BYJU'S Study Planner for Board Term I
(CBSE Grade 12)

Date: 19/11/2021

Subject: Chemistry

Topic : Solutions

Class: Standard XII

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1. Read the passage given below and answer the following questions:
   A soluble solid in solution has the effect of raising its boiling point and depressing its freezing point. The addition of non-volatile substances to a solvent decreases the vapor pressure and the added solute particles affects the formation of pure solvent crystals. According to many researches the decrease in freezing point directly correlated to the concentration of solutes dissolved in the solvent. This phenomenon is expressed as freezing point depression and it is useful for several applications such as freeze concentration of liquid food and to find the molar mass of an unknown solute in the solution. Freeze concentration is a high quality liquid food concentration method where water is removed by forming ice crystals. This is done by cooling the liquid food below the freezing point of the solution.
   When a non-volatile solid is added to pure water it will

   ✗ **A.** Boils above 100^oC and freezes above 0^oC

   ✓ **B.** Boils above 100^oC and freezes below 0^oC

   ✗ **C.** Boils below 100^oC and freezes above 0^oC

   ✗ **D.** Boils below 100^oC and freezes below 0^oC

   Lowering in vapour pressure results in an elevation in boiling point. Therefore, when a non-volatile solid is added to pure water, it will boil at higher temperature and freeze at lower temperature, i.e. below 0^oC.

BYJU'S Study Planner for Board Term I
(CBSE Grade 12)

2. Read the passage given below and answer the following questions:
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Identify which of the following is colligative property:

✗ **A.** Freezing point

✗ **B.** Boiling point

✓ **C.** Osmotic pressure

✗ **D.** All of the above

Osmotic pressure is a colligative property as it depends on the number of solute present and not on the nature of the solute. Experimentally it was proved that osmotic pressure (π) is directly proportional to molarity (C) and temperature (T) .

BYJU'S Study Planner for Board Term I
(CBSE Grade 12)

3. Read the passage given below and answer the following questions:
A soluble solid in solution has the effect of raising its boiling point and depressing its freezing point. The addition of non-volatile substances to a solvent decreases the vapor pressure and the added solute particles affect the formation of pure solvent crystals. According to many researches the decrease in freezing point directly correlated to the concentration of solutes dissolved in the solvent. This phenomenon is expressed as freezing point depression and it is useful for several applications such as freeze concentration of liquid food and to fmd the molar mass of an unknown solute in the solution. Freeze concentration is a high quality liquid food concentration method where water is removed by forming ice crystals. This is done by cooling the liquid food below the freezing point of the solution.
Assume three samples of juices A, B and C which have glucose as the only sugar in them. The concentration of sample A, B and C are 0.1 M, 0.5 M and 0.2 M respectively. Freezing point will be highest for the fruit juice:

✗ **A.** A

✓ **B.** B

✗ **C.** C

✗ **D.** All have same freezing point

Greater is the concentration, lower will be the freezing point. Since sample B has highest concentration thus it has the lowest freezing point.

4. Which of the following analogies is correct regarding Raoult's law:

$\text{Depression in freezing point} : \text{molality} :: \text{Raoult's law} : - - -$

A. Molality

B. Molarity

C. Mole Fraction

D. Percentage composition $(\frac{w}{v})$

Raoult's law states that a solvent's partial vapour pressure in a solution (or mixture) is equal or identical to the vapour pressure of the pure solvent multiplied by its mole fraction in the solution.

Mathematically, Raoult's law equation is written as;
$P_{\text{solution}} = X_{\text{solvent}} P^0_{\text{solvent}}$
Where,
P_{solution} = vapour pressure of the solution
X_{solvent} = mole fraction of the solvent
P^0_{solvent} = vapour pressure of the pure solvent

5. Match the items given in Column I and Column II.

	Column I		Column II
(i)	Saturated solution	(a)	Solution having the same osmotic pressure at a given temperature as that of the given solution.
(ii)	Binary solution	(b)	A solution whose osmotic pressure is less than that of another.
(iii)	Isotonic solution	(c)	Solution with two components
(iv)	Hypotonic solution	(d)	A solution which contains the maximum amount of solute that can be dissolved in a given amount of solvent at a given temperature.
(v)	Solid Solution	(e)	A solution whose osmotic pressure is more than another.
(vi)	Hypertonic Solution	(f)	A solution in the solid phase

✗ **A.** $(i) \to (b),\ (ii) \to (c),\ (iii) \to (d),\ (iv) \to (a),\ (v) \to (e),\ (vi) \to (f)$

✗ **B.** $(i) \to (c),\ (ii) \to (b),\ (iii) \to (d),\ (iv) \to (a),\ (v) \to (e),\ (vi) \to (f)$

✗ **C.** $(i) \to (b),\ (ii) \to (d),\ (iii) \to (c),\ (iv) \to (a),\ (v) \to (e),\ (vi) \to (f)$

✓ **D.** $(i) \to (d),\ (ii) \to (c),\ (iii) \to (a),\ (iv) \to (b),\ (v) \to (f),\ (vi) \to (e)$

Saturated solution is a solution which contains the maximum amount of solute that can be dissolved in a given amount of solvent at a given temperature.
Binary solution is a solution with two components in it.
Isotonic solution is a solution having the same osmotic pressure at a given temperature as that of the given solution.
Hypotonic solution is a solution whose osmotic pressure is less than that of
Solid solution is a solution in the solid phase.
Hypertonic solution is a solution whose osmotic pressure is more than that of the given solution.

So, (D) $(i) \to (d),\ (ii) \to (c),\ (iii) \to (a),\ (iv) \to (b),\ (v) \to (f),\ (vi) \to (e)$

BYJU'S Study Planner for Board Term I
(CBSE Grade 12)

6. Assertion (A): Elevation in boiling point is a colligative property.
Reason (R): Elevation in boiling point is directly proportional to molality.

- ✔ **A.** Both A and R are true and R is the correct explanation of A
- ✘ **B.** Both A and R are true but R is NOT the correct explanation of A
- ✘ **C.** A is true but R is false
- ✘ **D.** A is false and R is true

Elevation in boiling point is a colligative property. It depends on the amount of solute present in the solution. So it is directly proportional to molality also.
$\Delta T_b = K_b \times m$
Where, $\Delta T_b = \text{Elevation in boiling point}$
$m = \text{molality}$

7. Assertion (A): An ideal solution obeys Henry's law.
Reason (R): In an ideal solution, solute-solute as well as solvent-solvent interactions are similar to solute-solvent interaction.

- ✘ **A.** Both A and R are true and R is the correct explanation of A
- ✘ **B.** Both A and R are true and R is NOT the correct explanation of A
- ✘ **C.** A is true but R is false
- ✔ **D.** A is false but R is True

An ideal solution obeys Raoult's law and in case of an ideal solution the intermolecular attractive interactions of solvent-solvent and solute-solute are nearly same to the solute-solvent interactions.

8. Assertion : Azeotropic mixtures are formed only by non - ideal solutions and they may have boiling points either greater than both the components or less than both the components.
Reason : The composition of the vapour phase is same as that of the liquid phase of an azeotropic mixture.

- A. Both assertion and reason are correct and the reason is a correct explanation of the assertion
- B. Both assertion and reason are correct but reason is not a correct explanation of the assertion
- C. The assertion is correct but reason is incorrect
- D. Both assertion and reason are incorrect

Azeotropic mixtures are formed only by non - ideal solutions and they may have boiling points either greater than both the components or less than both the components and based on that they are called maximum boiling azeotrope and minimum boiling azeotrope respectively.
Azetropic mixtures are binary mixtures having the same composition in liquid and vapour phase and boil at a constant temperature.

9. The gas with highest value of Henry's constant for the solubility in water among the following

- A. He
- B. O_2
- C. Methane
- D. Vinyl chloride

Gas with poor solubility will have the highest value Henry's constant. Helium has the poorest solubility in water.
Hence it has the highest value of Henry's constant.

BYJU'S Study Planner for Board Term I
(CBSE Grade 12)

10. p_A and p_B are the vapour pressures of pure liquid components, A and B, respectively of an ideal binary solution. If x_A represents the mole fraction of component A, the total pressure (P) of the solution will be:

✗ **A.** $p_A + x_A(p_B - p_A)$

✗ **B.** $p_A + x_A(p_B - p_A)$

✗ **C.** $p_B + x_A(p_B - p_A)$

✓ **D.** $p_B + x_A(p_A - p_B)$

Accordung to Raoult's law,
$P = x_A p_A + x_B p_B \ldots (i)$
For binary solution,
$x_A + x_B = 1$
$x_B = 1 - x_A \ldots (ii)$
Putting the values of x_B from equation (ii) into equation (i), we get
$P = x_A p_A (1 - x_A) p_B = x_A p_A + p_B - x_A p_B$
$P = p_B + x_A(p_A - p_B)$

11. An unripe mango placed in a concentrated salt solution to prepare pickle, shrivels because:

✗ **A.** It gains water due to osmosis

✗ **B.** It loses water due to reverse osmosis

✗ **C.** It gains water due to reverse osmosis

✓ **D.** It loses water due to osmosis

It loses water due to osmosis. Due to osmosis, solvent molecules moves from low concentration side to high concentration side. Hence, a raw mango placed in concentrated salt solution loses water via osmosis and shrivel into pickle.

12. Which of the following statements is false?

✗ **A.** Units of atmospheric pressure and osmotic pressure are the same

✓ **B.** In reverse osmosis, solvent molecules move through a semipermeable membrane from a region of lower concentration of solute to a region of higher concentration

✗ **C.** The value of molal depression constant depends on nature of solvent

✗ **D.** Relative lowering of vapour pressure, is a dimensionless quantity

In reverse osmosis, solvent molecules from higher concentration moves towards towards solution with low concentration. It is the principle used in the purification of water.

13. If molality of the dilute solution is doubled, the value of molal depression constant (K_f) will be:

✗ **A.** Doubled

✗ **B.** Halved

✗ **C.** Tripled

✓ **D.** Unchanged

The molal depression constant is

$$K_f = \frac{RT_f^2 M_1}{\Delta H_{fus}}$$

where M_1 is the molar mass of the solvent.

K_f depends only on the nature of the solvent and hence does not depend on molality.

14. 20 g of non-electrolyte, non-volatile solute $(C_xH_{2x}O_x)$ when dissolved in 100 g water at 100° C, lowers the vapour pressure of solution by $\left(\frac{1}{100}\right) th$ of the vapour pressure of pure water. What is formula of the compound?

- **A.** $C_6H_{12}O_6$
- **B.** $C_{12}H_{24}O_{12}$
- **C.** $C_{44}H_{88}O_{44}$
- **D.** $C_3H_6O_3$

Given, weight of solvent $(W_1) = 100$ g and weight of solute $(W_2) = 20g$
p_1^0 is the vapour pressure of pure water and p_1 is the vapour pressure of the solution.

We know, $\frac{p_1^0 - p_1}{p_1^0} = \frac{w_2 \times m_1}{m_2 \times w_1}$

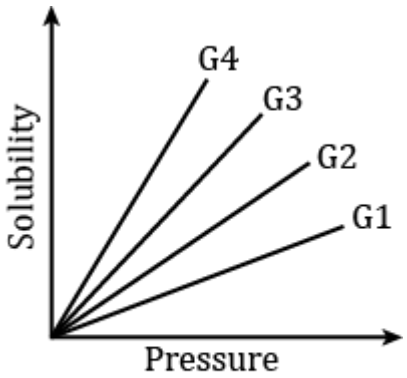
$\Rightarrow \frac{100 - 99}{100} = \frac{20 \times 18}{30x \times 100}$

$\Rightarrow x = 12$

So, the formula is $C_{12}H_{24}O_{12}$.

BYJU'S Study Planner for Board Term I
(CBSE Grade 12)

15. The variation of solubility of four different gases (G_1, G_2, G_3, G_4) in a given solvent with pressure at a constant temperature is given below. The gas having lowest value of Henry's law constant is:



A. G_1

B. G_2

C. G_4

D. G_3

The variation of solubility of four different gases (G_1, G_2, G_3, G_4) in a given solvent with pressure at constant temperature is shown in the plot.
According to Henry's law, the solubility of a gas in a liquid is directly proportional to the partial pressure of the gas present above the surface of liquid or solution
In mathematical term,
$p = K_h \chi$
Where, $p = \text{Partial pressure of the gas}$
$\chi = \text{ Mole fraction of solute}$
Again more is the mole fraction more is the solubility.
$\therefore \chi = \frac{1}{K_H} p$
Which is analogous to $y = mx + C$
So, slope will be $\frac{1}{K_H}$
Since G_4 has highest solubility at a particular pressure, hence, K_H will be lowest for G_4.

16. A mixture of 2 moles of H_2, 3 moles of NH_3, 4 moles of CO_2 and 5 moles of N_2 exerts a total pressure of 798 torr. What is the partial pressure of CO_2 gas ?

- ✗ **A.** 286 torr
- ✗ **B.** 117 torr
- ✓ **C.** 228 torr
- ✗ **D.** 415 torr

Total number of moles of the gases $= 2 + 3 + 4 + 5 = 14$ mol
Using Dalton's law of partial pressure
$p = P_{\text{total}} \times \chi$
Where, $p = \text{Partial pressure}$
$p_{\text{total}} = \text{Total vapour pressure}$

Mole fraction of $CO_2 = \dfrac{\text{moles of } CO_2}{\text{moles of solution}} = \dfrac{4}{14}$

So, partial pressure of $CO_2 = 798 \times \dfrac{4}{14} = 228$ torr

17. Which of the following condition(s) is/are valid for an ideal solution?

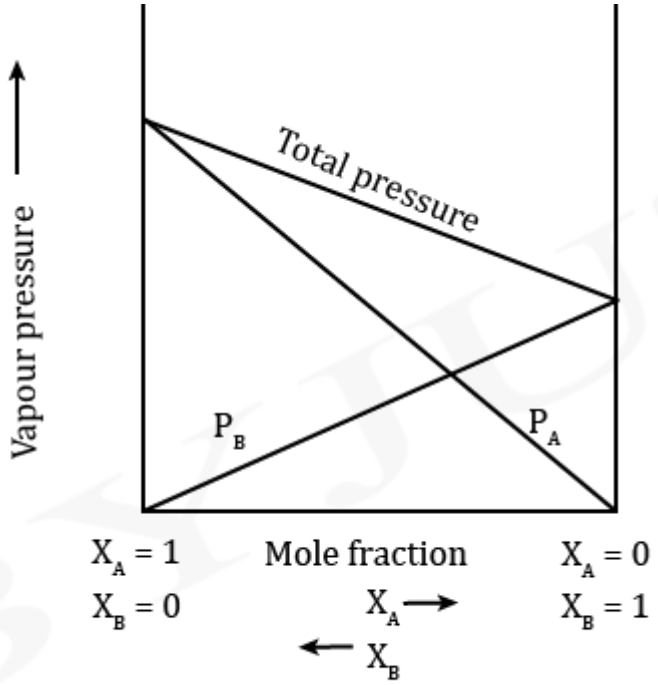
- ✗ **A.** No change in volume on mixing. $\Delta V_{mix} = 0$
- ✗ **B.** No change in enthalpy on mixing. $\Delta H_{mix} = 0$
- ✗ **C.** Entropy on mixing $\Delta S_{mix} > 0$
- ✓ **D.** All of the above.

Ideal solutions:
Solvent-solute interaction is equal to solvent-solvent and solute-solute interactions. There should be no association or dissociation of solute.
$\Delta S_{mix} > 0$
$\Delta V_{mix} = 0$
$\Delta H_{mix} = 0$
Ideal solutions follow Raoult's Law.

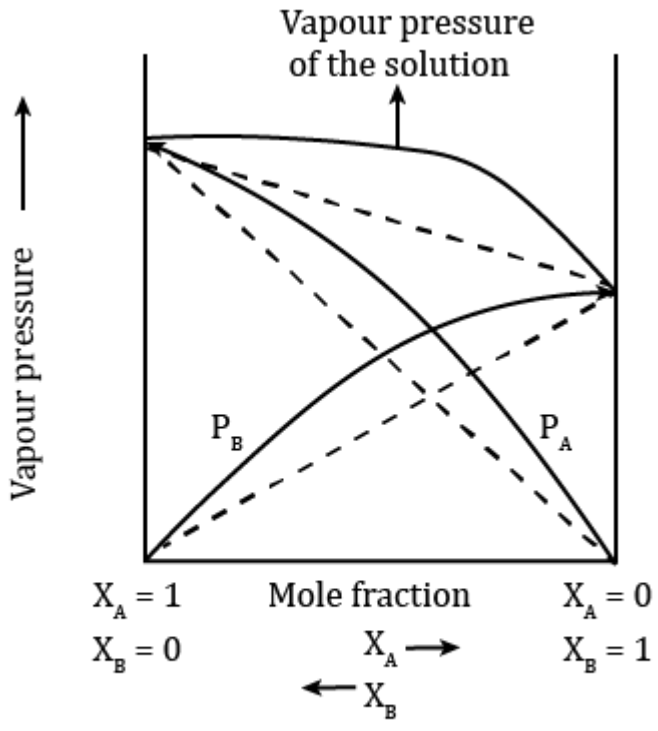
BYJU'S Study Planner for Board Term I
(CBSE Grade 12)

18. Which of the following graph is valid for a solution containing phenol and aniline?
Assume that at the given constant temperature of solution, vapour pressure of phenol (A) in pure state is more than that of aniline (B) in pure state.

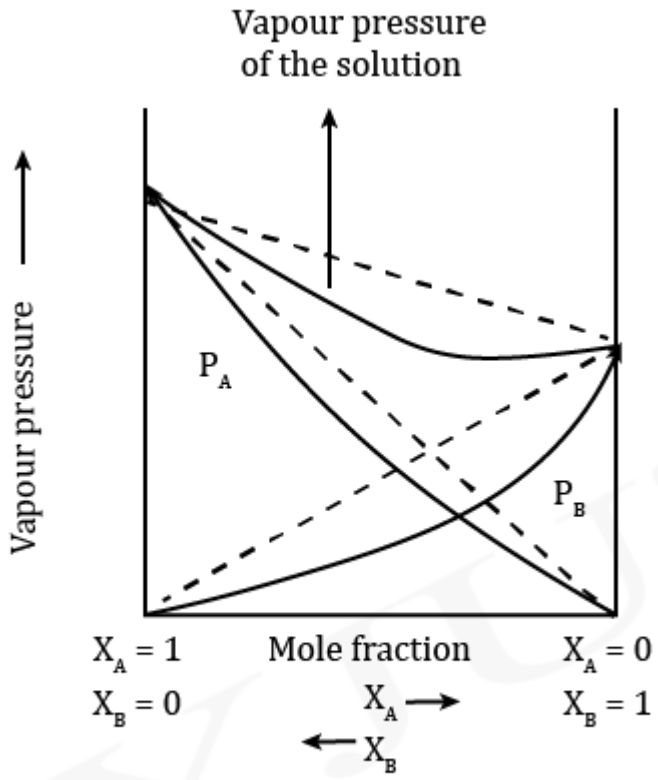
✗ **A.**



✗ **B.**



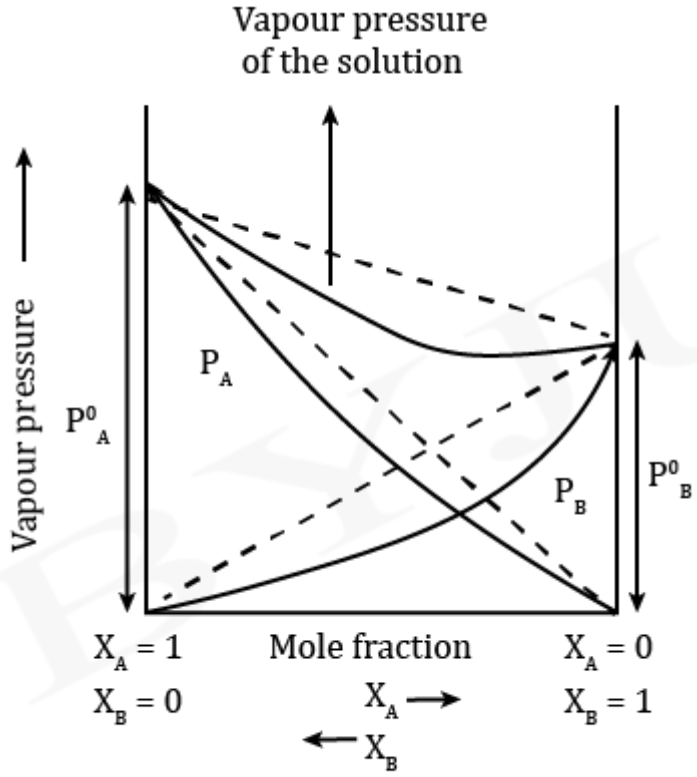
C.



D. None of the above

BYJU'S Study Planner for Board Term I
(CBSE Grade 12)

A mixture of phenol and aniline shows negative deviation from raoult's law. Liquids showing negative deviation will have total vapour pressure less than what it should be according to Raoult's Law because solvent-solute interaction is more than the solvent-solvent and the solute-solute interactions. Intermolecular hydrogen bonding between phenolic proton and lone pair on nitrogen atom (in aniline) is stronger than the respective intermolecular hydrogen bonding between similar molecules.
In option (c): $P_T < p^{\circ}_A \chi_A + p^{\circ}_B \chi_B$



19. Calculate the $(V/V)\%$ of a solution of 15 mL of alcohol in 60 mL of water.

A. 10

B. 20

C. 30

D. 40

Given,
Volume of solute, V_1 = 15 mL
Volume of solvent, V_2 = 60 mL
$\text{Volume of solution} = \text{Volume of solute} + \text{Volume of solvent}$
= 15 + 60 = 75 mL
Volume percent, % $\frac{V}{V}$ is the percent ratio of volume of solute in mL to volume of solution in mL

$$\%\frac{V}{V} = \frac{\text{Volume of solute in mL}}{\text{Volume of solution in mL}} \times 100$$

$$\%\frac{V}{V} = \frac{15}{75} \times 100 = 20\%$$

Hence, the correct answer is option (b).

20. Given that vapour pressure of water vapour at $29^{\circ}C$ is $30\ torr$ and relative humidity is 0.9. Calculate the partial pressure of water vapour at the same temperature

A. $9\ torr$

B. $30\ torr$

C. $87\ torr$

D. $27\ torr$

Relative humidity is defined as :

$$\text{R.H} = \frac{\text{Partial pressure of water vapour}}{\text{Vapour pressure of water at the same temperature}}$$

For R.H to be 0.9 :

$$0.9 = \frac{\text{Partial pressure}}{30}$$

$$\text{Partial pressure} = 27\ torr$$