17 Electrochemistry

Conceptual MCQs

1. The standard reduction potentials of 4 elements are given below. Which of the following will be the most suitable reducing agent
I = – 3.04 V, II = – 1.90 V, III = 0 V, IV = 1.90 V
(a) I (b) II (c) III (d) IV

2. The number of coulombs required to reduce 12.3 g of nitrobenzene to aniline is :
(a) 115800 C (b) 5790 C
(c) 28950 C (d) 57900 C

3. When a lead storage battery is discharged
(a) SO_2 is evolved
(b) Lead sulphate is consumed
(c) Lead is formed
(d) Sulphuric acid is consumed

4. A certain amount of current liberates 0.50 g of hydrogen in 2 hours. How many grams of copper can be liberated by the same current flowing for the same time in a copper sulphate solution?
(a) 12.7 g (b) 15.9 g (c) 31.8 g (d) 63.5 g

5. Given below are the standard electrode potentials of few half cells. The correct order of these metals in increasing reducing power will be
$K^+ | K = -2.93$ V, $Ag^+ | Ag = 0.80$ V,
$Mg^{2+} | Mg = -2.37$ V, $Cr^{3+} | Cr = -0.74$ V.
(a) K < Mg < Cr < Ag (b) Ag < Cr < Mg < K
(c) Mg < K < Cr < Ag (d) Cr < Ag < Mg < K

6. To deposit 0.6354 g of copper by electrolysis of aqueous cupric sulphate solution, the amount of electricity required (in coulombs) is
(a) 9650 (b) 4825
(c) 3860 (d) 1930

7. What is the E°_{cell} for the reaction
$$Cu^{2+}(aq) + Sn^{2+}(aq) + \rightleftharpoons Cu(s) + Sn^{4+}(aq)$$
at 25 °C if the equilibrium constant for the reaction is 1×10^6?
(a) 0.5328 V (b) 0.3552 V
(c) 0.1773 V (d) 0.7104 V

8. The efficiency of a fuel cell is given by
(a) $\frac{\Delta G}{\Delta S}$ (b) $\frac{\Delta G}{\Delta H}$ (c) $\frac{\Delta S}{\Delta G}$ (d) $\frac{\Delta H}{\Delta G}$

9. Standard electrode potential of Ag^+ / Ag and Cu^+ / Cu is +0.80V and +0.34V respectively. These electrodes are joint together by salt bridge if
(a) Copper electrode work like cathode, then E°_{cell} is +0.45 V
(b) Silver electrode work like anode then E°_{cell} is –0.34 V
(c) Copper electrode work like anode then E°_{cell} is +0.46 V
(d) Silver electrode work like cathode then E°_{cell} is –0.34 V

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

11. For the galvanic cell
$Zn | Zn^{2+}$ (0.1M) || Cu^{2+} (1.0M)|Cu the cell potential increase if:
(a) $[Zn^{2+}]$ is increased
(b) $[Cu^{2+}]$ is increased
(c) $[Cu^{2+}]$ is decreased
(d) surface area of anode is increased

12. The equivalent conductances of two strong electrolytes at infinite dilution in H_2O (where ions move freely through a solution) at 25°C are given below :
$$\Lambda^\circ_{CH_3COONa} = 91.0 \text{ S cm}^2 / \text{eq.}$$
$$\Lambda^\circ_{HCl} = 426.2 \text{ S cm}^2 / \text{eq.}$$
What additional information/ quantity one needs to calculate Λ° of an aqueous solution of acetic acid?
(a) Λ° of chloroacetic acid ($ClCH_2COOH$)
(b) Λ° of NaCl
(c) Λ° of CH_3COOK
(d) the limiting equivalent coductance of $H^+ (\lambda^\circ_{H^+})$.

13. Which of the following condition will increase the voltage of the cell, represented by the equation
$$Cu(s) + 2Ag^+(aq) \longrightarrow Cu^{2+}(aq) + 2Ag(s)$$
(a) Increase in the concentration of Ag^+ ion
(b) Increase in the concentration of Cu^+ ion
(c) Increase in the dimension of silver electrode
(d) Increase in the dimension of copper electrode

14. According to Nernst equation, which is not correct if $Q = K_c$:

(a) $E_{cell} = 0$ (b) $\frac{RT}{nF} \ln Q = E^\circ_{cell}$

(c) $K_c = e^{\frac{nFE^\circ_{cell}}{RT}}$ (d) $E_{cell} = E^\circ_{cell}$

15. The equivalent conductivity of N/10 solution of acetic acid at 25°C is 14.3 $ohm^{-1}\ cm^2\ eq^{-1}$. What will be the degree of dissociation of acetic acid?

($\Lambda^\infty_{CH_3COOH} = 390.71\ ohm^{-1}\ cm^2\ eq^{-1}$)

(a) 3.66% (b) 3.9% (c) 2.12% (d) 0.008%

Application Based MCQs

16. In a metal oxide, there is 20% oxygen by weight. Its equivalent weight is

(a) 40 (b) 64 (c) 72 (d) 32

17. Three faradays of electricity is passed through molten Al_2O_3, aqueous solution of $CuSO_4$ and molten NaCl taken in different electrolytic cells. The amount of Al, Cu and Na deposited at the cathodes will be in the ratio of

(a) 1 mole : 2 mole : 3 mole
(b) 3 mole : 2 mole : 1 mole
(c) 1 mole : 1.5 mole : 3 mole
(d) 1.5 mole : 2 mole : 3 mole

18. Corrosion of iron is essentially an electrochemical phenomenon where the cell reactions are

(a) Fe is oxidised to Fe^{2+} and dissolved oxygen in water is reduced to OH^-
(b) Fe is oxidised to Fe^{3+} and H_2O is reduced to O_2^{2-}
(c) Fe is oxidised to Fe^{2+} and H_2O is reduced to O_2^-
(d) Fe is oxidised to Fe^{2+} and H_2O is reduced to O_2

19. The standard reduction potentials for Zn^{2+}/Zn, Ni^{2+}/Ni and Fe^{2+}/Fe are –0.76, –0.23 and –0.44 V respectively. The reaction $X + Y^{2+} \longrightarrow X^{2+} + Y$ will be spontaneous when :

(a) X = Ni, Y = Fe (b) X = Ni, Y = Zn
(c) X = Fe, Y = Zn (d) X = Zn, Y = Ni

20. If the standard electrode potential for a cell is 2 V at 300 K, the equilibrium constant (K) for the reaction

$$Zn(s) + Cu^{2+}(aq) \rightleftharpoons Zn^{2+}(aq) + Cu(s)$$

at 300 K is approximately

($R = 8\ JK^{-1}\ mol^{-1}$, F = 96000 C mol^{-1})

(a) e^{-80} (b) e^{-160} (c) e^{320} (d) e^{160}

21. Given $E^\circ_{Cr^{3+}/Cr} = -0.72$ V, $E^\circ_{Fe^{2+}/Fe} = -0.42$ V. The potential for the cell

$Cr|Cr^{3+}(0.1M)||Fe^{2+}(0.01\ M)|$ Fe is

(a) 0.26V (b) 0.336V (c) −0.339 V (d) 0.26V

22. Electrolysis of dilute aqueous NaCl solution was carried out by passing 10 milli ampere current. The time required to liberate 0.01 mol of H_2 gas at the cathode is (1 Faraday = 96500 C mol^{-1})

(a) 9.65×10^4 s (b) 19.3×10^4 s
(c) 28.95×10^4 s (d) 38.6×10^4 s

23. During the electrolysis of molten NaCl solution, 230g of sodium metal is deposited on the cathode, then how many moles of chlorine will be obtained at anode

(a) 10.0 (b) 3.48 (c) 35.5 (d) 17.0

24. A 0.5 M NaOH solution offers a resistance of 31.6 ohm in a conductivity cell at room temperature. What shall be the approximate molar conductance of this NaOH solution if cell constant of the cell is 0.367 cm^{-1}.

(a) 234 S $cm^2\ mol^{-1}$ (b) 23.2 S $cm^2\ mol^{-1}$
(c) 4645 S $cm^2\ mol^{-1}$ (d) 5464 S $cm^2\ mol^{-1}$

25. The e.m.f. of a Daniell cell at 298 K is E_1.

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

When the concentration of $ZnSO_4$ is 1.0 M and that of $CuSO_4$ is 0.01 M, the e.m.f. changed to E_2. What is the relationship between E_1 and E_2?

(a) $E_2 = 0 \neq E_1$ (b) $E_1 > E_2$
(c) $E_1 < E_2$ (d) $E_1 = E_2$

26. In the electrolysis of acidulated water, it is desired to obtain 1.12 cc of hydrogen per second under S.T.P. condition. The current to be passed is

(a) 9.65 A (b) 19.3 A (c) 0.965 A (d) 1.93 A

27. The correct order of $E^\circ_{M^{2+}/M}$ values with negative sign for the four successive elements Cr, Mn, Fe and Co is

(a) Mn > Cr > Fe > Co
(b) Cr < Fe > Mn > Co
(c) Fe > Mn > Cr > Co
(d) Cr > Mn > Fe > Co

28. $\Lambda_{ClCH_2COONa} = 224\ ohm^{-1}cm^2 g\,eq^{-1}$,

$\Lambda_{NaCl} = 38.2\ ohm^{-1}cm^2 g\,eq^{-1}$,

$\Lambda_{HCl} = 203\ ohm^{-1}cm^2 g\,eq^{-1}$,

What is the value of Λ_{ClCH_2COOH} ?

(a) $288.5\ ohm^{-1}cm^2\ g\ eq^{-1}$
(b) $289.5\ ohm^{-1}cm^2\ g\ eq^{-1}$
(c) $388.8\ ohm^{-1}cm^2\ g\ eq^{-1}$
(d) $59.5\ ohm^{-1}cm^2\ g\ eq^{-1}$

29. Aluminium oxide may be electrolysed at 1000°C to furnish aluminium metal (At. Mass = 27 amu; 1 Faraday = 96,500 Coulombs). The cathode reaction is

$Al^{3+} + 3e^- \rightarrow Al$

To prepare 5.12kg of aluminium metal by this method would require

(a) 5.49×10^7 C of electricity (b) 1.83×10^7 C of electricity
(c) 5.49×10^4 C of electricity (d) 5.49×10^1 C of electricity

30. The reduction potential of hydrogen half-cell will be negative if:

(a) $p(H_2) = 1$ atm and $[H^+] = 2.0$ M
(b) $p(H_2) = 1$ atm and $[H^+] = 1.0$ M
(c) $p(H_2) = 2$ atm and $[H^+] = 1.0$ M
(d) $p(H_2) = 2$ atm and $[H^+] = 2.0$ M

31. 9.65 C of electric current is passed through fused anhydrous magnesium chloride. The magnesium metal thus, obtained is completely converted into a Grignard reagent. The number of moles of the Grignard reagent obtained is

(a) 5×10^{-4} (b) 1×10^{-4} (c) 5×10^{-5} (d) 1×10^{-5}

32. How many atoms of calcium will be deposited from a solution of $CaCl_2$ by a current of 25 milliamperes flowing for 60 seconds

(a) 4.68×10^{18} (b) 4.68×10^{15}
(c) 4.68×10^{12} (d) 4.68×10^9

33. The E° values of the following reduction reactions are given

$Fe^{3+}(aq) + e \rightarrow Fe^{2+}(aq)$; E° = +0.771V

$Fe^{2+}(aq) + 2e \rightarrow Fe(s)$; E° = –0.447V

What will be the free energy change for the reaction

$Fe^{3+}(aq) + 3e^- \rightarrow Fe(s)$ ($1\ F = 96485\ C\ mol^{-1}$)

(a) $+18.51\ kJ\ mol^{-1}$ (b) $+11.87\ kJ\ mol^{-1}$
(c) $-8.10\ kJ\ mol^{-1}$ (d) $-10.41\ kJ\ mol^{-1}$

34. On passing one faraday of electricity through the electrolytic cells containing Ag^+, Ni^{2+} and Cr^{3+} ions solution, the deposited Ag(At. wt. = 108), Ni(At. wt. = 59) and Cr(At. wt. = 52) is

	Ag	Ni	Cr
(a)	108 g	29.5 g	17.3 g
(b)	108 g	59.0 g	52.0 g
(c)	108 g	108.0 g	108.0 g
(d)	108 g	117.5 g	166.0 g

35. The cell,

$$Zn\,|\,Zn^{2+}(1\,M)\,||\,Cu^{2+}(1\,M)\,|\,Cu\ (E^\circ_{cell} = 1.10\ V)$$

was allowed to be completely discharged at 298 K. 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) $10^{37.3}$

36. An electric charge of 5 Faradays is passed through three electrolytes $AgNO_3$, $CuSO_4$ and $FeCl_3$ solution. The grams of each metal liberated at cathode will be

(a) Ag = 10.8 g, Cu = 12.7 g, Fe = 1.11 g
(b) Ag = 540 g, Cu = 367.5 g, Fe = 325 g
(c) Ag = 108 g, Cu = 63.5 g, Fe = 56 g
(d) Ag = 540 g, Cu = 158.8 g, Fe = 93.3 g

37. Resistance of a conductivity cell filled with a solution of an electrolyte of concentration 0.1 M is 100 Ω. The conductivity of this solution is $1.29\ S\ m^{-1}$. Resistance of the same cell when filled with 0.02 M of the same solution is 520 Ω. The molar conductivity of 0.02 M solution of electrolyte will be

(a) $1.24 \times 10^{-4}\ S\ m^2\ mol^{-1}$ (b) $12.4 \times 10^{-4}\ S\ m^2\ mol^{-1}$
(c) $124 \times 10^{-4}\ S\ m^2\ mol^{-1}$ (d) $1240 \times 10^{-4}\ S\ m^2\ mol^{-1}$

38. Resistance of 0.2 M solution of an electrolyte is 50 Ω. The specific conductance of the solution is $1.3\ S\ m^{-1}$. If resistance of the 0.4 M solution of the same electrolyte is 260 Ω, its molar conductivity is :

(a) $6.25 \times 10^{-4}\ S\ m^2\ mol^{-1}$ (b) $625 \times 10^{-4}\ S\ m^2\ mol^{-1}$
(c) $62.5\ S\ m^2\ mol^{-1}$ (d) $6250\ S\ m^2\ mol^{-1}$

39. An electrolytic cell contains a solution of Ag_2SO_4 and have platinum electrodes. A current is passed until 1.6 g of O_2 has been liberated at anode. The amount of silver deposited at cathode would be

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

40. On passing a current of 1.0 A for 16 min and 5 sec through one litre solution of $CuCl_2$, all copper of the solution was deposited at cathode. The strength of $CuCl_2$ solution was (Molar mass of Cu = 63.5; Faraday constant = $96,500\ C\ mol^{-1}$)

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

Skill Based MCQs

41. 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} Sm^2mol^{-1} respectively. Λ^0_m $Ba(OH)_2$ in $S\,m^2\,mol^{-1}$ is

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

42. In a fuel cell methanol is used as fuel and oxygen gas is used as an oxidiser. The reaction is

$$CH_3OH(l) + 3/2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$$

At 298 K standard Gibb's energies of formation for $CH_3OH(l)$, $H_2O(l)$ and and CO_2 (g) are –166.2 –237.2 and –394.4 kJ mol^{-1} respectively. If standard enthalpy of combustion of methanol is – 726 kJ mol^{-1}, efficiency of the fuel cell will be:

(a) 87% (b) 90% (c) 97% (d) 80%

43. How long (approximate) should water be electrolysed by passing through 100 amperes current so that the oxygen released can completely burn 27.66 g of diborane? (Atomic weight of B = 10.8 u)

(a) 6.4 hours (b) 0.8 hours
(c) 3.2 hours (d) 1.6 hours

44. At 298K the standard free energy of formation of H_2O (l) is –237.20 kJ mol^{-1} while that of its ionisation into H^+ ion and hydroxyl ions is 80 kJ mol^{-1}, then the emf of the following cell at 298 K will be

[Faraday constant F = 96500C]

$H_2(g, 1\text{ bar}) \,|\, H^+(1M) \,||\, OH^-(1M) \,|\, O_2(g, 1\text{ bar})$

(a) 0.40V (b) 0.81V (c) 1.23 V (d) – 0.40 V

45. Resistance of 0.2 M solution of an electrolyte is 50 Ω. The specific conductance of the solution is 1.4 S m^{-1}. The resistance of 0.5 M solution of the same electrolyte is 280 Ω. The molar conductivity of 0.5 M solution of the electrolyte in $S\,m^2\,mol^{-1}$ is:

(a) 5×10^{-4} (b) 5×10^{-3}
(c) 5×10^{3} (d) 5×10^{2}

46. An electric current is passed through silver nitrate solution using silver electrodes. 10.79 g of silver was found to be deposited on the cathode if the same amount of electricity is passed through copper sulphate solution using copper electrodes, the weight of copper deposited on the cathodes.

(a) 6.4 g (b) 2.3 g (c) 1.6 g (d) 3.2 g

47. Calculate the volume of H_2 gas at NTP obtained by passing 4 amperes through acidified H_2O for 30 minutes is

(a) 0.0836 L(b) 0.0432 L (c) 0.1672 L (d) 0.836 L

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

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

49. A current of 96.5 A is passed for 18 min between nickel electrodes in 500 mL solution of 2M $Ni(NO_3)_2$. The molarity of solution after electrolysis would be

(a) 0.46 M (b) 0.92 M
(c) 0.625 M (d) 1.25 M

50. The standard reduction potential for Cu^{2+} /Cu is +0.34 V. What will be the reduction potential at pH = 14?
[Given : K_{sp} of $Cu(OH)_2$ is 1.0×10^{-19}]

(a) 2.2 V (b) 3.4 V (c) –0.22 V (d) –2.2 V

ANSWER KEY															
Conceptual MCQs															
1	(a)	**3**	(d)	**5**	(b)	**7**	(c)	**9**	(c)	**11**	(b)	**13**	(a)	**15**	(a)
2	(d)	**4**	(b)	**6**	(d)	**8**	(b)	**10**	(b)	**12**	(b)	**14**	(d)		
Application Based MCQs															
16	(d)	**19**	(d)	**22**	(b)	**25**	(b)	**28**	(c)	**31**	(c)	**34**	(a)	**37**	(c)
40	(a)														
17	(c)	**20**	(d)	**23**	(b)	**26**	(a)	**29**	(a)	**32**	(a)	**35**	(d)	**38**	(a)
18	(a)	**21**	(d)	**24**	(b)	**27**	(a)	**30**	(c)	**33**	(b)	**36**	(d)	**39**	(d)
Skill Based MCQs															
41	(b)	**42**	(c)	**43**	(c)	**44**	(a)	**45**	(a)	**46**	(d)	**47**	(d)	**48**	(d)
49	(b)	**50**	(c)												