ELECTROCHEMISTRY PART-II

1. Faraday's laws of electrolysis are related to the

1) Molar mass of the electrolyte

2) Equivalent weight of the cation or anion

3) Molecular mass of the electrolyte

4) Atomic mass of the cation or anion

2. The unit of electrochemical equivalent is

1) Gram. Coulomb 2) gram. Ampere

3) gram / Coulomb 4) Coulomb / gram

3. The mass deposited by the passage of 1 amp current for one second is called as

1) a mole 2) gram equivalent weight

3) electro–chemical equivalent 4) gram atomic weight.

4. A copper voltammeter, a silver voltammeter and a water voltammeter are connected in series and current is passed for some time. The ratio of the number of moles of copper, silver and hydrogen formed at the cathode is

1) 2:1:1 2) 1:1:1 3) 1:2:1 4) 1:2:2

Hint: when same quantity of electricity is passed through different electrolyte solutions then no. of moles of elements deposited are in the ratio $1/Z_1:1/Z_2:1/Z_3:\ldots$where Z_1, Z_2, $Z_3\ldots$.are valency of elements.

$\therefore\ n_{Cu}: n_{Ag} :n_{H2}\ =1/2: 1/1:1/2=1:2:1$

5. When one faraday of current is passed, which of the following would deposit one gram atomic weight of the metal?

1) $BaCl_2$ 2) NaCl 3) $AlCl_3$ 4) $CuCl_2$

Hint: For Na^+, GEW=GAW

6. The charge on 1mole of Mg^{+2} ions is

1) 96,500 coulombs 2)193000coulmbs 3) 48250 coulombs 4) 1930 coulombs

Hint; The charge on 1mole M^{n+} or M^{n-} ions=n Faradays.

7. The value of electrochemical equivalent is highest for

1) Al 2) Ag 3) Ca 4) Mg

Hint; e α GEW

8. **The reaction ½ H_2 (g) + AgCl(s) ⇋ H^+ (aq) + Ag(s) can be represented in the galvanic cell**

As

1) Ag/AgCl(s) | KCl(sol) || $AgNO_3$ (sol) | Ag

2) Pt, H_2(g) | HCl (sol) || $AgNO_3$ (sol) | Ag

3) Pt,H_2(g) | HCl(sol) || AgCl(s) | Ag

4) H_2(g) | HCl(sol) || AgCl(s) | Ag

9. **In a Galvanic cell, the electrons flow from**

1) Anode to cathode through the solution
2) Cathode to anode through the solution
3) Anode to cathode through the external circuit
4) Cathode to anode through the external circuit.

10. **Which of the following statements is wrong about galvanic cells?**

1) Cathode is the positive electrode
2) Cathode is the negative electrode
3) In this chemical energy is converted into electrical energy.
4) Reduction occurs at cathode

11. **The purpose of the salt bridge in a galvanic cell is to**

1) Prevent accumulation of charges around the electrodes
2) Facilitate continuity of the cell reaction
3) To produce current at a constant strength
4) All the above

12. **A reversible galvanic cell is connected to an external battery. It the EMF of the battery is less than EMF of the galvanic cell, then current**

1) Will not pass through the circuit
2) Flows from the battery into the galvanic cell
3) Flows from the galvanic cell into the battery
4) All the three may take place

13. When salt bridge is removed, the voltage of Galvanic cell

1) Drops to zero 2) increase rapidly 3) increase slowly. 4) Remains same.

14 The electrolyte used in salt bridge of a galvanic cell is

1) agar–agar gel 2) solid KNO_3

3) Fused KNO_3 4) saturated aqueous KNO_3 solution.

15. Consider the following E^0 values

$E^0_{Fe^{3+}/Fe^{2+}} = +0.77$ V and $E^0_{Sn^{2+}/Sn} = -0.14$ V. Under standard conditions the potential for the reaction $Sn_{(s)} + 2Fe^{3+}_{(aq)} \rightarrow 2Fe^{2+}_{(aq)} + Sn^{2+}_{(aq)}$ is

1) 1.68 V 2) 0.63 V 3) 0.91 V 4) 1.40 V

Solution; $E_{cell} = E^0_{Fe^{3+}/Fe^{2+}} - \mathbf{E^0_{Sn^{2+}/Sn}}$

16. E^0 for the reaction $Fe + Zn^{2+} \rightarrow Zn + Fe^{2+}$ is –0.35 V. The given cell reaction is

1) Spontaneous 2) not feasible 3) rapid 4) slow

Hint; If EMF of cell is negative then cell reaction is non spontaneous.

17. E.M.F of the cell reaction, $2Ag^+ + Cu \rightarrow 2Ag + Cu^{2+}$ is 0.46 V. If $E^0_{Cu^{2+}/Cu}$ is + 0.34 V then $E^0_{Ag^+/Ag}$ is

1) 0.80 V 2) 0.12 V 3) 0.40 V 4) 1.60 V

Hint; EMf of cell= $E^0_{Ag^+/Ag} - E^0_{Cu^{2+}/Cu}$

18. The significance of using saturated solution of KNO_3 as electrolyte in the Salt Bridge is

1) Velocity of K^+ is greater than that of NO^-_3

2) Velocity of NO^-_3 is greater than that of K^+

3) Velocities of both K^+ and NO^-_3 are nearly the same.

4) KNO_3 is highly soluble in water.

19. The standard electrode potential of the two half cells are given below

$Ni^{+2} + 2e^-$ Ni; $E^o = -0.25$ Volt

$Zn^{+2} + 2e^-$ Zn; $E^o = -0.77$ volt

The voltage of cell formed by combining the two half cells would be

1) –1.02 2) +0.52 volt 3) +1.02 volt 4) –0.52 volt

Hint; in this Zn acts as anode (lower SRP) and Ni acts as cathode (higher SRP).

Emf= $E^o_{cathode}$-E^o_{anode}

20) The hydrogen electrode is dipped in a solution of pH = 3 at 25^0 C. The potential of the cell would be (the value of 2.303 RT/F is 0.059 V)

1) 0.177 V 2) 0.087 V 3) –0.177 V 4) 0.059 V

Hint; R.P of Hydrogen electrode = –0.059 x P^H

21. When 965 amp current is passed through aqueous solution of salt X using platinum electrodes for 10 sec, the volume of gasses liberated at the respective electrodes is in 1:1 ratio. Then X is

1) $MgSO_4$ 2) AgCl 3) $MgCl_2$ 4) KNO_3

Hint; aqueous $MgCl_2$ contains Mg^{+2},H^+.Cl^- and OH^- ions. On electrolysis it gives H_2 at cathode and Cl_2 at anode. As same quantity of electricity is passed volumes of both are in the ratio 1:1

22. Three faradays of electricity are passed through molten Al_20_3, aqueous solution of $CuSO_4$ and molten NaCl taken in three different electrolytic cells. The amount of Al, Cu and Na deposited at the cathodes will be in the ratio of

1) 1 mole :2 mole :3 mole 2)1 mole:1.5 mole :3 mole

3) 3 mole :2 mole :1 mole 4) 1 mole :1.5 mole :2 mole

Hint; Three faradays will deposit three equivalents of each electrolyte.

23. Number of coulombs of current required to convert completely 1 mole of $MnO^-{}_4$ ions in acid medium in to Mn^{2+} ions is

1) 96500 2) 5x96500

3) 96500x2 4) 96500x6

Hint; in acid medium MnO_4^-+5e⟶ Mn^{2+}

No. of electrons gained per ion = 5, ∴ Current required = 5F

24. How long will a current of 2 ampere take for complete deposition of copper from 0.5 liter of 1N$CuSO_4$. solution?

1) 96500 sec 2) 2x96500sec 3)48250 sec 4) 24125 sec

Hint; no. of equivalents of Cu^{+2} =N X Vin lit=1X0.5=0.5.

1 Equivalent requires 1faraday i.e. 96500 coulombs. Thus o.5 equivalents need 48250 coulombs.

i.e. Q=c t or t=Q/c=48250/2=24125 sec

25. The number of electrons required for deposition of one mole of copper on the cathode during the electrolysis of $CuSO_4$ solution is

1) $6.0x10^{23}$ 2) $1.2x10^{24}$ 3) $4.8x10^{24}$ 4) $3x10^{23}$E

Hint; 1 mole of Cu^{2+} requires 2F (or) 2 'N' e^-s i.e. $2X6X10^{23}=12X10^{23}=1.2X10^{24}$

26. 1.2 gm of a metal is deposited in 965 seconds by passing a current of 10 amperes through its respective electrolytic solution. The equivalent mass of metal is

1) 12 2) 24 3) 60 4) 6

Hint; m =Ect/F or E=mF/ct=1.2X96500/965X10=12

27. On passing a current through a molten aluminium chloride for some time, produced 11.2lit of Cl_2 at NTP at anode, the quantity of aluminium deposited at cathode is

1) 27grams 2) 18gram 3) 9gram 4) 36 gram

Hint; W_{Al} / W_{Cl2} = E_{Al} / E_{Cl2} , 11.2 lit Cl_2 at STP = 35.5 gm = 1 GEW

1 GEW of 'Al' will be deposited which is '9'gm

28. In the electrolysis of acidulated H_2O, 11.2 liters of H_2 is liberated at the cathode. The volume of O_2 liberated at the anode is

1) 11.2 lit 2) 5.6 lit 3) 2.8lit 4) 22.4 lt

Hint; 1 faraday gives 11.2 lit of H_2 or 5.6lit of O_2 at STP'i.e 11.2 lit of H_2 = 5.6lit of O_2

29. How much time is required for a current of 2 amp to decompose 18g of water

1) 96500 hours 2) 9650 hours 3) 26.8 hours 4) 2.68 hours

Hint; For water, GEW=9gm. 9gm water decomposed by 96500c

$\therefore$ 18gm water decomposed by 2X96500c,

$\therefore$ t=Q/c= 2X96500/2=96500sec=96500/3600=26.8hours

30. When electric current is passed through molten NaCl for 1930 sec, 1120 ml of Cl_2 is liberated at anode at STP. The current passed in amp is

1) 0.05 2) 0.5 3) 5 4) 50

Hint; 1F i.e 96500 coulombs=11200ml of Cl_2.$\therefore$ 1120ml of Cl_2 is give by 9650 coulombs.

C=Q/t=9650/1930=5

31. One faraday of electricity is passed separately through one liter of one molar aqueous solution of I) $AgNO_3$, ii) $SnCl_4$ and iii) $CuSO_4$. The number of moles of Ag, Sn and Cu deposited at cathode are respectively

1) 1.0, 0.25, 0.5 2) 1.0, 0.5, 0.25 3) 0.5, 1.0, 0.25 4) 0.25, 0.5, 1.0

Hint; moles of $Ag^{+} : Sn^{+4} : Cu^{+2} \quad = \frac{1}{1} : \frac{1}{4} : \frac{1}{2} = 1.0,\ 0.25,\ 0.5$

32. A current of 2amps passing for 5 hours deposits 22.2g of tin (at.wt. = 119), the oxidation state of tin is

1) zero 2) three 3) two 4) four

Hint; m=Mct/ZF ∴ Z=Mct/mF= 119X2X5x3600/22, 2x96500=1.999 ie; 2

33. 1 ampere current is passed for 60 seconds into an electrolytic cell. Number of electrons that pass through the solution is.

1) $6.0 \text{x} 10^{23}$ 2) $1.2 \text{ x } 10^{24}$ 3) $3.75 \text{ x } 10^{20}$ 4) $7.48 \text{x} 10^{21}$

Hint: 96,500C = $6.023 \text{ x } 10^{23}$ e^{-}s

60C =60X6.023 x 10^{23} e^{-}s/96500=3.75 x 10^{20}

34. The STP volume of oxygen liberated by 2 ampere of current when passed through acidulated water for 3 minutes and 13 seconds, is

1) 120cc 2) 22.4cc 3) 11.2cc 4) 44.8 cc

Hint; Q=ct=2X193=386coulombs.

96500C liberates 5600cc of oxygen.

∴ 386C liberates 386X5600/96 500cc=22.4 of oxygen

35. Total volume of gases evolved at STP when 36g of H_2O are completely electrolysed between platinum electrodes

1) 22.4lit 2) 44.8 lit 3) 33.6lit 4) 67.2 lit

Hint; $2H_2O \rightarrow 2H_2 + O_2$

i.e. 36gm of water gives 3 moles of gases.

∴ Total volume of gases evolved at STP =3 x 22.4 lit= 67.2 lit

36. For a cell the cell reaction is Mg(s) + Cu^{2+} (aq) →Cu(s) + Mg^{2+} (aq).

If the S.R.P. values of Mg and Cu are –2.37v and +0.34v respectively, the e.m.f. of the cell is

1) +2.03V 2) –2.03V 3) +2.71V 4) –2.71V

Hint; $E^{0}_{Cell} = E^{0}_{Sn^{2+}/Sn} - E^{0}_{Zn^{2+}/Zn}$

37. **The standard reduction potentials of Ag, Cu,Co and Zn are +0.799,+0.337,-0.277 and-0.762V respectively. Which of the following cells will have maximum cell e.m.f?**

1) $Zn|Zn^{+2}(1M)||Cu^{2+}(1M)|Cu$

2) $Zn|Zn^{2+}(1M)||Ag^{+}(1M)|Ag$

3) $Zn|Zn^{2+}(1M)||Co^{2+}(1M)Co$

4) $Cu|Cu^{2+}(1M)||Ag^{+}(1M)|Ag$

Hint; emf of the cell is maximum when cathode has highest and anode has lowest SRP values.

38. **The standard reduction potentials at 298K for the following half–cell reaction are given below:**

Zn^{2+} (aq) +2e^{-} →Zn(s) E= – 0.762 V

Cr^{3+} (aq) +3e^{-} →Cr(s) E= + 0.762 V

$2H^{+}$ (aq) + 2e^{-} →H_2(g) E=+ 0.00 V

Fe^{3+} (aq) +e^{-} →Fe^{2+}(aq) E=+0.770 V

Which one is the strongest reducing agent?

1) Zn(s) 2) Cr(s) 3) H_2 (g) 4) Fe^{+2} (aq)

Hint; Lower the SRP value higher is the reducing power

39. **The standard reduction potential of three metals X, Y, Z are 0.52, –3.03 and –1.18V respectively. The order of reducing power of the corresponding metals is**

1) Y > Z > X 2) X > Y > Z 3) Z > Y > X 4) Z > X > Y

Hint; Lower the SRP value higher is the reducing power

40. **Given:** $Fe^{+2}+2e^{-} \rightarrow Fe; E^{0}=-0.44V$

$Pb^{2+}+2e^{-} \rightarrow Pb_{(s)}; E^{0}=-0.13V$

$Cu^{2+}+2e^{-} \rightarrow Cu; E^{0}=+0.34V$

$Ag^{+}+e^{-} \rightarrow Ag; E^{0}=+0.8V$

- **Which of the following metals will oxidise iron?**

a) Ag b) Cu c) Pb d) None of these

1) only a 2) a,b 3) a,b,c 4) only b

Hint; Higher SRP metal oxidizes lower SRP metals.SRP values of pb, Ag, Cu are higher than Fe. ∴ Pb, Ag, Cu oxidises the Fe

41. **When electrons are used in the electrolysis of a metallic salt, 1.9 gm of the metal is deposited at the cathode. The atomic weight of that metal is 57. So oxidation state of the metal in the salt is**

1) +2 2) +3 3) +1 4) +4

Hint; Z=Mct/mF

42. **The electrochemical equivalent of an element is 0.001118 gm/coulomb. Its equivalent weight is**

1) 10.7 2) 53.5 3) 111.8 4) 107

Hint; GEW= eX 96500

43. **The charge required to reduce 1mole $Cr_2O_7^{-2}$ to Cr^{+3} ions is**

1) 3F 2) 2F 3) 6F 4) 12F

Hint; $Cr_2O_7^{-2} + 14H^+ + 6e \rightarrow 2Cr^{3+} + 7H_2O$

No. of electrons gained per ion = 6

∴ Charge required = 6F

44. **One ampere of current is passed for 9650seconds through molten $AlCl_3$. What is the weight in grams of Al deposited at cathode? (Atomic weight of Al=27).**

1) 0.9 2) 2.7 3) 9 4) 27

Hint; m= Ect/F for Al E=27/3=9, m=9x1x9650/96500=0.9gm

45 **The $E^0_{M^{3+}/M^{2+}}$ values for Cr, Mn, Fe and Co are –0.14, +1.57, + 0.77 and +1.97 V respectively. For which one of these metals the change in oxidation state from +2 to +3 is easiest?**

1) Cr 2) Co 3) Fe 4) Mn

Hint; lower SRP metal is strong reducing agent i.e. easily oxidized.

46. **The cell reaction of the galvanic cell, $Cu_{(s)} / Cu^{2+}_{(aq)} // Hg^{2+}_{(aq)} / Hg_{(l)}$ is**

1) $Hg + Cu^{2+} \rightarrow Hg^{2+} + Cu$

2) $Hg + Cu^{2+} \rightarrow Hg^{+} + Cu^{+}$

3) $Hg + Cu^{+} \rightarrow CuHg$

4) $Cu + Hg^{2+} \rightarrow Cu^{2+} + Hg$

47. (A): The Daniel cell becomes dead after some time

(R): Oxidation potential of zinc anode increases and that of copper cathode decreases

The correct answer is

1) Both A and R are true, and R is the correct explanation of A
2) Both A and R are true, and R is not the correct explanation of A
3) A is true, but R is false
4) Both A and R are false

48. The reaction,

$$1/2H_2(g) + AgCl(s) \rightarrow H^+(aq) + Cl^-(aq) + Ag(s)$$

occurs in the galvanic cell :

1) $Ag|AgCl_{(s)}|KCl_{(aq)}|AgNO_{3(aq)}|Ag$
2) $Pt, H_{2(s)}|HCl_{(aq)}|AgNO_{3(aq)}|Ag$
3) $Pt, H_{2(g)}||HCl_{(aq)}||AgCl_{(s)}|Ag$
4) $Pt, H_{2(g)}||KCl_{(aq)}||AgCl_{(s)}|Ag$

49. Which metal will dissolve if the cell works $Cu|Cu^{2+}||Ag^{+}|$ **Ag**

1) Cu 2) Ag 3) Both (1) and (2) 4) None of these

Hint; at anode metal is dissolved.

50. Given standard electrode potentials:

$Fe^{3+} + 3e^- \rightarrow Fe$; $E^0 = -0.036V$

$Fe^{2+} + 2e^- \rightarrow Fe$; $E^0 = -0.440V$

The standard electrode potential E^0 for $Fe^{3+} + e \rightarrow Fe^{2+}$ is

1) 0.476V 2) –0.404V 3) 0.40V 4) +0.772V

Hint; Required equation is obtained by subtracting eq 2 from eq1. $\therefore$ $E_3^0 = \frac{n_1E_1^0 - n_2E_2^0}{n_3}$

=3[-0.036]-2[-0.44]/1 =+0.772V

KEY

1) 2	2) 3	3) 3	4) 3	5) 2	6) 2	7) 2	8) 3	9) 3	10) 2
11) 4	12)3	13) 1	14) 4	15)3	16)2	17)1	18)3	19)2	20)3
21) 3	22) 2	23) 2	24) 4	25) 2	26)1	27)3	28)2	29 3	30) 3
31)1	32) 3	33)3	34)2	35) 4	36)3	37)2	38)1	39)1	40)3
41)2	42)4	43)3	44)1	45)1	46)4	47)3	48)3	49)1	50)4