) These will not form ideal solution.
   a. Only i
   b. Both i and ii
   c. i, ii, iii
   d. ii, iii, iv

ASSERTION REASON TYPE

a. Assertion and reason both are correct statements and reason is correct explanation for assertion.
b. Assertion and reason both are correct statements but reason is not correct explanation for assertion.
c. Assertion is correct statement but reason is wrong statement.
d. Assertion is wrong statement but reason is correct statement.

11. **Assertion:** Molarity of a solution in liquid state changes with temperature.
    Reason: The volume of a solution changes with change in temperature.

12. **Assertion:** When a solution is separated from the pure solvent by a semi- permeable membrane, the solvent molecules pass through it from pure solvent side to the solution side.
    Reason: Diffusion of solvent occurs from a region of high concentration solution to a region of low concentration solution.

13. **Assertion:** When NaCl is added to water a depression in freezing point is observed.
    Reason: The lowering of vapour pressure of a solution causes depression in the freezing point.

2 Marks

14. Define the following terms.
    a. Mole fraction
    c. Molal Elevation constant (K_b)

15. State Henry's law correlating the pressure of a gas and its solubility in a solvent and mention two applications for the law.

16. What is meant by
    a. Colligative property b. Molality of a solution

17. State the following
    a. Raoult's law in its general form in reference to solutions.
    b. Henry's law about partial pressure of a gas in a mixture.

18. a. Why does a solution containing non-volatile solute have higher boiling point than the pure solvent?
    b. Why is elevation of boiling point a colligative property?

19. Blood cells are isotonic with 0.9% sodium chloride solution. What happens if we place blood cells in a solution containing
    a. 1.2% sodium chloride solution?
    b. 0.4% sodium chloride solution?

3 Marks

20. Calculate the freezing point of the solution when 31 g of ethylene glycol ($C_2H_6O_2$) is dissolved in 500 g of water. (K_f for water = 1.86 $KKgmol^{-1}$)

21. A solution containing 15g of urea (M = 60 $gmol^{-1}$) per litre of solution in water has the same osmotic pressure (isotonic) as a solution of glucose (M = 180 $gmol^{-1}$) in water. Calculate the mass of glucose present in one litre of its solution.

22. A solution of glucose (M = 180 $gmol^{-1}$) in water is labelled as 10% (by mass). What would be the molality and molarity of the solution? (Density of the solution = 1.2 gml^{-1})

23. 100 mg of a protein is dissolved in enough water to make 10 L of a solution. If this solution has an osmotic pressure of 13.3 mm Hg at 25 ºC, what is the molar mass of protein?
(R = 0.0821 $LatmK^{-1}mol^{-1}$ and 760 mm Hg = 1 atm)

24. a. Calculate the temperature at which a solution containing 54 g of glucose, ($C_6H_{12}O_6$), in 250 g of water will freeze. (K_f for water = 1.86 $KKgmol^{-1}$)
b. Out of 1 M glucose and 2M glucose, which one has higher boiling point and why?

25. Define the terms, 'osmosis' and 'osmotic pressure'. What is the advantage of using osmotic pressure as compared to other colligative properties for the determination of molar mass of solutes in solutions?

26. 30 g of urea (M = 60 $gmol^{-1}$) is dissolved in 846 g of water. Calculate the vapour pressure of water for this solution if vapour pressure of pure water at 298 K is 23.8 mm Hg.

5 Marks

27. a. Write two differences between ideal and non-ideal solution.
b. A 10% solution (by mass) of sucrose in water has a freezing point of 269.15K. Calculate the freezing point of 10% glucose in water if the freezing point of pure water is 273.15 K
(Molar masses of sucrose = 342 $gmol^{-1}$ and glucose = 180 $gmol^{-1}$)

28. Give reasons for the following.
a. Fruits are preserved in sugar and hence protected from bacteria.
b. Aquatic animals are more comfortable in cold water than in warm water.
c. Solubility of gases in liquids decreases with rise in temperature.
d. Ethylene glycol is added to car radiators in cold countries.
e. A mixture of chloroform and acetone forms a solution with negative deviation from Raoult's law.

CASE STUDY TYPE QUESTIONS

29.29.

The properties which depend on number of solute particle but not on the nature of the solute particles are called colligative properties.

Relative lowering of vapour pressure is an example of colligative properties. For an experiment, sugar solution is prepared for which lowering of vapour pressure was found to be 0.061 mm of Hg.(Vapour pressure of water at 20°C is 17.5 mm of Hg)

Answer the following questions by choosing the most appropriate options.

i. Relative lowering of vapour pressure for the given solution is

a. 0.00348 b. 0.061

c. 0.122 d. 1.75

ii. The vapour pressure (mm of Hg) of solution will be

a. 17.5 b. 0.61

b. 17.439 d. 0.00348

iii. Mole fraction of sugar in the solution is

a. 0.00348 b. 0.9965

c. 0.061 d. 1.75

iv. If weight of sugar taken is 5 g in 108 g of water then molar mass of sugar will be

a. 358 b. 120

c. 240 d. 400

v. The vapour pressure (mm of Hg) of water at 293 K when 25 g of glucose is dissolved in 450 g of water is

a. 17.2 b. 17.4

c. 17.120 d. 17.02

Q.NO	ANSWERS	MARKS
1	d	1
2	b	1
3	b	1
4	c	1
5	b	1
6	a	1
7	a	1
8	b	1
9	b	1
10	b	1
11	a	1
12	c	1
13	a	1

14	a. Mole fraction of a component = $\frac{\text{Number of moles of the component}}{\text{Total number of moles of all the components}}$ b. Elevation of boiling point of a 1 molal solution. $\triangle Tf = Kf\ m$	1 1
15	Henrys law - The partial pressure of the gas in vapour phase (p) is proportional to the mole fraction of the gas (x) in the solution. $p = K_H\ \chi$ Applications- Anoxia, Bends, Carbonated drinks	1 1
16	a. The properties which depend on the number of solute particles irrespective of their nature relative to the total number of particles present in the solution. b. Molality (m) = $\frac{\text{Moles of solute}}{\text{Mass of solvent in kg}}$	1 1
17	a. Raoults law - For a solution of volatile liquids, the partial vapour pressure of each component of the solution is directly proportional to its mole fraction present in solution. For component 1, **p_1 a χ_1** b. Henrys law - The partial pressure of the gas in vapour phase (p) is proportional to the mole fraction of the gas (x) in the solution. $p = K_H\ \chi$	1 1
18	a. The vapour pressure of the solution at a given temperature is found to be lower than the vapour pressure of the pure solvent at the same temperature. Therefore, higher temperature is needed for the vapour pressure to become equal to atmospheric pressure so as to boil. b. Elevation of boiling point is dependent on the presence of dissolved particles and their number, but not their identity. It is an effect of the dilution of the solvent in the presence of a solute.	1 1
19	a. Blood cells will shrink b. Blood cells swell.	1 1
20	$\triangle Tf = \frac{Kf \times w_2 \times 1000}{M_2 \times w_1}$ $= 1.86$ K	1 1

	$\triangle T_f = T_f^\circ - T_f$ $T_f = 271.29$ K	1
21	π of urea = π of glucose (isotonic) $\frac{w_2}{M_2 \times V} = \frac{w_2}{M_2 \times V}$ $\frac{15}{60} = \frac{\text{mass of glucose}}{180}$ Mass of glucose = 45 g	1 1 1
22	Molality = $\frac{w_2 \times 1000}{M_2 \times w_1}$ $= \frac{10 \times 1000}{180 \times 90}$ = 0.617 m Molarity = $\frac{\text{mass\%} \times \text{density} \times 10}{\text{Molar mass of solute}}$ $= \frac{10 \times 1.2 \times 10}{180}$ = 0.667 M	1 1 1
23	$\pi = \frac{w_2 \times R\,T}{M_2 \times V}$ $0.0175 \text{ atm} = \frac{100 \times 10^{-3} \text{ g} \times 0.0821 \text{ LatmK}^{-1}\text{mol}^{-1} \times 298 \text{ K}}{M_2 \times 10 \text{ L}}$ $M_2 = 13980.45 \times 10^{-3}$ g mol^{-1}	1 1 1
24	a. $\triangle T_f = \frac{K_f \times w_2 \times 1000}{M_2 \times w_1}$ $= \frac{1.86 \times 54 \times 1000}{180 \times 250}$ = 2.232 K $\triangle T_f = T_f^\circ - T_f$ 2.232 = 273.15 – Tf Tf = 270.918 K	1 1 1

<table>
<tr>
<td>25</td>
<td>Osmosis – The movement of solvent molecules from a less concentrated solution to more concentrated solution through a semi permeable membrane.
Osmotic pressure – The pressure applied on the solution side to just stop the flow of solvent (osmosis) is called osmotic pressure of the solution.

Advantages of using osmotic pressure
i. Pressure measurement is around the room temperature.
ii. Molarity of the solution is used instead of molality.
iii. As compared to other colligative properties, its magnitude is large even for very dilute solutions</td>
<td>1
1
1</td>
</tr>
<tr>
<td>26</td>
<td>$\frac{p_1° - p_1}{P_1°} = \frac{w_2 \times M_1}{M_2 \times w_1}$

$\frac{23.8 - p1}{23.8} = \frac{30 \times 18}{60 \times 846}$

$P_1 = 23.547$ mm Hg</td>
<td>1
1
1</td>
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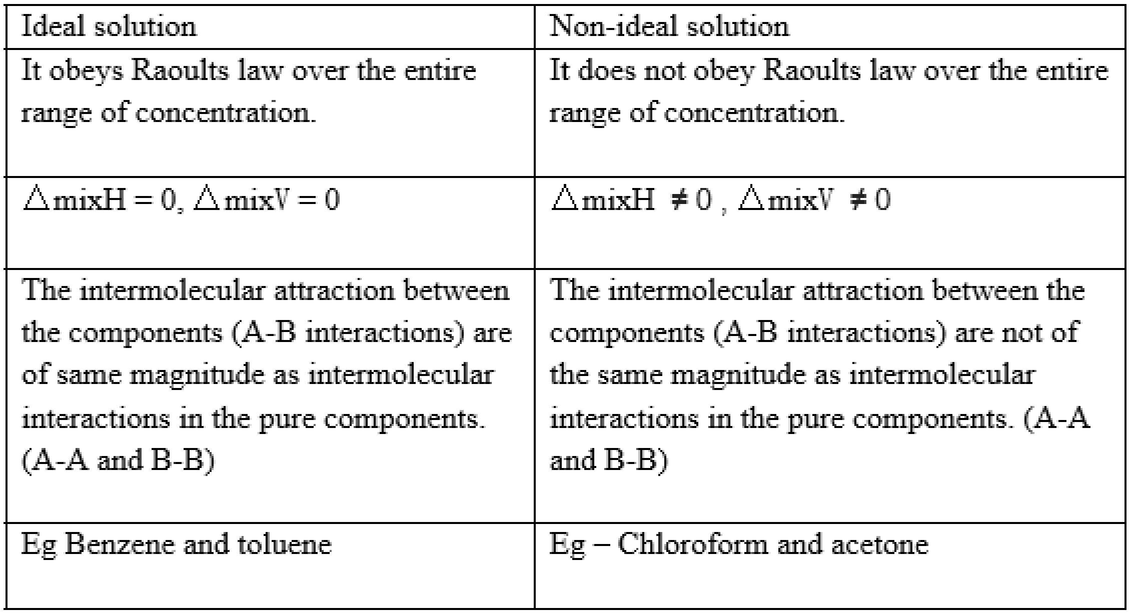
<tr>
<td>27</td>
<td>a.

<table>
<tr><th>Ideal solution</th><th>Non-ideal solution</th></tr>
<tr><td>It obeys Raoults law over the entire range of concentration.</td><td>It does not obey Raoults law over the entire range of concentration.</td></tr>
<tr><td>$\triangle$mixH = 0, $\triangle$mixV = 0</td><td>$\triangle$mixH $\neq 0$, $\triangle$mixV $\neq 0$</td></tr>
<tr><td>The intermolecular attraction between the components (A-B interactions) are of same magnitude as intermolecular interactions in the pure components. (A-A and B-B)</td><td>The intermolecular attraction between the components (A-B interactions) are not of the same magnitude as intermolecular interactions in the pure components. (A-A and B-B)</td></tr>
<tr><td>Eg Benzene and toluene</td><td>Eg – Chloroform and acetone</td></tr>
</table>
b.
$\triangle Tf = Kf \times \frac{w_2 \times 1000}{M_2 \times w_1}$

$273.15 - 269.15 = \frac{Kf \times 10 \times 1000}{342 \times 90}$

$Kf = \frac{4 \times 342 \times 90}{10 \times 1000}$</td>
<td>1
1
½
1</td>
</tr>
</table>

	$= 12.31\ Kkg\ mol^{-1}$ For glucose $\triangle Tf = \frac{Kf \times w_2 \times 1000}{M_2 \times w_1}$ $= \frac{12.31 \times 10 \times 1000}{180 \times 90}$ = 7.5 K Tf° - Tf = 7.5 K Tf = 273.15 – 7.5 = 265.65 K	½ 1
28	a. Through the process of osmosis, a bacterium on candied fruit loses water, shrivels and dies b. Solubility of gases increases decrease in temperature. c. Dissolution of gas in liquid is exothermic. Low temp favours dissolution (Le Chatelier's principle) d. To prevent water from freezing. It's an antifreeze. It lowers the freezing point of water. e. This is because chloroform molecule is able to form hydrogen bond with acetone molecule. This decreases the escaping tendency of molecules for each component and consequently, the vapour pressure decreases resulting in negative deviation from Raoult's law	1 1 1 1 1
29	i. a ii. b iii. a iv. c v. b	1 1 1 1 1