CBSE Class 12 physics
Important Questions
Chapter 3
Electrochemistry

2 Marks Questions

1. How is standard electrode potential of a cell related to :-

1) Equilibrium constant?

2) Gibbs free energy change.

Ans. (i) Standard electrode potential and equilibrium constant

$$E^0_{cell} = \frac{2.303RT}{nF} \log k_c$$

Where E^0_{cell} = standard electrode potential of cell

R = Gas constant

T = temperature in Kelvin

n = no. of electrons.

F = Faraday's constant and

Kc = Equilibrium constant

(ii) Standard electrode potential and Gibbs free energy change-

$$\Delta G^0 = -n\,F\,E^0 cell$$

Where ΔG^0 = Change in Gibbs' free energy

n = No. of electrons

F = Faraday's Constant

E^0_{cell} = Standard electrode Potential of cell.

2. What is the half cell potential for Fe^{3+}/Fe electrode in which $\left[Fe^{3+}\right]=0.1\ m$.

$$E^0 Fe^{3+}/Fe = +0.771V$$

Ans. $Fe^{3+}+3e^- \rightarrow Fe$

According to Nernst Equation –

$$E_{Fe^{3+}/Fe} = E^0_{Fe^{3+}/Fe} - \frac{0.059}{n} \log \frac{1}{[Fe^{3+}]}$$

= 0.771 V - $\frac{0.059}{3} \log \frac{1}{0.1}$

= 0.771 V - 0.0197 V

= +0.7513V

3. Calculate pH of following half cell. Pt , H_2 / H_2SO_4, if its electrode potential is 0.03V.

Ans. $P^H = -Log\left[H^+\right]$

The cell reaction is –

$$H^+ + e- \rightarrow H_2(g)$$

According to Nearest Equation

$$E = E^0 - \frac{0.059}{n} \log \frac{1}{[H^+]}$$

0.03V = 0 + $\frac{0.059}{1} \left(-\log \frac{1}{[H^+]}\right)$

$$= 0 + 0.059_p{}^H$$

PH = $\frac{0.03V}{0.059}$ = 5.07 V

4. What are the factors on which conductivity of an electrolyte depend?

Ans. The conductivity of an electrolyte depends upon

i) The nature of electrolyte

ii) Size of the ions produced

iii) Nature of solvent and its viscosity.

iv) Concentration of electrolyte.

v) Temperature

5. How is molar conductance related to conductivity of an electrolyte ?

Ans. Molar conductance, Ωm is related to conductively by the relation.

$\Omega m = \frac{k}{c}$

Where κ = conductivity in s/m.

C = concentration in mol / m^3

6. Write an expression relating cell constant and conductivity?

Ans. Cell constant and conductivity are related by the expression-

$\kappa = \frac{G}{R}$ where G = Cell constant

κ = conductivity

R = Resistance.

7. The conductivity of an aqueous solution of NaCl in a cell is $92\Omega^{-1}\ cm^{-1}$ the resistance offered by this cell is 247.8Ω. Calculate the cell constant?

Ans. Specific conductivity = $\frac{\text{cell constant}}{\text{Resistance}}$

Or cell constant = $conductivity \times Resistance$

= 92 Ω^{-1} cm^{-1} $\times$ 247.8 Ω

= 22797.6 Ω^{-1}

8. The molar conductivity of 0.1M CH_3COOH solution is $4.6\ cm^2 mol^{-1}$. What is the conductivity and resistivity of the solution?

Ans. $\lambda m = \frac{\kappa}{C} \times 1000\ \text{S cm}^2\ \text{mol}_{-1}$

$= \frac{1000\ \kappa}{M}$

$\kappa = \frac{\lambda m \times M}{1000}$

$= \frac{4.6\ S\ cm^2 / mol \times 0.1\text{m}}{100}$

= 0.00046 s/cm

Resistivity = $\frac{1}{\kappa}$

$= \frac{1}{0.00046\ \text{S cm}^{-1}} = 2174\ \Omega\ \text{cm}.$

9. The conductivity of metals decreases while that of electrolytes increases with increases in temperature. Why?

Ans. With increase in temperature, the K.E. of metal cation increases and obstructs the free flow of electrons decreasing the conducts of metal while in case of electrolytes, increased temperature increases the mobility of ions this increases the conductance of ions.

10. The measured resistance of a cell containing $7.5\times10^{-3}M$ solution of KCl at $25^{0}C$ was 1005 Ω calculate

(a) Specific conductance and

(b) Molar conductance of the solution. Cell Constant = $1.25\ cm^{-1}$

Ans. $k = 1.2\ 2/3\times10^{-3}\ \Omega^{-1}\text{cm}^{-1}$

$\lambda m = 165.7\ \Omega^{-1}\ \text{cm}^{2}\ \text{mol}^{-1}.$

11. How is Limiting molar conductivity related to

i) degree of ionization and

ii) dissociation constant

Ans. Relation between limiting molar conductance and degree of dissociation –

$\alpha = \frac{\Omega m}{\Omega^{\circ} m}$ where α = degree of dissociation

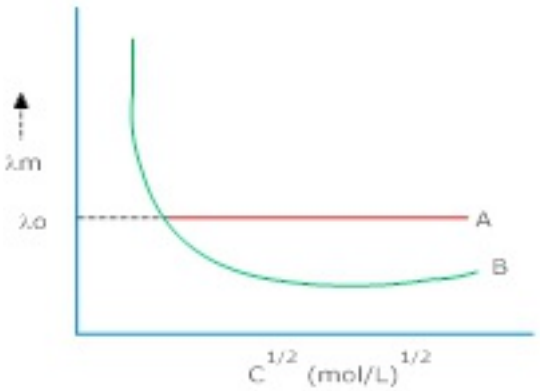
$\lambda m =$ molar conductance molar

λm^{0} Limiting molar conductance

Relation between dissociation constant and limiting molar conductance –

$Ka = \frac{C\ \lambda \text{m}^{2}}{\lambda m^{0}\ (\lambda \text{m}^{0} - \lambda \text{m})}$ where c = concentration

12. In fig. (1), identify the nature of electrolyte A& B. In which case it is not possible to obtain value of limiting molar conductance?



Ans. A = strong Electrolyte

B = weak Electrolyte

In case of B , it is not possible to get an exact value of limiting molar conductance.

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

Ans. $\lambda_m^0\ (NH_4OH) = \lambda_m^\circ\ (Na_4Cl) + \lambda_m^\circ\ (NaOH) - \lambda_m^\circ\ (NaCl)$

= 129.8 +217.4 – 108.9 $= 237.35\ cm^2 / mol$

Degree of dissociation, $\alpha = \frac{\lambda m}{\lambda m^0} = \frac{9.33\ 5\ cm^2 / mol}{237.3\ 5\ cm^2 / mol}$

= 0.039 or 3.9 %.

14. State Faraday's Laws of electrolysis?

Ans. Faraday's Laws of electrolysis

First Law: The amount of chemical reaction which occurs at any electrode during electrolysis by a current is proportional to the quantity of electricity passed through the electrolyte.

Second Law: The amount of different substances liberated by the same quantity of electricity passing through the electrolytic solution is proportional to their chemical equivalent weights.

15. How many g of chlorine can be produced by the electrolysis of molten NaCl with a current of 1 amp. for 15 min?

Ans. Q = It $= 1 \times 15 \times 60 = 900C$

The reaction is $2Cl^- \; Cl_2 + 2e^-$

2mol 1mol 2mol

$\therefore$ 2F . produces 1 mol of Cl_2

1mol of $Cl_2 = 71g$

$\therefore$ $2 \times$ 96500 C produces 71g of Cl_2

900 C will produce $\frac{71}{2} \times \frac{900}{96500}$ g $= 0.331\,g \; of \; Cl_2$.

16. How many electrons flow when a current of 5 amps is passed through a solution for 193 sec. Given f = 96500 C. $N_A = 6.002 \times 10^{23} mol^{-1}$**?**

Ans. Q = It $= 5 \times 193 = 965 \; C$

96500C = 1 mol of electrons $= 6.022 \times 10^{23} mol^{-1}$

965 C = $6.022 \times 10^{23} \times \frac{965}{96500}$

$= 6.022 \times 10^{21}$ electrons.

17. There are two possible reactions for cathode in the electrolysis of aqueous $ZnCl_2$ **:**

$Zn^{2+}(aq) + \rightarrow 2e^- Zn(s)$ **E = -0.76v,** $2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ **E = - 0.83v**

Which one will take place ?

Ans. Zn^{2+} has higher reduction potential (-0.76v) Than $H_2O \; (-0.83v)$ and therefore Zn^{2+} is reduced to Zn preferentially at cathode.

18. Silver is deposited on a metallic vessel by passing a current of 0.2 amps. for 3 hrs. Calculate the weight of silver deposited. (At mass of silver = 108 amu, F = 96500 C?

Ans. 2.417 g of silver.

19. What do you mean by primary and secondary battery?

Ans. In the primary batteries, the reaction occurs only once and after the use over a period of time battery becomes dead and cannot be reused again. A secondary battery , after used, can be recharged by passing current through it in the opposite direction so that it can be used again.

20. Name the cell used for low current devices like hearing aids, watches etc. Also give the half cell reactions for such a cell?

Ans. This cell is mercury cell – Half cell reactions are Anode

$Zn(Hg) + 2OH^- \rightarrow ZnO + H_2O + 2e^-$ and those

$HgO + H_2O + 2e^- \rightarrow Hg(e) + 2OH^-$

21. Rusting of iron is quicker in saline water than in ordinary water. Explain?

Ans. Saline water consists of greater no. of ions than normal water which increases the electrochemical reaction. This increases rate of corrosion.

22. Enlist the factors affecting corrosion?

Ans. Factors affecting corrosion are -

1) Water and air

2) Presence of electrolytes in water.

3) Presence of gases like CO_2, SO_2.

23. The conductivity of 0.20 M solution of KCl at 298 K is $0.0248\ S\ cm^{-1}$. Calculate its molar conductivity.

Ans. Given,

K= 0.0248 S cm^{-1}

c = 0.20 M

Therefore, Molar conductivity, $A_m = \frac{K \times 1000}{c}$

$= \frac{0.0248 \times 1000}{0.2}$

$= 124\ Scm^2mol^{-1}$

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

Ans. Given,

Conductivity, $K = 0.146 \times 10^{-3}\ S\ cm^{-1}$

Resistance, R = 1500Ω

Therefore, Cell constant = $K \times R$

= $0.146 \times 10^{-3} \times 1500$

= $0.219\ cm^{-1}$

25. In the button cells widely used in watches and other devices the following reaction takes place: $Zn(s) + Ag_2O(s) + H_2O(l) \rightarrow Zn^{2+}(aq) + 2Ag(s) + 2OH^-(aq)$ Determine $\Delta_r G^\ominus$ and $E^\ominus$ for the reaction.

Ans.

$$Zn_{(s)} \longrightarrow Zn^{2+}_{(aq)} + 2e^- \ ; \ E^\ominus = 0.76V$$

$$Ag_2O_{(s)} + H_2O_{(l)} + 2e^- \longrightarrow 2Ag_{(s)} + 2OH^-_{(aq)} \ ; \ E^\ominus = 0.344\ V$$

$$Zn_{(s)} + Ag_2O_{(s)} + H_2O_{(l)} \longrightarrow Zn^{2+}_{(aq)} + 2Ag_{(s)} + 2OH^-_{(aq)} ; \ E^\ominus = 1.104\ V$$

Therefore, E° = 1.104 V

We know that,

$$\Delta_r G^{\circ} = -nFE^{\circ}$$

= $-2 \times 96487 \times 1.04$

= –213043.296 J

= –213.04 kJ

26. Given the standard electrode potentials,

$K^+ / H = -2.93, Ag^+ / Ag = 0.80V$,

$Hg^{2+} / Hg = 0.79V$

$Mg^{2+} / Mg = -2.37V, Cr^{3+} / Cr = -0.74V$

Arrange these metals in their increasing order of reducing power.

Ans. The lower the reduction potential, the higher is the reducing power. The given standard electrode potentials increase in the order of
$K^+ / K < Mg^{2+} / Mg < Cr^{3+} / Cr < Hg^{2+} / Hg < Ag^+ / Ag$.

Hence, the reducing power of the given metals increases in the following order:

Ag < Hg < Cr < Mg < K

27. What is the quantity of electricity in coulombs needed to reduce 1 mol of $Cr_2O_7^{2-}$?
Consider the reaction: $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 8H_2O$

Ans. The given reaction is as follows: $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

Therefore, to reduce 1 mole of $Cr_2O_7^{2-}$, the required quantity of electricity will be:

=6 F = 6×96487 C

= 578922 C

28. Why does the conductivity of a solution decrease with dilution?

Ans. The conductivity of a solution is the conductance of ions present in a unit volume of the solution. The number of ions (responsible for carrying current) decreases when the solution is diluted. As a result, the conductivity of a solution decreases with dilution.

29. Suggest a way to determine the Λ_m^0 value of water.

Ans. 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.

30. Can you store copper sulphate solutions in a zinc pot?

Ans. Zinc is more reactive than copper. Therefore, zinc can displace copper from its salt solution. If copper sulphate solution is stored in a zinc pot, then zinc will displace copper from the copper sulphate solution.

$$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$$

Hence, copper sulphate solution cannot be stored in a zinc pot.

31. Consult the table of standard electrode potentials and suggest three substances that can oxidise ferrous ions under suitable conditions.

Ans. Substances that are stronger oxidising agents than ferrous ions can oxidise ferrous ions.

$$Fe^{2+} \rightarrow Fe^{3+} + e^{-1};\ E^{\ominus} = -0.77V$$

This implies that the substances having higher reduction potentials than +0.77 V can oxidise ferrous ions to ferric ions. Three substances that can do so are F_2, Cl_{12}, and O_2.