ELECTRO CHEMISTRY PART-III

1. **According to Nernst equation the potential of single electrode depends upon**

   1) The nature of the electrode

   2) Temperature

   3) Concentration of the ion with respect to which it is reversible

   4) All the above

2. **The Nernst equation giving dependence of potential of metal electrode on concentration is**

   1) $E = E^0 + \frac{2.303\ RT}{nF}\ \log \frac{[M]}{[M^{n+}]}$

   2) $E = E^0 + \frac{2.303\ RT}{nF}\ \log \frac{[M^{n+}]}{[M]}$

   3) $E = E^0 - \frac{2.303\ RT}{nF}\ \log \frac{[M^{n+}]}{[M]}$

   4) $E = E^0 - \frac{2.303\ RT}{nF}\ \log [M^{n+}]$

3. **Consider the following four electrodes:**

   $A = Cu^{2+}$ (0.002M) / $Cu_{(s)}$

   $B = Cu^{2+}$ (0.2 M) / $Cu_{(s)}$

   $C = Cu^{2+}$ (0.03 M)/ $Cu_{(s)}$

   $D = Cu^{2+}$ (0.004 M)/$Cu_{(s)}$

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

   1) A > D > C > B 2) B > C > D > A 3) C > D > B > A 4) A > B > C > D

   Hint: In case of metal electrodes, the reduction potential decrease with decrease in concentration of metal ion.

4. **The Nernst equation for the reduction potential of a non metal A when $[A^{n-}]$ = C is given by**

   1) $E^0 + \frac{0.059}{n} \log C$ 2) $E^0 - \frac{0.059}{n} \log C$ 3) $E^0 + \frac{0.059}{n} \log C^n$ 4) $E^0 - \frac{0.059}{n} \log \frac{1}{C}$

5. **The e.m.f. of the following Daniell cell at 298 K is E_1 Zn /$ZnSO_4$(0.01M)//$CuSO_4$ (1.0M)/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 E2. What is the relationship between E_1 and E_2 ?**

1) $E_1 > E_2$ 2) $E_1 < E_2$ 3) $E_1 = E_2$ 4) E_1 =10 E2

Hint; Cell reaction is $Zn(s)+Cu^{+2} \leftrightharpoons Zn^{+2} + Cu(s)$, $E_{cell} = E^0_{cell} - \frac{0.059}{n}\log\frac{[Zn^{2+}]}{[Cu^{2+}]}$

$$E_1 = E^0_{cell} - \frac{0.059}{2}\log\frac{0.01}{1} = E^0_{cell} + 0.059 \text{ and } E_2 = E^0_{cell} - \frac{0.059}{2}\log\frac{1}{0.01} = E^0_{cell} - 0.059$$

∴ $E_1 > E_2$

6. **For the cell Zn/Zn^{2+}//Cu^{2+}/Cu, if the concentration of Zn^{2+} and Cu^{2+} ions is doubled, the emf of the cell**

1) Doubles 2) reduces to half 3) remains same 4) remains zero

Hint; Cell reaction is $Zn(s)+Cu^{+2} \leftrightharpoons Zn^{+2} + Cu(s)$, $E_{cell} = E^0_{cell} - \frac{0.059}{n}\log\frac{[Zn^{2+}]}{[Cu^{2+}]}$ If concentration of both ions is doubled, the ratio remains unchanged.

7. **In a cell that utilises the reaction**

$Zn_{(s)} + 2H^{+}_{(aq)} \leftrightharpoons Zn^{2+}_{(aq)} + H_{2(g)}$ addition of H_2SO_4 to cathode compartment, will

1) Lower the E and shift equilibrium to the left
2) Increase the E and shift equilibrium to the left
3) Increase the E and shift equilibrium to the right
4) Lower the E and shift equilibrium to the right

Hint; $E_{cell} = E^0_{cell} - \frac{0.059}{n}\log\frac{[Zn^{2+}]}{[H^+]^2}$ due to addition of acid,$[H^+]$increase i.e cell potential will increase and equilibrium state shifts to the right

8. **For a cell reaction, $Cu^{2+}(C_1, aq) + Zn_{(s)} \rightleftharpoons Zn^{2+}(C_2, aq) + Cu_{(s)}$ of an electro chemical cell, the change in standard free energy (ΔG^o), at a given temperature is**

1) $\log C_1$ 2) $\frac{0.0591}{2}\log\frac{C_2}{C_1}$ 3) $\log C_2$ 4) $\log(C_1 + C_2)$

9. **The relationship between standard reduction potential of a cell and equilibrium constant is shown by**

1) $E^0_{cell} = \frac{n}{0.059}\log K_c$ 2) $E^0_{cell} = \frac{0.059}{n}\log K_c$

3) $E^0_{cell} = 0.059\, n \log K_c$ 4) $E^0_{cell} = \frac{\log K_c}{n}$

10. **For a spontaneous reaction the ΔG, equilibrium constant (K) and E^0_{cell} will be respectively**

1) –ve, >1, +ve 2) –ve, >1, –ve 3) –ve, <1, –ve 4) –ve, >1, –ve

11. **For the cell representation Pt /H_2(1atm) / $H^+_{(aq)}$ // $Cl^-_{(aq)}$ /AgCl/Ag , K_c (equilibrium constant) is represented as**

1) $K_c = \frac{[H^+][H_2]}{[Cl^-][AgCl]}$ 2) $K_c = \frac{[Cl^-][AgCl]}{[H^+][H_2]}$

3) $K_c = [H^+][Cl^-]$ 4) $K_c = \frac{[H_2]}{[Ag]}$

Hint: Cell reaction is $\frac{1}{2}H_{2(g)} + \frac{1}{2}Cl_{2(g)} \Leftrightarrow H^+_{aq} + Cl^-_{aq}$,

12. **The relationship between free energy and electrode potential is**

1) $\Delta G = -nEF$ 2) $\Delta G = nEF$ 3) $\Delta G = \frac{EF}{n}$ 4) $\Delta G = \frac{n}{EF}$

13. **The correct relationship between free energy change in a reaction and the corresponding equilibrium constant K_C is**

1) $\Delta G^o = RT \ln K_c$ 2) $\Delta G^o = -RT \ln K_C$ 3) $\Delta G = RT \ln K_C$ 4) $\Delta G = RT \ln K_C$

14. **E^0 for $F_2 + 2e^- \rightarrow 2F^-$ is 2.8 V then E^0 for $1/2\, F_2 + e^- \rightarrow F^-$ is**

1) 2.8 V 2) 1.4 V 3) –2.8 V 4) –1.4 V

Hint; E^0 is independent of stoichiometry of the equation.

15. The standard reduction potentials for the two half-cell reactions are given below:

$Cd^{2+}{}_{(aq)} + 2e^- \to Cd_{(s)}$; $E^0 = -0.40V$

$Ag^+{}_{(aq)} + e^- \to Ag_{(s)}$; $E^0 = 0.80V$

The standard free energy change for the reaction $2Ag^+{}_{(aq)} + Cd_{(s)} \to 2Ag_{(s)} + Cd^{2+}{}_{(aq)}$ is given by

1) 115.8 kJ 2) –115.8 kJ 3) –231.6 kJ 4) 231.6 kJ

Hint; $E^o = E^o{}_{Ag} - E^o{}_{Cd}$:=0.80-(-0.40)=1.2v

$\Delta G^o = -nE^0F = -2 \times 1.2 \times 96500J = -231600J = -231.6$ KJ

16. What is the reduction potential of half-cell consisting of zinc electrode in 0.01 M $ZnSO_4$ solution at 25^0C ($E_{ox}{}^o = 0.76$ V)

1) -0.819 V 2) +0.819 V 3)- 0.701 V 4) +0.701 V

Hint; $E_{rp}{}^o = -0.76$ V, for metal electrode $E_{RP} = E^o + 0.059/n \log [Zn^{+2}]$

$E_{RP} = -0.76 + 0.059/2 \log [10^{-2}] = -0.76 - 0.059 = -0.819v$

17. The standard e.m.f. for the cell reaction, $2Cu^+{}_{(aq)} \leftrightharpoons Cu_{(s)} + Cu^{2+}{}_{(aq)}$ is +0.59V

at 298 K. The equilibrium constant of the reaction is

1) 1×10^{10} 2) 1×10^{12} 3) 2×10^{12} 4) 2×10^6

Hint; E0cell $= \frac{0.059}{n} \log K_c$,n=1 ,log K= 0.59/0.059=10 $\therefore$ K=10^{10}

18. The standard e.m.f. of a galvanic cell involving cell reaction with n = 2 is found to be 0.295 V at 25^0C. The equilibrium constant of the reaction would be

1) 1.0×10^{10} 2) 2.0×10^{11} 3) 4.0×10^{12} 4) 1.0×10^2

Hint; $E^0{}_{cell} = \frac{0.059}{n} \log K_c$,n=1

19. **During the charging of a lead storage battery, the reaction occurring at the cathode is represented by**

1) $Pb \rightarrow Pb^{+2} + 2\bar{e}$

2) $Pb^{+2} + 2\bar{e} \rightarrow Pb$

3) $Pb^{+2} + SO_4^{-2} \rightarrow PbSO_4$

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

20. **A depolariser used in dry cell is**

1) NH_4Cl 2) MnO_2 3) K_2O 4) Na_3PO_4

21. **When lead storage battery is charged**

1) Lead dioxide dissolves 2) H_2SO_4 is regenerated

3) The lead electrode becomes coated 4) Amount of H_2SO_4 decreases

22. **In a dry cell, the reaction which takes place at the zinc anode is**

1) $Zn^{+2} + 2\bar{e} \rightarrow Zn$ 2) $Zn \rightarrow Zn^{+2} + 2e^-$ 3) $Mn^{+2} + 2e^- \rightarrow Mn$ 4) $Mn \rightarrow Mn^{+2} + 2e^-$

23. **The cell which cannot be recharged is**

1) Fuel cell 2) solar cell 3) primary cell 4) secondary cell

24. **When a lead storage battery is discharged, then**

1) SO_2 is evolved 2) Lead is formed

3) Lead sulphate is consumed 4) Sulphuric acid is consumed

25 **A fuel cell is**

1) The voltaic cells in which continuous supply of fuels are sent at anode to give oxidation

2) The voltaic cell in which fuels such as CH_4, H_2, CO are used up at anode

3) $H_2 - O_2$ fuel cell involves the reaction Anode: $2H_2 + 4OH^- \rightarrow 4H_2O_{(l)} + 4\bar{e}$

Cathode: $O_2 + 2H_2O_{(l)} + 4\bar{e} \rightarrow 4OH^-$ 4) All the above

26. **In which of the following will the corrosion of iron be most rapid**

1) In pure water 2) in pure O_2

3) in air & moisture 4) in air & saline water

27. **The composition of rust is**

1) $Fe_2O_3\ xH_2O$ 2) $Fe_2O_3\ 6H_2O$ 3) $Fe_2O_3\ 2H_2O$ 4) Fe_2O_3

28. **With respect to $H_2 - O_2$ fuel cell the false statement is**

1) It is free from pollution 2) It is more efficient than ordinary galvanic cells

3) The reaction at anode is 4) These cells take little time to go into operation

29. Which of the following metals act as a sacrificial anode for iron objects?

1) Cu 2) Zn 3) Ag 4) Sn

30. Hydrogen - Oxygen cells are used in space crafts to supply

1) Power for heat & light 2) Power for pressure

3) Oxygen 4) All the above

31. Zn is used to protect corrosion of iron because

1) E_{oxi} of Zn < E_{oxi} of Fe 2) E_{red} of Zn < E_{red} of Fe

3) Zn is cheaper than Fe 4) Zn is abundantly available

32. In a fuel cell, combustion of hydrogen occurs to

1) Generate heat

2) creates potential difference between the two electrodes

3) produce high purity of water

4) Remove absorbed oxygen from electrode surface

33. The corrosion of iron article is favored by

1) Presence of H^+ ion 2) Presence of moisture in air

3) Presence of impurities in iron object 4) All of the above

34. The rusting of iron takes place as follows

$2H^+ + 2\bar{e} + \frac{1}{2}O_2 \rightarrow H_2O_{(\lambda)}; E^o = +1.23v$

$Fe^{+2} + 2\bar{e} \rightarrow Fe; E^o = -0.44v$

The ΔG^o for the process is

1) –322 KJ mol^{-1} 2) –161 KJ mol^{-1} 3) –152 KJ mol^{-1} 4) –76 KJ mol^{-1}

35 Galvanized iron is

1) Tin sheet coated with Zn 2) Tin sheet coated with steel

3) Zinc sheet coated with Fe 4) Fe sheet coated with Zn

36. The emf of the concentration cell $Zn_{(s)}\left|Zn^{+2}(0.1M)\right|KCl_{(sats)}\left|Zn^{+2}(1M)\right|Zn$ is

1) Zero 2) 0.0592 v 3) –0.0296 v 4) 0.0296v

37. Rusting of iron is

1) a decomposition process 2) a photochemical process

3) an electrochemical process 4) a reduction process

38 **In a lead storage battery**

1) Pb is oxidised to $PbSO_4$ at the anode

2) PbO_2 is reduced to $PbSO_4$ at the cathode

3) Both electrodes are immersed in the same aqueous solution of H_2SO_4

4) All the above

39. **Which of the following cells has a constant voltage throughout its life?**

1) Leclanche cell 2) Electrolytic cell 3) Mercury cell 4) Daniel cell

40. **Consider the following cell with hydrogen electrodes at different pressures P_1 & P_2**

$Pt, H_{2(P1)} \left| H^+ (1M) \right| H_{2(P_2)}, Pt$ **.The emf of the cell is given by**

1) $\frac{RT}{F} ln \frac{P_1}{P_2}$ 2) $\frac{RT}{2F} ln \frac{P_1}{P_2}$ 3) $\frac{RT}{F} ln \frac{P_2}{P_1}$ 4) $\frac{RT}{2F} ln \frac{P_2}{P_1}$

41. **Double sulphonation theory is applied to make**

1) Ni – Cd batteries 2) Fuel cells 3) Alkaline batteries 4) Lead storage batteries

42 **In the rusting of iron, which of the following cell reactions occurs at the cathode**

1) Fe^{+2} / Fe 2) O_2 / H_2O 3) Fe^{+3} / Fe^{+2} 4) Fe / Fe^{+3}

43. **Which of the following statements in the context of a battery is correct?**

1) It is an electrochemical cell

2) It is used as a source of energy

3) The stored energy is released during the redox reaction

4) All of these

44. **The cathode reaction during the charging of a lead - acid battery leads to the**

1) Formation of $PbSO_4$ 2) Reduction of Pb^{+2} to Pb

3) Formation of PbO_2 4) Deposition of Pb at the anode

45. **Which of the following is rechargeable?**

1) Lead storage cell 2) Ni-Cd cell 3) Edison cell 4) All of these

46. **For a cell reaction involving two electron change, the standard emf of the cell is found to be 0.295v at 25^{o}C. The equilibrium constant of the reaction at 25^{o}C is**

1) 1×10^{-10} 2) 29.5×10^{-2} 3) 10 4) $1x10^{10}$

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

1) Fe is oxidised to Fe^{+2} & dissolved oxygen in water is reduced to OH^-

2) Fe is oxidised to Fe^{+3} & H_2O is reduced to O_2^{-2}

3) Fe is oxidised to Fe^{+2} & H_2O is reduced to O_2^-

4) Fe is oxidised to Fe^{+2} & H_2O is reduced to O_2

48. The correct statement of Leclanche cell

1) it has amalgamated zinc as anode
2) MnO_2 + C act as cathode
3) 20 % NH_4Cl is electrolyte
4) All the above

49. The cathode reaction of dry cell is

1) $Zn \rightarrow Zn^{+2} + 2e^-$
2) $MnO_2 + NH_4^+ + \bar{e} \rightarrow MnO(OH) + NH_3$
3) $Zn^{+2} + 2\bar{e} \rightarrow Zn$
4) $MnO_2 \rightarrow 4H^+ + 2\bar{e} \rightarrow Mn^{+2} + 2H_2O$

50. The voltage of dry cell is

1) 2.0 v
2) 1.5 v
3) 1.0 v
4) 1.25 v

51 The incorrect statement of dry cell is

1) MnO_2 acts as cathodic depolariser & facilitates the H^+ ion discharge by removing the absorbed H - atoms

2) Zn^{+2} ions absorb NH_3 formed in the reaction

3) It can not be recharged

4) It contains liquid state electrolyte

52. When lead accumulator is discharged

1) Anode reaction is oxidation of PbO_2 to Pb^{+2}

2) Cathode reaction is reduction of Pb^{+2} to Pb

3) H_2SO_4 is consumed

4) H_2SO_4 is formed

53. The incorrect statement of lead accumulator is

1) The voltage varies between 1.88v to 2.15 v

2) 40 % H_2SO_4 electrolyte gives a voltage 2.15 v

3) 5 % H_2SO_4 electrolyte gives a voltage 2.0 v

4) The net cell reaction with 2 moles of $PbSO_4$ formation involves 2 faradays

54. Which cannot be an oxidant in a fuel cell?

1) O_2 2) H_2O_2 3) HCHO 4) HNO_3

55. Which of the following are used as electrodes in a fuel cell?

1) Porous PVC or Teflon coated with Ag 2) Nickel boride & Raney Ni

3) Pt 4) All of these

56 A fuel cell operates at 125^{o}C. It is an example of

1) Low temperature cell

2) Medium temperature cell

3) High temperature cell

4) None

57 The theoretical efficiency of a fuel cell is

1) 70% 2) 90% 3) 100% 4) 60%

58. Which of the following metals corrosion does not liberate H_2 gas

1) Fe 2) Sn 3) Zn 4) Cu

KEY

1)4 2)2 3)2 4)2 5)1 6)3 7)3 8)2 9)2 10)1

11)3 12)1 13)2 14)1 15)3 16)1 17)1 18) 2 19)2 20)2

21)2 22)2 23)3 24)4 25) 4 26) 4 27)1 28) 3 29) 2 30) 4

31) 2 32) 1 33) 4 34) 1 35) 4 36) 4 37) 3 38) 4 39)3 40)2

41) 4 42)2 43) 4 44) 2 45)4 46)4 47) 1 48) 4 49) 2 50) 2

51)4 52)3 53)3 54)3 55)4 56)2 57)3 58)4