Blue Print (As per PU Board)

Topic	1 mark questions	2 marks questions	3 marks questions	5 marks questions	Total Marks
Electrochemistry	1	1	–	1	8

One mark questions

1. **What happens to molar conductivity when one mole of KCl dissolved in one litre is diluted to five litres**
   Answer: Increases
2. **What is a secondary cell?**
   Answer: Cell that can be recharged again
3. **Write the S.I unit of molar conductivity**
   Answer: $Sm^2\ mol^{-1}$

Two marks questions

4. **What are the products of electrolysis of molten and aqueous sodium chloride?**
   Answer: Molten $NaCl$: Na at cathode (1 mark)
   Cl_2 gas at anode
   Aqueous $NaCl$: H_2 gas at cathode
   Cl_2 gas at anode (1 mark)
5. **What is molar conductivity? How is it related to the conductivity of a solution whose concentration is C mol m^{-3}?**
   Answer: Molar conductivity of a solution at a given concentration & temperature is the conductance due to 1 mole of the electrolyte in volume V of solution placed between 2 electrodes of area of cross section A and at a distance of unit length 'ℓ'.
   Or
   Conductivity of a solution containing one mole of the electrolyte (1 mark)
   $\wedge_m = \frac{KM}{\ell} \qquad \because \ell = 1 \quad \& \qquad A = V$
   $= \frac{KA}{\ell}$ or $\wedge_m = \frac{K}{C}$ as $V \propto \frac{1}{C}$ (1 mark)
   Or
   Molar conductivity is inversely proportional to concentration in mol m^{-3}

6. **What is corrosion? Name one method to prevent it**
   Answer: When iron is exposed to moist air, it reacts with moisture, CO_2 and oxygen present is air to form Rust and the phenomenon is called as corrosion. Corrosion takes place by transfer of electrons & so is called an electrochemical phenomenon (1 mark)
   It can be prevented by Barrier protection or sacrificial protection (1 mark)

Three marks questions

7. **Calculate the EMF of the cell for the reaction,** $Mg_{(s)} + 2Ag^+_{(aq)} \rightarrow \underset{(aq)}{Mg^{2+}} + 2Ag_{(s)}$
   Given $E^\circ\left(Mg^{2+}/Mg\right) = -2.37V$, $E^\circ\left(Ag^+/Ag\right) = 0.80\ V$, $\left[Mg^{2+}\right] = 0.001M; \left[Ag^+\right] = 0.0001M$
   $\log 10^5 = 5$
   Answer: $E^\circ_{cell} = E_{Right} - E_{left}$

$= 0.80 - (-2.37) = 3.17$ V (1 mark)

$$E = E^\circ - \frac{0.059}{n} \log \frac{[\text{Product}]}{[\text{Reactant}]}$$

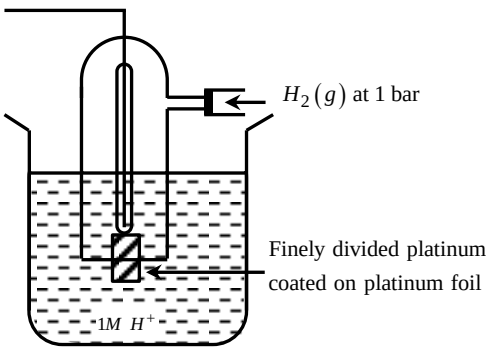
$$= 3.17 - \frac{0.059}{2} \log \frac{\left[10^{-3}\right]}{\left[10^{-4}\right]^2}$$ (1 mark)

$$= 3.17 - \frac{0.059}{2} \log 10^5$$

$$= 3.17 - \frac{0.059 \times 5}{2} = 3.0225\ V$$ (1 mark)

8. **Draw labelled diagram of SHE. Write its half-cell reaction and E° value.**

Answer:



(1 mark)

Cell reaction $H^+_{(aq)} + e^- \rightarrow \frac{1}{2} H_2(g)$ (1 mark)

E° value $= O$ volts (1 mark)

9. **Balance and calculate the equilibrium constant of the cell reaction at 298 K**

$Al + Zn^{2+} \rightarrow Al^{3+} + Zn \quad E^\circ_{\text{cell}} = 0.9$ V

Answer: $Al \rightarrow Al^{3+} + 3e-\} \times 2$

$Zn^{2+} + 2e^- \rightarrow Zn\ \} \times 3$

$2Al + 3Zn^{2+} \rightarrow 2Al^{3+} + 3Zn \quad \therefore n = 6$ (1 mark)

$$E^\circ_{\text{cell}} = \frac{0.0591}{n} \log Kp$$

$$\log\ Kp = \frac{E^\circ \text{cell} \times n}{0.0591} = \frac{0.9 \times 6}{0.0591} = 91.37$$ (1 mark)

$Kp = \text{Antilog}\ (91.37) = 2.344 \times 10^{91}$ (1 mark)

Five marks questions

10. **(a) Find the value of ΔG° at $25^\circ C$ for the following electrochemical cell,**

$Cu / Cu^{2+}(1M) \,||\, Ag^+(1M) \,|\, Ag \quad \left(E^\circ_{Cu} = +0.34\text{ V and } E^\circ_{Ag} = 0.8\,\text{V}\right)$

Answer: $E^\circ_{cell} = E^\circ_R - E^\circ_L = E^\circ_{Ag} - E^\circ_{Cu}$ (1 mark)

$= 0.8 - (0.34) = 0.46V$ (1 mark)

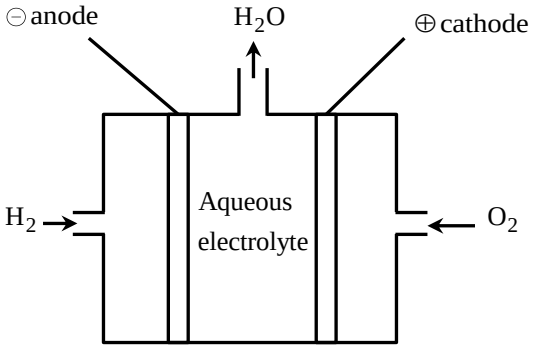
$\Delta G^\circ = -nFE^\circ_{\text{cell}}$

$= -2 \times 96500 \times 0.46$

$= -88780J = -88.78\ kJ$ (1 mark)

(b) Write a neat diagram of $H_2 - O_2$ fuel cell. Mention the reactions taking place at anode and cathode when it is functioning. (2 marks)

Answer:



(1 mark)

At cathode: $O_{2(g)} + 2H_2O_{(\ell)} + 4e^- \rightarrow 4OH^-_{(aq)}$

At Anode: $2H_{2(g)} + 4OH^-_{(aq)} \rightarrow 4H_2O_{(\ell)} + 4e^-$ (1 mark)

11. **(a) The molar conductances of sodium chloride, hydrochloride and sodium acetate at infinite dilution are 126.45, 426.16 and 91.0** $\text{ohm}^{-1}\,\text{cm}^2\,\text{mol}^{-1}$ **at** $25°C$ **respectively, calculate the molar conductance at infinite dilution.** (2 marks)

Answer: $\overset{\circ}{\wedge}_{CH_3COOH} = \overset{\circ}{\wedge}_{CH_3COONa} + \overset{\circ}{\wedge}_{HCl} - \overset{\circ}{\wedge}_{NaCl}$ (1 mark)

$= 91.0 + 426.16 - 126.45$

$= 390.71\ S\,\text{cm}^2/\text{mol}$ (1 mark)

(b) The resistance of solution of a salt occupying a volume between two platinum electrodes 1.8 cm apart and $5.4\,\text{cm}^2$ **in area was found to be 32 ohms. Calculate the conductivity of the solution** (2 marks)

Answer: Conductivity = cell constant × Conductance

$K = \frac{\ell}{A} \times \frac{1}{R}$ (1 mark)

$K = \frac{1.8}{5.4} \times \frac{1}{32}$ (1 mark)

$K = 0.01042\ \text{Scm}^{-1}$ (1 mark)

(c) Write the symbolic representation of SHE

Answer: $Pt_{(s)} \mid H_{2(g)} \mid H^+_{(aq)}$ or (1 mark)

$Pt(s) \mid H_{2(g,1bar)} / H^+(aq, 1M)$ (1 mark)

12. **(a) How much electricity in terns of Faraday is required to produce.**
(i) 20 g of Ca from molten $CaCl_2$ **?**
(ii) 40 g Al from molten Al_2O_3 **?** (1 mark)

Answer: (i) $Ca^{2+} + 2e^- \rightarrow Ca$

Thus 1 mole of Ca ie 40 g require electricity = 2F

$\therefore$ 20 g require electricity = 1F

(ii) $Al^{3+} + 3e^- \rightarrow Al$

Thus 1 mole of Al i.e., 27 g require electricity = 3F

$\therefore$ 40 g require $\frac{40 \times 3}{27} = 4.44F$

(b) Three electrolytic cells A, B, C containing solutions of $ZnSO_4$, $AgNO_3$ and $CuSO_4$ respectively are connected in series. A steady current of 1.5 amperes was passed through them until 1.45 g of silver deposited at the cathode of cell B. How long did the current flow?
What mass of copper and zinc were deposited? (3 marks)

Answer: $Ag^+ + e \rightarrow Ag$

ie. 108 g of Ag are deposited by 1F = 96500 C

$\therefore$ 1.45 g of $Ag \rightarrow \dfrac{96500 \times 1.45}{108} = 1295.6\,\text{C}$ (1 mark)

WKt, $Q = I \times t$

or $t = \dfrac{Q}{I} = \dfrac{1295.6}{1.5} = 863.7$ sec (1 mark)

$= 14\,\text{min},\ 24\,\text{sec}$

$Cu^{2+} + 2e^- \rightarrow Cu$

ie 2×96500 C deposits 1 mole of $Cu = 63.5$ g

$\therefore$ 1295.6 C will deposit $\rightarrow \dfrac{63.5 \times 1295.6}{2 \times 96500} = 0.426$ g

$Zn^{2+} + 2e^- \rightarrow Zn$

$\therefore$ Zn deposited $= \dfrac{65.3 \times 1295.6}{2 \times 96500} = 0.438$ g