CBSE Test Paper-01

Class 12 Chemistry (Electrochemistry)

1. Given
   i. $Cu^{2+} + 2e^- \longrightarrow Cu$, $E^0 = 0.337$ V
   ii. $Cu^{2+} + e^- \longrightarrow Cu^+$, $E^0 = 0.153$ V

   Electrode potential E° for the reaction $Cu^{2+} + e^- \rightarrow Cu$ will be
   a. 0.52 V
   b. 0.38 V
   c. 0.30 V
   d. 0.90 V
2. How much electricity is required in coulomb for the oxidation of 1 mol of FeO to Fe_2O_3?
   a. 95000C
   b. 96000C
   c. 96487C
   d. 95550C
3. Correct arrangement of Al, Cu, Fe, Mg and Zn in the order in which they displace each other from the solution of their salts is
   a. Mg > Al > Cu > Fe > Zn
   b. Mg > Al > Zn > Cu > F
   c. Mg > Al > Zn > Fe > Cu
   d. Cu > Al >Zn > Fe > Mg
4. In the button cells widely used in watches and other devices the following reaction takes place:

   $Zn_{(s)} + Ag_2O_{(s)} + H_2O_{(l)} \rightarrow Zn^{2+}_{(aq)} + 2Ag_{(s)} + 2OH^-_{(aq)}$ [Given E^0 Zn^{2+}/Zn = -0.76V, $E^0 Ag_2O/Ag$ = +0.344V]

   Determine E^0 cell for the reaction.
   a. 1.104 V
   b. 1.005 V
   c. 0.913 V

d. 1.159 V

5. Conductivity of 0.00241 M acetic acid is 7.896 × 10^{-5} S cm^{-1}. If $\Lambda\ ^0m$ for acetic acid is 390.5 S cm^2mol^{-1}, what is its dissociation constant?
   a. 1.75 × 10^{-5}
   b. 2.05 × 10^{-5}
   c. 1.95 × 10^{-5}
   d. 1.85 × 10^{-5}

6. Write the cell formulation and calculate the standard cell potential of the galvanic cell in which the following reaction takes place:

   Fe^{2+}(aq) + Ag^+(aq) $\rightarrow$ Fe^{3+}(aq) + Ag(s)
   Calculate $\Delta_r G^0$ for the above reaction
   [Given: $E^0_{Ag^+/Ag} = +0.80V$
   $E^0_{Fe^{3+}/Fe} = +0.77V$
   [1 F = 96500 C mol^{-1}]

7. What is the representation of a Daniell cell?

8. Why is the voltage of a mercury cell constant during its working?

9. Suggest a way to determine the Λ^0_m value of water?

10. Molar conductance of 1.5 M solution of an electrolyte is found to be 138.9 S cm^2 mol^{-1} What would be the specific conductance of this solution?

11. At 298 K, the molar conductivities at infinite dilution of NH_4Cl, NaOH and NaCl are 129.8, 217.4 and 108.9s cm^2mol^{-1} respectively. The molar conductivity of 0.01 M NH_4OH solution is 9.33s cm^2mol^{-1}, calculate the degree of dissociation of NH_4OH at this dilution?

12. Consider the reaction:

    $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$
    What is the quantity of electricity in coulombs needed to reduce 1 mol of $Cr_2O_7^{2-}$?

13. a. The resistance of a conductivity cell containing 0.0001 M KCl solution at 298 K is 1500Ω. What is the cell constant if the conductivity of 0.001 M KCl solution at 298 K is $0.146 \times 10^{-3} S\,cm^{-1}$

    b. Predict the products of electrolysis in the following:

    A solution of H_2SO_4 with platinum electrode.

14. Zinc rod is dipped in 0.1 M solution of $ZnSO_4$

    The salt is 95% dissociated at is dilution at 298 K . Calculate the electrode potential.

    Given:

    $E^0(Zn^{2+}/Zn)$ = -0.76

15. Explain construction and working of standard Hydrogen electrode?

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Solutions

1. a. 0.52 V

   Explanation: E^0 cell = 2(0.337)-0.153

2. c. 96487C

   Explanation: For converting FeO to Fe_2O_3 1mol of electrons are required.

3. c. Mg > Al > Zn > Fe > Cu

   Explanation: In application of electrochemical series, the metal which has lower reduction potential has higher tendency to get oxidised and would displace metals with lesser reduction potential from their salt solution.

4. a. 1.104 V

   Explanation: $E_{cell}^0 = E_{cathode}^0 - E_{anode}^0$

   E^0cell = $E^0 Ag_2O/Ag$ - E^0 Zn^{2+}/Zn

   = +0.344-(-0.76) = 1.104V

5. d. 1.85×10^{-5}

   Explanation: $\Lambda m = \frac{k}{c} \times 1000$ = 7.896 x 10^{-5} $\times$1000/0.00241 = 32.76Scm^2/mol

   and $\alpha = \Lambda m / \Lambda^0 m$ = 32.76/390.5 = 0.084

   and K = Cα^2/1-α = 0.00241$\times$ $(0.084)^2$/1-0.084 = 1.85 $\times 10^{-5}$

6. $E_{cell}^0 = E_{Ag^+/Ag}^0 - E_{Fe^{3+}/Fe}^0$

   = +0.80 V - (+0.77) V

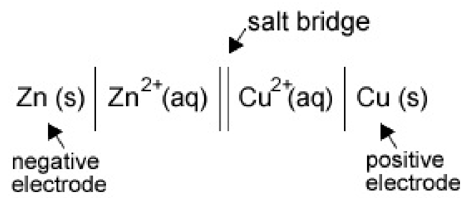
   = 0.03 V

   $\Delta_r G^0 = -nFE^o$

   $= -2 \times 0.03V \times 96500$

   = -5790 J mol^{-1}

   = 57.90 KJ mol^{-1}

7. 

8. As all the products and reactants are either in solid or liquid state, their concentration does not change with the use of the cell.

9. Applying Kohlrausch's law of independent migration of ions, the Λ_m^0 value of water can be determined as follows:
$\Lambda^0_{m(H_2O)} = \lambda^0_{H^+} + \lambda^0_{OH^-}$
$= \left(\lambda^0_{H^+} + \lambda^0_{Cl^-}\right) + \left(\lambda^0_{Na^+} + \lambda^0_{OH^-}\right) - \left(\lambda^0_{Na^+} + \lambda^0_{Cl^-}\right)$
$= \lambda^0_{m(HCl)} + \lambda^0_{m(NaOH)} - \lambda^0_{m(NaCl)}$
Hence, by knowing the λ_m^0 values of HCl, NaOH, and NaCl, the λ_m^0 value of water can be determined.

10. Given that
molarity = 1.5 m
molar conductivity = 138.9 S cm^2 mol^{-1}
$\lambda_m = \frac{1000K}{M} = K = \frac{\lambda_m \times M}{1000}$
$= \frac{138.9\, S\, cm^2\, mol^{-1} \times 1.5 mol}{1000\, cm^3}$
K = 0.20835 S cm^{-1}
$= 2.0835 \times 10^{-1}\, S\, cm^{-1}$

11. $\lambda_m{}^0(\mathrm{NH_4OH}) = \lambda_\mathrm{m}{}^\mathrm{o}(\mathrm{Na_4Cl}) + \lambda_\mathrm{m}{}^\mathrm{o}(\mathrm{NaOH}) - \lambda_\mathrm{m}{}^\mathrm{o}(\mathrm{NaCl})$
= 129.8 +217.4 - 108.9 = 237.3 5cm^2/mol
Degree of dissociation, $\alpha = \frac{\lambda m}{\lambda m^0} = \frac{9.335 \mathrm{cm}^2 / \mathrm{mol}}{237.35 \mathrm{cm}^2 / \mathrm{mol}}$
= 0.039 or 3.9%.

12. From the given reaction
1 mol of $Cr_2O_7^{2-}$ ions requires
$6F = 6 \times 96500\ C$
= 579000 C of electricity for reduction of Cr^{3+}.

13. a. At Anode:

$$Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$$

At Cathode:

$$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$$

Overall reaction is:

$$Mg(s) + Cu^{2+}(aq) \rightarrow Mg^{2+}(aq) + Cu(s)$$

Using nernst equation for n=2,

$$E_{cell} = [E^0{}_{Cu^{2+}/Cu} - E^0{}_{Mg^{2+}/Mg}] - \frac{0.0591}{2}\log\frac{[Mg^{2+}]}{[Cu^{2+}]}$$
$$= +0.34V - (-2.37V) - \frac{0.0591}{2}\log\frac{0.001}{0.0001}$$
$$= 2.71V - \frac{0.0591}{2}\log 10$$

= 2.71V - 0.0295V

= 2.6805 V

For free gibbs energy

$$\Delta G = -nEF$$
$$= -2 \times 2.6805 \times 96500$$

= -517336.5 J mol^{-1}

= -517.34 KJ mol^{-1}

b. At cathode: $2H^+(aq) + 2e^- \rightarrow H_2(g)$

At anode: $2OH^-(aq) \rightarrow O_2(g) + 2H^+(aq) + 4e^-$

H_2(g) is evolved at cathode and O_2(g) is evolved at anode.

14. $\left[Zn^{2+}\right] = 0.1 \times \frac{95}{100} = 0.095M$

$$Zn^{2+} + 2e^- \rightarrow Zn$$
$$E_{(Zn^+/Zn)} = E^0_{(Zn^+/Zn)} - \frac{0.0591}{2}\log\frac{1}{[Zn^{2+}]}$$
$$= -0.76V - \frac{0.0591}{2}\log\frac{1}{0.095}$$
$$= -0.76V - \frac{0.0591}{2}[\log 1000 - \log 95]$$
$$= -0.76 - \frac{0.0591}{2}[3.000 - 1.9777]$$
$$= -0.76V - \frac{0.0591}{2} \times 1.0223$$
$$= -0.76V - \frac{0.0604}{2} = 0.76 - 0.0302$$

= - 0.7902 V

15. **Construction:** SHE consists of a platinum electrode coated with platinum black. The electrode is dipped in an acidic solution and pure Hydrogen gas is bubbled through it.

The concentration of both the reduced and oxidized. Forms of Hydrogen is maintained at unity i.e) pressure of H_2 gas is 1 bar and concentration of Hydrogen ions in the solution is 1 molar.

Working – The reaction taking place in SHE is $H^+ (aq) + e^- \rightarrow 1/2 H_2 (g)$ At 298 K, the emf of the cell constructed by taking SHE as anode and other half-cell as cathode, gives the reduction potential of the other f cell whereas for a cell constructed by taking SHE as anode gives the oxidation potential of other half cell as conventionally the electrode potential of SHE is zero.