

Electrochemistry

SOLUTIONS

Exercise-I (Conceptual Questions)

- Ans. (3)**
Strong electrolytes are those for which degree of dissociation (α) is 100% at any concentration.
- Ans. (2)**
When a salt like NaCl is molten, in molten state its ions become mobile and those mobile ions are charge carriers which are responsible for conduction of electricity.
- Ans. (3)**
In electrolytic conduction charge carriers are mobile ions due to which conduction occurs.
- Ans. (1)**
Equivalent conductance ($\lambda_{eq.}$) = $\frac{\kappa \times 1000}{N}$
For KCl v.f. = 1, So $N = M$
$$\lambda_{eq} \propto \frac{1}{N}$$
$$N \uparrow \Rightarrow \lambda_{eq} \downarrow \quad \text{or} \quad M \uparrow \Rightarrow \lambda_{eq} \downarrow$$
- Ans. (3)**
Given : Specific resistance (ρ) = R
Concentration (N) = C g-eq L^{-1}
Now, Specific conductance (κ) = $\frac{1}{\rho} = \frac{1}{R}$
Equivalent conductance (λ_{eq}) = $\frac{\kappa \times 1000}{N}$
$$= \frac{1}{R} \times 1000$$
$$= \frac{1000}{R.C}$$
- Ans. (3)**
Specific conductance (κ) = $\frac{1}{\rho}$
 $\kappa \downarrow \Rightarrow \rho \uparrow$
 $R = \rho \cdot \frac{\ell}{A}$
 $\kappa \downarrow \Rightarrow \rho \uparrow \Rightarrow R \uparrow$

- Ans. (3)**
Given :
Specific conductance (κ) = $1.061 \times 10^{-4} S cm^{-1}$
Now Molar conductance (λ_m) = $\frac{\kappa \times 1000}{M}$
$$= \frac{1.061 \times 10^{-4} \times 10^3}{0.01}$$
$$= 10.61 S cm^2 mol^{-1}$$
- Ans. (2)**
With dilution, inter ionic interaction decreases so conductance increases.
- Ans. (1)**
Given : Concentration (N) = 0.01 N
Resistance (R) = 210 Ω
Cell constant (G^*) = $\frac{\ell}{A} = 0.66 cm^{-1}$
Now $G = \frac{1}{R} = \frac{1}{120}$
$$\kappa = G \cdot G^* = \frac{1}{210} \times 0.66$$
$$\lambda_{eq} = \frac{\kappa \times 10^3}{N} = \frac{\left(\frac{1}{210} \times 0.66\right) \times 10^3}{0.01}$$
$$= 314.28 mho cm^2 eq^{-1}$$
- Ans. (2)**
In case of electrolytic conduction charge carriers are mobile ions while in case of metallic conduction charge carriers are electrons, so increasing temp. mobility of ion increases hence resistance decreases.
- Ans. (1)**
Given : specific conductance (κ) = $0.0014 \Omega^{-1} cm^{-1}$
Conc. (M) = 0.01 M
Now
$$\lambda_{eq} = \frac{\kappa \times 1000}{N}$$
$$= \frac{0.0014 \times 1000}{0.01}$$
$$\lambda_{eq} = 140$$

n-factor for KCl = 1
So $N = M = 0.01$
- Ans. (1)**

Specific conductance is conductance due to 1 ml electrolytic solution on dilution no of ions per ml decreases hence specific conductance decreases.

13. Ans. (1)

$$\text{Given: } \lambda_{\text{e CH}_3\text{COONa}}^{\infty} = 91 \text{ mho cm}^2 \text{eq}^{-1}$$

$$\lambda_{\text{e HCl}}^{\infty} = 426 \text{ mho cm}^2 \text{eq}^{-1}$$

$$\lambda_{\text{e CH}_3\text{COOH}}^{\infty} = 391 \text{ mho cm}^2 \text{eq}^{-1}$$

$$\lambda_{\text{e NaCl}}^{\infty} = \lambda_{\text{e Na}^+}^{\infty} + \lambda_{\text{e Cl}^-}^{\infty}$$

$$= \lambda_{\text{e CH}_3\text{COONa}}^{\infty} + \lambda_{\text{e HCl}}^{\infty} - \lambda_{\text{e CH}_3\text{COOH}}^{\infty}$$

$$= 91 + 426 - 391$$

$$= 126$$

14. Ans. (3)

$$\text{Given : } \alpha = 90\% = 0.9$$

$$\lambda_{\text{e}}^{\infty} = 425 \Omega^{-1} \text{cm}^2 \text{eq}^{-1}$$

$$\kappa = 3.825 \Omega^{-1} \text{cm}^{-1}$$

$$\text{Now, } \alpha = \frac{\lambda_{\text{e}}^{\text{c}}}{\lambda_{\text{e}}^{\infty}}$$

$$\lambda_{\text{e}}^{\text{c}} = \lambda_{\text{e}}^{\infty} \times \alpha$$

$$\lambda_{\text{e}}^{\text{c}} = 425 \times \frac{90}{100} \quad \dots (1)$$

$$\text{Also, } \lambda_{\text{e}}^{\text{c}} = \frac{\kappa \times 1000}{N} \quad \dots (2)$$

$$\text{Equation (1) \& (2)}$$

$$425 \times \frac{90}{100} = \frac{\kappa \times 1000}{N}$$

$$425 \times \frac{90}{100} = \frac{3.825 \times 1000}{N}$$

$$N = 10N$$

15. Ans. (1)

$$\Lambda_{\text{HOAc}}^{\circ} = \Lambda_{\text{H}^+}^{\circ} + \Lambda_{\text{OAc}^-}^{\circ}$$

$$= \Lambda_{\text{NaOAc}}^{\circ} + \Lambda_{\text{HCl}}^{\circ} - \Lambda_{\text{NaCl}}^{\circ}$$

To subtract molar conductance of Na^+ and Cl^-

We required $\Lambda_{\text{NaCl}}^{\circ}$.

16. Ans. (2)

$$\Lambda_{\text{M NaNO}_3}^{\circ} = \Lambda_{\text{M Na}^+}^{\circ} + \Lambda_{\text{M NO}_3^-}^{\circ}$$

$$= \Lambda_{\text{M NaCl}}^{\circ} + \Lambda_{\text{M AgNO}_3}^{\circ} - \Lambda_{\text{M AgCl}}^{\circ}$$

$$= 110.3 + 116.5 - 121.6$$

$$= 105.2 \text{ Scm}^2 \text{mol}^{-1}$$

17. Ans. (4)

$$\text{Given : } \kappa = 3.06 \times 10^{-6} \Omega^{-1} \text{cm}^{-1}$$

$$\lambda_{\text{M}} = 1.53 \Omega^{-1} \text{cm}^{-1} \text{mol}^{-1}$$

At saturation,

$$\lambda_{\text{M}} = \frac{\kappa \times 1000}{S}$$

$$S = \frac{3.06 \times 10^{-6} \times 1000}{1.53} = 2 \times 10^{-3} \text{ mol/L}$$

BaSO_4 is AB type of salt

$$K_{\text{sp}} = S^2$$

$$= (2 \times 10^{-3})^2 = 4 \times 10^{-6}$$

18. Ans. (2)

Acc. To KOHLRAUSCH'S LAW,

At infinite dilution, each ion make definite contribution to equivalent conductance of an electrolyte whatever be the nature of other ion of the electrolyte.

19. Ans. (2)

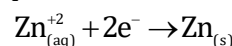
In galvanic cell, electron move from anode to cathode in external circuit so current flows from cathode to anode. From representation Cu to Ag.

20. Ans. (2)

In Daniel cell current flows from cathode to anode. So copper to zinc in external circuit.

21. Ans. (4)

Reaction representing standard reduction potential of zinc.



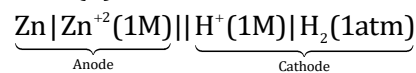
22. Ans. (2)

Zero electrode potential of standard hydrogen electrode is assumed to be zero.

23. Ans. (4)

In construction of S.H.E. a platinum block is used with conducting wire at $1\text{M}[\text{H}^+]$, 1 bar pressure and 25°C temp. The use of platinum block is adsorb H_2 gas at surface.

24. Ans. (2)



$$E_{\text{cell}}^{\circ} = (E_{\text{RP}}^{\circ})_{\text{Cathode}} - (E_{\text{RP}}^{\circ})_{\text{Anode}}$$

↓

$$= E_{\text{H}^+/\text{H}_2}^{\circ} - E_{\text{Zn}^{+2}/\text{Zn}}^{\circ}$$

$$= 0 - (-0.76)$$

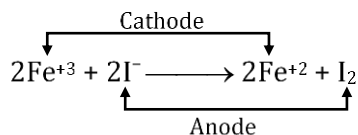
$$= +0.76 \text{ V}$$

25. Ans. (2)

Acc. to representation, it is reverse of Daniel cell so non spontaneous

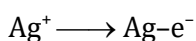
So $E_{\text{cell}} = -\text{ive}$

26. **Ans. (3)**

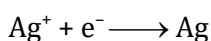


$$\begin{aligned}
 E_{\text{Cell}}^{\circ} &= E_{\text{Fe}^{+3}/\text{Fe}^{+2}}^{\circ} - E_{\text{I}_2/\text{I}^-}^{\circ} \\
 &= 0.771 - 0.536 \\
 &= 0.235 \text{ V}
 \end{aligned}$$

27. **Ans. (1)**



On rearranging



That is reduction reaction.

28. **Ans. (1)**

At anode always oxidation occurs At cathode always reduction occurs.

29. **Ans. (4)**

In Daniel cell, Anode is zinc and cathode is copper.

Zinc is consumed and copper is deposited

30. **Ans. (4)**

Acc. to E.C.S.; $\text{SRP}_{\text{Na}^+} < \text{SRP}_{\text{Zn}^{+2}}$

So Na being more reactive, Zn cannot displace Na^+ ion.

31. **Ans. (1)**

Strong reducing agent will have more standard oxidation potential.

$$E_{\text{Zn}/\text{Zn}^{+2}}^{\circ} > E_{\text{Cr}/\text{Cr}^{+3}}^{\circ} > E_{\text{H}_2/\text{H}^+}^{\circ} > E_{\text{Fe}^{+2}/\text{Fe}^{+3}}^{\circ}$$

32. **Ans. (3)**

More SOP $\Rightarrow$ more reactive metal displaces less reactive.

$$E_{\text{Fe}/\text{Fe}^{+2}}^{\circ} > E_{\text{Cu}/\text{Cu}^{+2}}^{\circ} > E_{\text{Ag}/\text{Ag}^+}^{\circ}$$

33. **Ans. (4)**

More SOP $\Rightarrow$ more Reducing power

SOP $A < C < B$

34. **Ans. (2)**

Check by option $E_{\text{cell}} = (E_{\text{RP}})_{\text{Cathode}} - (E_{\text{RP}})_{\text{Anode}}$

$$\begin{aligned}
 1. \quad &\Rightarrow E_{\text{Cu}^{+2}/\text{Cu}} - E_{\text{Zn}^{+2}/\text{Zn}} \\
 &= +0.34 - (-0.76) = 1.1 \text{ V}
 \end{aligned}$$

$$\begin{aligned}
 2. \quad &\Rightarrow E_{\text{Ag}^+/\text{Ag}} - E_{\text{Zn}^{+2}/\text{Zn}} \\
 &= +0.80 - (-0.76) = +1.56 \text{ V}
 \end{aligned}$$

$$\begin{aligned}
 3. \quad &\Rightarrow E_{\text{Cu}^{+2}/\text{Cu}} - E_{\text{H}^+/\text{H}_2} \\
 &= 0.34 - 0 = +0.34 \text{ V}
 \end{aligned}$$

$$\begin{aligned}
 4. \quad &\Rightarrow E_{\text{Ni}^{+2}/\text{Ni}} - E_{\text{H}^+/\text{H}_2} \\
 &= -0.55 - 0 = -0.55 \text{ V}
 \end{aligned}$$

35. **Ans. (2)**

SRP $\text{Mg}^{+2} > \text{Na}^+ > \text{Ba}^{+2} > \text{Li}^+$

More SRP $\Rightarrow$ strong oxidising Agent

36. **Ans. (1)**

For non-metal, substance having more SRP have greater tendency to reduce itself and oxidise other, while less SRP substance have greater tendency to oxidise itself and reduce other.

37. **Ans. (3)**

Lesser SRP substance will oxidise itself and reduce other.

Like Zn will oxidise itself but reduce Ag^+ and Cu^{+2} ions.

38. **Ans. (3)**

SRP $C > B > A > D$

Lesser SRP $\Rightarrow$ more reactive metal more reactive metal displace less reactive from its aqueous solution.

39. **Ans. (4)**

For solution to turn blue copper must get oxidise and convert into Cu^{+2} .

Acc. to E.C.S.

SRP of $\text{Cu} < \text{SRP of Ag}$

So, copper will displace Ag^+ ions from its solutions.

40. **Ans. (3)**

Acc. to E.C.S., metals having lesser SRP are more reactive and displacer less reactive metal ion in their aqueous solutions.

41. **Ans. (1)**

Strong oxidizing agent will have lesser SOP.
Oxidising agent ion will reduce itself and oxidise other.

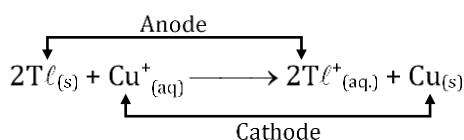
42. Ans. (3)

Cell is at standard condition.

$$\begin{aligned} \text{So } E_{\text{cell}}^{\circ} &= (E_{\text{RP}}^{\circ})_{\text{cathode}} - (E_{\text{RP}}^{\circ})_{\text{Anode}} \\ &= E_{\text{Au}^{+3}/\text{Au}}^{\circ} - E_{\text{Ni}^{+2}/\text{Ni}}^{\circ} \\ &= 1.5 - (-0.25) \\ &= 1.75 \text{ V} \end{aligned}$$

43. Ans. (4)

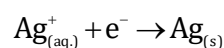
Cell reaction :



$$E_{\text{cell}} = E_{\text{cell}}^{\circ} = E_{\text{cell}}^{\circ} - \left\{ \frac{0.0591}{n} \log \frac{[\text{Tl}^{+}]^2}{[\text{Cu}^{+2}]} \right\}$$

From relation $[\text{Cu}^{+2}] \uparrow$ or $[\text{Tl}^{+}] \downarrow \Rightarrow E_{\text{cell}} \uparrow$

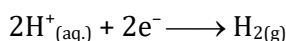
44. Ans. (4)



$$\begin{aligned} E_{\text{cell}} &= E_{\text{red}}^{\circ} - \frac{0.0591}{n} \log \frac{1}{[\text{Ag}^{+}]} \\ &= E_{\text{red}}^{\circ} - \frac{0.0591}{1} \log \frac{1}{10^{-1}} \quad \because [\text{Ag}^{+}] = 10^{-1} \\ &= E_{\text{red}}^{\circ} - 0.0591 \end{aligned}$$

45. Ans. (3)

$$\text{pH} = 1; \quad [\text{H}^{+}] = 10^{-1} \text{ M}$$



Nernst equation

$$E_{\text{cell}} = E_{\text{red}}^{\circ} - \frac{0.0591}{2} \log \frac{p_{\text{H}_2}}{[\text{H}^{+}]^2}$$

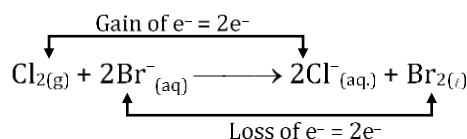
$$\because p_{\text{H}_2} = 1; [\text{H}^{+}] = 1 \text{ M}; E_{\text{red}}^{\circ} = 0$$

$$E_{\text{cell}} = 0 - \frac{0.0591}{2} \log \frac{1}{(10^{-1})^2}$$

$$E_{\text{cell}} = -0.0591 \text{ V}$$

46. Ans. (2)

Reaction :



Nernst equation

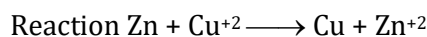
$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{n} \log \frac{[\text{Cl}^{-}]^2}{P_{\text{Cl}_2} \times [\text{Br}^{-}]^2}$$

$$E_{\text{cell}}^{\circ} = 0.29 \text{ V}; n = 2; P_{\text{Cl}_2} = 0.25;$$

$$[\text{Cl}^{-}] = [\text{Br}^{-}] = 0.01 \text{ M}$$

$$\begin{aligned} E_{\text{cell}} &= 0.29 - \frac{0.0591}{2} \log \frac{(0.01)^2}{(0.25)(0.01)^2} \\ &= 0.272 \text{ V} \end{aligned}$$

47. Ans. (1)



no. of e^{-} transferred = 2e^{-}

Nernst equation

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{n} \log \frac{[\text{Zn}^{+2}]}{[\text{Cu}^{+2}]}$$

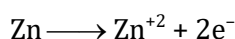
$$= 1.1 - \frac{0.0591}{2} \log \frac{(0.1)}{(0.1)}$$

$$= 1.1 \text{ V}$$

48. Ans. (1)

EMF of cell is intensive property does not depend on stoichiometric coefficient.

49. Ans. (1)



$$\text{Let } [\text{Zn}^{+2}]_i = 1 \text{ M}$$

$$\text{After 10 times dilution } [\text{Zn}^{+2}]_f = \frac{1}{10} \text{ M}$$

Nernst equation

$$E_i = E^{\circ} - \frac{0.0591}{2} \log [\text{Zn}^{+2}]_i = E^{\circ}$$

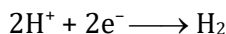
$$E_f = E^{\circ} - \frac{0.0591}{2} \log [\text{Zn}^{+2}]_f$$

$$= E^{\circ} - \frac{0.0591}{2} \log (10^{-1})^1$$

$$= E^{\circ} + 0.0295$$

$$= \approx E^{\circ} + 0.03$$

50. Ans. (4)



$$\text{pH}_i = 0; [\text{H}^+]_i = 10^0 = 1 \text{ M}$$

$$\text{pH}_f = 7; [\text{H}^+]_f = 10^{-7} \text{ M}$$

Nernst equation

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{2} \log \frac{P_{\text{H}_2}}{[\text{H}^+]^2}$$

$$(\because P_{\text{H}_2} = 1 \text{ atm}); E_{\text{cell}}^{\circ} = 0$$

$$E_i = 0 - \frac{0.0591}{2} \log \frac{1}{1} = 0$$

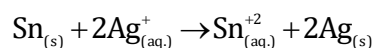
$$E_f = 0 - \frac{0.0591}{2} \log \frac{1}{(10^{-7})^2} = \frac{-0.0591}{2} \times \log 10^{14}$$

$$= -\frac{0.0591}{2} \times 14$$

$$= -0.0591 \times 7$$

$$= -0.41 \text{ V}$$

51. **Ans. (3)**



no. of e^- transferred = 2e^-

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{2} \log \frac{[\text{Sn}^{+2}]}{[\text{Ag}^+]^2}$$

$$[\text{Ag}^+] \uparrow \Rightarrow E_{\text{cell}} \uparrow$$

52. **Ans. (2)**

$$E_{\text{cell}}^{\circ} = -0.35 \text{ V}$$

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

= +ve

non-spontaneous

53. **Ans. (1)**

$$E_{\text{cell}}^{\circ} = + \frac{0.0591}{n} \log (K_c)$$

$$= \frac{0.0591}{2} \log 10^{12}$$

$$= 0.354 \text{ V}$$

54. **Ans. (3)**

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

$$(i) \text{OCl}^- + 2\text{e}^- \rightarrow \text{Cl}^-; \Delta G_1^{\circ} = -2 \times F \times 0.94$$

$$(ii) \text{Cl}^- \rightarrow \frac{1}{2} \text{Cl}_2 + \text{e}^-; \Delta G_2^{\circ} = -1 \times F \times (-1.36)$$

$$(iii) \text{OCl}^- + 1\text{e}^- \rightarrow \frac{1}{2} \text{Cl}_2; \Delta G_3^{\circ} = -1 \times F \times E_3^{\circ}$$

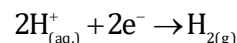
$$(iii) = (i) + (ii)$$

$$\Delta G_3^{\circ} = \Delta G_1^{\circ} + \Delta G_2^{\circ}$$

$$-1 \times F \times E_3^{\circ} = [-2 \times F \times 0.94] + [-1 \times F \times (-1.36)]$$

$$E_3^{\circ} = 0.52 \text{ V}$$

55. **Ans. (2)**



$$\text{pH} = 3; [\text{H}^+] = 10^{-3} \text{ M}$$

Nernst equation

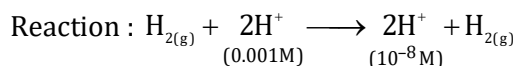
$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{n} \log \frac{P_{\text{H}_2}}{[\text{H}^+]^2}$$

$$n = 2; P_{\text{H}_2} = 1 \text{ atm}; [\text{H}^+] = 10^{-3} \text{ M}; E_{\text{cell}}^{\circ} = 0$$

$$E_{\text{cell}} = 0 - \frac{0.0591}{2} \log \frac{1}{(10^{-3})^2}$$

$$= -0.177 \text{ V}$$

56. **Ans. (3)**



no. of e^- transferred = 2e^-

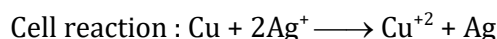
$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{n} \log \frac{(10^{-8})^2}{(10^{-3})^2}$$

$$E_{\text{cell}}^{\circ} = 0; n = 2$$

$$E_{\text{cell}} = 0 - \frac{0.0591}{2} \log \frac{10^{-16}}{10^{-6}}$$

$$= +0.295 \text{ V}$$

57. **Ans. (3)**



No. of e^- transferred = 2

$$\text{Initial: } [\text{Cu}^{+2}]_i = 1 \text{ M} = [\text{Ag}^+]_i$$

$$\text{Final: } [\text{Cu}^{+2}]_f = 10 \text{ M} = [\text{Ag}^+]_f$$

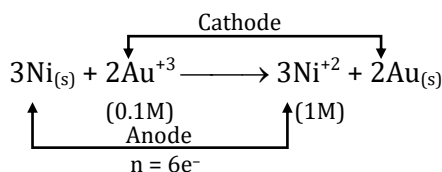
$$\text{Initial: } E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{2} \log \frac{[\text{Cu}^{+2}]_i}{[\text{Ag}^+]_i^2} = E_{\text{cell}}^{\circ}$$

Final:

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{2} \log \frac{(10)^1}{(10)^2} = E^{\circ} + 0.0295 \text{ V}$$

58. **Ans. (4)**

Cell Reaction:



$$\begin{aligned}
 E_{\text{cell}} &= E_{\text{cell}}^{\circ} - \frac{0.0591}{6} \log \frac{[\text{Ni}^{+2}]^3}{[\text{Au}^{+3}]^2} \\
 &= \left[E_{\text{Au}^{+3}/\text{Au}}^{\circ} - E_{\text{Ni}^{+2}/\text{Ni}}^{\circ} \right] - \frac{0.0591}{6} \log \frac{1^3}{(10^{-1})^2} \\
 &= [1.5 - (-0.25)] - \frac{0.0591}{6} \log 10^2 \\
 &= 1.73 \text{ V}
 \end{aligned}$$

59. Ans. (3)

At 298K for reaction $n = 2$

$$\text{So, } E_{\text{cell}}^{\circ} = \frac{0.0591}{n} \log K_c$$

$$\begin{aligned}
 \log K_c &= \frac{E_{\text{cell}}^{\circ} \times n}{0.0591} \\
 &= \frac{0.465 \times 2}{0.0591}
 \end{aligned}$$

$$\log K_c = 15.73$$

Taking antilog

$$K_c = 3.16 \times 10^{15}$$

60. Ans. (2)

For reaction $n = 2$

$$E_{\text{cell}} = 0.5105 \text{ V}$$

Nernst equation

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{2} \log \frac{[\text{Zn}^{+2}]}{[\text{Ni}^{+2}]}$$

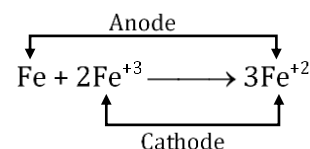
$$E_{\text{cell}}^{\circ} = E_{\text{cell}} + \frac{0.0591}{2} \log \frac{[\text{Zn}^{+2}]}{[\text{Ni}^{+2}]}$$

$$= 0.5105 + \frac{0.0591}{2} \log \frac{(1)}{(0.1)}$$

$$= 0.54 \text{ V}$$

61. Ans. (3)

Cell reaction :



$$E_{\text{cell}}^{\circ} = (E_{\text{RP}}^{\circ})_{\text{cathode}} - (E_{\text{RP}}^{\circ})_{\text{Anode}}$$

$$= E_{\text{Fe}^{+3}/\text{Fe}^{+2}}^{\circ} - E_{\text{Fe}^{+2}/\text{Fe}}^{\circ}$$

$$= 0.771 - (-0.441)$$

$$= 1.212 \text{ V}$$

62. Ans. (1)

$$n_{\text{H}_2} = \frac{V_{\text{ml at STP}}}{22400} = \frac{112}{22400} = \frac{1}{200}$$

$$w_{\text{H}_2} = n_{\text{H}_2} \times (M_w)_{\text{H}_2} = \frac{1}{200} \times 2 = \frac{1}{100} \text{ g}$$

Faraday 1st law

$$w_{\text{H}_2} = \frac{E_{\text{H}_2}}{96500} \times i \times t \quad \therefore E_{\text{H}_2} = 1$$

$$\frac{1}{100} = \frac{1}{96500} \times i \times 965$$

$$i = 1 \text{ A}$$

63. Ans. (4)

Acc to Faraday IInd law :-

For FeCl_2 and FeCl_3

$$\frac{w_{\text{Fe}^{+2}}}{w_{\text{Fe}^{+3}}} = \frac{E_{\text{Fe}^{+2}}}{E_{\text{Fe}^{+3}}}$$

$$\therefore E_w = \frac{M_w}{v.f.}$$

$$= \frac{56}{2}$$

$$= \frac{56}{3}$$

$$= \frac{3}{2}$$

64. Ans. (3)

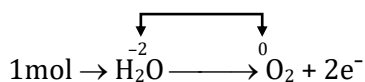
Farady 1st law :-

$$w = \frac{E_w}{96500} \times i \times t$$

$$3 = \frac{E_w}{96500} \times 9.65 \times (10 \times 60)$$

$$E_w = 50$$

65. Ans. (3)



Loss of $\text{e}^- = 2\text{ mol}$

$$\begin{aligned}\text{Charge transfer} &= 2F \quad (\because 1\text{ mol e}^- = 1F) \\ &= 2 \times 96500\text{C} \\ &= 1.93 \times 10^5\text{C}\end{aligned}$$

66. **Ans. (1)**

Faraday Ist law

$$w = \frac{\text{At wt}}{96500} \times Q \quad (\because Q = i \times t)$$

$$2.977\text{ g} = \frac{106.4}{96500} \times 10800$$

$$v.f. = +4$$

67. **Ans. (1)**

For dil. H_2SO_4

At Cathode : H_2 gas is liberated

At Anode : O_2 gas is liberated

Faraday IInd law :

$$\frac{w_{\text{Cathode}}}{w_{\text{Anode}}} = \frac{E_{\text{H}_2}}{E_{\text{O}_2}} = \frac{1}{8}$$

68. **Ans. (2)**



At Cathode : Ca is deposited

At Anode : H_2 is liberated

69. **Ans. (3)**

Faraday Ist law :

$$\begin{aligned}w &= \frac{E_{\text{Ag}}}{96500} \times i \times t \\ &= \frac{107.87}{96500} \times 965 \times 1 \\ &= 1.0787\text{ g}\end{aligned}$$

70. **Ans. (3)**

Acc. to reaction

1 mol Al deposit on transfer of 3 mol e^- (3 F charge)

$$\begin{aligned}1\text{ mol Al} &\longrightarrow 3F\text{ charge} \\ 13.5\text{ g} &\Rightarrow \frac{1}{2}\text{ mol Al} \longrightarrow \frac{3}{2} = 1.5\text{ F charge}\end{aligned}$$

71. **Ans. (4)**

For aq. Na_2SO_4

$$\text{SOP}_{\text{SO}_4^{2-}} < \text{SOP}_{\text{H}_2\text{O}}$$

So at anode : O_2 will liberate

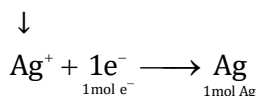
$$\text{SRP}_{\text{Na}^+} < \text{SRP}_{\text{H}_2\text{O}}$$

Cathode : H_2 will liberate

72. **Ans. (2)**

$$1\text{ F} \Rightarrow 1\text{ mol e}^-$$

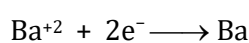
So, AgNO_3



73. **Ans. (1)**



$$96500\text{C} \Rightarrow 1\text{ Faraday} \Rightarrow 1\text{ mol e}^-$$



$$\begin{array}{ccc} \downarrow & & \downarrow \\ (2F) & 2\text{ mol e}^- \rightarrow 1\text{ mole barium} \\ 1F & \longrightarrow \frac{1}{2}\text{ mole barium} \end{array}$$

74. **Ans. (2)**

Faraday IInd law

$$\begin{aligned} \frac{w_{\text{Ca}}}{w_{\text{Al}}} &= \frac{(E_w)_{\text{Ca}}}{(E_w)_{\text{Al}}} \\ &= \frac{40}{27} \end{aligned}$$

$$\begin{aligned} w_{\text{Al}} &= 18000\text{ g} \\ &= 18\text{ Kg} \end{aligned}$$

75. **Ans. (2)**

Acc. to Faraday IInd law :

$$\begin{aligned} w_{\text{Ag}} : w_{\text{Cu}} : w_{\text{Fe}} &= E_{w_{\text{Ag}}} : E_{w_{\text{Cu}}} : E_{w_{\text{Fe}}} \\ &= \frac{108}{1} : \frac{63.5}{2} : \frac{56}{3} \end{aligned}$$

$$\text{Now convert mass in mole} = \frac{w}{\text{At. wt}}$$

$$\begin{aligned} n_{\text{Ag}} : n_{\text{Cu}} : n_{\text{Fe}} &= \frac{w_{\text{Ag}}}{(\text{At. wt})_{\text{Ag}}} : \frac{w_{\text{Cu}}}{(\text{At. wt})_{\text{Cu}}} : \frac{w_{\text{Fe}}}{(\text{At. wt})_{\text{Fe}}} \\ &= \frac{108}{108} : \frac{63.5}{63.5} : \frac{56}{56} \\ &= \frac{1}{1} : \frac{1}{2} : \frac{1}{3} \end{aligned}$$

76. **Ans. (2)**

For aq. CuSO_4

At Cathode : $\text{Cu}^{+2} + 2\text{e}^- \longrightarrow \text{Cu}_{(\text{s})}$

At Anode : $2\text{H}_2\text{O}_{(\text{l})} \longrightarrow \text{O}_{2(\text{g})} + 4\text{H}^+ + 4\text{e}^-$

$[\text{H}^+] \uparrow \Rightarrow \text{pH} \downarrow$

77. **Ans. (3)**

For aq. NaCl

At cathode : H_2 gas is liberated

At anode : Cl_2 gas is liberated

78. **Ans. (1)**

On charging lead accumulator, reverse of galvanic cell happen i.e. becomes electrolytic cell.

79. **Ans. (3)**

Thermodynamic efficiency of cell :

$$= \frac{\Delta G}{\Delta H} \times 100$$

$$= \frac{-nFE}{\Delta H} \times 100$$

Exercise-II (Previous Year Questions)

1. **Ans. (3)**

Balancing Charge
 $\text{MnO}_4^{-2} \longrightarrow \text{MnO}_4^- + 1\text{e}^-$

$\downarrow$
 $1\text{mol} \longrightarrow 1\text{mol e}^-$
 $0.1\text{mol MnO}_4^{-2} \longrightarrow 0.1\text{mol e}^-$

$\downarrow$
 0.1 F
 $\downarrow$
 0.1×96500
 $= 9650\text{ C}$

2. **Ans. (4)**

$$n_{\text{O}_2} = \frac{V_{\text{ml}}}{22400} = \frac{5600}{22400} = \frac{1}{4}$$

$$w_{\text{O}_2} = n_{\text{O}_2} \times (M_w)_{\text{O}_2}$$

$$= \frac{1}{4} \times 32 = 8\text{g}$$

Faraday IInd law

$$\frac{w_{\text{Ag}}}{w_{\text{O}_2}} = \frac{E_{\text{Ag}}}{E_{\text{O}_2}} = \frac{108}{8}$$

$$\frac{w_{\text{Ag}}}{8} = \frac{108}{8}$$

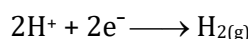
$$w_{\text{Ag}} = 108$$

3. **Ans. (4)**

Fuel cell converts combustion energy of fuels like H_2 & CH_4 directly into electrical energy.

4. **Ans. (1)**

In pure water $\text{pH} = 7$; $[\text{H}^+] = 10^{-7}$



$$E_{\text{Cell}} = E_{\text{Cell}}^{\circ} - \frac{0.0591}{2} \log \frac{P_{\text{H}_2}}{[\text{H}^+]^2}$$

$$0 = 0 - \frac{0.0591}{2} \log \frac{P_{\text{H}_2}}{(10^{-7})^2}$$

$$0 = \log P_{\text{H}_2} - \log 10^{-14}$$

$$\log P_{\text{H}_2} = \log 10^{-14}$$

$$P_{\text{H}_2} = 10^{-14}\text{ atm}$$

5. **Ans. (4)**

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

$$= \frac{5.76 \times 1000}{0.5}$$

$$= 11.52\text{ S cm}^2/\text{mol}$$

6. **Ans. (4)**

Faraday Ist law :

$$w_{\text{Cl}_2} = \frac{E_{\text{Cl}}}{96500} \times i \times t \quad \because w_{\text{Cl}_2} = n_{\text{Cl}_2} \times (M_w)_{\text{Cl}_2}$$

$$7.1 = \frac{35.5}{96500} \times 3 \times t = 0.1 \times 71$$

$$t = 6600\text{ Sec} = 7.1\text{g}$$

$$t = 110\text{min.}$$

7. **Ans. (3)**

Given :- $E_{\text{Cell}}^{\circ} = -ve$

$$\Delta G^{\circ} = -nFE_{\text{Cell}}^{\circ} \quad E_{\text{Cell}}^{\circ} = \frac{0.0591}{n} \log K$$

$$\Rightarrow +ve \text{ or } > 1 \quad \log K < 0$$

$$\quad \quad \quad K < 1$$

8. **Ans. (1)**

Electrochemistry

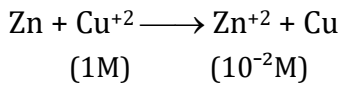
$$\text{Charge (Q)} = i \times t$$

$$= 1 \times 60$$

$$= 60 \text{ C}$$

$$\text{no. of } e^- = \frac{Q}{\text{Charge on } 1e^-} = \frac{60}{1.6 \times 10^{-19}} = 3.75 \times 10^{20}$$

9. Ans. (2)



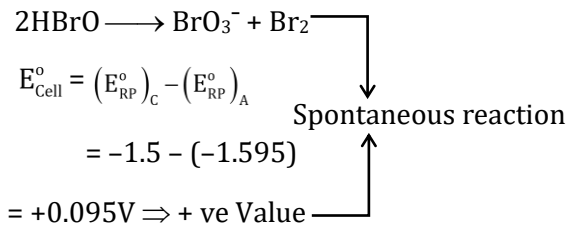
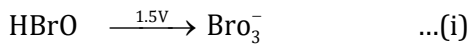
$$E_1 = E^\circ - \frac{0.00591}{2} \log \frac{|\text{Zn}^{+2}|^1}{|\text{Cu}^{+2}|^1}$$

$$= E^\circ - \frac{0.00591}{2} \log \frac{10^{-2}}{1} = E^\circ + 0.00591$$

$$E_2 = E^\circ - \frac{0.00591}{2} \log \frac{1}{10^{-2}} = E^\circ - 0.00591$$

$$E_1 > E_2$$

10. Ans. (4)



So HBrO disproportionates to BrO₃⁻ & Br₂

11. Ans. (3)

$$E_{\text{Cell}}^\circ = \frac{0.0591}{n} \log K_C$$

$$\log K_C = \frac{E_{\text{Cell}}^\circ \times n}{0.0591} = \frac{0.59 \times 1}{0.0591}$$

$$\log K_C = 10$$

$$K_C = 10^{10}$$

12. Ans. (1)

$$\Delta G^\circ = -nF E_{\text{Cell}}^\circ$$

$$= -2 \times 96500 \times 0.24$$

$$= -46320 \text{ J/mol}$$

$$= -46.32 \text{ KJ/mol}$$

13. Ans. (4)

$$\lambda_{\text{M}_{\text{CH}_3\text{COOH}}}^\circ = \lambda_{\text{M}_{\text{CH}_3\text{COO}^-}}^\circ + \lambda_{\text{M}_{\text{H}^+}}^\circ$$

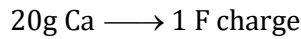
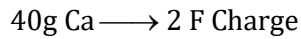
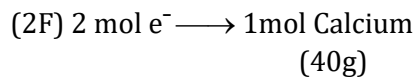
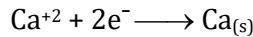
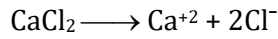
$$= \lambda_{\text{M}_{\text{CH}_3\text{COOK}^+}}^\circ + \frac{1}{2} \lambda_{\text{M}_{\text{H}_2\text{SO}_4}}^\circ - \frac{1}{2} \lambda_{\text{M}_{\text{K}_2\text{SO}_4}}^\circ$$

$$= z + \frac{x}{2} - \frac{y}{2}$$

14. Ans. (2)

More Reducing Power $\Rightarrow$ SRP min
K > Al > Cr > Ag

15. Ans. (2)



16. Ans. (3)

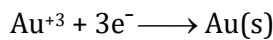
For dil. H₂SO₄

at Anode H₂O get discharge

So product at anode will be O₂ (gas).

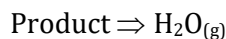
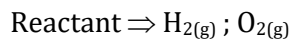
17. Ans. (3)

According to ECS ; max SRP will be of



18. Ans. (2)

Fuel cell :-



19. Ans. (2)

$$\lambda_{\text{M}_{\text{CH}_3\text{COOH}}}^\infty = \lambda_{\text{M}_{\text{CH}_3\text{COO}^-}}^\infty + \lambda_{\text{M}_{\text{H}^+}}^\infty$$

$$= \lambda_{\text{M}_{\text{CH}_3\text{COONa}^+}}^\infty + \lambda_{\text{M}_{\text{HCl}^-}}^\infty - \lambda_{\text{M}_{\text{NaCl}^-}}^\infty$$

$$= 91 + 426.16 - 126.45$$

$$= 390.71$$

20. Ans. (3)

$$\lambda_{\text{M}_{\text{CH}_3\text{COOH}}}^\circ = \lambda_{\text{M}_{\text{CH}_3\text{COO}^-}}^\circ + \lambda_{\text{M}_{\text{H}^+}}^\circ$$

$$= 50 + 350 = 400$$

$$\alpha = \frac{\lambda_{\text{M}}^{\text{C}}}{\lambda_{\text{M}}^\circ} = \frac{20}{400} = \frac{1}{20}$$

$$\alpha = 5\%$$

$$K_c = C\alpha^2$$

$$= 0.007 \times \left(\frac{1}{20}\right)^2$$

$$= 1.75 \times 10^{-5} \text{ mol/L}$$

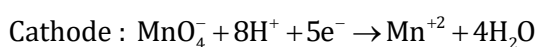
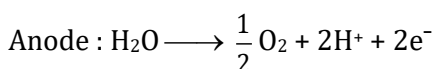
21. Ans. (3)

For non spontaneous $\Rightarrow E_{\text{Cell}}^{\circ} = -ve$

$$\begin{aligned} E_{\text{Cell}}^{\circ} &= (E_{\text{RP}}^{\circ})_{\text{C}} - (E_{\text{RP}}^{\circ})_{\text{A}} \\ &= E_{\text{Cu}^{+2}/\text{Cu}}^{\circ} - E_{\text{Ag}^{+}/\text{Ag}}^{\circ} \\ &= 0.34 - (0.8) \\ &= -0.46 \text{ V} \end{aligned}$$

22. Ans. (4)

Acc. to question for O_2 to liberate possible reaction at Cathode & Anode will be :



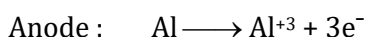
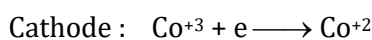
$$\begin{aligned} \text{So } E_{\text{Cell}}^{\circ} &= (E_{\text{RP}}^{\circ})_{\text{C}} - (E_{\text{RP}}^{\circ})_{\text{A}} \\ &= 1.51 - (1.223) \\ &= +0.287\text{V} \\ &= \text{the sport.} \end{aligned}$$

So O_2 gas will liberate

23. Ans. (3)

$$E_{\text{Co}^{+3}/\text{Co}^{+2}}^{\circ} > E_{\text{Al}^{+3}/\text{Al}}^{\circ}$$

So reaction at cathode & Anode will be:-



$$\begin{aligned} E_{\text{Cell}}^{\circ} &= (E_{\text{RP}}^{\circ})_{\text{C}} - (E_{\text{RP}}^{\circ})_{\text{A}} = 1.81 - (-1.66) \\ &= + 3.47\text{V} \end{aligned}$$

24. Ans. (2)

$$\begin{aligned} \Delta G^{\circ} &= -nF E_{\text{Cell}}^{\circ} \\ &= -2 \times 96500 \times 1.1 \\ &= -21227 \text{ J/mol} \\ &= -212.27 \text{ kJ/mol} \end{aligned}$$

25. Ans. (2)

$$\text{Centimolar solution} = \frac{1}{100} \text{M} = 0.01\text{M}$$

$$\text{Conductivity (k)} = 0.0210 \text{ ohm}^{-1} \text{ cm}^{-1}$$

$$\text{Resistance (R)} = 60 \text{ ohm}$$

$$k = \frac{1}{R} \left(\frac{\ell}{A} \right)$$

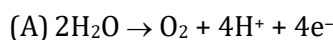
$$\Rightarrow 0.0210 = \frac{1}{60} \left(\frac{\ell}{A} \right) \Rightarrow \frac{\ell}{A} = 1.26 \text{ cm}^{-1}$$

26. Ans. (4)

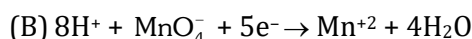
$$\Delta_r G = -nF E_{\text{cell}}$$

E_{cell} is an intensive property and $\Delta_r G$ is an extensive property as it depends on number of e^{-} transferred in cell reaction.

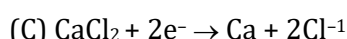
27. Ans. (1)



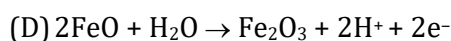
1 mol H_2O will req. 2F charge



1 mole MnO_4^{-} will req. 5F charge.



1.5 mole Ca will req. 3F charge.



1 mole FeO will req. 1 F charge.

(A)-(II), (B)-(IV), (C)-(I), (D)-(III)

28. Ans. (2)

$$W = \frac{E_{\text{it}}}{96487}$$

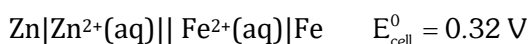
$$W = \frac{\frac{63}{2} \times 9.6487 \times 100}{96487}$$

$$W = 0.315 \text{ g of Cu}$$

29. Ans. (2)

Production of hydrogen by electrolysis of water is not an example of corrosion.

30. Ans. (1)



$$\Delta G^{\circ} = -nF E_{\text{cell}}^{\circ}$$

$$\Delta G^{\circ} = -2 \times 96487 \times 0.32 \text{ J}$$

$$\Delta G^{\circ} = -61.75 \text{ kJ/mol}$$

Exercise-III (Analytical Questions)

1. Ans. (4)

$$\text{Statement-I : } W_{\text{NonPV}} = -\Delta G = W_{\text{electrical}}$$

$$\text{Statement-II : } \Delta G = -nF E_{\text{Cell}}$$

$n \Rightarrow$ no. of e^{-} transfer depends on & stoichiometry

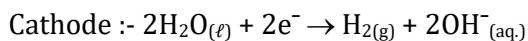
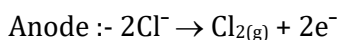
$$E_{\text{Cell}} \Rightarrow \text{EMF of Cell} \rightarrow \text{intensive}$$

$$F \Rightarrow 96500 \text{ C}$$

$$G \Rightarrow \text{extensive property}$$

2. **Ans. (3)**

Statement-I : For electrolysis of aq. NaCl
Product obtained are



Statement-II : $E^\circ_{\text{Cu}^{+2}/\text{Cu}} > E^\circ_{\text{Fe}^{+2}/\text{Fe}}$

Copper is more reactive than iron

3. **Ans. (1)**

Statement-I : EMF of cell is intensive property

Statement-II : EMF of cell = cell voltage which is intensive

4. **Ans. (2)**

Statement-I : In electrolytic cell

Cathode is negative

Anode is positive

In galvanic cell

Cathode is positive

Anode is negative

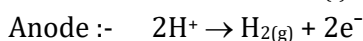
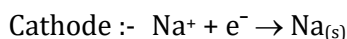
Statement-II : In Daniel cell

Oxidation of Zinc occurs $\Rightarrow$ loss of e^-

Reduction of Copper occurs $\Rightarrow$ gain of e^-

5. **Ans. (3)**

Statement-I : molten NaH $\Rightarrow \text{Na}^+ ; \text{H}^-$



Statement-II : In electrolytic refining

Impure metal $\Rightarrow$ Anode

Pure metal $\Rightarrow$ Cathode

6. **Ans. (2)**

On dilution of weak electrolyte

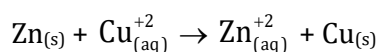
1. d.o.d $\alpha\% \uparrow \Rightarrow$ no. of ions $\uparrow$

2. Inter ionic attraction forces $\downarrow$

Hence molar conductance increases rapidly.

7. **Ans. (1)**

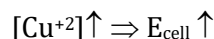
Daniel Cell



Nernst equation:

$$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.0591}{2} \log \frac{[\text{Zn}^{+2}]}{[\text{Cu}^{+2}]}$$

$$E_{\text{cell}} = E^\circ_{\text{cell}} + \frac{0.0591}{2} \log \frac{[\text{Cu}^{+2}]}{[\text{Zn}^{+2}]}$$

8. **Ans. (4)**

Statement-I :

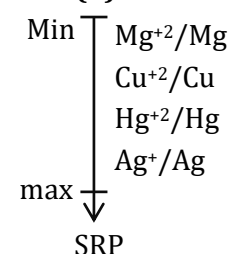
$$\text{Cell const. } G^* = \frac{\ell}{A}$$

depends on Construction of cell.

Statement-II : Conductance is due to charge carries (ions):-

(i) mobility

(ii) no. of charge carrier (ions)

9. **Ans. (2)**

SRP min $\Rightarrow$ metal reactivity $\uparrow$

* Mg^{+2} can not be displaced by Cu.

* Ag can not displace Cu^{+2}

10. **Ans. (3)**

Spontaneous Condition :-

$\rightarrow \Delta G = \text{negative}$

also $\Delta G = -nFE_{\text{cell}}$

$\rightarrow$ So $E_{\text{cell}} = \text{positive}$

11. **Ans. (3)**

(a) λ_m - with temp. - because in increase in K.E. of Ions.

(c) increase in concentration, increases inter ionic attraction forces hence λ_m decreases.

(d) Increases in polarity will increase d.o.d (X) Which will increase ions no. so increase in molar conductivity.