CHAPTER 02 ELECTROCHEMISTRY

Exercise 1: NCERT Based Topic-wise MCQs

2.0 INTRDUCTION

1. Batteries and fuel cells convert NCERT/ Page-65 / N-32
(a) chemical energy into electrical energy.
(b) electrical energy into chemical energy.
(c) chemical energy into potential energy.
(d) electrical energy into potential energy.

2.1 ELECTROCHEMICAL CELLS

2. Which device converts chemical energy of a spontaneous redox reaction into electrical energy?
NCERT/ Page-66 / N-33
(a) Galvanic cell
(b) Electrolytic cell
(c) Daniell cell
(d) Both (a) and (c)

3. $\underset{\text{(anode)}}{Zn(s) \mid Zn2+(aq)} /\!/ \underset{\text{(cathode)}}{Cu2+(aq) \mid Cu(s)}$ is The cell is called
(a) Weston cell
(b) Daniell cell
(c) Calomel cell
(d) Faraday cell

4. In the electrolytic cell, flow of electrons is from NCERT/ Page-66 / N-32
(a) cathode to anode in solution
(b) cathode to anode through external supply
(c) cathode to anode through internal supply
(d) anode to cathode through internal supply

2.2 GALVANIC CELLS

5. Which of the following statements about galvanic cell is incorrect NCERT/ Page-66 / N-33
(a) anode is positive
(b) oxidation occurs at the electrode with lower reduction potential
(c) cathode is positive
(d) reduction occurs at cathode

6. In which of the following conditions salt bridge is not required in a galvanic cell?

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(a) When galvanic cell is used in geyser.
(b) When distance between oxidation half cell and reduction half cell is negligible.
(c) Electrolytic solutions used in both the half cells are of same concentration.
(d) When both the electrodes are dipped in the same electrolytic solution.

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7. The tendency of an electrode to lose electrons is known as
(a) electrode potential
(b) reduction potential
(c) oxidation potential
(d) e.m.f.

8. The chemical reaction,
2AgCl(s)+H2(g)→2HCl(aq)+2Ag(s)
taking place in a galvanic cell is represented by the notation
(a) Pt(s) | H2 (g), 1 bar |1MKCl(aq)|AgCl (s) | Ag (s)
(b) Pt(s) | H2 (g), 1 bar |1M HCl(aq)|1MAg+(aq) | Ag (s)
(c) Pt(s) | H2 (g), 1 bar |1MHCl(aq)|AgCl (s) | Ag (s)
(d) Pt(s) | H2 (g), 1 bar | 1MHCl (aq) | Ag (s) | AgCl (s)

9. For cell representation:

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Cu(s)|Cu2+(aq)||Ag+(aq)|Ag(s)
Which of the following is correct?
(i) Cu is reducing agent.
(ii) Overall cell reaction is Cu(s)+2Ag+(aq)→Cu2+(aq)+2Ag(s)
(iii) Cu is cathode
(iv) Ag is anode
(a) (ii), (iii) and (iv)
(b) (ii), (iii) and (iv)
(c) (iii) and (iv)
(d) (i) and (ii)

10. The reference electrode is made by using
(a) ZnCl2
(b) CuSO4
(c) HgCl2
(d) Hg2Cl2

11. Standard electrode potential for Sn4+/Sn2+ couple is +0.15V and that for the Cr3+/Cr couple is −0.74V
These two couples in their standard state are connected to make a cell.
The cell potential will be

NCERT/ Page-68 / N-34

(a) +1.19V
(b) +0.89V
(c) +0.18V
(d) +1.83V

12. From the given option identify the electrode in which metal in contact with own ion in solution
(a) Colomel electrode
(b) Pt/Fe2+,Fe+3
(c) Ag in AgNO3
(d) Gas electrode

13. Which of the following statements regarding given cell representation is/are correct?
$Cd(s)|Cd^{2+}(aq)||Ag^{+}(aq)|Ag(s)$
(i) In the given cell, Cd electrode act as an anode whereas Ag electrode acts as a cathode.
(ii) In the given cell, Cd electrode acts as a cathode whereas Ag electrode acts as a anode.
(iii) $E_{cell} = E_{Ag^+/Ag} - E_{Cd^{2+}/Cd}$
(a) (i) and (ii)
(b) Only (ii)
(c) Only(i)
(d) (i) and (iii)

14. If salt bridge is removed from two half-cells the voltage
(a) drops to zero
(b) does not change
(c) increases gradually
(d) increases rapidly

2.3 NERNST EQUATION

15. For the given Nernst equation $E_{cell} = E^{\circ}_{cell} - \frac{RT}{2F} \ln \frac{[Mg^{2+}]}{[Ag^{+}]^2}$ NCERT/ Page-70 / N-38
Which of the following representation is correct?
(a) $Ag^+|Ag||Mg^{2+}|Mg$
(b) $Mg^{2+}|Mg||Ag|Ag^+$
(c) $Mg|Mg^{2+}||Ag^+|Ag$
(d) $Mg|Mg^{2+}||Ag|Ag^+$

16. Standard electrode potential of three metals X, Y and Z are −1.2V, +0.5V and −3.0V, respectively. The reducing power of these metals will be: NCERT/ Page-71 / N-37
(a) $Y > Z > X$
(b) $X > Y > Z$
(c) $Z > X > Y$
(d) $X > Y > Z$

NCERT/ Page-71 / N-37

17. Standard reduction potentials of the half reactions are given below :
$F_2(g) + 2e^- \rightarrow 2F^-(aq); E^{\circ} = +2.85V$
$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq); E^{\circ} = +1.36V$
$Br_2(l) + 2e^- \rightarrow 2Br(aq); E^{\circ} = +1.06V$
$I_2(s) + 2e^- \rightarrow 2I^-(aq); E^{\circ} = +0.53V$
The strongest oxidising and reducing agents respectively are
(a) F_2 and I^-
(b) Br_2 and Cl
(c) Cl_2 and Br
(d) Cl_2 and I_2

18. The value of electrode potential $(10^{-4}M)H^+|H_2(1atm)|Pt$ at 298K would be NCERT/ Page-70 / N-38
(a) −0.236V
(b) +0.404V
(c) +0.236V
(d) −0.476V

19. The electrode potential $E(Zn^{2+}/Zn)$ of a zinc electrode at $25^{\circ}C$ with an aqueous solution of $0.1M\,ZnSO_4$ is [$E^{\circ}(Zn^{2+}/Zn)=-0.76V$. Assume $\frac{2.303RT}{F}=0.06$ at 298K]. NCERT Page-70 / N-38

(a) +0.73
(b) -0.79
(c) -0.82
(d) -0.70

20. For a cell reaction involving two electron change, the standard EMF of the cell is 0.295V at $2^{\circ}C$. The equilibrium constant of the reaction at $25^{\circ}C$ will be: NCERT Page-74 / N-39

(a) 29.5×10^{-2}
(b) 10
(c) 1×10^{10}
(d) 2.95×10^{-10}

21. Without losing its concentration; $ZnCl_2$ solution cannot be kept in contact with NCERT Page-71 / N-37

(a) Au
(b) Al
(c) Pb
(d) Ag

22. The oxidation potentials of A and B are +2.37 and +1.66V respectively. In chemical reactions NCERT/Page-71 / N-37

(a) A will be replaced by B
(b) A will replace B
(c) A will not replace B
(d) A and B will not replace each other

23. For a cell, Cu(s) | Cu^{2+}(0.001M||Ag^{+}(0.01M) | Ag(s) the cell potential is found to be 0.43V at 298K. The magnitude of standard electrode potential for Cu^{2+}/Cu is $\times10^{-2}V$.

[Given : $E^{\ominus}_{Ag^{+}/Ag}=0.80V$ and $\frac{2.303RT}{F}=0.06V$] NCERT/Page-70 / N-38

(a) 0.34
(b) 3.4
(c) 9.2
(d) 34.0

24. According to Nernst equation, which is not correct if $Q=Kc$: NCERT (Page-73 / N-38

(a) Ecell =0
(b) $\frac{RT}{nF}\ln Q=E^{\circ}_{cell}$
(c) $Kc=e^{\frac{nFE^{\circ}_{cell}}{RT}}$
(d) $E_{cell}=E^{\circ}_{cell}$

25. For the galvanic cell $Zn|Zn^{2+}(0.1M)\,//\,Cu^{2+}(1.0M)|Cu$ the cell potential increase if: NCERT/Page-72 / N-38

(a) $[Zn^{2+}]$ is increased
(b) $[Cu^{2+}]$ is increased
(c) $[Cu^{2+}]$ is decreased
(d) surface area of anode is increased

26. For the reaction taking place in the cell: NCERT/ Page-74 / N-40

Pt(s) | H_2(g) | H^{+}(aq) || Ag^{+}(aq) | Ag(s)

$E^{o}Cell = +0.5332V$.

The value of $\Delta_f G^0$ is $kJmol^{-1}$.

(a) -97
(b) -51
(c) -100
(d) 5.1

27. The cell potential for $Zn|Zn^{2+}(aq) \,//\, Sn^{x+}|Sn$ is 0.801V at 298 K. The reaction quotient for the above reaction is 10^{-2}. The number of electrons involved in the given electrochemical cell reaction is NCERT(Page-70 / N-39

(Given: $E^{o}_{Zn^{2+}|Zn} = -0.763V$, $E^{o}_{Sn^{x+}|Sn} = +0.008V$ and $\frac{2.303RT}{F} = 0.06V$)

(a) 2
(b) 4
(c) 1
(d) 3

28. The correct order of reduction potentials of the following pairs is

A. Cl/Cl^-
B. I/I^-
C. Ag^+/Ag
D. Na^+/Na
E Li^+/Li

(a) A > C > B > D > E
(b) A > B > C > D > E
(c) A > C > B > E > D
(d) A > B > C > E > D

29. Consider the following four electrodes: NCERT/Page-70 / N-38

$P = Cu^{2+}(0.0001M)/Cu(s)$
$Q = Cu^{2+}(0.1M)/Cu(s)$
$R = Cu^{2+}(0.01M)/Cu(s)$
$S = Cu^{2+}(0.001M)/Cu(s)$

If the standard reduction potential of Cu^{2+}/Cu is +0.34V, the reduction potentials in volts of the above electrodes follow the order.

(a) $P > S > R > Q$
(b) $S > R > Q > P$
(c) $R > S > Q > P$
(d) $Q > R > S > P$

30. For the given reactions NCERT/Page-74 / N-37

$Sn^{2+} + 2e^- \rightarrow Sn$
$Sn^{4+} + 2e^- \rightarrow Sn$

The electrode potentials are; $E^{o}_{Sn^{2+}/Sn} = -0.140V$ and $E^{o}_{Sn^{4+}/Sn} = 0.010V$. The magnitude of standard electrode potential for Sn^{4+}/Sn^{2+} i.e. $E^{o}_{Sn0^{+}/Sn^{2+}}$ is $\times 10^{-2}$ V.

(a) -0.16
(b) +0.16
(c) 16
(d) -16

31. In which of the following half cells, electrochemical reaction is pH dependent?
(a) $Pt \mid Fe^{3+}, Fe^{2+}$
(b) $MnO_4^{-} \mid Mn^{2+}$
(c) $Ag|AgCl|Cl^{-}$
(d) $\frac{1}{2}F_2 | F^{-}$

32. Standard cell voltage for the cell $Pb|Pb^{2+} \parallel Sn^{2+}|Sn$ is $-0.01V$. If the cell is to exhibit $E_{cell} = 0$, the value of $[Sn^{2+}]/[Pb^{2+}]$ should be antilog of – NCERT Page-70 / N-38
(a) +0.3
(b) 0.5
(c) 1.5
(d) 1−0.5

33. The cell, $Zn|Zn^{2+}(1M) \parallel Cu^{2+}(1M)|Cu$ ($E^\circ_{cell} = 1.10V$) was allowed to be completely discharged at 298K. The relative concentration of Zn^{2+} to Cu^{2+} $\left(\frac{[Zn^{2+}]}{[Cu^{2+}]}\right)$ is
(a) 9.65×10^4
(b) antilog(24.08)
(c) 37.3
(d) $10^{37.3}$.

34. What is the potential of half-cell consisting of zinc electrode in $0.01M\,ZnSO_4$ solution at $25^\circ C$ ($E^\circ_{ox} = 0.763V$) NCERT Page-70 / N-38
(a) 0.8221V
(b) 8.221V
(c) 0.5282V
(d) 9.282V

35. The cell potential for the given cell at 298K
$Pt \mid H_2(g, 1\ bar) \mid H^+(aq) \parallel Cu^{2+}(aq)|Cu(s)$ is 0.31V. The pH of the acidic solution is found to be 3 , whereas the concentration of Cu^{2+} is $10^{-x}M$. The value of x is
(Given $E^\circ_{Cu^{2+}/Cu} = 0.34V$ and $\frac{2.303RT}{F} = 0.06V$) NCERT/Page-70 / N-38
(a) 7
(b) 14
(c) -7
(d) -14

36. Consider the following cell reaction: NCERT Page-70/N-38
$2Fe(s) + O_2(g) + 4H^+(aq) \rightarrow 2Fe^{2+}(aq) + 2H_2O(l); E^\circ = 1.67V$
At $[Fe^{2+}] = 10^{-3}M, p(O_2) = 0.1atm$ and pH=3, the cell potential at $25^\circ C$ is
(a) 1.47V
(b) 1.77V
(c) 1.87V
(d) 1.57V

37. In a cell, the following reactions take place NCERT/Page-68 / N-40

$Fe^{2+} \rightarrow Fe^{3+} + e^-$ $E^\circ_{Fe^{3+}/Fe^{2+}} = 0.77V$

$2I^- \rightarrow I_2 + 2e^-$ $E^\circ_{I_2/I^-} = 0.54V$

The standard electrode potential for the spontaneous reaction in the cell is $x \times 10^{-2}V$ 298K. The value of x is (Nearest Integer)

(a) -23
(b) -2
(c) 23
(d) 20

38. For a relation NCERT Page-74 / N-40

$$\Delta_r G = -nFE_{cell}$$

$E_{cell} = E^\circ_{cell}$ in which of the following condition?
(a) Concentration of any one of the reacting species should be unity
(b) Concentration of all the product species should be unity.
(c) Concentration of all the reacting species should be unity.
(d) Concentration of all reacting and product species should be unity.

2.4 CONDUCTANCE OF ELECTROLYTIC SOLUTIONS

39. If 0.01M solution of an electrolyte has a resistance of 40 ohms in a cell having a cell constant of 0.4cm^{-1}, then its molar conductance in ohm cm^{-1}mol^{-1} is NCERT Page-79 / N-45
(a) 102
(b) 104
(c) 10
(d) 103

40. Specific conductance of a 0.1NKCl solution at 23°C is 0.012ohm^{-1}cm^{-1}. Resistance of cell containing the solution at same temperature was found to be 55ohm. The cell constant is NCERT Page-78 / N-44
(a) 0.0616cm^{-1}
(b) 0.66cm^{-1}
(c) 6.60cm^{-1}
(d) 660cm^{-1}

41. The conductivity of a weak acid HA of concentration 0.001molL^{-1} is 2.0×10^{-5}Scm^{-1}. If Λ°_m(HA)= 190Scm^{2}mol^{-1}, the ionization constant (K_a) of HA is equal to _____×10^{-6}. NCERT Page-84 / N-50
(a) 24
(b) 48
(c) 12
(d) 45

42. Specific conductance of 0.1MHNO$_3$ is 6.3×10^{-2}ohm^{-1}cm^{-1}. The molar conductance of the solution is
(a) 100ohm^{-1}cm^2
(b) 515ohm^{-1}cm^2
(c) 630ohm^{-1}cm^2
(d) 6300ohm^{-1}cm^2

43. The unit of specific conductivity is NCERT/Page-75 / N-44
(a) ohmcmcm^{-1}
(b) ohmcm^{-2}
(c) ohm^{-1}cm
(d) ohm^{-1}cm^{-1}

44. Which of the following pair(s) is/are incorrectly matched? NCERT Page-75 / N-44
   (i) R (resistance) –ohm(Ω)
   (ii) ρ (resistivity) - ohm metre (Ωm)
   (iii) G (conductance) - seimens or ohm (S)
   (iv) κ (conductivity) - seimens metre $^{-1}$(Sm^{-1})
   (a) (i),(ii) and (iii)
   (b) (ii) and (iii)
   (c) (i), (ii) and (iv)
   (d) (iii) only

45. The molar conductivity of a conductivity cell filled with 10 moles of 20mLNaCl solution is Λ_{m_1} and that of 20 moles another identical cell having 80mLNaCl solution is Λ_{m_2}. The conductivities exhibited by these two cells are same. NCERT/Page-79 / N-45
   The relationship between Λ_{m_2} and Λ_{m_1} is
   (a) $\Lambda_{m_2}=2\Lambda_{m_1}$
   (b) $\Lambda_{m_2}=\Lambda_{m_1}/2$
   (c) $\Lambda_{m_2}=\Lambda_{m_1}$
   (d) $\Lambda_{m_2}=4\Lambda_{m_1}$

46. The electrical properties and their respective SI units are given below. Identify the wrongly matched pair. NCERT/Page-75 & 78 / N-44

Electrical property	SI unit
(a) Specific conductance	Sm^{-1}
(b) Conductance	S
(c) Equivalent conductance	$Smgeq^{-1}$
(d) Cell constant	M

47. The resistance of 0.01N solution of an electrolyte was found to be 220ohm at 298K using a conductivity cell with a cell constant of $0.88cm^{-1}$. The value of equivalent conductance of solution is -
   (a) $400 mho cm^2 geq^{-1}$
   (b) $295 mho cm^2 geq^{-1}$
   (c) $419 mho cm^2 geq^{-1}$
   (d) $425 mho cm^2 geq^{-1}$

48. Which of the following solutions of KCl will have the highest value of specific conductance? NCERT/Page-79 & 80 / N-47
   (a) 1.0N
   (b) 0.1N
   (c) 1.0×10^{-2}N
   (d) 1.0×10^{-3}N

49. Which of the following expression correctly represents molar conductivity? NCERT/Page-79 & 81 / N-45
   (a) $\Lambda_m=\frac{K}{C}$
   (b) $\Lambda_m=\frac{KA}{l}$
   (c) $\Lambda_m=KV$
   (d) All of these

50.

Electrolyte:	KCl	KNO3	HCl	NaOAC	NaCl
Λ^∞(S cm^2 mol^{-1}):	149.9	145	426.2	91	126.5

Calculate Λ^∞_{HOAc} using appropriate molar conductances of the electrolytes listed above at infinite dilution in H_2O at 25°C NCERT/Page-83 / N-49

(a) 217.5
(b) 390.7
(c) 552.7
(d) 517.2

51. Which of the following expressions correctly represents the equivalent conductance at infinite dilution of $Al_2(SO_4)_3$. Given that $\Lambda^\circ_{Al^{3+}}$ and $\Lambda^\circ_{SO_4^{2-}}$ are the equivalent conductances at infinite dilution of the respective ions? NCERT/Page-83 / N-49

(a) $\frac{1}{3}\Lambda^\circ_{Al^{3+}} + \frac{1}{2}\Lambda^\circ_{SO_4^{2-}}$
(b) $2\Lambda^\circ_{Al^{3+}} + 3\Lambda^\circ_{SO_4^{2-}}$
(c) $\Lambda^\circ_{Al^{3+}} + \Lambda^\circ_{SO_4^{2-}}$
(d) $(\Lambda^\circ_{Al^{3+}} + \Lambda^\circ_{SO_4^{2-}}) \times 6$

52. At 25°C, the molar conductance at infinite dilution for the strong electrolytes NaOH, NaCl and $BaCl_2$ are 248×10^{-4}, 126×10^{-4} and 280×10^{-4} S m^2 mol^{-1} respectively. $\Lambda^0_m Ba(OH)_2$ in S m^2 mol^{-1} is NCERT/ Page-83 / N-49

(a) 52.4×10^{-4}
(b) 524×10^{-4}
(c) 402×10^{-4}
(d) 262×10^{-4}

53. The ion of least limiting molar conductivity among the following is NCERT Page-78 & 79 / N-47

(a) SO_4^{2-}
(b) H^+
(c) Ca^{2+}
(d) CH_3COO^-

54. Molar ionic conductivities of a two-bivalent electrolytes x^{2+} and y^{2-} are 57 and 73 respectively. The molar conductivity of the solution formed by them will be NCERT/Page-83 / N-49

(a) 130 S cm^2 mol^{-1}
(b) 65 S cm^2 mol^{-1}
(c) 260 S cm^2 mol^{-1}
(d) 187 S cm^2 mol^{-1}

55. 0.1 mole, per litre solution is present in a conductivity cell where electrode of 100 cm^2 area are placed at 1 cm apart and resistance observed is 5×10^3 Ohm, what is molar conductivity of solution?

NCERT/Page-78 & 79 / N-45

(a) 5×10^2 S cm^2 mole^{-1}
(b) 2×10^4 S cm^2 mole^{-1}
(c) 200 S cm^2 mole^{-1}
(d) 0.02 S cm^2 mole^{-1}

56. The resistance of a conductivity cell with cell constant $1.14cm-1$, containing $0.001MKCl$ at $298K$ is 1500Ω. The molar conductivity of $0.001MKCl$ solution at $298K$ in $Scm2mol-1$ is__ (Integer answer)
    (a) 86
    (b) 860
    (c) 920
    (d) 760

57. Resistance of $0.2M$ solution of an electrolyte is 50Ω. The specific conductance of the solution is $1.3Sm-1$. If resistance of the $0.4M$ solution of the same electrolyte is 260Ω, its molar conductivity is :

NCERT/Page-78 & 79 / N-45

    (a) $6.25\times10-4Sm2mol-1$
    (b) $625\times10-4Sm2mol-1$
    (c) $62.5Sm2mol-1$
    (d) $6250Sm2mol-1$

58. The limiting molar conductivities of HCl, $CH3COONa$ and $NaCl$ are respectively 425,90 and $125mhocm2mol-1$ at $25\circ C$. The molar conductivity of $0.1MCH_3COOH$ solutions is $7.8mhocm^2mol^{-1}$ at the same temperature. The degree of dissociation of $0.1M$ acetic acid solution at the same temperature is

NCERT/Page-83 / N-50

    (a) 0.10
    (b) 0.02
    (c) 0.15
    (d) 0.03

59. A weak electrolyte having the limiting equivalent conductance of $400Scm2$. equivalent □-1 at $298K$is 2% ionized in its $0.1N$ solution. The resistance of this solution (in ohms) in an electrolytic cell of cell constant $0.4cm-1$ at this temperature is

NCERT Page-84 / N-47

    (a) 200
    (b) 300
    (c) 400
    (d) 500

60. Arrange the following in increasing order of their conductivity $Na+(A)$,$K+(B)$,$Ca2+(C)$,$Mg2+(D)$

NCERT Page-78 &79/ N-49

    (a) A,B,C,D
    (b) B,A,C,D
    (c) C,A,D,B
    (d) A,B,D,C

61. The conductivity of electrolytic solutions depends upon which of the following?

NCERT Page-78 & 79 / N-49

    (i) Size of ions produced
    (ii) Viscosity of the solvent
    (iii) Concentration of electrolyte
    (iv) Solvation of ions produced
    (a) (i) and (iii)
    (b) (i), (ii) and (iii)
    (c) (i),(iii) and (iv)
    (d) All of these

62 . The amount of charge in F (Faraday) required to obtain one mole of iron from Fe3O4 isX

NCERT/Page-86 / N-52

(a) 2
(b) 3
(c) 6
(d) 8

63 ⋆ . Which of the following is the use of electrolysis?

(a) Electrorefining
(b) Electroplating
(c) Both (a) & (b)
(d) None of these

64 ⋆ . An electrolytic cell contains a solution of Ag2SO4 and has platinum electrodes. A current is passed until 1.6g of O2 has been liberated at anode. The amount of silver deposited at cathode would be

NCERT/Page-86 / N-52

(a) 107.88g
(b) 1.6g
(c) 0.8g
(d) 21.60g

65 ⋆ . When 9650 coulombs of electricity is passed through a solution of copper sulphate, the amount of copper deposited is (given at. wt. of Cu=63.6)

NCERT Page-85 & 86 / N-52

(a) 0318g
(b) 3.18g
(c) 31.8g
(d) 63.6g

66 ⋆ . A silver cup is plated with silver by passing 965 coulombs of electricity. The amount of Ag deposited is :

NCERT/Page-86 / N-52

(a) 107.89g
(b) 9.89g
(c) 1.0002g
(d) 1.08g

67 ⋆ . The amount of electricity that can deposit 108g of Ag from AgNO3 solution is: NCERT/Page-86 / N-52

(a) 1F
(b) 2A
(c) 1C
(d) 1A

68 ⋆ . On passing C ampere of electricity through a electrolyte solution for t second. m gram metal deposits on cathode. The equivalent weight E of the metal is

(a) $E = \frac{C \times t}{m \times 96500}$
(b) $E = \frac{C \times m}{t \times 96500}$
(c) $E = \frac{96500 \times m}{C \times t}$
(d) $E = \frac{C \times t \times 96500}{m}$

69⋆. The number of electrons passing per second through a cross-section of copper wire carrying 10−6 amperes of current per second is found to be
(a) 1.6×10−19
(b) 6×10−35
(c) 6×10−16
(d) 6×1012

70 *. The electric charge for electrode decomposition of one gram equivalent of a substance is
(a) one ampere per second NCERT Page-85 & 52
(b) 06500 coulombs per second
(c) one ampere for one hour
(d) charge on one mole of electrons

71⋆. In electrolysis of dilute H2SO4 using platinum electrodes NCERT Page-87, 88 / N-52
(a) H2 is evolved at cathode
(b) NH2 is produced at anode
(c) Cl2 is obtained at cathode
(d) O2 is produced

72⋆. Electrolysis of fused NaCl will give NCERT Page-87 / N-52
(a) Na
(b) NaOH
(c) NaClO
(d) None of these

73. How many moles of Pt may be deposited on the cathode when 0.80F of electricity is passed through a 1.0M solution of Pt4+ ? NCERT Page-85 & 86 / N-52
(a) 1.0mol
(b) 0.20mol
(c) 0.40mol
(d) 0.80mol

74⋆. Aluminium oxide may be electrolysed at 1000∘C to furnish aluminium metal (At. Mass =27amu;1 Faraday =96,500 Coulombs). The cathode reaction is −Al3++3e−→Al
To prepare 5.12kg of aluminium metal by this method, we require electricity of NCERT/Page-85 / N-52
(a) 5.49×101C
(b) 5.49×104C
(c) 1.83×107C
(d) 5.49×107C

75⋆. Find the charge in coulombs required to convert 0.2 mole VO3^{-2} into VO4^{-3}
(a) 1.93×104
(b) 9.65×104
(c) 1.93×105
(d) 9.65×105

76⋆. The number of coulombs required to reduce 12.3g of nitrobenzene to aniline is : NCERT/Page-86 / N-52
(a) 115800C
(b) 5790C

(c) 28950C
(d) 57900C

77⋆. The volume of oxygen gas liberated at NTP by passing a current of 9650 coulombs through acidified water is (a) 1.12 litre NCERT/Page-86 / N-52
(b) 2.24 litre
(c) 11.2 litre
(d) 0.56 litr

78⋆. Three faradays electricity was passed through an aqueous solution of iron (II) bromide. The weight of iron metal (at. wt=65) deposited at the cathode (in g) is NCERT/Page-86 / N-52
(a) 56
(b) 84
(c) 112
(d) 168

79 *. Faraday's laws of electrolysis will fail when
(a) temperature is increased
(b) inert electrodes are used
(c) a mixture of electrolytes is used
(d) None of these cases

80⋆. A solution of Fe2(SO4)3 is electrolyzed for ' x ' min with a current of 1.5A to deposit 0.3482g of Fe. The value of x is [nearest integer]
Given : 1F=96500Cmol−1
Atomic mass of Fe=56gmol−1 NCERT/Page-86 / N-52
(a) 1800
(b) 3
(c) 20
(d) 1200

81 * A solution of copper sulphate (CuSO4) is electrolysed for 10 minutes with a current of 1.5 amperes. The mass of copper deposited at the cathode (at. mass of Cu=63u) is NCERT/Page-86 / N-52
(a) 0.3892g
(b) 0.2938g
(c) 0.2398g
(d) 0.3928g

82 *. Electrolysis of a salt solution was carried out, after some time solution turned yellow.
The salt can be NCERT Page-87 / N-52
(i) NaCl
(ii) KCl
(iii) RbCl
(iv) KBr
(a) (i), (ii) and (iii)
(b) (ii), (ii) and (iv)
(c) (i), (ii) and (iv)
(d) (i), (iii) and (iv)

83⋆. Which of the following statements is incorrect? NCERT Page-76 & 77 / N-47
(a) Both electronic and electrolytic conductance depends on the nature of conducting material.
(b) Both electronic and electrolytic conductance varies similarly with temperature.

(c) Electronic conductance is independent but electrolytic conductance depends on the amount of the conducting substance.
(d) All the above statements are incorrect.

84⋆. Which of the following statements is incorrect?
(a) Electrodes made up of gold participates in the chemical reaction. NCERT/Page-87 / N-52
(b) Electrolytic products of NaCl are Na and Cl_2 whereas of aqueous NaCl are NaOH,Cl_2 and H_2.
(c) During electrolysis at cathode, reaction with higher value of E⊕ is preferred.
(d) All of the above statements are incorrect.

85⋆. When electric current is passed through acidified water, 112mL of hydrogen gas at STP collected at the cathode in 965 seconds. The current passed in amperes is NCERT/Page-86 / N-52
(a) 1.0
(b) 0.5
(c) 0.1
(d) 2.0

86*. On passing current through two cells, connected in series, containing solution of $AgNO_3$ and $CuSO_4$,0.18g of Ag is deposited. The amount of the Cu deposited is: NCERT (Page-85 / N-52
(a) 0.529g
(b) 10.623g
(c) 0.0529g
(d) 1.2708g

87⋆ In the electrolysis of water, one faraday of electrical energy would liberate NCERT/Page-86 / N-52
(a) one mole of oxygen
(b) one gram atom of oxygen
(c) 8g oxygen
(d) 22.4 lit. of oxygen

88⋆. Electrolysis of dilute aqueous NaCl solution was carried out by passing 10 milli ampere current. The time required to liberate 0.01molof H_2 gas at the cathode is
(1 Faraday =96500Cmol−1) NCERT/Page-86 / N-52
(a) 9.65×104sec
(b) 19.3×104sec
(c) 28.95×104sec
(d) 38.6×104sec

89⋆. What is the amount of chlorine evolved when 2 amperes of current is passed for 30 minutes in an aqueous solution of NaCl ? NCERT/Page-86 / N-52
(a) 66g
(b) 1.32g
(c) 33g
(d) 99g

90⋆. One Faraday of electricity is passed through molten Al_2O_3, aqueous solution of $CuSO_4$ and molten NaCl taken in three different electrolytic cells connected in series. The mole ratio of Al,Cu and Na deposited at the respective cathode is NCERT(Page-86 / N-52
(a) 2:3:6
(b) 6:2:3

(c) 6:3:2
(d) 1:2:3

91 *. On passing a current of 1.0 ampere for 16min and 5sec through one litre solution of CuCl2, all copper of the solution was deposited at cathode. The strength of CuCl2 solution was (Molar mass of Cu=63.5; Faraday constant = 96,500Cmol) NCERT/Page-86 / N-52

(a) 0.01N
(b) 0.01M
(c) 0.02M
(d) 0.2N

92.0.2964g of copper was deposited on passage of a current of 0.5amp for 30mins through a solution of copper sulphate. Calculate the oxidation state of Cu (At. mass 63.56). NCERT/Page-85 & 86 / N-52

(a) +1
(b) +2
(c) +3
(d) +4

93*. The quantity of electricity in Faraday needed to reduce 1mol of $CrO2^{-}_{27}$ to 3Cr3+ is NCERT Page-86 / N-52

(a) 3
(b) 6
(c) 2
(d) 8

2.6 BATTERIES

94. Reaction that takes place at anode in dry cell is NCERT/Page-88 / N-54

(a) Zn2++2e−→Zn(s)
(b) Zn(s)→Zn2++2e−
(c) Mn2++2e−→Mn(s)
(d) Mn(s)→Mn++e−+1.5V

95. Which colourless gas evolves, when NH4Cl reacts with zinc in a dry cell battery

(a) NH4
(b) N2
(c) H2
(d) Cl2

96.

97. Among the following cells: NCERT Page-88, 89 & 90/N-54 & 55

(i) Leclanche cell
(iii) Lead storage battery
(iv) Mercury cell primary cells are
(a) (i) and (ii)
(b) (i) and (iii)
(c) (ii) and (iii)
(d) (i) and (iv)
(ii) Nickel-Cadmium cell

97. The electrolyte used in Leclanche cell is NCERT/Page-88 / N-54

(a) paste of KOH and ZnO
(b) 38% solution of H2SO4

(c) moist paste of NH4Cl and ZnCl2
(d) moist sodium hydroxide

98 ⋆ . Which of the following batteries cannot be reused?

NCERT/ Page-84 / N-54

(a) Lead storage battery
(b) Ni-Cd cell
(c) Mercury cell
(d) Both (b) and (c)

99. During the charging of lead storage battery, the reaction at anode is represented by NCERT/ Page-89 / N-55
(a) $Pb2++SO2-4 \rightarrow PbSO4$
(b) $PbSO_4+2H2O \rightarrow PbO2+SO4^{2-}+4H^{+}+2e^{-}$
(c) $Pb \rightarrow Pb2++2e-$
(d) $Pb2++2e- \rightarrow Pb$

100 ⋆ . Which of the following is a merit of Ni–Cd cell over lead storage battery? NCERT/ Page-90 / N-55
(a) Ni–Cd cell can be re-used.
(b) Ni–Cd cell is comparatively economical to manufacture
(c) Ni–Cd cell has comparatively longer life
(d) All the above are the merits of Ni–Cd cell over lead storage battery.

101. When a lead storage battery is discharged

NCERT/ Page-89 / N-55

(a) SO2 is evolved
(b) Lead sulphate is consumed
(c) Lead is formed
(d) Sulphuric acid is consumed

102. Which of the following statements is incorrect regarding dry(Leclanche) cell? NCERT/ Page-88 / N-54
(a) Cathode used in the cell is coated by powdered manganese dioxide and carbon.
(b) Most common application of this cell is in our transistors and clocks. (c) At cathode, Mn is oxidised from +3 to +4 .
(d) At anode Zn is oxidised from 0 to +2 .

2.7 FUEL CELLS

103. In a hydrogen-oxygen fuel cell, combustion of hydrogen occurs to NCERT/ Page-90
(a) produce high purity water
(b) create potential difference between two electrodes
(c) generate hea
(d) remove adsorbed oxygen from elctrode surfaces

104. Which one of the following cells can convert chemical energy of H2 and O2 directly into electrical energy?

NCERT/ Page-90 / N-56

(a) Mercury cell
(b) Daniell cell
(c) Fuel cell
(d) Lead storage cell

105. Which of the following statements regarding fuel cell is incorrect? NCERT/ Page-90 / N-56
(a) These cells are eco-friendly.

(b) These cells convert energy of combustion of fuels like H_2, CH_4, CH_3OH etc., directly into electrical energy.
(c) H_2-O_2 fuel cell is used in Apollo space programme.
(d) Fuel cells produce electricity with an efficiency of about 100%.

106. Hydrogen-Oxygen fuel cells are used in space craft to supply
(a) power for heat and light
(b) electrical power
(c) oxygen
(d) water

2.8 CORROSION

107*. Prevention of corrosion of iron by zinc coating is called
(a) electrolysis
(b) photoelectrolysis
(c) cathodic protection
(d) galvanization

108 *. The best way to prevent rusting of iron is
(a) making it cathode
(b) putting in saline water
(c) Both of these
(d) None of these

109*. The most durable metal plating on iron to protect against corrosion is
(a) nickel plating
(b) copper plating
(c) tin plating
(d) zinc plating

Exercise 2: NCERT Exemplar & Years NEET

NCERT EXEMPLAR QUESTIONS

1. Which cell measure standard electrode potential of copper electrode? NCERT/Page-69 / N-34
(a) Pt(s) I H_2(g,0.1 bar)||H^+(aq,1M) // Cu^{2+}(aq,1M) I Cu
(b) Pt(s) I H_2(g,1 bar)||H^+(aq,1M)||Cu^{2+}(aq,2M) I Cu
(c) Pt(s) I H_2(g,1 bar) || H^+(aq,1M)||Cu^{2+}(aq,1M) I Cu
(d) Pt(s)|H_2(g,0.1bar)||H^+(aq,0.1M)||Cu^{2+}(aq,1M)|Cu

2. The difference between the electrode potentials of two electrodes when no current is drawn through the cell is called...... NCERT(Page-68 / N-34
(a) cell potential
(b) cell emf
(c) potential difference
(d) cell voltage

3. Using the data given below, find out the strongest oxidising agent. NCERT/Page-70 / N-37

$E^\circ_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33V$; $E^\circ_{Cl_2/Cl^-} = 1.36V$

$E^\circ_{MnO_4^-/Mn^{2+}} = 1.51V$; $E^\circ_{Cr^{3+}/Cr} = -0.74V$

(a) Cl^-
(b) Mn^{2+}
(c) MnO_4^-
(d) Cr^{3+}

4. Using the data given in Q. 3 find out in which option the order of reducing power is correct. NCERT Page-7i / N-37

(a) $Cr^{3+} < Cl^- < Mn^{2+} < Cr$
(b) $Mn^{2+} < Cl^- < Cr^{3+} < Cr$
(c) $Cr^{3+} < Cl^- < Cr_2O_7^{2-} < MnO_4^-$
(d) $Mn^{2+} < Cr^{3+} < Cl^- < Cr$

5. Use the data given in Q. 3 and find out the most stable ion in its reduced form. NCERT (Page-71 / N-37

(a) Cr
(b) Cr^{3+}
(c) Gr
(d) Mn^{2+}

6. Use the data of Q. 3 and find out the most stable oxidised species. NCERT/ Page-71 / N-37

(a) Cr^{3+}
(b) MnO_4^-
(c) $Cr_2O_7^{2-}$
(d) Mn^{2+}

7 ⋆. The quantity of charge required to obtain one mole of aluminium from Al_2O_3 is

(a) 1F
(b) 6F
(c) 3F
(d) 2F

8. The cell constant of a conductivity cell ...... NCERT/Page-78 / N-44

(a) changes with change of electrolyte
(b) changes with change of concentration of electrolyte
(c) changes with temperature of electrolyte
(d) remains constant for a cell

9. $\Lambda^\circ_m(NH_4OH)$ is equal to NCERT/Page-83 / N-49

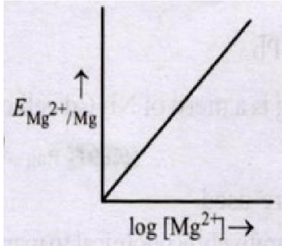
(a) $\Lambda^\circ_m(NH_4OH) + \Lambda^\circ_m(NH_4Cl) - \Lambda^\circ_m(HCl)$
(b) $\Lambda^\circ_m(NH_4Cl) + \Lambda^\circ_m(NaOH) - \Lambda^\circ_m(NaCl)$
(c) $\Lambda^\circ_m(NH_4Cl) + \Lambda^\circ_m(NaCl) - \Lambda^\circ_m(NaOH)$
(d) $\Lambda^\circ_m(NaOH) + \Lambda^\circ_m(NaCl) - \Lambda^\circ_m(NH_4Cl)$

10. Electrode potential for Mg electrode varies according to the equation

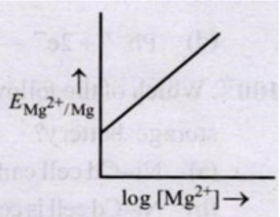
$$E_{Mg^{2+}/Mg} = E^\circ_{Mg^{2+}/Mg} - \frac{0.059}{2}\log\frac{1}{[Mg^{2+}]}$$

The graph of $E_{Mg^{2+}/Mg}$ vs $\log[Mg^{2+}]$ is

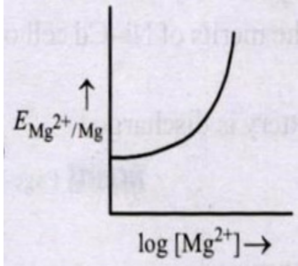
(a)



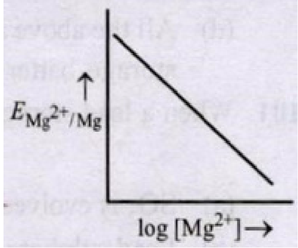
(b)



(c)



(d)



11. Which of the following statement is correct? NCERT/ Page-74 / N-40
    (a) Ecell and ΔrG of cell reaction both are extensive properties.
    (b) Ecell and ΔrG of cell reaction both are intensive properties.
    (c) Ecell is an intensive property while ΔrG of cell reaction is an extensive property.
    (d) Ecell is an extensive property while ΔrG of cell reaction is an intensive property.

12. Which of the following statement is not correct about an inert electrode in a cell? NCERT/ Page-69 / N-34
    (a) It does not participate in the cell reaction
    (b) It provides surface either for oxidation or for reduction reaction
    (c) It provides surface for conduction of electrons
    (d) It provides surface for redox reaction

13. An electrochemical cell can behave like an electrolytic cell when NCERT/Page-66 / N-33
    (a) Ecell =0
    (b) Ecell >Eext
    (c) Eext >Ecell
    (d) Ecell =Eext

14. Which of the statements about solutions of electrolytes is not correct? NCERT/Page-78 & 79 / N-44
    (a) Conductivity of solution depends upon size of ions
    (b) Conductivity depends upon viscosity of solution
    (c) Conductivity does not depend upon solvation of ions present in solution
    (d) Conductivity of solution increases with temperature

15. While charging the lead storage battery ..... NCERT/Page-89 / N-55
    (a) PbSO4 anode is reduced to Pb
    (b) PbSO4 cathode is reduced to Pb
    (c) PbSO4 cathode is oxidised to Pb
    (d) PbSO4 anode is oxidised to PbO2

16. In the electrolysis of aqueous sodium chloride solution which of the half cell reaction will occur at anode? NCERT/Page-87 / N-52
    (a) $Na^+(aq)+e^- \rightarrow Na(s); E^\circ$cell $=-2.71V$
    (b) $2H_2O(l) \rightarrow O_2(g)+4H^+(aq)+4e^-; E^0$ cell $=1.23V$
    (c) $H^+(aq)+e^- \rightarrow \frac{1}{2}H_2(g); E^\circ_{cell}=0.00V$
    (d) $Cl^-(aq) \rightarrow \frac{1}{2}Cl_2(g)+e^-; E^\circ$ cell $=1.36V$

17. Given below are two statements: one is labelled as Assertion *A* and the other is labelled as Reason *R* Assertion A : In equation $\Delta_r G = -nFE_{cell}$ value of $\Delta_r G$ depends on n.
Reasons *R*:*E*cell is an intensive property and $\Delta_r G$ is an extensive property. In the light of the above statements, choose the correct answer from the options given below NCERT/Page-74 / N-40 |
(a) Both A and Rare true and R is the correct explanation of A
(b) Both A and R are true and R is NOT the correct explanation of **A**
(c) **A** is true but R is false
(d) *A* is false but *R* is true

18. The conductivity of centimolar solution of KCl at 25∘C is $0.0210\ \text{ohm}^{-1}\text{cm}^{-1}$ and the resistance of the cell containing the solution at 25∘C is 60ohm. The value of cell constant is NCERT/Page-78 / N-44|
(a) $1.34\ \text{cm}^{-1}$
(b) $3.28\ \text{cm}^{-1}$
(c) $1.26\ \text{cm}^{-1}$
(d) $3.34\ \text{cm}^{-1}$

19. Given below are half cell reactions: NCERT/Page-69 / N-52 |
$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$,
$E^\circ_{Mn^{2+}/MnO_4^-} = -1.510V$
$\frac{1}{2}O_2 + 2H^+ + 2e^- \rightarrow H_2O$
$E^\circ_{O_2/H_2O} = +1.223V$
Will the permanganate ion, MnO_4^- liberate O_2 from water in the presence of an acid?
(a) No, because E∘cell =−0.287V
(b) Yes, because E∘cell =+2.733V
(c) No, because E∘cell =−2.733V
(d) Yes, because E∘cell =+0.287V

20. Find the emf of the cell in which the following reaction takes place at 298K
$Ni(s) + 2Ag^+(0.001M) \rightarrow Ni^{2+}(0.001M) + 2Ag(s)$ NCERT/ Page-70 / N-38 |
(Given that E°_{cell} =10.5V, $\frac{2.303RT}{F} = 0.059$ at 298K)
(a) 1.385V
(b) 0.9615V
(c) 1.05V
(d) 1.0385V

21. The molar conductance of NaCl,HCl and CH_3COONa at infinite dilution are 126.45,426.16 and $91.0\ \text{S cm}^2\text{mol}^{-1}$ respectively. The molar conductance of CH_3COOH at infinite dilution is
(a) $540.48\ \text{S cm}^2\text{mol}^{-1}$ NCERT/ Page-83 / N-49
(b) $201.28\ \text{S cm}^2\text{mol}^{-1}$
(c) $390.71\ \text{S cm}^2\text{mol}^{-1}$
(d) $698.28\ \text{S cm}^2\text{mol}^{-1}$

22⋆. The number of Faradays (F) required to produce 20g of calcium from molten CaCl2 (Atomic mass of Ca= 40gmol−1) is:
NCERT Page-85

(a) 2
(b) 3
(c) 4
(d) 1

23⋆. On electrolysis of dil. sulphuric acid using Platinum (Pt) electrode, the product obtained at anode will be
NCERT/ Page-87 / N-52

(a) Oxygen gas
(b) H2S gas
(c) SO2 gas
(d) Hydrogen gas

24. For the cell reaction
NCERT/ Page-74 / N-38 | NEET

2Fe3+(aq)+2I−(aq)→2Fe2+(aq)+I2(aq)

E^{o}_{cell} =0.24V at 298K. The standard Gibbs energy ($\Delta_r G^{\ominus}$) of the cell reaction is: [Given that Faraday constant F=96500Cmol−1]

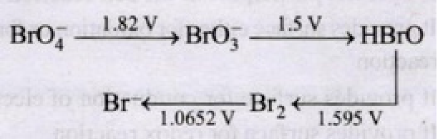
(a) −46.32kJmol−1
(b) −23.16kJmol−1
(c) 46.32kJmol−1
(d) 23.16kJmol−1

25.For a cell invo lving one electron $E^{\ominus}_{cell}$ =0.59V at 298K, the equilibrium constant for the cell reaction is :

[Given that $\frac{2.303RT}{F}$ =0.059V at T=298K]
NCERT Page-74 / N-39 | NEET

(a) 1.0×102
(b) 1.0×105
(c) 1.0×1010
(d) 1.0×1030

26. Consider the change in oxidation state of bromine corresponding to different emf values as shown in the diagram below:
NCERT Page-74 / N-37 | NEET



Then the species undergoing disproportionation is

(a) BrO−3
(b) BrO−4
(c) HBrO (d) Br2

27. Ionic mobility of which of the following alkali metal ions is lowest when aqueous solution of their salts are put under an electric field?
NCERT/ Page-70 / N-49

(a) K
(b) Rb
(c) Li
(d) Na

28. In the electrochemical cell :- NCERT/ Page-70 / N-38 |
Zn|ZnSO4(0.01M)||CuSO4(1.0M)|Cu, the emf of this Daniel cell is $E1$. When the concentration of ZnSO4 is changed to 1.0M and that of CuSO4 changed to 0.01M, the emf changes to $E2$. From the followings, which one is the relationship between $E1$ and $E2$? (Given, $\frac{RT}{F}$ =0.059)
(a) $E1<E2$
(b) $E1>E2$
(c) $E2=0\neq E1$
(d) $E1=E2$

29. The pressure of H2 required to make the potential of H2 electrode zero in pure water at 298K is
NCERT/ Page-70 / N-38 | NEET
(a) 10−14atm
(b) 10−12atm
(c) 10−10atm
(d) 10−4atm

HINTS AND SOLUTIONS

Exercise - 1: (NCERT Based Topic-wise MCQs)

1	(a)	12	(c)	23	(d)	34	(a)	45	(a)	56	(d)	67	(a)	78	(b)	89	(b)	100	(c)
2	(d)	13	(d)	24	(d)	35	(a)	46	(d)	57	(a)	68	(c)	79	(d)	90	(a)	101	(d)
3	(b)	14	(a)	25	(b)	36	(d)	47	(a)	58	(b)	69	(d)	80	(c)	91	(a)	102	(c)
4	(d)	15	(c)	26	(b)	37	(c)	48	(a)	59	(d)	70	(d)	81	(b)	92	(b)	103	(b)
5	(a)	16	(c)	27	(b)	38	(d)	49	(d)	60	(d)	71	(a)	82	(a)	93	(b)	104	(c)
6	(d)	17	(a)	28	(a)	39	(d)	50	(b)	61	(d)	72	(a)	83	(b)	94	(b)	105	(d)
7	(c)	18	(a)	29	(d)	40	(b)	51	(c)	62	(b)	73	(b)	84	(a)	95	(c)	106	(b)
8	(a)	19	(b)	30	(c)	41	(c)	52	(b)	63	(c)	74	(d)	85	(a)	96	(d)	107	(d)
9	(d)	20	(c)	31	(b)	42	(c)	53	(d)	64	(d)	75	(a)	86	(c)	97	(c)	108	(a)
10	(d)	21	(b)	32	(a)	43	(d)	54	(a)	65	(b)	76	(d)	87	(c)	98	(c)	109	(d)
11	(b)	22	(b)	33	(d)	44	(d)	55	(d)	66	(d)	77	(d)	88	(b)	99	(b)		

Exercise - 2 : (NCERT Exemplar NEET)

1	(c)	4	(b)	7	(c)	10	(b)	13	(c)	16	(d)	19	(d)	22	(d)	25	(c)	28	(b)
2	(b)	5	(d)	8	(d)	11	(c)	14	(c)	17	(b)	20	(N)	23	(a)	26	(c)	29	(a)
3	(c)	6	(a)	9	(b)	12	(d)	15	(a)	18	(c)	21	(c)	24	(a)	27	(c)		

EXERCISE - 1

1. (a) Batteries and fuel cells convert chemical energy into electrical energy.
2. (d) Daniell cell is a type of galvanic cell.
3. (b) The cell in which Cu and Zn rods are dipped in its solution is called Daniell cell.
4. (d) In electrolytic cell, the flow of electrons is from anode to cathode through internal supply.
5. (a) Anode has negative polarity.
6. (d) When both the electrodes are kept in the same solution there will be no requirement of salt bridge.
7. (c) The magnitude of the electrode potential of a metal is a measure of its relative tendency to loose or gain electrons.

$$M \rightarrow M^{n+} + ne^- \text{(oxidation potential)}$$
$$M^{n+} + ne^- \rightarrow M \text{ (reduction potential)}$$

8. (a) $2AgCl(s) + H_2(g) \rightarrow 2HCl(aq) + 2Ag(s)$

The activities of solids and liquids are taken as unity and at low concentrations, the activity of a solute is approximated to its molarity.
The cell reaction will be

$$Pt(s)|H_2(g), 1bar|H^+(aq)\ 1M|AgCl(aq) 1M|Ag(s)$$

9. (d) Cu is anode and Ag^+ is cathode.
10. (d) Calomel electrode is used as reference electrode.
11. (b) Given $E_{Sn^{4+}/Sn^{2+}} = +0.15V; E_{Cr^{3+}/Cr} = -0.74V$

Sn^{4+} will reduce and Cr will oxidize, as the standard reduction potential value is positive for Sn^{4+}.

$$E^\circ_{cell} = E^\circ_{ox} + E^\circ_{red} = (0.74 + 0.15)V = 0.89V$$

12. (c)
13. (d) According to an accepted convention, anode is written on the left side and cathode on the right while representing the galvanic cell.
14. (a) Salt bridge allows the flow of current by completing circuit. No current will flow and voltage will drop to zero, if salt bridge is removed.
15. (c) $Mg \rightarrow Mg^{2+} + 2e^-$ (oxidation at anode)

$Ag^+ + e^- \rightarrow Ag$ (reduction at cathode)
Anode is written on the left and cathode is written on the right side.

16. (c) As the value of standard reduction potential decreases the reducing power increases i.e., $\underset{(-3.0)}{Z} > \underset{(-1.2)}{X} > \underset{(+0.5)}{Y}$
17. (a) Higher the value of reduction potential higher will be the oxidising power whereas the lower the value of reduction potential higher will be the reducing power.

(a)

$$E = E^\circ - \frac{0.059}{n}\log\frac{1}{[H^+]}$$
$$= 0 - \frac{0.059}{1}\log\frac{1}{10^{-4}} = -0.236V$$

19. (b) For $Zn^{2+} \rightarrow Zn$

$$E_{Zn^{2+}/Zn} = E^\circ_{Zn^{2+}/Zn} - \frac{2.303RT}{nF}\log\frac{[Zn]}{[Zn^{2+}]}$$
$$= -0.76 - \frac{0.06}{2}\log\frac{1}{[0.1]} = -0.76 - 0.03$$
$$E_{Zn^{2+}/Zn} = -0.79V$$

20. (c) Using the relation,

$$E^\circ_{cell} = \frac{2.303RT}{nF}\log K_c = \frac{0.0591}{n}\log K_c$$

$$\therefore 0.295V = \frac{0.0591}{2}\log K_c \Rightarrow \log K_c = \frac{2 \times 0.295}{0.0591} = 10$$
or $K_c = 1 \times 10^{10}$

21. (b) Without losing its concentration, $ZnCl_2$ solution cannot kept in contact with Al because Al is more reactive than Zn due to its highly negative electrode reduction potential.

22. (b) Suppose A and B forms, A^+ and B^+ ions. From the given value of oxidation potentials, it is clear that A will oxidize to A^+ and B^+ will reduce to B.

$$A + B^+ \longrightarrow A^+ + B \quad \text{or}$$
$$A + BX \longrightarrow AX + B$$

We can say that A will replace B from its solution.

23. (d) cell reaction $\rightarrow Cu + 2Ag^+ \rightarrow Cu^{2+} + 2Ag$

According to Nernst equation

$$E_{cell} = E^\circ_{cell} - \frac{0.06}{2}\log\frac{[Cu^{2+}]}{[Ag^+]^2}$$

$$0.43 = E^\circ_{cell} - \frac{0.06}{2}\log\frac{(0.001)}{(0.01)^2}$$

$$E^\circ_{cell} = 0.46\,V$$

$$E^\circ_{cell} = E^\circ_{Ag^+/Ag} - E^\circ_{Cu^{2+}/Cu} \Rightarrow 0.46 = 0.80 - E^\circ_{Cu^{2+}/Cu}$$

$$E^\circ_{Cu^{2+}/Cu} = 0.34 \text{ volt} \Rightarrow 34 \times 10^{-2}$$

24. (d) $E_{cell} = E^\circ_{cell} - \frac{RT}{nF}\ln Q$

At equilibrium, $E_{cell} = 0$ and $Q = K_c \Rightarrow E_{cell} \neq E^\circ_{cell}$

25. (b) For the given cell

$$E_{cell} = E^\circ_{cell} - \frac{0.059\,V}{2}\log\frac{[Zn^{2+}(aq)]}{[Cu^{2+}(aq)]}$$

The cell potential decreases with increase in $[Zn^{2+}(aq)]$ and increases with increase in $[Cu^{2+}(aq)]$.

26. (b) $\frac{1}{2}H_2 + Ag^+ \rightarrow H^+ + Ag; n = 1$

$$\Delta G^\circ = -nE^\circ F = -1 \times 0.5332 \times 96500\,J = -51.35\,kJ/mol$$

27. (b) From Nernst Eq.

$$E_{cell} = E^\circ_{cell} - \frac{RT}{nF}\ln Q$$

or, $E_{cell} = E^\circ_{cell} - \frac{2.303RT}{nF}\log Q$

or, $0.801 = (0.008 + 0.763) - \frac{0.06 \times (-2)}{n}$ or, $n = 4$

28. (a) According to standard electrode potential table, the order of electrode couple from top to bottom is :

$$Cl_2/Cl^- > Ag^+/Ag > I^-/I_2 > Na^+/Na > Li^+/Li$$

29. (d) $E_{red} = E^\circ_{red} + \frac{0.591}{n}\log[M^{n+}]$

Lower the concentration of M^{n+}, lower is the reduction potential.

Hence order of reduction potential is : $Q > R > S > P$

30. (c) $\Delta G = -nFE^\circ_{cell}$

$$Sn^{2+} + 2e^- \rightarrow Sn \quad \Delta G^\circ_1 = +2 \times 0.140 \times F$$
$$Sn^{4+} + 4e^- \rightarrow Sn \quad \Delta G^\circ_2 = -4 \times 0.01 \times F \qquad (ii)$$

Subtracting (i) from (ii), we get

$$Sn^{4+} + 2e^- \rightarrow Sn^{2+} \quad \Delta G^\circ_3 = -2 \times E^\circ_{Sn^{4+}/Sn^{2+}} \times F$$
$$\Delta G^\circ_3 = \Delta G^\circ_2 - \Delta G^\circ_1 \Rightarrow -2 \times E^\circ \times F = -(0.04 + 0.28) \times F$$
$$E^\circ = 0.16 \text{ volt} = 16 \times 10^{-2}\,V$$

31. (b) Reduction of MnO_4^- is pH dependent.

In acidic medium, $MnO_4^- + 5e^- \rightarrow Mn^{2+}$

In neutral medium, $MnO_4^- + 3e^- \rightarrow Mn^{4+}$

In basic medium, $MnO_4^- + e^- \rightarrow Mn^{6+}$

So, according to pH, the reaction and potential of cell changes.

32. (a) Apply Nernst equation to the reaction

$$Pb+Sn^{2+}\rightarrow Pb^{2+}+Sn$$

$$E_{cell}=E^\circ-\frac{0.059}{2}\times\log\frac{[Pb^{2+}]}{[Sn^{2+}]}$$

or $E^\circ+\frac{0.059}{2}\log\frac{[Sn2+]}{[Pb2+]}=E_{cell}$

or $\log\frac{[Sn2+]}{[Pb2+]}=\frac{0.01\times2}{0.059}=0.3$ ($\because E$cell $=0$)

or $\frac{[Sn2+]}{[Pb2+]}=\text{antilog}(0.3)$

33. (d) Ecell =0 ; when cell is completely discharged.

$$E_{cell}=E^\circ cell-\frac{0.059}{2}\log\left(\frac{[Zn2+]}{[Cu2+]}\right)$$

$$\text{or } 0=1.1-\frac{0.059}{2}\log\left(\frac{[Zn^{2+}]}{[Cu2+]}\right)$$

$$\log\left(\frac{[Zn2+]}{[Cu2+]}\right)=\frac{2\times1.1}{0.059}=37.3\therefore\left(\frac{[Zn2+]}{[Cu2+]}\right)=1037.3$$

34. (a) The Half cell reaction is $Zn2++2e-\rightarrow Zn.$

$$E_{cell}=E^\circ_{cell}-\frac{0.059}{2}\log\frac{1}{[Zn2+]}\quad[E^\circ_{cell}=-E^\circ_{ox}]$$

$$=-0.763-\frac{0.059}{2}\log\frac{1}{0.01}=-0.822V$$

$$Eoxi=0.822V$$

35. (a) The cell reaction is

$$H_2(g)+Cu^{2+}(aq.)\rightarrow2H^+(aq.)+Cu(s)$$

$$n=2$$

According to Nernst equation $0.31=0.34-\frac{0.06}{2}\log\frac{[H+]^2}{[Cu2+]}$

$pH=3-\log[H^+]=3\ [H^+]=10^{-3}$

$[Cu^{2+}]=10^{-7}$ M

$x=7$

36. (d) Here $n=4$, and $[H^+]=10-3$(as pH=3)

Applying Nernst equation

$$E=E^\circ-\frac{0.059}{n}\log\frac{[Fe2+]^2}{[H+]^4(pO)_2}$$

$$=1.67-\frac{0.059}{4}\log\frac{(10-3)^2}{(10-3)^4\times0.1}$$

$$=1.67-\frac{0.059}{4}\log107=1.67-0.103=1.567V$$

37. (c) $Fe^{3+}+I^-\rightarrow I_2+Fe^{2+}$

The E° value for spontaneous reaction is positive.

$E^\circ_{Cell}=E^\circ_{cathode}-E^\circ_{anode}=(0.77-0.54)V=0.23V$

$=23\times10^{-2}V.$

38. (d) When the concentration of all reacting and product species kept unity, then Ecell $=E^\circ$ cell and the given relation will become $\Delta_rG=-nFE^\circ$ cell e.g. redox reaction for Daniell cell : $Zn(s)+Cu^{2+}(aq)\rightarrow Zn2+(aq)+Cu(s)$ solutions of $CuSO_4$ and $ZnSO_4$ are the reacting species. The Ecell for this cell : Ecell $=E^\circ$cell

$$-\frac{RT}{nF}\ln\frac{[Zn2+]}{[Cu2+]}\Rightarrow E_{cell}=E^\circ_{cell}$$

$$\text{if } [Zn2+]=[Cu2+]=1$$

39. (d) Molarity =0.01M; Resistance =40ohm;

Cell constant $\frac{l}{A}$=0.4cm−1.

Specific conductivity (κ)

$$= \frac{\text{cell constant}}{\text{resistance}} = \frac{0.4}{40} = 0.01\,\text{ohm}^{-1}\text{cm}^{-1}$$

Molar conductance ($\wedge$m)= $\frac{1000\kappa}{\text{Molarity}}$

$$= \frac{1000 \times 0.01}{0.01} = 10^3\,\text{ohm}^{-1}\text{cm}^2\text{mol}^{-1}$$

40. (b) Specific conductance of the solution (κ)=0.012ohm−1cm−1 and resistance (R)=55ohm.

Cell constant = Specific conductance × Observed resistance =0.012×55=0.66cm−1.

41. (c) $\Lambda m = 1000 \times \frac{\kappa}{M}$

$$= 1000 \times \frac{2 \times 10^{-5}}{0.001} = 20\,\text{S}\,\text{cm}^2\text{mol}^{-1}$$

$$\Rightarrow \alpha = \frac{\Lambda m}{\Lambda^\circ m} = \frac{20}{190} = \left(\frac{2}{19}\right)$$

$$\underset{0.001(1-\alpha)}{HA} \rightleftharpoons \underset{0.001\alpha}{H^+} + \underset{0.001\alpha}{A^-}$$

$$K_a = 0.001\left(\frac{\alpha^2}{1-\alpha}\right) = \frac{0.001 \times \left(\frac{2}{19}\right)^2}{1-\left(\frac{2}{19}\right)} = 12.3 \times 10^{-6}$$

42. (c) Molar conductance of solution is related to specific conductance as follows :

$$\wedge_m = \kappa \times \frac{1000}{C}$$

$$\Lambda_m = (6.3 \times 10^{-2}\,\text{ohm}^{-1}\,\text{cm}^{-1}) \times \frac{1000}{(0.1\,\text{mol/cm}^3)}$$

$$= 6.3 \times 10^{-2} \times 10^4\,\text{ohm}^{-1}\,\text{cm}^2\text{mol}^{-1} = 630\,\text{ohm}^{-1}\,\text{cm}^2\text{mol}^{-1}$$

43. (d) $\text{ohm}^{-1}\text{cm}^{-1}$

44. (d) Correct matching for pair (iii) will be [G (conductance) - siemens or ohm^{-1} (S).]

45. (a) $\Lambda_m = \frac{\kappa}{C} \Rightarrow \kappa = \Lambda_m \times C$

from question, $\kappa_1 = \kappa_2$

$$\Lambda_{m_1} \times C_1 = \Lambda_{m2} \times C_2 \Rightarrow \Lambda_{m1} \times \frac{10 \times 10^3}{20} = \Lambda_{m2} \times \frac{20 \times 10^3}{80}$$

$$2\Lambda_{m_1} = \Lambda_{m2}$$

46. (d) Cell constant $= l/a$ ∴ Unit $= \text{m}/\text{m}^2 = \text{m}^{-1}$.

47. (a) $\Lambda_{eq} = \kappa \times \frac{1000}{N} = \frac{1}{R} \times \frac{l}{a} \times \frac{1000}{N}$

$$= \frac{1}{R} \times \text{cell constant} \times \frac{1000}{N} = \frac{1}{220} \times 0.88 \times \frac{1000}{0.01} = 400\,\text{mho}\,\text{cm}^2\text{geq}^{-1}$$

48. (a) The specific conductance increases with concentration. The number of ions per cm^3 increase with increase of concentration.

49. (d) Conductance $G = \frac{KA}{l}$

Molar conductivity of a solution at a given concentration is the conductance of the volume V of solution containing one mole of electrolyte kept between two electrodes with area of cross section A and distance of unit length.

Molar conductivity $\wedge m = \frac{KA}{l}$

Since, l=1 and A=V (volume containing one mole of electrolyte) then $\wedge m = K.V$

If the concentration is Cmol/ litre then $\wedge m = K/C$

$\Lambda^{\infty}_{AcOH} = \Lambda^{\infty}_{HCl} + \Lambda^{\infty}_{AcONa} - \Lambda^{\infty}_{NaCl}$

50. (b) $= [426.2 + 91.0 - 126.5] = 390.7$

51. (c) Equivalent conductance at infinite dilution of an electrolyte is the sum of equivalent conductance at infinite dilutions of its constituent ions.

$\Lambda^{\circ}_{Al_2(SO_4)_3} = \Lambda^{\circ}_{Al^{3+}} + \Lambda^{\circ}_{SO_4^{2-}}$

52. (b) $\Lambda^{\circ}_{Ba(OH)_2} = \Lambda^{\circ}_{BaCl_2} + 2\Lambda^{\circ}_{NaOH} - 2\Lambda^{\circ}_{NaCl}$

$\Lambda^{\circ}_{Ba(OH)_2} = 280\times10^{-4} + 2\times248\times10^{-4} - 2\times126\times10^{-4}$

$\Lambda^{\circ}_{Ba(OH)_2} = 524\times10^{-4}\,S\,m^2\,mol^{-1}$.

53. (d) Larger the size, lower the speed.

54. (a) $xy \rightleftharpoons x^{2+} + y^{2-}$ $\Lambda^{\infty}_m = 57 + 73 = 130\,S\,cm^2\,mol^{-1}$

55. (d) Molar conductivity $\wedge m = \frac{\kappa\times1000}{M}$ $\kappa = \frac{1}{R}\times$ cell constant ;$= \frac{1}{R}\times\frac{\ell}{A}$

$= \frac{1}{5\times10^3\Omega}\times\frac{1cm}{100cm^2} = 2\times10^{-6}\Omega^{-1}cm^{-1}\,or\,S\,cm^{-1}$

$= \frac{2\times10^{-6}\times1000}{0.1}$;$= \frac{2}{100}\,S\,cm^2\,mole^{-1}$

56. (d) $\kappa = \frac{1}{R}\times l/A = \left(\left(\frac{1}{1500}\right)\times1.14\right)S\,cm^{-1}$

$\Rightarrow \Lambda m = \frac{1000\times\kappa}{C} = 1000\times\frac{\left(\frac{1.14}{1500}\right)}{0.001}\,S\,cm^2\,mol^{-1}$

$= 760\,S\,cm^2\,mol^{-1}$

57.

(a) $\kappa = \frac{1}{R}\times\frac{\ell}{A} \Rightarrow 1.3 = \frac{1}{50}\times\frac{\ell}{A} \Rightarrow \frac{\ell}{A} = 65\,m^{-1}$

$\Lambda = \frac{\kappa\times1000}{\text{molarity}} = \frac{\left(\frac{1}{260}\times65\,m^{-1}\right)\times1000\,cm^3}{0.4\,moles}$

$= \frac{650\,m^{-1}}{260\times4\,mol}\times\frac{1}{1000}\,m^3 = 6.25\times10^{-4}\,S\,m^2\,mol^{-1}$

58. (b) Λ° for $CH_3COOH = \lambda^{\circ}_{CH_3COO^-} + \lambda^{\circ}_{H^+}$

$= (\lambda^{\circ}_{CH_3COO^-} + \lambda^{\circ}_{Na^+}) + (\lambda^{\circ}_{H^+} + \lambda^{\circ}_{Cl^-}) - (\lambda^{\circ}_{Na^+} + \lambda^{\circ}_{Cl^-})$

$= 90 + 425 - 125 = 390\,mho\,cm^2\,mol^{-1}$.

Degree of dissociation $(\alpha) = \frac{\Lambda^{c}_{m}}{\Lambda^{\circ}_{m}} = \frac{7.8}{390} = 0.02$

59. (d) $\Lambda_C = \Lambda_0\times\alpha = 400\times\frac{2}{100} = 8$

$\Lambda C = \frac{1}{R}\times\frac{\ell}{A}\times\frac{1000}{N} \Rightarrow R = \frac{1000}{\Lambda C\times N}\times\left(\frac{\ell}{A}\right)$

$\Rightarrow R = \frac{0.4\times1000}{8\times0.1} = 500\,Ohms$

60. (d) Charge on Mg and Ca ion is greater than that of Na and K, Mg and Ca ions possess higher conductivity, also solvation of metal ion decreases as we move down the group, hence conductivity increases).

61. (d) The conductivity of electrolytic solution depends upon all of the given factors.

62. (b) Fe_3O_4 is a mixture of FeO and Fe_2O_3. The oxidation state of Fe in FeO and Fe_2O_3 are +2 and +3 respectively.

$\overset{(+2)}{FeO} \xrightarrow{2e^-} Fe$

$\overset{(+3)}{Fe_2O_3} \xrightarrow{6e^-} 2Fe$

$Fe_3O_4 \xrightarrow{8F} 3Fe$

3 mole Fe requires =8F

1 mole Fe requires $\frac{8}{3}$F=2.6F

63. (c) Electrorefining and electroplating are done byelectrolysis.

64.(d) $\frac{W_A}{E_A} = \frac{W_B}{E_B}; \frac{1.6}{8} = \frac{\text{Wt. of Ag}}{108}$

65. (b) Cu2++2e−→Cu(s)

∴ Wt. of Ag=21.6g

9650C will deposit = $\frac{63.6}{2\times96500}$×9650=3.18g

66. (d) Ag++e−⟶Ag 96500 coulombs deposit =108g of Ag

∴965 coulombs deposit = $\frac{108}{96500}$×965=1.08gAg

67. (a) According to Faraday law of electrolysis, amount of electricity required to deposit 1 mole of metal = 96500C=1F i.e., for deposition of 108gAg, electricity required =1F

68. (c) E= $\frac{96500\times w}{I\times t}$ ⇒E= $\frac{96500\times m}{C\times t}$

69. (d) Charge (Coulombs) pass per second =10−6

Number of electrons passed per second

$$= \frac{10-6}{1.602\times10-19} = 6.24\times1012$$

70. (d) Charge on one mole of electrons =96500C.

71. (a) When platinum electrodes are dipped in dilute solution of H2SO4 then H2 is evolved at cathode.

72. (a) When molten or fused NaCl is electrolysed, it yields metallic sodium and gaseous chlorine. Reactions involved are as follows:

NaCl(s)→Na+(l)+Cl−(l)

Na+(l)+e−→Na(l)

(at cathode)

Cl−(l)→Cl(g)+e−

Cl(g)+Cl(g)→Cl2(g)

(at anode)

73. (b) Pt4++4e−→Pt

4F electricity is required to deposit 1 mole of Pt.

∴0.80F of electricity will deposit

=1/4×0.80 moles of Pt=0.20mol.

74. (d) 1 mole of e−=1F=96500C

27g of Al is deposited by 3×96500C

5120g of Al will be deposited by= $\frac{3\times96500\times5120}{27}$ =5.49×107C

75. (a) $\overset{+4}{V}O_3$2−→$\overset{+5}{V}O_4$3− This reaction involves transfer of one electrons.

Thus, for conversion of 1 mole, 1F of electricity is required.

Charge =0.2×1 Faraday =0.2×96500 coulombs

=19300=1.93×104 coulombs

76. (d) $C_{65}HNO_2$+6H++6e− →C6H5NH2+2H2O

EC6 H5 NO2(eq.wt) = $\frac{123}{6}$ =20.5

Number of coulombs required = $\frac{w\times96500}{\text{Eq. wt}}$

$$= \frac{12.3\times96500}{20.5} = 57900C$$

77. (d) Oxidation reaction at anode, upon electrolysis of water:

$$2H_2O(l)\rightarrow O_2(g)+4H(aq)^{+}+4e^-; E^\circ\text{cell} = +1.23V$$

Thus, 1 mole of oxygen is liberated by 4 moles of electrons. 4×96500 coulombs electricity liberates =22.4 L. O2 gas

9650 coulombs electricity liberates = $\frac{22.4}{4\times96500}\times9650$
$=0.56L \cdot O_2$ gas

78. (b) $Fe^{2+}+2e^{-}\rightarrow Fe; E_{Fe}=\frac{56}{2}=28$

1 Faraday liberates =28g of Fe

3 Faraday liberates =3×28=84g

79. (d) Change in temperature, electrode or electrolyte compsoition does not effect faraday's law.

80. (c) $Fe^{3+}+3e^{-}\longrightarrow Fe$

3F≡1 mole Fe is deposited

For 56g≡3×96500 (required charge)

For 0.3482g $\equiv\frac{3\times96500}{56}\times0.3482=1800$ coulomb

$$Q=it\Rightarrow1800=1.5t\Rightarrow t=1200s=20min$$

81. (b) $W=Zit$

where Z= Electrochemical equivalent

Eq. wt. of copper = $\frac{63}{2}=31.5; Z=\frac{31.5}{96500}$

$W=Zit=\frac{31.5}{96500}\times1.5\times10\times60=0.2938g$

82. (a) Electrolysis of these (i), (ii) and (iii) salt release chlorine which is yellowish in colour while Br_2 is reddish brown in colour

83. (b) Electronic conductance decreases with increase in temperature whereas electrolytic conductance increases with increase in temperature as no. of ions or charge carriers increases with increase in temperature.

84. (a) Gold is an inert metal. Electrodes made up of inert metals does not participate in chemical reaction.

85. (a) $2H^{+}+2e^{-}\rightarrow H_2$

E_H (Eq. wt) $=\frac{2}{2}=1g=\frac{22400}{2}=11200mL(STP)$

Total charge passed = $\frac{96500\times112}{11200}=965$ coulomb

$Q=It=965$ and $t=965s$.

$I=\frac{965}{965}=1amp$.

86. (c) Using Faraday's second law of electrolysis, $\frac{\text{Weight of Cu deposited}}{\text{Weight of Ag deposited}}=\frac{\text{Equ. wt. of Cu}}{\text{Equ. wt. of Ag}}$

$\Rightarrow\frac{w_{Cu}}{0.18}=\frac{63.5}{2}\times\frac{1}{108}\Rightarrow w_{Cu}=\frac{63.5\times18}{2\times108\times100}=0.0529$ g.

87. (c) According to the definition, 1F or 96500C is the charge carried by 1mol of electrons. When water is electrolysed:

$$2H_2O\rightarrow4H^{+}+O_2+4e^{-}$$

So, 4 Faraday of electricity liberate =32g of O_2.

Thus 1 Faraday of electricity liberate

$=\frac{32}{4}$ g of O_2 = 8g of O_2

88. (b) $H_2O\rightleftharpoons H^{+}+OH^{-}$

$H^{+}+e^{-}\rightarrow\frac{1}{2}H_2$

∴ 0.5 mole of H_2 is liberated by 1F=96500C

0.01 mole of H_2 will be liberated by = $\frac{96500}{0.5}\times0.01=1930C$

$Q=I\times t$

$$t=\frac{Q}{I}=\frac{1930C}{10\times10^{-3}A}=19.3\times10^{4}sec$$

89. (b) At Anode, $Cl^{-}\rightarrow\frac{1}{2}Cl_2+e^{-}$

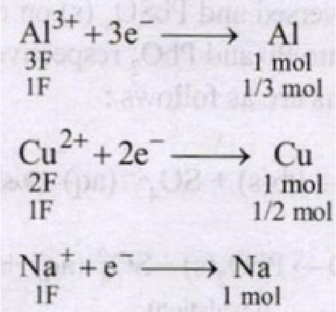
Equivalent wt. of chlorine (E_{Cl_2}) $= \frac{35.5\times2}{2} = 35.5$

$W_{Cl_2} = \frac{E_{Cl_2}\times I\times t}{96500} = \frac{35.5\times2\times30\times60}{96500} = 1.32g.$

90. (a) The charge carried by 1 mole of electrons is one faraday. Thus for a reaction

$$M^{n+} + ne^- \longrightarrow M$$

nF=1 mole of M



$Al^{3+} + 3e^- \longrightarrow Al$
3F 1 mol
1F 1/3 mol

$Cu^{2+} + 2e^- \longrightarrow Cu$
2F 1 mol
1F 1/2 mol

$Na^+ + e^- \longrightarrow Na$
1F 1 mol

The mole ratio of Al,Cu and Na deposited at the respective cathode is $\frac{1}{3}:\frac{1}{2}:1$ or 2:3:6.

91.(a) By Faraday's 1st Law of electrolysis, $\frac{W}{E} = \frac{Q}{96500}$ (where $Q = it =$ charge of ion)

We know that no. of gram equivalent

$$= \frac{W}{E} = \frac{it}{96500} = \frac{1\times965}{96500} = \frac{1}{100}$$

(where i=1A,t=16×60+5=965sec.)

Since, we know that

Normality $= \frac{\text{No. of gram equivalent}}{\text{Volume (in litre)}} = \frac{\frac{1}{100}}{1} = 0.01N$

92. (b) Quantity of charge passed =0.5×30×60=900 coulomb

900 coulomb will deposit =0.2964g of copper

∴96500 coulomb will deposit

$$= \frac{0.2964}{900}\times96500 = 31.75g \text{ of copper}$$

Thus, 31.75 is the eq. mass of copper

At. mass = Eq. mass × Valency

$$63.56 = 31.75\times x$$
$$x = +2.$$

93. (b) The oxidation state of Cr changes from +6 to +3 .

$$\underset{1mol}{\overset{+6}{Cr_2O_7^{-2}}} + \underset{6mol}{6e^-} \rightarrow Cr^{+3}$$

⇒number of faradays = moles of electrons = 6

94. (b) Oxidation takes place at zinc anode.

95. (c) $2NH_4Cl + Zn \rightarrow 2NH_3 + ZnCl_2 + H_2\uparrow$.

96. (d) Primary cells are those cells, in which the reaction occurs only once and after use over a period of time, it becomes dead and cannot be reused again. e.g., Leclanche cell and mercury cell.

97. (c) The electrolyte used in Leclanche cell is moist paste of NH4Cl and ZnCl2.

98. (c) Mercury cell being primary in nature can be used only once.

99. (b) During charging, the lead storage battery behaves like an electrolytic cell. So, at anode the reaction is

$$PbSO_4 + 2H_2O \rightarrow PbO_2 + 4H^+ + SO_4^{2-} + 2e^-$$

100. (c) Ni–Cd cells have longer half-life than lead-storage battery.

101. (d) $Pb + PbO_2 + 2H_2SO_4 \underset{\text{Recharge}}{\overset{\text{Discharge}}{\rightleftharpoons}} 2PbSO_4 + 2H_2O.$

Sulphuric acid is consumed on discharging.

102. (c) At cathode, reduction occurs according to following reaction.

$$\overset{+4}{MnO_2} + NH_4^+ + e^- \longrightarrow \overset{+3}{MnO(OH)} + NH_3$$

103. (b) In H2−O2 fuel cell, the combustion of H2 occurs to create potential difference between the two electrodes.
104. (c) Fuel cells produce electricity with an efficiency of about 100%.
105. (d) Fuel cells produce electricity with an efficiency of about 70% compared to thermal plants whose efficiency is about 40%.
106. (b) H2−O2 fuel cell supply electrical power.
107. (d) Prevention of corrosion by zinc coating is called galvanization
108. (a) Cathodic protection is best method to prevent iron from rusting. In this method iron is made cathode by application of external current.
Saline water is highly conducting and hence accelerates the formation of rust.
109. (d) This is because zinc has higher oxidation potential than Ni,Cu and Sn. The process of coating of iron surface with zinc is known as galvanization. Galvanized iron sheets maintain their lustre due to the formation of protective layer of basic zinc carbonate.

EXERCISE - 2

1. (c) Standard electrode potential of copper electrode can be calculated by constructing a concentration cell composed of two half cell reactions in which concentration of species on left hand and right hand side are unity.

$$\underbrace{Pt(s) \mid H_2(g, 1bar)}_{\text{Oxidation half cell}} \parallel \underbrace{H^+(aq, 1M) \mid Cu^{2+}(aq, 1M) \mid Cu}_{\text{Reduction half cell}}$$

2. (b) Cell emf is the difference between the electrode potential of two electrodes when no current is drawn through the cell.
3. (c) Higher the positive value of standard reduction potential of metal ion, higher will be its oxidising capacity. Since, $E^\circ_{MnO_4^-/Mn^{2+}}$ has highest positive value hence, it is the strongest oxidising agent.
4. (b) On moving down in electrochemical series reducing power decreases as the value of electrode potential decreases.
5. (d) $E^\circ_{MnO_4^-/Mn^{2+}}$ has highest positive value. So, Mn^{2+} is most stable ion in its reduced form.
6. (a) $E^\circ_{Cr^{3+}/Cr}$ has the lowest value of SRP. Hence, Cr^{3+} is the most stable oxidised species.
7. (c) $Al^{3+}(aq) \xrightarrow{+3e^-} Al(s)$

Hence, total 3F is required.

8. (d) Cell constant $(G) = \frac{l}{A}$ where l = length of object and A = area of cross section Since, l and A remain constant for any particular object hence, value of cell constant always remains constant.

9. (b)

$$\Lambda^\circ_m(NH_4Cl) = \lambda^\circ_{(NH_4^+)} + \lambda^\circ_{(Cl^-)} \quad (i)$$

$$\Lambda^\circ_m(NaOH) = \lambda^\circ_{(Na^+)} + \lambda^\circ_{(OH^-)} \quad (ii)$$

$$\Lambda^\circ_m(NaCl) = \lambda^\circ_{(Na^+)} + \lambda^\circ_{(Cl^-)} \quad (iii)$$

On adding (i) & (ii) and subtract (iii), we get : $\Lambda^\circ_m(NH_4Cl) + \Lambda^\circ_{m(NaOH)} - \Lambda^\circ_{m(NaCl)} = \Lambda^\circ_{m(NH_4OH)}$

10. (b) Electrode potential for Mg electrode varies according to the equation :

$$E_{Mg^{2+}/Mg} = E^\circ_{Mg^{2+}/Mg} - \frac{0.059}{2}\log\frac{1}{[Mg^{2+}]}$$

$$E_{Mg^{2+}/Mg} = E^\circ_{Mg^{2+}/Mg} + \frac{0.059}{2}\log[Mg^{2+}]$$

$$E_{Mg^{2+}/Mg} = \frac{0.059}{2}\log[Mg^{2+}] + E^\circ_{Mg^{2+}/Mg}$$

This equation represents equation of straight line.

Hence, intercept $(c) = E^\circ_{Mg^{2+}/Mg}$ and slope $= \frac{0.059}{2}$

Thus, equation can be diagrammatically represented as in option (b).

11. (c) Ecell is an intensive property as it is independent of the mass of species but ΔrG of cell reaction is an extensive property because this depends upon mass of species.
12. (d) Inert electrode does not participate in redox reaction and acts only as source or sink for electrons. It provides surface either for oxidation or for reduction reaction.
13. (c) If an external opposite potential is applied on the galvanic cell and increased slowly. It is observed that the reaction continues to take place till the opposing voltage reaches the value 1.1V. At this stage, no current flow through the cell. Any further increase in the external potential restarts the reaction but in the opposite direction. Hence, now the cell will behave like an electrolytic cell.
14. (c) Greater the solvation of ions of an electrolyte, lesser will be the electrical conductivity of the solution.
15. (a) When the lead storage battery is recharged, the reaction occurring on cell is reversed and PbSO4(s) on anode and cathode is converted into Pb and PbO_2 respectively.

The electrode reactions are as follows :

Anode reaction: $PbSO_4(s) + 2e^- \rightarrow Pb(s) + SO_4^{2-}(aq)$ (Reduction)

Cathode reaction: $PbSO_4(s) + 2H_2O \rightarrow PbO_2(s) + SO_4^{2-}(aq) + 4H^+ + 2e^-$ (Oxidation)

Net reaction: $2PbSO_4(s) + 2H_2O \rightarrow Pb(s) + PbO_2(s) + 4H^+(aq) + 2SO_4^{2-}(aq)$

16. (d) In the electrolysis of aqueous NaCl, following reactions are possible at anode.

At anode; $Cl^-(aq) \rightarrow \frac{1}{2}Cl_2(g) + e^-$; $E^\circ_{cell} = 1.36V$

At cathode; $2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$;

$E^\circ_{cell} = 1.23V$

The reaction at anode with lower value of E° is preferred and therefore, water should get oxidised in preference to Cl−(aq). However, on account of overpotential of oxygen, reaction (d) is preferred.

17. (b) The value of ΔrG depends on n value as per the equation $\Delta_r G = -nFE_{cell}$

So, assertion statement is correct

Ecell is an intensive property while $\Delta_r G$ is an extensive thermodynamic property

So, reason is correct but not explaining the assertion.

18. (c) Conductivity = conductance × cell constant $k = \frac{1}{R} \times \frac{l}{A}$

$$\frac{l}{A} = k \times R = 0.0210 \times 60 = 1.26cm^{-1}$$

19. (d) $E^\circ_{cell} - \frac{0.059}{n}\log\frac{[Ni^{+2}]}{[Ag+]^2}$

According to Kohlrausch law of independent migration of ions.

$\Lambda^\circ_m(CH_3COOH)$

$$= \Lambda^\circ_m(CH_3COONa) + \Lambda^\circ_m(HCl) - \Lambda^\circ_m(NaCl)$$

20. (N) $Ni(s) + 2Ag^+(0.001M) \rightarrow Ni^{+2}(0.001M) + 2Ag(s)$

$$E_{cell} = E^\circ cell - \frac{0.059}{n}\log\frac{[Ni+2]1}{[Ag+]2}$$

$$Ecell = 10.5 - \frac{0.059}{2}\log\frac{10-3}{(10-3)2}$$

$$= 10.5 - \frac{0.059}{2}\log 10^{+3} = 10.5 - \frac{0.059}{2} \times 3 = 10.4115V$$

(Calculated answer is not given in options)

21. (c) According to Kohlrausch law of independent migration of ions.

$\Lambda^\circ_m(CH_3COOH)$

$$= \Lambda^\circ_m(CH_3COONa) + \Lambda^\circ_m(HCl) - \Lambda^\circ_m(NaCl)$$

$= 91.0 Scm^2 mol^{-1} + 426.16 Scm^2 mol^{-1} - 126.45 Scm^2 mol^{-1}$

$= 390.71 Scm^2 mol^{-1}$

22. (d) 1 equivalent of any substance is deposited by 1F of charge.

20g calcium contains,

Number of equivalents $= \frac{\text{Given mass}}{\text{Equivalent mass}}$

(Equivalent mass of $Ca = \frac{\text{Atomic mass}}{\text{Valency}} = \frac{40}{2} = 20$)

$$\frac{20}{20} = 1$$

So, 1 Faraday of charge is required to deposit 1 equivalent of Ca.

23. (a) During the electrolysis of dil. sulphuric acid using Pt electrodes following reaction occurs.

At cathode : $4H^+(aq) + 4e^- \rightarrow 2H_2(g)$

At anode : $2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$

24. (a) $\Delta G = -nFE^\circ = -2 \times 96500 \times 0.24 = -46320 J/mol = -46.32 kJ/mol$

25. (c) $E^\circ_{cell} = \frac{2.303RT}{nF}\log K$

Given : $E^\circ_{cell} = 0.59V$,
n = 1

$0.59 = \frac{0.059}{1}\log K \Rightarrow \frac{0.59}{0.059} = \log K \Rightarrow 10 = \log K$

$K = 10^{10}$

26. (c) Calculate E°_{cell} corresponding to each compound undergoing disproportionation reaction. The reaction for which E°_{cell} comes out + ve is spontaneous.

$HBrO \rightarrow Br_2$ $E^\circ = 1.595V$, SRP (cathode)
$HBrO \rightarrow BrO_3^-$ $E^\circ = -1.5V$, SOP (anode)

$$2HBrO \rightarrow Br_2 + BrO_3^-$$

E°_{cell} = SRP (cathode) − SRP(anode) = 1.595 − 1.5 = 0.095V

$E^\circ_{cell} > 0 \Rightarrow \Delta G^\circ < 0$ [spontaneous]

27. (c) Li^+ being smallest, has maximum charge density.

∴ Li^+ is most heavily hydrated among all alkali metal ions. Effective size of Li^+ in aqueous solution is therefore, largest. So, moves slowest under electric field.

28. (b) For cell,

$Zn|ZnSO_4\ (0.01M)\ \|\ CuSO_4\ (1.0M)|Cu$

$$E_{cell} = E^\circ_{cell} - \frac{2.303RT}{nF}\log\frac{[Zn^{2+}]}{[Cu^{2+}]}$$

$$\therefore E_1 = E^\circ_{cell} - \frac{2.303RT}{2 \times F} \times \log\frac{(0.01)}{1}$$

When concentrations are changed for ZnSO4 and CuSO4, we can write

$$E_2 = E^\circ_{cell} - \frac{2.303RT}{2F} \times \log\frac{1}{0.01}$$

$$\therefore E_1 > E_2$$

29. (a) $2H^+(aq) + 2e^- \rightarrow H_2(g)$

$$\therefore E = E^0 - \frac{0.0591}{2}\log\frac{P_{H_2}}{[H^+]^2}$$

$$0 = 0 - 0.0295\log\frac{P_{H_2}}{(10^{-7})^2} \Rightarrow \frac{P_{H_2}}{(10^{-7})^2} = 1$$

$$P_{H_2} = 10^{-14}\ atm$$