Exam Paper

Instructions

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Q1. A beaker contains a solution of substance 'A'. Precipitation of substance 'A' takes place when small amount of 'A' is added to the solution. The solution is _________. **1 Mark**

A Saturated. **B** Supersaturated. **C** Unsaturated. **D** Concentrated.

Ans: **B** Supersaturated.

Explanation:
When small amount of solute is added to its solution and it does not dissolve and get precipitated then this solution is supersaturated solution.

Q2. In isotonic solutions ____________. **1 Mark**

A Solute and solvent both are same.
B Osmotic pressure is same.
C Solute and solvent may or may not be same.
D Solute is always same solvent may be different.

Ans: **B** Osmotic pressure is same. **C** Solute and solvent may or may not be same.

Explanation:
For isotonic solutions osmotic pressure is same, solute or solvent may not be same.

Q3. Van't Hoff factor i is given by the expression __________. **1 Mark**

A $\mathrm{i} = \frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$
B $\mathrm{i} = \frac{\text{Abnormal molar mass}}{\text{Normal molar mass}}$
C $\mathrm{i} = \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$
D $\mathrm{i} = \frac{\text{Calculated colligative property}}{\text{Observed colligative property}}$

Ans: **A** $\mathrm{i} = \frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$ **C** $\mathrm{i} = \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$

Q4. 4L of 0.02M aqueous solution of NaCl was diluted by adding one litre of water. The molality of the resultant solution is __________. **1 Mark**

A 0.004 **B** 0.008 **C** 0.012 **D** 0.016

Ans: **D** 0.016

Explanation:
Apply the relation, $M_1V_1 = M_2V_2$
Given, $M_1 = 0.02M$, $V_1 = 4L$, $M_2 = ?$, $V_2 = 5L$
Therefore, $0.02 \times 4L = M_2 \times 5L$
$M_2 = 0.08/5$
$=0.016M$

Q5. Which of the following aqueous solutions should have the highest boiling point? **1 Mark**

A 1.0M NaOH **B** 1.0M Na_2SO_4 **C** 1.0M NH_4NO_3 **D** 1.0M KNO_3

Ans: **B** 1.0M Na_2SO_4

Explanation:
In 1.0M Na_2SO_4 solution vant H off factor, i > 1 and is maximum when compared with the other three given electrolytes. So, the extent of dissociation in case of 1.0M Na_2SO_4 would be highest yielding maximum no. of ions as compared to the other given electrolytes in their 1.0M solutions.

Q6. Why do gases always tend to be less soluble in liquids as the temperature is raised? **2 Marks**

Ans: When gases are dissolved in water, it is accompanied by a release of heat energy, i.e., process is exothermic. When the temperature is increased, according to Lechatlier's Principle, the equilibrium shifts in backward direction, and thus gases becomes less soluble in liquids.

Q7. State Henry's law and mention some important applications? **2 Marks**

Ans: The effect of pressure on the solubility of a gas in a liquid is governed by Henry's Law. It states that the solubility of a gas in a liquid at a given temperature is directly proportional to the partial pressure of the gas Mathematically, $P = K_H X$ where P is the partial pressure of the gas; and X is the mole fraction of the gas in the solution and K_H is Henry's Law constant.

Applications of Henry's law:

1. In the production of carbonated beverages (as solubility of C02 increases at high pressure).
2. In the deep sea diving.
3. For climbers or people living at high altitudes, where low blood 0_2 causes climbers to become weak and make them unable to think clearly.

Q8. Calculate the mass percentage of aspirin ($C_9H_8O_4$) in acetonitrile (CH_3CN) when 6.5 g of $C_9H_8O_4$ is dissolved in 450 g of CH_3CN. **2 Marks**

Ans: Mass of solute = 6.5 g

Mass of solution = 450 + 6.5 = 456.6 g

$\text{Mass percentage} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$

$= \frac{6.5}{456.5} \times 100 = \frac{650}{456.5} = 1.424\%$

Q9. Give an example of a material used for making semipermeable membrane for carrying out reverse osmosis. **2 Marks**

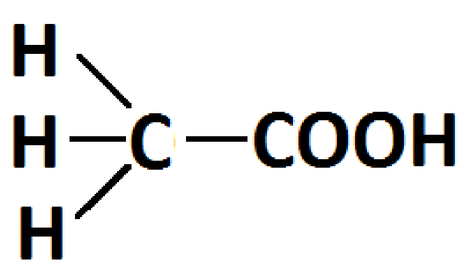
Ans: Material used for making semipermeable membrane for carrying out reverse osmosis is- "a film of cellulose acetate placed over a suitable support."

Q10. 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. **2 Marks**

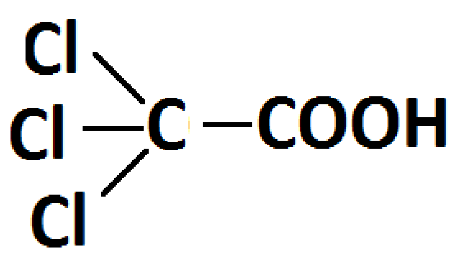
Ans: Since both the components are appearing in the distillate and composition of liquid and vapour is same, this shows that liquids have formed azeotropic mixture and hence cannot be separated at this stage by distillation.

Q11. The depression in freezing point of water observed for the same amount of acetic acid, trichloroacetic acid and trifluoroacetic acid increases in the order given above. Explain briefly. **2 Marks**

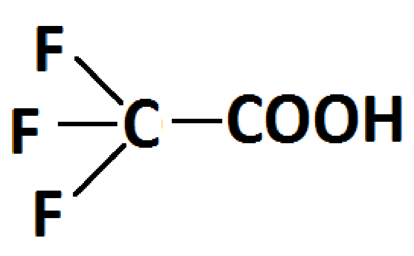
Ans:



Acetic acid



Trichloroacetic acid



Trifluoroacetic acid

Among H, Cl, and F, H is least electronegative while F is most electronegative. Then, F can withdraw electrons towards itself more than Cl and H. Thus, trifluoroacetic acid can easily lose H + ions i.e., trifluoroacetic acid ionizes to the largest extent. Now, the more ions produced, the greater is the depression of the freezing point. Hence, the depression in the freezing point increases in the

order:
Acetic acid < trichloroacetic acid < trifluoroacetic acid.

Q12. Explain the following phenomena with the help of Henry's law. **2 Marks**
Why soda water bottle kept at room temperature fizzes on opening?

Ans: When a soda water bottle kept at room temperature is opened to air the partial pressure of CO_2 above the solution decreases suddenly, (as per Henry's law).This results into a decrease in solubility of carbon dioxide, hence CO_2 bubbles come out of the bottle with a fizz.

Q13. Calculate the mass of a non-volatile solute (molar mass 40 g mol^{-1}) which should be dissolved in 114 g octane to reduce its vapour pressure to 80%. **3 Marks**

Ans: P_s = 80% of P^0
$= \frac{80}{100}\ \mathrm{P}^\circ = 0.8\ \mathrm{P}^\circ$

Let W_g of solute is present in mixture.
Moles of solute present $= \frac{\mathrm{W}}{40}$ moles
Molar mass of octane, C_8H_{18}
= 8 x 12 + 18 = 114 $gmol^{-1}$
$\therefore$ Moles of octane $= \frac{114}{114} = 1$ mol
Now, $\frac{\mathrm{P}^\circ - \mathrm{P}_s}{\mathrm{P}^\circ} = x_2 = \frac{\frac{\mathrm{W}}{40}}{\frac{\mathrm{W}}{40}+1}$
$\frac{\mathrm{P}^\circ - 0.80\ \mathrm{P}^\circ}{\mathrm{P}^\circ} = \frac{\frac{\mathrm{W}}{40}}{\frac{\mathrm{W}}{40}+1}$
$1 - 0.80 = \frac{\mathrm{W}\times 40}{40(\mathrm{W}+40)} = \frac{\mathrm{W}}{\mathrm{W}+40}$
$0.20 = \frac{\mathrm{W}}{\mathrm{W}+40}$
0.2 W + 8 = W
8 = W(l - 0.2)
8 = 0.8 W
$\therefore\ \mathrm{W} = \frac{8}{0.8} = 10g.$

Q14. Calculate the molarity of each of the following solutions: **3 Marks**
1. 30 g of $Co(NO_3)_2$. $6H_2O$ in 4.3 L of solution.
2. 30 mL of 0.5 M H_2SO_4 diluted to 500 mL.

Ans: Molarity (M) is defined as number of moles of solute dissolved in one litre (or one cubic decimetre) of solution.
1. Mol. mass of Co (NO_3). $6H_2O$
= 58.9 + (14 + 3 × 16)2 + 6(18)
= 58.9 + (14 + 48) × 2 + 108
= 58.9 + 124 + 108 = 290.9
Moles of Co $(NO)_3$. $6H_2O$
$= \frac{30}{290.9} = 0.103$ mol
Volume of solution = 4.3 L
Molarity,
$\mathrm{M} = \frac{\text{Moles of solute}}{\text{Volume of solution in litre}}$
$= \frac{103}{4.3} = 0.024$ M.
2. Number of moles present in 1000 ml of 0.5 M H_2SO_4= 0.5 mol
therefore number of moles present in 30ml of 0.5M $H_2SO_4 = \frac{0.5\times 30}{1000}$ mol
= 0.015 mol
Therefore molarity = 0.015/0.5 L
Thus molarity is 0.03M.

Q15. How does sprinkling of salt help in clearing the snow covered roads in hilly areas? Explain the phenomenon involved in the process. **3 Marks**

Ans: The phenomenon involved in clearing the snow-covered roads in hilly areas is 'Depression in freezing point of water when a non volatile solute is dissolves in it'. Thus when salt is spread over snow covered roads, snow starts melting from the surface because of the depression in freezing point of water and it helps in clearing the roads.

Q16. **3 Marks**

A 5% solution (by mass) of cane sugar in water has freezing point of 271K. Calculate the freezing point of 5% glucose in water if freezing point of pure water is 273.15 K.

Ans: Mass of sugar in 5% (by mass) solution means 5gin 100g of solvent (water)

Molar mass of sugar = 342 g mol^{-1}

$\text{Molality of sugar solution} = \frac{5\times1000}{342\times100} = 0.146$

$\therefore\ \Delta T_f$ for sugar solution = 273.15 - 271 = 2.15°

$\Delta T_f = K_f \times m$

$\Delta T_f = K_f \times 0.146 \Rightarrow K_f = 2.15/0.146$

Molality of glucose solution

$= \frac{5}{180} \times \frac{1000}{100} = 0.278$

(Molar mass of glucose = 180 g mol^{-1})

$\Delta T_f = K_f \times m = \frac{2.15}{0.146} \times 0.278 = 4.09^\circ$

$\therefore$ Freezing point of glucose solution

= 273.15 - 4·09 = 269.06 K.

Q17. Explain the following phenomena with the help of Henry's law. **3 Marks**

1. Painful condition known as bends.
2. Feeling of weakness and discomfort in breathing at high altitude.

Ans: 1. According to Henry's law pressure of a gas is directly proportional to solubility. Scuba divers when come towards surface the air pressure gradually decreases. This reduced pressure releases the dissolved gases present in blood and leads to the formation of bubbles of nitrogen in the blood. This blocks capillaries and creates a medical condition known as bends, which is painful and dangerous to life.

2. At high altitude, partial pressure of oxygen is less than that of ground level. This leads to low concentrations of oxygen in blood and tissues of people living at high altitudes. Low blood oxygen causes weakness and discomfort.

Q18. Explain the terms ideal and non-ideal solutions in the light of forces of interactions operating between molecules in liquid solutions. **5 Marks**

Ans: Ideal solutions: The solutions which obey Raoult's law over the entire range of concentration are known as ideal solution. For an ideal solution,

$\Delta_{mix}H = 0, \Delta_{mix}V = 0$

A-B interactions $\approx$ A-A interactions and B-B interactions.

None-ideal solutions: When a solution does not obey Raoult's law over the entire range of consentration, it is called non-ideal solution.

Positive deviations: Vapour pressure of such solution shows higher value than the predicted value.

$\Delta_{mix}H = +ve$

$\Delta_{mix}V = +ve$

A-B interactions < A-A and B-B interactions.

Negative deviation: Vapour pressure of such solutions shows lower value than expected.

$\Delta_{mix}H = -ve$

$\Delta_{mix}V = -ve$

A-B interactions < A-A and B-B interactions.

Q19. Define the following modes of expressing the concentration of a solution. Which of these modes are independent of temperature and why? **5 Marks**

1. w/w (mass percentage)
2. V/V (volume percentage)
3. w/V (mass by volume percentage)
4. ppm. (parts per million)
5. x (mole fraction)
6. M (Molarity)
7. m (Molality)

Ans: 1. w/w (mass percentage) $= \frac{\text{Mass of component in the solution}}{\text{Total mass of the solution}} \times 100$

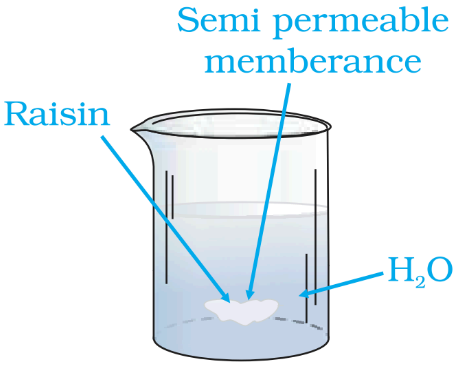
2. V/V (volume percentage) $= \frac{\text{Volume of the component}}{\text{Total volume of the solution}} \times 100$

3. w/V (mass by volume percentage) $= \frac{\text{Mass of solute}}{\text{100ml of solution}}$

4. ppm. (parts per million) $= \frac{\text{Number of parts of component}}{\text{Total number of parts of all components of the solution}} \times 10^6$
5. x (mole fraction) $= \frac{\text{Number of moles of component}}{\text{Total number of moles all the components}}$
6. M (Molarity) $= \mathrm{M} = \frac{\text{Moles of solute}}{\text{Volume of solution in litre}}$
7. m (Molality) $= \frac{\text{Moles of solute}}{\text{Mass of solvent in kg}}$
8. Mass percentage, ppm, mole fraction and molality are independent of temperature since mass does not change with temperature.

Q20. When kept in water, raisin swells in size. Name and explain the phenomenon involved with the help of a diagram. Give three applications of the phenomenon. **5 Marks**

Ans: Raisins swell in size on keeping in water. This happens due to the phenomenon of osmosis. The outer skin of raisin acts as a semipermeable membrane. Water moves from a place of lower concentration to a place of higher concentration through the semipermeable membrane. Thus, water enters inside the raisins and make them swell.



Applications of the phenomenon:
1. Movement of water from soil into plant roots and subsequently into upper portion of the plant is partly due to osmosis.
2. Preservation of meat against bacterial action by adding salt.
3. Preservation of fruits against bacterial action by adding sugar. Bacterium in canned fruit loses water through the process of osmosis, shrivels and dies.
4. Reverse osmosis is used for desalination of water.

Q21. Colligative properties are observed when ___________. **1 Mark**

A A non volatile solid is dissolved in a volatile liquid.
B A non volatile liquid is dissolved in another volatile liquid.
C A gas is dissolved in non volatile liquid.
D A volatile liquid is dissolved in another volatile liquid.

Ans: **A** A non volatile solid is dissolved in a volatile liquid. **B** A non volatile liquid is dissolved in another volatile liquid.

Explanation:
Colligative properties are observed when a non-volatile solid or liquid are dissolved in a volatile liquid.