Solution

CLASS 12 CHEMISTRY

Class 12 - Chemistry

Section A

1. **(a)** shows a positive deviation from Raoult’s law

   Explanation:

   If the azeotropic solution has a lower boiling point than either of its two liquids then it shows positive deviation from Raoult's law.

2. **(d)** unchanged

   Explanation:

   While doubling the molality will double the elevation in boiling point, it will not change K_b, as it remains constant for a given solvent.

3. **(a)** low atmospheric pressure

   Explanation:

   Low concentration of oxygen in the blood and tissues of people living at high altitude is due to low atmospheric pressure. Because at high altitude, the partial pressure of oxygen is less than at the ground level.

4. **(a)** n-hexane and n-heptane

   Explanation:

   n-hexane and n-heptane will form an ideal solution as their intermolecular interactions (solute-solvent) after forming solution are similar to their intermolecular attractions (solute-solute, solvent-solvent) before mixing the components.

5. **(d)** osmotic pressure

   Explanation:

   osmotic pressure, as it depends upon number of particles(moles).

6. **(c)** 2.0 M KCl

   Explanation:

   2.0 M KCl

7. **(c)** Cu is formed at cathode

   Explanation:

   Cu is formed at cathode

8. **(d)** Fe^{3+}

   Explanation:

   Strongest oxidizing agent is one having more positive or less negative reduction potential. The reduction potential of Fe^{3+}/Fe^{2+} = 0.77V. so it has more tendency to get reduced or gain electrons. hence it is good oxidising agent.

9. **(c)** 2.651 V

   Explanation:

$E_{cell} = E^{\circ}_{cell} - \frac{0.059}{n}\log\frac{[Mg^{2+}]}{[Cu^{2+}]}$

$= 2.71 - \frac{0.059}{2}\log\frac{0.1}{0.001}$

$= 2.71 - \frac{0.059}{2}\log 10^2$

$E_{cell} = 2.651$ V

10.

(b) Zn | Zn^{2+} || Ag^+ | Ag

Explanation:

Zn | Zn^{2+} || Ag^+ | Ag is correct cell representation

11.

(c) 96500C

Explanation:

For converting FeO to Fe_2O_3 1mol of electrons are required

$Fe^{2+} \rightarrow Fe^{3+}$

Oxidation of one mole of Fe^{2+} will require 1 × 96500 = 96500C.

12.

(c) to complete the circuit so that current can flow

Explanation:

In an electrochemical cell, a salt bridge is used to complete the circuit so that current can flow.

13.

(c) (A) is true, but (R) is false.

Explanation:

Osmotic pressure is proportional to molarity.

14. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

Both A and R are true and R is the correct explanation of A.

15.

(b) Both (A) and (R) are true, but (R) is not the correct explanation of (A).

Explanation:

Molar conductivity increases with decrease in concentration. This is because the total volume, V, of solution containing one mole of electrolyte also increases

16. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

Cathode: $O_{2(g)} + 2H_2O(l) + 4e^- \rightarrow 4OH^-_{(aq)}$

Anode: $4H_2O(l) + 4e^- \rightarrow 2H_2 + 4OH^-_{(aq)}$

Overall reaction being: $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$

Section B

17. Given, $m = 0.0711\,m,\ \Delta T_f = 0.320,\ K_f = 1.86^0 C\,mol^{-1}$

$\Delta T_f = i\,K_f\,m$

$i = \frac{\Delta T_f}{K_f \times m} = \frac{0.320}{1.86 \times 0.0711}$

$= \frac{0.320}{0.132} = 2.42$

18. When salt is spread over snow-covered roads, it lowers the freezing point of water due to the addition of salt to such an extent that water does not freeze to form ice. As a result, the snow starts melting from the surface, and therefore, it helps in clearing the roads in hilly areas. Hence, common salt acts as a de-icing agent
19. Galvanic cell for the reaction is:
    $\mathrm{pt}|\mathrm{Sn}^{2+}(aq)|\mathrm{Sn}^{4+}(aq)||\mathrm{MnO}_4^-(aq)|\mathrm{Mn}^{2+}(aq)|\mathrm{pt}$
    Call reaction is:
    $2MnO^{-4}+16H^{+}+5Sn^{2+}\rightarrow 2Mn^{2+}+8H_2O+5Sn^{4+}$
    $\therefore E^0_{cell}=E^0_{(Mn^{-4}/Mn^{2+})}-/E^0_{(Sn^{4+}/Sn^{2+})}$
    = 1.51V - (-0.15V)
    $\mathrm{E}^0_{cell}=1.66V$
    As we know $\Delta\mathrm{G}^0=-nFE^0$
    on putting the values in above equation,
    $\Delta\mathrm{G}^0$ for the reaction will be negative, therefore the reaction is product favoured.
20. Overall cell reaction consisting of cathode and anode is:
    $\mathrm{Pb}+\mathrm{PbO}_2+2\mathrm{H}_2\mathrm{SO}_4\xrightarrow{\text{Discharge}}2\mathrm{PbSO}_4+2\mathrm{H}_2\mathrm{O}$
    The density of electrolytes decreases because water is formed and sulphuric acid consumed as the product during discharge of the battery.
21. A fuel cell is similar to a galvanic cell, it generates electricity directly by the electrochemical conversion of gaseous or liquid fuels fed to the cell as required.
    At anode: $H_2(g)+2OH^-(aq)\rightarrow 2H_2O(l)+2e^-$
    At cathode: $O_2(g)+2H_2O(l)\rightarrow 4e^-\rightarrow 4H^-(aq)$
    Overall reaction: $2H_2(g)+O_2(g)\rightarrow 2H_2O(l)$

Section C

22. A solution (liquid mixtures) at certain concentration when continues to boil at constant temperature without change in its composition in solution & in vapour phase is called an azeotrope.
    Example: ethanol and water.
23. Freezing point = -0.068$^{\mathrm{o}}$ C
    $\mathrm{K_f}$ for water = 1.86 K kg mol^{-1}
    ΔT_f = normal boiling point - Actual boiling point
    ΔT_f = 0 - (-0.068) = 0.068
    ΔT_f = $i\times K_f\times m$
    0.068 = i $\times$ 1.86 $\times$ 0.01
    i = $\frac{0.068}{1.86\times0.01}$ = 3.6559
    We have formula,
    i = $\frac{1+(n-1)\alpha}{1}\alpha=\frac{i-1}{n-1}$
    For $\mathrm{AlCl_3}\rightleftharpoons\mathrm{Al^{3+}}+3\mathrm{Cl^-}$
    n = 1 + 3 = 4
    α = $\frac{3.6559-1}{4-1}$ = 0.8853
    percentage of dissociation = $\alpha\times100$ = 0.8853 $\times$ 100 = 88.53%
24. i. **Colligative properties:** The properties of solution which depend upon the number of solute particles and not upon the nature of the solute particles are known as colligative properties.
       There are four colligative properties:
       a. Relative lowering of vapour pressure.
       b. Elevation of boiling point
       c. Depression of freezing point
       d. Osmotic pressure.
    ii. **Molality (m) :** It is the number of moles of solute dissolved per kilograms (kg) of the solvent. It is denoted by m.
       Molality (m) $=\frac{\text{Mole of solute}}{\text{Mass of solvent in Kg}}$
       $\therefore\ m=\frac{W_2\times1000}{M_2\times W_1}$

Where W_1 = Mass of solvent

W_2 = Mass of solute

M_2 = Molar mass of solute

25. given that Quantity of electricity passed $= 5A \times 20 \times 60s$
= 6000 C time = 20 min
$Ni^{2+} + 2e^{-} \rightarrow Ni$
Thus, 2 F, i.e. $2 \times 96500\,C$ deposit Ni = 1 mole i.e. 58.7 g
(at mass of Ni = 58.7)
Thus 2 F i.e. $2 \times 96500\,C$ deposit Ni = 1 mole
6000 C will deposit Ni
$= \frac{58.7}{2 \times 96500} \times 6000g$ = 1.825 g

26. The balanced cell reaction is:

$Zn(s) + 2Ag^{+} \longrightarrow Zn^{2+} + 2Ag(s)$

E^{o} for the cell is 0.80 V (given for $\frac{Ag^{+}}{Ag}$) and -0.76 V (given for $\frac{Zn^{2+}}{Zn}$).

n the number of moles of electrons transferred, which is 2 in this case.

[A] is the concentration of Zn^{2+}, which is 0.01 M.

[B] is the concentration of Ag^{+}, which is 0.001 M.

E = $E^{\circ} - \frac{0.0591}{n} \log\left(\frac{[A]^m}{[B]^n}\right)$

Now, substitute these values into the Nernst equation:

E = 0.80 V - $\frac{0.0591}{2} \log\left(\frac{0.01}{0.001}\right)$

Calculate the logarithmic term:

$\log\left(\frac{0.01}{0.001}\right)$ = log(10) = 1

Now, substitute this value back into the equation:

E = 0.80 V - $\frac{0.0591}{2} \cdot 1$ = 0.80 V - 0.02955 V = 0.77045 V

So, the emf of the given cell is approximately 0.770 V.

27. **Kohlrausch law of independent migration of ions:** It states that limiting molar conductivity of an electrolyte can be represented as the sum of the individual contributions of the anion and cation of the electrolyte. If $\lambda^{o}Na^{+}$ and $\lambda^{o}Cl^{-}$ are limiting molar conductivity for sodium chloride is given by
$\lambda_m^0\,(NaCl) = \lambda^{o}Na + \lambda^{0}Cl^{-}$
Calculation of degree of dissociation of weak electrolyte like acetic acid. The degree of dissociation α is given by:
$\alpha = \frac{\lambda_m}{\lambda_m^0}$
where λ_m be molar conductivity and λ_m^0 be the limiting molar conductivity.

28.
    i. Given: Conductivity of CH_3COOH solution,$\kappa = 3.905 \times 10^{-5}\mathrm{Scm}^{-1}$ and $[CH_3COOH]$, M = 0.001 mol L^{-1} = 0.001 M

       Now, Molar conductivity of solution can be calculated as $\lambda_{\mathrm{m}} = \kappa \times \frac{1000}{M}$ = $\frac{(3.905 \times 10^{-5}) \times (1000)}{0.001}$ = 39.05 S $cm^2 mol^{-1}$
       Also, Molar conductivity at infinite dilution (λ_{m}^0) for CH_3COOH = $\lambda_{\mathrm{m}}^{\circ}(CH_3\mathrm{COOH}) = \lambda^0_{\mathrm{CH_3COO^-}} + \lambda^{\circ}_{\mathrm{H^+}}$ = 40.9 + 349.6 = 390.5 S cm^2 mol^{-1}
       We know that, Degree of dissociation, $\alpha = \frac{\lambda_{\mathrm{m}}}{\lambda_{\mathrm{m}}^{\circ}}$ = $\frac{39.05}{390.5}$ = 0.1 i.e. 10% dissociated.
    ii. Electrochemical cell: A device used to convert the chemical energy produced in a spontaneous redox reaction into electrical energy is called an electrochemical cell. Electrochemical cells are divided into two main types: (a) Electrolytic cell (b) Galvanic or voltaic cell. When external potential applied becomes greater than $E^{\circ}_{\mathrm{cell}}$ of an electrochemical cell, electrons flow from cathode to anode, i.e. electrochemical cell behaves like an electrolytic cell.

Section D

29.
    i. KCl in a kg of water would be expected to increase the boiling point by 2 × 0.52 K = 1.04 K. This could led us to conclude that mass of 2 moles of particles is 74.5 g hence mass of 1 mole of KCl would be 37.25 g. Hence, in case of KCl where dissociation occurs experimentally determined molar mass is always lower than true value.
    ii. Negative Deviation.
    iii. A liquid mixture consisting of 20 % acetone and 80%. chloroform by mass.

    OR

Negative Deviation.

OR

i. Silver plate acts as cathode.

ii. Salt bridge permits the flow of current by completing the circuit as well as it maintains the charge balance between anode and cathode by movement of electrons. If the salt bridge is removed no current will flow in the circuit and the voltage will drop to zero.

iii. An electrochemical cell behaves like an electrolytic cell when there is an application of an external opposite potential on the galvanic cell and reaction is not inhibited until the opposing voltage reaches the value 1.1 V. At this stage, no current flows through the cell and on increasing the external potential any further the reaction will function in the opposite direction.
$E_{ext} > E_{cell}$

OR

a. When $E_{cell} = 0$, an equilibrium condition is reached and the concentration of Zn^{2+} and Ag^{+} remains same.

b. Conductivity of a solution defined as the conductance of ions present in a unit volume of the solution. On dilution, the number of ions per unit volume decreases. Thus, the conductivity of the solution decreases on dilution.

30. i. Specific condutance decreases on dilution of electrolyte solution.

ii. The correct order of equivalent conductance at infinite dilution is KCl>NaCl>LiCl

iii. In KCl electrolyte solution $\Lambda_m$and $\Lambda_e$are equal.

iv. (b) $\Lambda = \Lambda^\circ$ as $c \rightarrow 0$ equality holds good for a strong electrolyte.

v. The conductance of a solution of an electrolyte is equal to that of its specific conductance. The cell constant of the conductivity cell is equal to the Unity

Section E

31. i. Mole fraction:

The mole fraction of a component in a mixture is defined as the ratio of the number of moles of the component to the total number of moles of all the components in the mixture.

i.e., Mole fraction of a component = $\frac{\text{Number of moles of the component}}{\text{Total number of moles of all components}}$

Mole fraction is denoted by 'x'.

If in a binary solution, the number of moles of the solute and the solvent are nA and nB respectively, then the mole fraction of the solute in the solution is given by,

$x_A = \frac{n_A}{n_A+n_B}$

Similarly, the mole fraction of the solvent in the solution is given as:

$x_B = \frac{n_B}{n_A+n_B}$

ii. Molality

Molality (m) is defined as the number of moles of the solute dissolved per kilogram of the solvent. It is expressed as:

Molality (m) = $\frac{\text{Moles of solute}}{\text{Mass of solvent in kg}}$ It is expressed as mol/Kg

iii. Molarity

Molarity (M) is defined as the number of moles of the solute dissolved in one Litre of the solution.

It is expressed as:

Molarity (M) = $\frac{\text{Moles of solute}}{\text{Volume of solvent in Litre}}$ It is expressed as mol/L

iv. Mass percentage:

The mass percentage of a component of a solution is defined as the mass of the solute in grams present in 100 g of the solution. It is expressed as:

Mass % of a component = $\frac{\text{Mass of component in solution}}{\text{Total mass of solution}} \times 100$

32. The molar conductivity of methanoic acid

$\lambda_m^c = 46.1\, S\, cm^2 mol^{-1}$

$\lambda_m^c = (HCOOH) = \lambda^0\left(H^+\right) + \lambda^0\left(HCOO^-\right)$

= $349.6 + 54.6$S cm^2 mol^{-1}

= 404.2 S cm^2 mol^{-1}

$\alpha = \frac{\lambda m^c}{\lambda m^0}$

$= \frac{46.1}{404.2} = 0.114$

$HCOOH \rightleftharpoons HCOO^- + H^+$

Initial conc. $n\,mol\,L^{-1}$ $\quad 0$

$n(1-\alpha) \quad n\alpha$

$\therefore K_a = \frac{x\alpha^2}{1-\alpha}$

$= \frac{0.025\times(0.114)^2}{1-0.114}$

$= 3.67 \times 10^{-4}$

33.
i. At cathode: The following reduction reactions compete to take place at the cathode.

$Ag^{+}_{(aq)} + e^{-} \rightarrow Ag_{(s)}$; E^{o} = 0.80V

$H^{+}_{(aq)} + e^{-} \rightarrow \frac{1}{2}H_{2(g)}$; E^{o} = 0.00V

The reaction with a higher value of E^{o} takes place at the cathode. Therefore, deposition of silver will take place at the cathode.
At anode:

The Ag anode is attacked by NO_3^- ions. Therefore, the silver electrode at the anode dissolves in the solution to form Ag+.

ii. At cathode:
The following reduction reactions compete to take place at the cathode.

$Ag^{+}_{(aq)} + e^{-} \rightarrow Ag_{(s)}$; E^{o} = 0.80V

$H^{+}_{(aq)} + e^{-} \rightarrow \frac{1}{2}H_{2(g)}$; E^{o} = 0.00 V

The reaction with a higher value of E° takes place at the cathode. Therefore, deposition of silver will take place at the cathode.
At anode:

Since Pt electrodes are inert, the anode is not attacked by NO_3^- ions. Therefore, OH^- or NO_3^- ions can be oxidized at the anode. But OH^- ions having a lower discharge potential and get preference and decompose to liberate O_2.

$OH^- \rightarrow OH + e^-$

$4OH^- \rightarrow 2H_2O + O_2$

iii. At the cathode, the following reduction reaction occurs to produce H_2 gas.

$H^+_{(aq)} + e^- \rightarrow \frac{1}{2} H_{2(g)}$

At the anode, the following processes are possible.

$2H_2O_{(l)} \rightarrow O_{2(g)} + 4H^{+}_{(aq)} + 4e^{-}$; E^{o} = +1.23V ...(i)

$2SO^{2-}_{4(aq)} \rightarrow S_2O^{2-}_{6(aq)} + 2e^{-}$; E^{o} = +1.96 V ....(ii)

For dilute sulphuric acid, reaction (i) is preferred to produce O_2 gas. But for concentrated sulphuric acid, reaction (ii) occurs.

iv. At cathode:
The following reduction reactions compete to take place at the cathode.

$Cu^{2+}_{(aq)} + 2e^{-} \rightarrow Cu_{(s)}$; E^{o} = 0.34V

$H^{+}_{(aq)} + e^{-} \rightarrow \frac{1}{2}H_{2(g)}$; E^{o} = 0.00 V

The reaction with a higher value of E^{o} takes place at the cathode. Therefore, deposition of copper will take place at the cathode.
At anode:
The following oxidation reactions are possible at the anode.

$Cl^{-}_{(aq)} \rightarrow \frac{1}{2}Cl_{2(g)} + e^{-1}$; E^{o} = 1.36V

$2H_2O_{(i)} \rightarrow O_{2(g)} + 4H^{+}_{(aq)} + 4e^{-}$; E^{o} = +1.23V

At the anode, the reaction with a lower value of E^{o} is preferred. But due to the over-potential of oxygen, Cl^- gets oxidized at the anode to produce Cl_2 gas.

OR

a. The following are features of non-ideal solutions:
Raoult's Law does not apply to non-ideal solutions. The interactions between the solute and the solvent (B–B) and the solvent and the solute (A–A) are not the same as the solvent-solute (A–B) interaction, $\Delta H_{mix} \neq 0$

b. n = 2 (dimer)
$\Delta T_f = i\, K_f m$

$i = 1.62 \times 122 \times 25/4.9 \times 2 \times 1000$

$i = 0.504$

$\alpha = 2(1 - i)$

$\alpha = 2(1 - 0.504)$

$= 0.992$

$= 99.2\%$