Class 12 Solutions Important Questions with Answers

Short Answer Type Questions

1. **Components of a binary mixture of two liquids A and B were being separated by distillation. After some time separation of components stopped and composition of vapour phase became same as that of liquid phase. Both the components started coming in the distillate. Explain why this happened.**

   Solution: When the composition of a binary mixture of two liquids A and B in the liquid state and in the vapour phase is the same, the mixture is known as azeotropic mixture. In any azeotropic mixture, liquids are boils at the same temperature without undergoing any change in composition.

2. **Explain why on addition of 1 mol of NaCl to 1 litre of water, the boiling point of water increases, while addition of 1 mol of methyl alcohol to one litre of water decreases its boiling point.**

   Solution: Sodium chloride (NaCl) is a non-volatile solute. When added to water taken in a beaker, the solute occupies some surface area. As a result, the vapour pressure decreases and the boiling point of solution increases. On the other hand, methyl alcohol is more volatile than water. The addition of methyl alcohol to water increases the total vapour pressure of the solution. The boiling point of the solution decreases.

3. **Explain the solubility rule "like dissolves like" in terms of intermolecular forces that exist in solutions.**

   Solution: The solubility, in general, is guided by the principle that "Like dissolve Like”. This means that a solute will dissolve in a particular solvent if both have the same nature. The ionic and polar solutes generally dissolve in polar solvents while the non-polar solutes are soluble in non-polar solvents. These are mostly organic in nature i.e benzene, carbon tetrachloride, carbon disulphide etc. However, there are many exceptions also. For example, non-polar solutes like sugar, glucose etc. dissolve in water mainly because of hydrogen bonding.

4. **Concentration terms such as mass percentage, ppm, mole fraction and molality are independent of temperature, however molarity is a function of temperature. Explain.**

   Solution:By definition, molarity takes into account the volume of the solution which changes with change in temperature. All other terms, such as mass percentage, ppm, mole fraction and molality for expressing the concentration of a solution involve the mass of the solvent which is not influenced by the temperature.

5. **What is the significance of Henry's Law constant K_H ?**

Solution: Henry's Law constant (K_H) helps in comparing the relative solubilities of different gases in the same solvent (e.g. water). In general, lesser the value of K_H, more is the solubility of a gas.

6. **Why are aquatic species more comfortable in cold water in comparison to warm water?**

Solution: The aquatic species are more comfortable in cold water than in warm water. This is because the solubility of any gas in water decreases with the rise in temperature. The solubility of oxygen in water is more in cold water than in warm or hot water. Since oxygen is essential for breathing, aquatic species can breathe more comfortably in cold water than in warm water due to higher percentage of oxygen present in cold water. Hence, they feel more comfortable in cold water than in warm water.

7. **(a) Explain the following phenomena with the help of Henry's law.**
(i) Painful condition known as bends.
(ii) Feeling of weakness and discomfort in breathing at high altitude.
(b) Why soda water bottle kept at room temperature fizzes on opening?

Solution:
(i) When scuba divers go deep in the sea, solubility of atmospheric gases increases in blood. When the divers come up, there is release of dissolved gases and it leads to the formation of bubbles of nitrogen in our blood capillaries and hence there is painful sensation called bends. To avoid bends; the tanks of scuba divers are filled with He,N_2 and oxygen.
(ii) At high altitude, partial pressure of oxygen is low, it leads to low concentration of oxygen in blood of people living there. Low concentration of oxygen develops anoxia, i.e., unable to think and act properly.

(b) In order to increase the solubility of CO_2 gas in soft drinks and soda water, the bottles are normally sealed under high pressure. Increase in pressure increases the solubility of a gas in a solvent according to Henry's Law. If the bottle is opened by removing the stopper or seal, the pressure on the surface of the gas will suddenly decrease. This will cause a decrease in the solubility of the gas in the liquid. As a result, it will rush out of the bottle producing a hissing noise or with a fiz.

8. **Why is the vapour pressure of an aqueous solution of glucose lower than that of water?**

Solution: Evaporation of liquid is a surface phenomenon. More the surface area available, more is the evaporation of the liquid. Now glucose is a non-volatile solute. It occupies certain surface area of water. This means evaporation of water from the surface gets reduced and its vapour presence also gets lowered.

9. **How does sprinkling of salt help in clearing the snow covered roads in hilly areas? Explain the phenomenon involved in the process.**

   Solution: The phenomenon involved in the melting of snow in snow covered roads is the depression in freezing point which caused by the addition of non-volatile impurities to a liquid. Addition of salt (sodium chloride) lowers the freezing point temperature of water and thus, helps in the melting of snow.

10. **What is "semi permeable membrane"?**

    Solution: The membranes which allow only the movement of the solvent molecules through them is called semi permeable membrane. The membranes appear to be continues sheet or flims. here only the molecules of the solvent can pass while those of the solute which are of bigger size, are not in a position to pass through.

11. **Give an example of a material used for making semipermeable membrane for carrying out reverse osmosis.**

    Solution: Polymer cellulose acetate is used for making semipermeable membrane for carrying out reverse osmosis.

Matching Type Questions

Note: In the following questions match the items given in Column I and Column II.

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

Column I	Column II
(a) Saturated solution	(i) Solution having same osmotic pressure at a given temperature as that of given solution.
(b) Binary solution	(ii) A solution whose osmotic pressure is less than that of another.
(c) Isotonic solution	(iii) Solution with two components.

(d) Hypotonic solution	(iv) A solution which contains maximum amount of solute that can be dissolved in a given amount of solvent at a given temperature.
(e) Solid solution	(v) A solution whose osmotic pressure is more than that of another.
(f) Hypertonic solution	(vi) A solution in solid phase.

Solution: (a)-(iv); (b)-(iii); (c)-(i); (d)-(ii); (e)-(vi); (f)- (v)

2. Match the items given in Column I with the type of solutions given in Column II.

Column I	Column II
(a) Soda water	(i) A solution of gas in solid
(b) Sugar solution	(ii) A solution of gas in gas
(c) German silver	(iii) A solution of solid in liquid
(d) Air	(iv) A solution of solid in solid
(e) Hydrogen gas in palladium	(v) A solution of gas in liquid
	(vi) A solution of liquid in solid

Solution: (a)-(v); (b)-(iii); (c)-(iv); (d)-(ii); (e)-(i)

3. Match the laws given in Column I with expresions given in Column II.

Column I	Column II
(a) Raoult's law	(i) $\Delta T_f = K_f\ m$
(b) Henry's law	(ii) $\pi = CRT$
(c) Elevation of boiling point	(iii) $p = x_1p_1^0 + x_2p_2^0$
(d) Depression in freezing point	(iv) $\Delta T_b = K_b\ m$

(e) Osmotic pressure	(v) $p = K_H x$

Solution: (a)-(iii); (b)-(v); (c)-(iv); (d)-(i); (e)-(ii)

4. Match the terms given in Column I with expressions given in Column II.

Column I	Column II
(a) Mass percentage	(i) Number of moles of the solute component / Volume of solution in litres
(b) Volume percentage	(ii) Number of moles of a component / Total number of moles of all the components
(c) Mole fraction	(iii) (Volume of the solute component in solution / Total volume of solution) x 100
(d) Molality	(iv) (Mass of the solute component in solution/ Total mass of the solution) x 100
(e) Molarity	(v) Number of moles of the solute components / Mass of solvent in kilograms

Solution: (a)-(iv); (b)-(iii); (c)-(ii); (d)-(v); (e)-(i)

Assertion and Reason Type Questions

Note: In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(iii) Assertion is correct statement but reason is wrong statement.
(iv) Assertion and reason both are incorrect statements.
(v) Assertion is wrong statement but reason is correct statement.

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

   Solution: (i) Both are correct statements and reason is correct explanation for assertion.

2. Assertion: When methyl alcohol is added to water, boiling point of water increases.

Reason: When a volatile solute is added to a volatile solvent elevation in boiling point is observed.

Solution: (iv) Assertion and reason both are incorrect statements.

3. 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.

   Solution: (i) Both are correct statements and reason is correct explanation for assertion.

4. 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.

   Solution: (ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

Long Answer Type Questions

1. Define the following modes of expressing the concentration of a solution. Which of these modes are independent of temperature and why?
(i) w/w (mass percentage)
(ii) V/V (volume percentage)
(iii) w/V (mass by volume percentage)
(iv) ppm. (parts per million)
(v) *x* (mole fraction)
(vi) M (Molarity)
(vii) m (Molality)

Solution:
(i) w/w (mass percentage) **:** It is defined as the amount of solute in grams present in 100 gram of the solution.
Mass percentage of solute = (mass of solute/ Mass of solution) x 100
= {mass of solute/ (mass of solvent + mass of solute)} x 100
(ii) V/V (volume percentage): It is defined as the volume of solute in mL present in 100 mL solution.
Percentage of solute by volume = (volume of solute/ volume of solution) x 100
(iii) w/V (mass by volume percentage): It is defined as the mass of solute present in 100 mL of solution.
Percent of solute mass by volume = (mass of solute/ volume of solution) x 100
(iv) ppm. (parts per million): It is defined as the quantity of solute in grams present in 10^6 gram of the solution.

ppm = (Mass of solute/ Mass of solution) x 10^6
(v) *x* (mole fraction): It is defined as the ratio of the number of moles of one component to the total number of moles of the solution.
(vi) M (Molarity): It is defined as the number of moles of the solute present per liter or per dm^3 of the solution.
Molarity = Number of moles of solute / Number of liters of the solution
(vii) m (Molality): It is defined as the number of moles of solute present in 1kg of the solvent.
Molality (m) = Number of moles of solute / Number of kilograms of solvent

The volume of the solution changes with change in temperature while the mass of the solution is independent of temperature.
Hence w/w (mass percentage), ppm. (parts per million), *x* (mole fraction) and m (Molality) independent of temperature as the mass does not depend on temperature.

2.Using Raoult's law, explain how the total vapour pressure over the solution is related to the mole fraction of components in the following solutions.
(i) $CHCl_3$ (*l*) and CH_2Cl_2(*l*) **(ii) NaCl(s) and H_2O (*l*)**

Solution:
(i) In this case, $CHCl_3$ (*l*) and CH_2Cl_2(*l*) both the components are volatile liquids.
According to Raoult's law,
$P_A = P_A^0 \chi_A$; $P_B = P_B^0 \chi_B$
$P = P_A + P_B$
$P = P_A^0 \chi_A + P_B^0 \chi_B = P_A^0 \chi_A + P_B^0 (1-\chi_A)$
Here, A and B are volatile components
P_A and P_B are the partial pressures while P is the total vapour pressure.
χ_A and χ_B are the mole fractions of the components in the binary solution.

(ii) In this case, NaCl(s) is non-volatile and Raoult's law is applicable only to water which is of volatile nature
According to Raoult's law,
$P = P_A^0 \chi_A$
Here the total vapour pressure of the solution is dependent on the mole fraction of solvent only.

3. Explain the terms ideal and non-ideal solutions in the light of forces of interactions operating between molecules in liquid solutions.

Solution:
<u>In case of ideal solution:</u>
(i) The forces of interaction of the components in the solution are the same as in pure components i.e. A..... B interactions are the same as A..... A and B....B. interactions.

(ii) There is no change in volume on mixing the components i.e. $\Delta V_{mixing} = 0$.
(iii) There is no change in ΔH upon mixing the components i.e. $\Delta H_{mixing} = 0$.
(iv) Components obey Raoult's Law at all temperatures and concentrations i.e.

$P_A = P_A^0 \chi_A$; $P_B = P_B^0 \chi_B$

<u>In case of non-ideal solution:</u>
(i) The forces of interaction of the components in the solution different from those present in pure components i.e. A….B interactions are different from A..... A and B.... B interactions.
(ii) There is a change in volume on mixing the components i.e. $\Delta V_{mixing} \neq 0$
(iii) There is a change in ΔH on mixing the components i.e. $\Delta H_{mixing} \neq 0$.
(iv) Components deviate from Raoult's Law i.e.

$P_A \neq P_A^0 \chi_A$; $P_B \neq P_B^0 \chi_B$

4. Why is it not possible to obtain pure ethanol by fractional distillation? What general name is given to binary mixtures which show deviation from Raoult's law and whose components cannot be separated by fractional distillation. How many types of such mixtures are there?

Solution:

- A mixture of ethanol and water is generally obtained when we prepare it commercially with the help of alcoholic fermentation.
- The two liquids are completely miscible with each other. Their boiling points are 351 K and 373K respectively. Since the two liquids differ in their boiling points by more than 20°, they should be easily separated by a fractional distillation process.
- However, during the operation, a stage is reached when we get a liquid mixture containing 95 percent ethanol and 5 percent water. This constitutes an azeotropic mixture also called constant boiling mixture. Both alcohol and water start boiling together at a temperature which is close to the boiling point temperature of alcohol.

The azeotropic mixture shows positive deviation from Raoult's Law. In fact there are two types of azeotropic mixtures.
(a) Azeotropic mixture which shows positive deviation from Raoult's Law (Minimum boiling azeotrope)
(b) Azeotropic mixture which shows negative deviation from Raoult's Law (Maximum boiling azeotrope)

5. When kept in water, raisins swell in size. Name and explain the phenomenon involved. Give three applications of the phenomenon.

Solution:
This happens due to a phenomenon known as osmosis. When the reisin kept in water, it swells in size. Actually water is hypotonic solution while the liquid or fluid inside the raisin is of hypertonic nature. The outer wall of the raisin acts as a semipermeable membrane. There is an osmosis of water molecules inside the raisin through this membrane and the raisin slowly swells in size.

Applications of osmosis:

(a) In animals circulation of water to all parts of the body takes place due to osmosis.
(b) Osmosis helps in plant growth and germination of seeds.
(c) When the dried fruits and vegetables are placed in water, they slowly swell because of osmosis.

6. Discuss biological and industrial importance of osmosis.

Solution:

<u>Biological importance of osmosis</u>

(i) Osmosis plays a significant role in the absorption of water by plant roots from the soil and its movement to different parts of the plant body.
(ii) When placed in water containing less than 0.9% (mass/volume) salt, blood cells collapse due to loss of water by osmosis.
(iii) In animals circulation of water to all parts of the body takes place due to osmosis.
(iv) Osmosis helps in plant growth and germination of seeds.

<u>Industrial importance of osmosis</u>

(i) The phenomenon of osmosis is also useful in some industrial processes. It is employed commercially for the desalination of sea water so that it may become useful for drinking purposes.(reverse osmosis)
(ii) The Reverse Osmosis process is very popular for the purification of drinking water in households.

7. How can you remove the hard calcium carbonate layer of the egg without damaging its semipermeable membrane? Can this egg be inserted into a bottle with a narrow neck without distorting its shape? Explain the process involved.

Solution:

The hard layer of egg white in colour, consists of calcium carbonate. It can be removed by placing the egg in dilute hydrochloric acid for some time. It dissolves calcium carbonate, leaving behind the egg without damaging its soft semipermeable membrane.
The size of the egg can be reduced or it shrinks by placing it in saline water (contains NaCl) for some time. The fluid from the egg slowly escapes and passes into saline water which is at higher osmotic pressure (hypertonic in nature). Now, the egg with reduced size can be inserted in a bottle with a narrow neck. If the bottle contains water, the egg will regain its original shape and size due to osmosis of water (hypotonic) through the semipermeable membrane.

8. Why is the mass determined by measuring a colligative property in case of some solutes is abnormal? Discuss it with the help of the Van't Hoff factor.

Solution:

Certain solutes do not behave normally in solution in the sense that they may either undergo dissociation or association. As a result, the number of solute particles in solution changes.

Since the colligative properties are linked with the number of particles, they show abnormal results. In the same way, the molecular masses of these solutes also show abnormal results.

The exact behavior of the solute in solution and the extent of association or dissociation can be expressed in terms of Van't Hoff factor (i).
i = Normal/ calculated molecular mass/ Observed molecular mass.
or i = Observed colligative properties/ Normal colligative properties.

- If $i = 1$, solute behave normally in the solution
- If $i > 1$, solute undergo dissociation in solution
- If $i < 1$, solute undergo association in solution