Chapter: 10

Electrochemistry

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Objective

1. The least value of reduction potential is for:

(A) Li^{+1} (B) Na^{+1} (C) K^{+1} (D) F_2

2. The electrode potential of standard hydrogen electrode is arbitrarily taken as:

(A) Negative (B) Zero (C) Vary with situation (D) Positive

3. The overall positive values for cell potential predicts that the process is energetically:

(A) Not feasible (B) Not possible (C) Cannot be predicted (D) Feasible

4. In electro-chemical series , the electrodes are compared with SHE and they are arranged in the decreasing order of:

(A) Ionization potential (B) Oxidation potential
(C) Reduction potential (D) Cell voltage

5. The electrochemical cell stop's working after sometime because:

(A) One of electrode completely vanishes.
(B) Electrode potentials of both the electrodes becomes zero.
(C) The reaction reverses its direction.
(D) Electrode potentials of both the electrodes equalize.

6. The catholic reaction in the electrolysis of dil. H_2SO_4 with Pt electrodes is:

(A) Reduction (B) Both oxidation and reduction
(C) Neither oxidation and reduction (D) Reduction

7. Which of the following statements is not correct about Galvanic cell?

(A) Reduction occurs at cathode (B) Reduction occurs at anode
(C) Cathode is positively charged (D) Anode is negatively charged

8. Strong the oxidizing agent , greater is the:

(A) Reduction potential (B) E.M.F of cell (C) Redox potential (D) Oxidation potential

9. If the salt bridge is not used between two half cells , then the voltage:

(A) Does not change (B) Decreases slowly (C) Drops to zero (D) Decreases rapidly

10. If a strip of Cu metal is placed in a solution of Fe SO_4:

(A) Cu and Fe both dissolve (B) No reaction takes place
(C) Fe is precipitated out (D) Cu will be deposited down

11. A redox reaction is:

(A) Proton combination reaction (B) Electron transfer reaction
(C) Proton transfer reaction (D) Ion combination reaction

12. Which of the following process always involve the decrease in oxidation number?

(A) Reduction (B) Oxidation (C) Decomposition (D) Hydrolysis

13. The oxidation number of C in $C_{12}H_{22}O_{11}$ is:

(A) 12 (B) Zero (C) -6 (D) +6

14. The oxidation number of chromium in $K_2Cr_2O_7$ is:

(A) 2 (B) 3 (C) 4 (D) 6

15. Oxidation number of Cr in K_2CrO_4 is:

(A) +8 (B) +6 (C) +4 (D) +2

16. The oxidation state of oxygen in OF_2 is:

(A) +1 (B) -1 (C) -2 (D) +2

17. The oxidation state of Mn in $KMnO_4$ is:

(A) +5 (B) +7 (C) +6 (D) +2

18. The reduction potential of Zn is:

(A) - 0.76V (B) + 0.34V (C) 0.34V (D) + 0.76V

19. The electrolysis of aqueous solution of NaCl is employed to prepare caustic soda on commercial scale. The reaction at the cathode is:

(A) Reduction of Na ions (B) Reduction of H ions
(C) Oxidation of Cl ions (D) Formation of water molecule

20. Cu metal can be purified in electrolytic cell by making the impure Cu are:

(A) SHE (B) Cathode (C) By making its CuSO (D) Anode

21. The electrode reaction of a voltaic cell can be reversed when:

(A) Temperature is increase
(B) Electrodes are interchanged.
(C) Concentration of solutions is changed.
(D) External circuit is employed to supply the source of electricity.

22. A salt bridge contains:

(A) Gelatin + H_2SO_4 (B) Gelatin + HCl
(C) Gelatin + NaOH (D) Gelatin + HCl

23. Which one of the following is not an example of voltaic cell:

(A) Ni - Cd cell (B) Fuel cell (C) Silver oxide battery (D) Down's cell

24. Which of the following statements is correct about Galvanic cell?

(A) Oxidation occurs at cathode (B) Anode is negatively charged
(C) Reduction occurs at anode (D) Cathode is positively charged

25. If a salt bridge is not used between two half-cells , then the voltage:

(A) Does not change (B) Decreases slowly (C) Drops to zero (D) Decreases rapidly

26. The cell in which electrical energy is converted into chemical energy is called:

(A) Electrolytic cell (B) Fuel cell (C) Daniel cell (D) Galvanic cell

27. When Non-spontaneous redox reaction is carried out by using the electrical current , then the process is called:

(A) Hydrolysis (B) Electrolysis
(C) Decomposition of the substances (D) Exothermic process

28. The standard electrode potential (in volt) of SHE is taken as:

(A) 1.00 (B) 10.0 (C) 100 (D) 0.00

29. The standard reduction potential of Ag and Zn are + 0.80 and - 0.76V respectively. Which of the following conclusions can be drawn from the data?

(A) Zn will always act as a reducing agent.
(B) Ag displaces Zn from a solution containing Zn ion.
(C) Ag is a poor Oxidizing agent.
(D) Zn has greater tendency than Ag to from positively charged ion.

30. In the reaction $2Fe + Cl_2 \longrightarrow 2FeCl_3$:

(A) Fe is oxidized (B) Cl_2 is oxidized (C) None of these (D) Fe is reduced

31. When fused PbBr2 is electrolyzed when:

(A) Lead appears at the anode (B) Lead is deposited at the cathode
(C) None of these (D) Bromine appears at cathode

32. During electrolysis of KNO_3, H_2 is evolved at:

(A) Anode (B) Cathode (C) None of these (D) Both a and b

33. An electrochemical cell is based upon:

(A) Nuclear reaction (B) Redox reaction
(C) Acid-base reaction (D) None of these

34. Which one of the following is good conductor of electricity:

(A) Chloroform (B) Molten NaCl
(C) Pure distilled water (D) Dilute solution of glucose

35. During a redox reaction, an oxidizing agent:

(A) Loses electrons (B) Gains electrons (C) Is hydrolyzed (D) Is oxidized

36. In an oxidation process the oxidation number of the element:

(A) Decreases (B) Increases (C) None of these (D) Does not change

37. Which element acts as a reducing agent in the reaction?

$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

(A) Zn (B) O (C) H (D) S

38. Electric current passes through both molten and solution form of NaCl because of:

(A) Na^+ and Cl ions (B) Hydration of ions (C) Ions of water (D) Ionic bonding

39. Oxidation number of sulphur in $S_2O_3^{2-}$ is:

(A) +2 (B) -2 (C) -4 (D) +6

40. Metallic conduction is due to the:

(A) Movement of ions (B) Movement of electrons
(C) Movement of ions & Movement of electrons (D) None of these

41. The process in which electric current is used to carry out a non-spontaneous redox reaction is called:

(A) Electrolysis (B) Metallic conductor (C) Electrolyte (D) None of these

42. The process in which ionic compound when fused or dissolved in water split up into charged particles is called:

(A) Conduction (B) Ionization (C) Hydration (D) Electrolysis

43. The metallic conductors in contact with the solution are called:

Ⓐ Down cell Ⓑ Insulator Ⓒ Electrolyte **Ⓓ Electrodes**

44. The reaction in a galvanic cell is:

Ⓐ Non-spontaneous **Ⓑ Spontaneous** Ⓒ Acid base Ⓓ None of these

45. Sodium metal is obtained by the electrolysis of fused NaCl in a cell is called:

Ⓐ Danicll cell Ⓑ Voltaic cell Ⓒ Nelson's cell **Ⓓ Down's cell**

46. The branch of chemistry which deals with the relationship between electricity and chemical reaction is called:

Ⓐ Stoichiometry **Ⓑ Electrochemistry** Ⓒ Thermochemistry Ⓓ Chemical kinetics

47. A cell in which spontaneous redox reaction generates an electric current is called:

Ⓐ Voltaic or galvanic cell **Ⓑ Biological cell**
Ⓒ Electrochemical cell Ⓓ Electrolytic cell

48. A cell in which an electric current drives a non-spontaneous reaction is called:

Ⓐ Voltaic cell **Ⓑ Electrolytic cell**
Ⓒ Electrochemical cell Ⓓ Biological cell

49. A process for converting one metal with a thin layer of another metal is called:

Ⓐ Electrode potential **Ⓑ Electroplating**
Ⓒ Electrolysis Ⓓ Standard electrode

50. Greater the value of standard reduction potential of a species indicates:

Ⓐ Greater its tendency to accepted electron: Ⓑ Greater tendency to lose electrons.
Ⓒ Lesser tendency to accept electrons. Ⓓ None of these

51. In lead accumulator the electrolyte H_2SO_4 solution is:

Ⓐ 30% Ⓑ 70% Ⓒ 60% H_2SO_4 Ⓓ 80%

52. In alkaline battery, the electrolyte contains:

Ⓐ MnO_2 **Ⓑ KOH** Ⓒ NaCl Ⓓ $NaNO_3$

53. Metals which are above SHE in electrochemical series:

Ⓐ Cannot always liberate H_2 from acid **Ⓑ Can liberate H_2 from acid**
Ⓒ None of these Ⓓ Cannot liberate H_2 from acid

54. Corrosion reactions are:

Ⓐ Spontaneous acid-base reactions. **Ⓑ Spontaneous redox reaction**
Ⓒ Non-spontaneous acid-base reactions. Ⓓ None of these

55. In SHE the standard is the …… atom.

Ⓐ H Ⓑ N Ⓒ O Ⓓ C

56. In cells metal oxides usually act as:

Ⓐ Anode Ⓑ Solution **Ⓒ Cathode** Ⓓ All of these

57. In alkaline battery, the electrolyte contains:

Ⓐ MnO_2 **Ⓑ KOH** Ⓒ NaCl Ⓓ $NaNO_3$

58. The tendency of an element to form ions in solution is called:

(A) Ionization potential (B) Electrode potential
(C) Cell potential (D) Standard electrode

59. While balancing an equation by ion electron method the number of oxygen atoms are balanced by:

(A) H^+ (B) OH^- (C) H_2O (D) O_2

60. Zinc-Copper galvanic cell may be formed by:

(A) Porous partition (B) Both a and c (C) Salt bridge (D) $NaNO_3$

61. Oxidation occurs at:

(A) Cathode (B) During movement (C) None of these (D) Anode

62. The oxidation number of free element is always taken to be:

(A) 2 (B) 0 (C) 1 (D) -1

Fill in the blanks

Q.1: Conductivity of metallic conductors is due to the flow of …….. while that of electrolytes is due to flow of.

Q.2: The oxidation number of O atom is ……. in OF_2 and is …….. in H_2O_2.

Q.3: Reaction taking place at the …… is termed as oxidation , and at the …… is called reduction.

Q.4: ……. is setup when a metal is dipped in its own ions.

Q.5: The reduction potential of Zn is …… volts and its oxidation potential is …… volts.

Answers

1. **Electrons Ions**	2. **+2 , -1**	3. **Anode , Cathode**
4. **Equilibrium**	5. **-0.76 , + 0.76**	

Chapter : 10 **Electrochemistry**

Subjective

Q1: **Define electrochemistry.**

Ans: **Chemical kinetics:**

It is the branch of chemistry which deals with the conversion of electrical energy into chemical energy in electrolytic cells as well as the conversion of chemical energy into electrical energy in galvanic or voltaic cell.

Q2: **Define oxidation reaction with an example.**

Ans: **Oxidation reaction:**

Those reaction, In which increase in oxidation state or loss of electrons take place.

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

Reduction reaction:

Those reactions, In which decrease in oxidation number or gain of electrons take place.

$$Cu^2 + 2e \longrightarrow Cu$$

Q3: **Calculate oxidation number of Cr in $CrCl_3$.**

Ans: Calculation of oxidation number of Cr in $CrCl_3$:

$$\text{O.N of Cl} = -1$$
$$\text{O.N of Cr} = X$$

$CrCl_3$:

$$x + 3(-1) = 0$$
$$x - 3 = 0$$
$$x = +3$$

Q4: **Calculate the oxidation number of chromium in Cr_2O_3?**

Ans: Calculation of oxidation number of chromium in Cr_2O_3:

$$\text{O.N of oxygen} = -2$$
$$\text{O.N of Cr} = X$$

Cr_2O_3:

$$2x + 3(-2) = 0$$
$$2x - 6 = 0$$
$$2x = +6$$
$$x = +3$$

Q5: **What are secondary cells. Write names of any two such cells**

Ans: Those cells which can be charged are called secondary cells.

Examples:

- Ni-cd battery.
- Ni-cd battery.

Q6: **Give four rules for assigning of oxidation number?**

Ans: Four rules for assigning of oxidation number:

- In neutral molecules, the algebraic sum of oxidation number of all the elements is zero.
- Oxidation number of hydrogen in all its compounds is +1 except metal hydride where it is −1.
- The oxidation number of an ion consisting of a single element is the same as charge on the ion.
- The oxidation number of free elements is zero. For example H, Mg, Na.

Q7: **Calculate the oxidation number of phosphorous in, (a) HPO_3 (b) Na_3PO_4.**

Ans: Calculation of the oxidation number of phosphorous in HPO_3:

$$\text{O.N of oxygen} = -2$$
$$\text{O.N of hydrogen} = +1$$
$$\text{O.N of P} = X$$

(a) HPO_3:

$$+1 + x + 3(-2) = 0$$
$$+1 + x - 6 = 0$$
$$x - 5 = 0$$
$$x = +5$$

Calculation of the oxidation number of phosphorous in Na_3PO_4:

$$\text{O.N of O} = -2$$
$$\text{O. N of Na} = +1$$
$$\text{O.N of P} = X$$

(b) Na_3PO_4:

$$3(+1) + x + 4(-2) = 0$$
$$3 + x + (-8) = 0$$
$$x - 5 = 0$$

Q8: **Calculate oxidation number of 'S' in, (a) $Cr_2(SO_4)_3$ (b) $S_2O_4^{2-}$.**

Ans: Calculation of the oxidation number of 'S' in $Cr_2(SO_4)_3$:

O.N of S = ?
O.N of O = −2
O.N of Cr = + 3

(a) $Cr_2(SO_4)_3$:

Oxidation No. of Cr) +3[(Oxidation No. of S) +4(Oxidation No. of O)] = 0
2(+3) +3[(Oxidation No. of S) +4(−2)] = 0
(+6) +3[(Oxidation No. of S) −8] = 0
(+6) +3(Oxidation No. of S) +3(-8) = 0
(+6) +3(Oxidation No. of S) −24 = 0
3(Oxidation No. of S) −18 = 0
3(Oxidation No. of S) = +18
(Oxidation No. of S) = $+6O_4^{2-}$

Calculation of the oxidation number of 'S' in $S_2O_4^{2-}$:

O.N of S = ?
O.N of O = −2

(b) $S_2O_4^{2-}$

(Oxidation No. of S) + 4(Oxidation No. of O)] = −2
(Oxidation No. of S) +4(−2) = −2
(Oxidation No. of S) −8 = −2
(Oxidation No. of S) = −2+8
(Oxidation No. of S) = +6

Q9: **Calculate oxidation number of Mn in (a) $KMnO_4$ (b) Na_2,MnO_4,**

Ans: Calculation of the oxidation number of Mn in $KMnO_4$:

O.N of K = + 1
O.N of O = −2
O.N of Mn =?

(a) $KMnO_4$:

(Oxidation No. of K) + (Oxidation No. of Mn) +4(Oxidation No. of O) = 0
(+1) + (Oxidation No. of Mn) +4(−2) = 0
(+1) + (Oxidation No. of Mn) −8 = 0
(Oxidation No. of Mn) −7 = 0
(Oxidation No. of Mn) = +7

Calculation of the oxidation number of Mn in Na_2,MnO_4:

O.N of Na = + 1
O.N of O = −2
O.N of Mn =?

(b) Na_2,MnO_4:

2(Oxidation No. of Na) + (Oxidation No. of Mn) +4(Oxidation No. of 0) = 0
2(+1) + (Oxidation No. of Mn) +4(−2) = 0
(+2) + (Oxidation No. of Mn) −8 = 0

$$(\text{Oxidation No. of Mn}) - 6 = 0$$
$$(\text{Oxidation No. of Mn}) = +6$$

Q10: **Calculate oxidation number of Mn in (i) $KMnO_4$ (ii) K_2,MnO_4,**

Ans: Calculation of the oxidation number of Mn in $KMnO_4$:

O.N of K $= +1$
O.N of O $= -2$
O.N of Mn $=?$

(i) $KMnO_4$:

$$(\text{Oxidation No. of K}) + (\text{Oxidation No. of Mn}) + 4(\text{Oxidation No. of O}) = 0$$
$$(+1) + (\text{Oxidation No. of Mn}) + 4(-2) = 0$$
$$(+1) + (\text{Oxidation No. of Mn}) - 8 = 0$$
$$(\text{Oxidation No. of Mn}) - 7 = 0$$
$$(\text{Oxidation No. of Mn}) = +7$$

Calculation of the oxidation number of Mn in K_2,MnO_4:

O.N of K $= +1$
O.N of O $= -2$
O.N of Mn $=?$

(ii) K_2,MnO_4:

$$2(\text{Oxidation No. of K}) + (\text{Oxidation No. of Mn}) + 4(\text{Oxidation No. of 0}) = 0$$
$$2(+1) + (\text{Oxidation No. of Mn}) + 4(-2) = 0$$
$$(+2) + (\text{Oxidation No. of Mn}) - 8 = 0$$
$$(\text{Oxidation No. of Mn}) - 6 = 0$$
$$(\text{Oxidation No. of Mn}) = +6$$

Q11: **What is Oxidation Number? Determine the Oxidation Number of Phosphorus in H_3PO_4?**

Ans: Oxidation number is the apparent charge on an atom of an element in a molecule or an ion. It may be positive or negative or zero.

Oxidation Number of Phosphorus in H_3PO_4:

O.N of H $= +1$
O.N of O $= -2$
O.N of P $=?$

H_3PO_4:

$$3(\text{Oxidation No. of H}) + (\text{Oxidation No. of P}) + 4(\text{Oxidation No. of 0}) = 0$$
$$3(+1) + (\text{Oxidation No. of P}) + 4(-2) = 0$$
$$(+3) + (\text{Oxidation No. of P}) - 8 = 0$$
$$(\text{Oxidation No. of P}) - 5 = 0$$
$$(\text{Oxidation No. of P}) = +5$$

Q12: **Determine oxidation number of Mn in $KMnO_4$, and K_2MnO_4.**

Ans: Oxidation number of $KMnO_4$:

$$+1 + \text{Mn} - 2(4) = 0$$
$$+1 + \text{Mn} - 8 = 0$$
$$\text{Mn} = 8 - 1 = +7$$

Oxidation number of K_2,MnO_4:

$$2(+1) + \text{Mn} - 2(4) = 0$$
$$+2 + \text{Mn} - 8 = 0$$

$$Mn = +8-2$$
$$Mn = +6$$

Q13: **Calculate the oxidation number of Cl in the following Compound $Ca(ClO_3)_2$.**

Ans: Calculation of the oxidation number of Cl in $Ca(ClO_3)_2$:

$$(\text{Oxidation No. of Ca}) +2[(\text{Oxidation No. of Cl}) +3(\text{Oxidation No. of O})] = 0$$
$$(+2) +2[(\text{Oxidation No. of C1}) +3(-2)] = 0$$
$$(+2) +2(\text{Oxidation No. of C1}) +6(-2) = 0$$
$$(+2) +2(\text{Oxidation No. of Cl}) -12 = 0$$
$$2(\text{Oxidation No. of Cl}) -10 = 0$$
$$2(\text{Oxidation No. of Cl}) = +10$$
$$(\text{Oxidation No. of Cl}) = +5$$

Q14: **Calculate oxidation number of 'S' in H_2SO_4.**

Ans: Calculation of the oxidation number of 'S' in H_2SO_4:

$$2(\text{Oxidation No. of H}) + (\text{Oxidation No. of S}) +4(\text{Oxidation No. of O}) = 0$$
$$2(+1) + (\text{Oxidation No. of S}) +4(-2) = 0$$
$$(+2)\ (\text{Oxidation No. of S}) -8 = 0$$
$$(\text{Oxidation No. of S}) -6 = 0$$
$$(\text{Oxidation No. of S}) = +6$$

Q15: **Calculate the oxidation state of fowlloing element. (i). $Ca(ClO_3)_2$ (ii). H_2PO_3.**

Ans: **(i). $Ca(ClO_3)_2$:**

$$(\text{Oxidation No. of Ca}) +2[(\text{Oxidation No. of Cl}) +3(\text{Oxidation No. of O})] = 0$$
$$(+2) +2[(\text{Oxidation No. of Cl}) +3(-2)] = 0$$
$$(+2) +2(\text{Oxidation No. of Cl}) +6(-2) = 0$$
$$(+2) +2(\text{Oxidation No. of Cl}) -12 = 0$$
$$2(\text{Oxidation No. of Cl}) -10 = 0$$
$$2(\text{Oxidation No. of Cl}) = +10$$
$$(\text{Oxidation No. of Cl}) = +5$$

(ii). H_2PO_3:

$$3(\text{Oxidation No. of H}) + (\text{Oxidation No. of P}) +3(\text{Oxidation No. of O}) = 0$$
$$3(+1) + (\text{Oxidation No. of P}) +3(-2) = 0$$
$$(+3) + (\text{Oxidation No. of P}) -6 = 0$$
$$\text{Oxidation No. of P} -3 = 0$$
$$\text{Oxidation No. of P} = +3$$

Q16: **Calculate Oxidation Number of Cr in (i). K_2CrO_4 (ii). Cr_2O_3.**

Ans: (i). K_2CrO_4:

$$2(\text{Oxidation No. of K}) + (\text{Oxidation No. of Cr}) +4(\text{Oxidation No. of O}) = 0$$
$$2(+1) + (\text{Oxidation No. of Cr}) +4(-2) = 0$$
$$(+2) + (\text{Oxidation No. of Cr}) -8 = 0$$
$$(\text{Oxidation No. of Cr}) -6 = 0$$
$$(\text{Oxidation No. of Cr}) = +6$$

(ii). Cr_2O_3:

$$2\ (\text{Oxidation No. of Cr}) +3(\text{Oxidation No. of O}) = 0$$
$$2\ (\text{Oxidation No. of Cr}) +3(-2) = 0$$
$$2\ (\text{Oxidation No. of Cr}) -6 = 0$$
$$2\ (\text{Oxidation No. of Cr}) = +6$$

(Oxidation No. of Cr) = +3 deference dif

Q17: **Differentiate between electrolytic and Galvanic ceils?**

Ans: Difference between electrolytic and galvanic ceils:

Electrolytic cell	Energy of activation
❖ A cell in which electrical energy is converted into chemical energy. ❖ Non-spontaneous redox reaction takes place here. ❖ Example: Down's cell.	❖ A cell in which chemical energy is converted into electrical energy. ❖ Spontaneous redox reaction takes place here. ❖ Example: Daniel cell.

Q18: **Differentiate between a battery and cell?**

Ans: Difference between a cell and battery:

Battery	Cell
The combination of two or more cells is called battery.	The arrangement in which electrical energy is converted into chemical energy or chemical energy is converted into electrical energy is called cell. It consists of two electrodes and an electrolyte.

Q19: **Differentiate between electrolysis and electrolytic conduction?**

Ans: Difference between electrolysis and electrolytic conduction:

Electrolysis	Electrolytic conduction
The process in which electricity is used to carry out a non-spontaneous redox reaction is called electrolysis.	The conduction of electricity carried out by ions present in fused or aqueous solution of an electrolyte is called electrolytic conduction.

Q20: **A porous plate or a salt bridge is not required in lead storage cell. Give reason?**

Ans: A porous plate or salt bridge is used in those cells where two different electrolytes are used and are required to keep separate. In case of lead storage cell, only dil. H_2SO_4 is used as an electrolyte. Hence, no separation is required by porous plate or salt bridge.

Q21: **Define electrolytic cell. Give example?**

Ans: **Electrolytic cell:**

A cell is which electric current is used to carry out a non-spontaneous reaction is called electrolytic cell.

Example:

Nelson cell, Down's cell

Q22: **Impure copper can be purified by electrolytic process. Explain it?**

Ans: During purification of Cu. impure Cu is made anode and thin sheet of pure Cu is made cathode and $CuSO_4$ solution is taken as electrolyte. Cu^{2+} atoms at anode loose electrons and go into the solution as Cu ion.

They migrate to cathode where they gain electrons and are deposited at cathode. In this way Cu atoms are migrate from anode to cathode and impurities are left in electrolyte.

$$Cu \longrightarrow Cu^{2+} + 2e^- \quad \text{(anode)}$$

$$Cu^{2+} + 2e^- \longrightarrow Cu \quad \text{(Cathode)}$$

Q23: **How anodized aluminum is produced and why it can absorb dyes?**

Ans: Anodized aluminum is prepared by making it an anode in an electrolytic cell containing sulphuric acid or chromic acid, which coats a thin layer of oxide on it. The aluminum oxide layer resists attack by corrosive agents.

The freshly anodized aluminum is hydrated and can absorb dyes.

Q24: **What is the difference between metallic conduction and electrolytic conduction?**

Ans: The difference between metallic conduction and electrolytic conduction:

Metallic conduction	Electrolytic conduction
The conduction of electricity through a metal due to free electrons is called metallic conduction.	The conduction of electricity carried out by ions present in fused or in an aqueous solution of an electrolyte is called electrolytic conduction.

Q25: **What is the difference between conduction through metals and molten electrolytes?**

Ans: The difference between conduction through metals and molten electrolytes:

Metallic conduction	Molten electrolytes
Metals are conductors of electricity because of the relatively free movement of their electrons throughout the metallic lattice. This electronic conduction is simply called metallic conduction.	Electrolytes in the form of solution in the fused state have the ability to conduct electricity. In this case the current is not carried by free electrons through the solution or through the fused electrolyte. Here, the current is carried by ions having positive and negative charges; these ions are produced in the solution or in fused state due to ionization of the electrolyte.

Q26: **What is electrolysis? Give example?**

Ans: The electrochemical reactions that occur at the electrodes during the electrolytic conduction constitute the phenomenon of electrolysis. For example the electrolysis of brine in electrolytic cell is given as:

$$NaCl_{(s)} \rightleftharpoons Na^{+}_{(aq)} + Cl_{(aq)}$$

At anode: $2Cl_{(g)} \longrightarrow Cl_2 + 2e^-$ (oxidation)

At cathode: $2H_2O_{(l)} + 2e^- \longrightarrow H_{2(g)} + 2OH_{(aq)}$ (reduction)

Q27: **A salt bridge maintains the electrical neutrality in the galvanic cell. Explain?**

Ans: Two half cells are electrically connected by a salt bridge. Consider a Zn-Cu cell. During reactions, of this cell, Zn half-cell continuously loose electrons. Thus this positive charge is increasing.

$$Zn \longrightarrow Zn^{2+} + 2e^-$$

While Cu, receiving electrons.

$$Cu^{2+} + 2e^- \longrightarrow Cu$$

Collection of positive charge in Zn electrode and negative charge in Cu would stop the reaction. Salt bridge prevents the net accumulation of charges in either beaker.

Thus through salt bridge negative ions move toward Zn half-cell. In this way salt bridge maintain the two solutions electrically neutral.

Q28: **Explain the function of salt bridge?**

Ans: Function of salt bridge:

A salt bridge performs following functions:

- ❖ It maintains electrical neutrality of two solutions.

- ❖ It brings electrical contact between two half cells.

Q29: **Define oxidizing agent and reducing agent.**

Ans: **Oxidizing Agent (Oxidants):**

The substances which help the oxidation to occur are called oxidizing agent or oxidants. They oxidize the other substance by taking electrons from them and get reduced itself.

Examples:

- ❖ Mostly non-metals are oxidants.
- ❖ Acidified $KMnO_4$ and $K_2Cr_2O_7$

Reducing Agents (Reductants):

The substances which helps the reduction to occur are called reducing agents. They reduce the other substances by giving electrons to them and themselves get oxidized.

Examples:

- ❖ CO, SO_2, H_2, KI are good reductants.
- ❖ Almost all metals are good reductants

Q30: **Define standard electrode potential.**

Ans: **Standard electrode potential:**

The potential setup when an electrode is in contact with one molar solution of its own ions at 298K is called standard electrode potential. It is denoted by E°.

Q31: **Write the importance of standard hydrogen electrode? Or What is standard hydrogen electrode (SHE)? Or Discuss in brief Standard Hydrogen Electrode.**

Ans: Standard hydrogen electrode (SHE) is used to determine the electrode potential of other electrode. It is used as reference electrode and its value is 0.0 volt. From SHE we drive electrochemical series.

Q32: **SHE act as anode when connected with Cu electrode but as cathode when connected with Zn electrode. Justify?**

Ans: When SHE is coupled with Cu electrode, Hydrogen give electrons to Cu and get oxidized.

$$H_2 \longrightarrow 2H^+ + 2e^-$$

Because reduction potential of Cu is greater than hydrogen. Since hydrogen.is oxidized, therefore it acts as anode. On the other hand when SHE is connected with Zn-electrode, Zn give electrons to hydrogen electrode and get oxidize.

$$Zn \longrightarrow Zn^{2+} + 2e^-$$

Since Zn have greater tendency to donate electrons than hydrogen. Therefore Zn acts as anode.

Q33: **What is meant by electromotive force (emf) of cell?**

Ans: **Electromotive force (emf):**

The measurement of energy that causes current to flow through a circuit is called emf. It is also called voltage,

Q34: **Give cathodic and anodic reactions of electrolysis of concentrated aqueous solution of sodium chloride?**

Ans: The anodic reactions of electrolysis of concentrated aqueous solution of sodium chloride:

$$2NaCl_{(s)} \xrightarrow{H_2O} 2Na^+ + 2Cl^-$$

At anode: $2Cl^- \longrightarrow Cl_2 + 2e^-$ (oxidation)

At cathode: $2H_2O + 2e^- \longrightarrow H_{2(g)} + 2OH^-$ (reduction)

Q35: **Write down the industrial applications of electrolysis. Or**

Write reactions involved in extraction of Sodium in Down's Cell.

Ans: Industrial applications of electrolysis:

- ❖ Na is produced in Down's cell commercially by the electrolysis of fused NaCl by iron cathode and graphite anode. Cl_2 gas obtained as a by produce.

$$2Na^+ + 2Cl^- \longrightarrow 2Na^+ + 2Cl^-$$

- ❖ Mg and Ca metals are extracted by electrolysis of their fused chlorides.
- ❖ Caustic soda is produced by electrolysis of an aqueous soln. of NaCl. This process is carried out in Nelson's cell.

$$2Na^+ + 2Cl^- + 2H_2O \longrightarrow 2Na^+ + 2OH^- + H_{2(g)} + Cl_{2(g)}$$

Q36: **Zinc electrode potential, Give example?**

Ans: When a Zn rod is placed in zinc sulphate solution. It bears accumulation of negative charges. This is due to net ionization of some of its atoms. The negative charge of zinc rod will attract an atmosphere of positively charged zinc ions around the rod to form a double layer.

Example or Reaction:

$$Zn \longrightarrow Zn^{2+} + 2e^-$$

Q37: **Zn can displace hydrogen from dilute acid solution but copper cannot. Justify the statement?**

Ans: Metals having greater values of reduction potential have less tendency to displace hydrogen from acid. Cu has high value of reduction potential and are not able to displace H_2. But Zn has low value of reduction potential and can easily displace hydrogen from acid.

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$$
$$Cu + H_2SO_4 \longrightarrow \text{No reaction}$$

Q38: **Define the electrochemical series?**

Ans: The elements are arranged in the order of their standard electrode potentials on the hydrogen scale, the resulting list is known as electrochemical series. This list has been prepared by comparison with standard hydrogen electrode (SHE).

In this list, elements above SHE have negative reduction potential while below have positive reduction potential.

Q39: **Give two examples of electrochemical series?**

Ans: Two examples of electrochemical series:

- ❖ Prediction of the feasibility of a chemical reaction. By the use of oxidation and reduction potential spontaneity of a cell reaction can be determined.

  Formula:

$$El_{cell} = E_{(av)} + E_{(red)}$$

- ❖ Relative chemical reactivity of metals can be determined by using electrochemical series, i.e. greater the reduction potential, lesser is the ability to loose electrons. Hence its reactivity is less.

Q40: **Na and K can displace hydrogen from acids but Pt, Pd and Cu cannot. Comment on it?**

Ans: Greater the value of standard reduction potential, lesser is the ability to loose electrons. Hence its reactivity is less. Na and K are highly reactive metals. They can easily displace hydrogen from acid whereas Pt, Pd and Cu are least reactive metal. Therefore cannot easily displace hydrogen.

Q41: **What is standard hydrogen electrode (SHE)?**

Ans: SHE stands for "standard hydrogen electrode" which is assigned a standard reduction potential of exactly 0 V and is based on the following half reaction.

$$2H_{(aq.\ IM)} + 2e^- \longrightarrow H_{2\ (g.\ 1\ atm)}$$

$$E^0_{(red)} = 0$$

It consists of an electrode coated electrolytically with finely divided Pt in contact with $H_{2\ (g)}$ at 1 atm pressure and 1M HCl solution at 25 °C. SHE is used as a reference electrode.

Q42: **What is the difference between a primary cell and secondary cell?**

Ans: Difference between a primary cell and secondary cell

Primary cell	Secondary cell
A primary cell is not rechargeable for example alkaline battery.	While a secondary cell can be rechargeable, for example lead accumulator and nickel cadmium battery.

Q43: **How does electrochemical series tell us the distinction between the oxidizing and reducing agent?**

Ans: The value of the reduction potential of a metal or a non-metal tells us the tendency to lose electrons and act as a reducing agent. It also gives the information about the tendency of a species to gain electrons and act as an oxidizing agent.

Greater the value of standard reduction potential of a given species, greater is its ability to accept electrons to undergo reduction and hence act as an oxidizing agent and vice versa.

Q44: **Lead accumulator is a chargeable battery. Comment on it.**

Ans: The lead accumulator is a secondary battery. During the process of recharging, the anode and cathode of the battery are connected to the anode and cathode of the external electrical source respectively. The redox reactions takes place at the respective electrodes are reversed, regenerating $Pb_{(s)}$ and $PbO_{2\ (s)}$.

At anode: $$PbSO_4 + 2e^- \longrightarrow Pb + SO_4^{2-}$$

At cathode: $$PbSO_{4(s)} + 2H_2O_{\ (1)} \longrightarrow PbO_{2\ (s)} + 4H^-_{(aq)} + 2SO^{2-}_{4(aq)} + 2e^-$$

Overall reactions:

$$2PbSO_4 + 2H_2O_{\ (1)} \longrightarrow Pb_{(s)} + PbO_{2\ (s)} + 4H^-_{(aq)} + 2SO^{2-}_{4(aq)}$$

Recharging is possible because $PbSO_4$ formed during discharge adheres to the electrodes. As the external source forces electrons form one electrode to another, the $PbSO_4$ is converted to Pb at one electrode and PbO_2 on the other.

Q45: **What is industrial importance of electrolysis?**

Ans: Electrolysis has following industrial importance:

- Copper, silver, nickel and chromium plating is done by various types of electrolytic cells.
- Aluminum is extracted by electrolyzing fused Bauxite, $Al_2O_3.2H_2O$.
- It is used for the purification of copper.
- Extraction of sodium by the electrolysis of fused sodium chloride.

Q46: **Differentiate ionization and electrolysis.**

Ans: Difference between ionization and electrolysis:

Ionization	Secondary cell
The process in which molten ionic compounds or dissolved in water split up into charged particles is called ionization. $NaCl \longrightarrow Na^{+} + 2Cl^{-}$	While when a non-spontaneous reaction takes place at the expense of electrical energy, is called electrolysis. The products are deposited at respective electrodes and electrolyte is decomposed.

Q47: **Define standard electrode potential?**

Ans: The potential set up when an electrode is in contact with one molar solution of its own ions at 298K, is known as standard electrode potential or standard reduction potential of the element. It is represented as E°.

Standard electrode potential of hydrogen has arbitrarily been chosen as zero, while the standard electrode potentials of other elements can be determined by comparing them with standard hydrogen electrode.

Q48: **Standard oxidation Potential of Zn is + 0.76 volts and its reduction potential is - 0.76 volts.**

Ans: The ability to lose electrons is called oxidation potential and ability to gain electrons is called reduction potential.

According to the law of conservation of energy, energy can neither be created nor destroyed. Therefore, if standard oxidation potential of Zn is 0.76 V, then standard reduction potential will also be same but with opposite sign.

Thus oxidation and reduction potential are always equal but opposite in sign.

$Zn \longrightarrow Zn^{2+} + 2e^{-}$ (Oxidation) E^{0} Oxidation = +0.76

$Zn^{2+} + 2e^{-} \longrightarrow Zn$ (Reduction) E^{0} Reduction = -0.76

Q49: **Zn can displace hydrogen from dilute acid solution but "Cu" cannot?**

Ans: An element lies above in the electrochemical series can displace the element lies below in electrochemical series form its solution.

Zinc can displace Hydrogen from dilute acid solution because zinc lies above than Hydrogen in electrochemical series. But Cu cannot displace Hydrogen from dilute acid solution because Cu lies below than Hydrogen in electrochemical series.

Q50: **What is an anode and cathode?**

Ans: In an electrochemical cell, the electrode at which oxidation occurs is called the anode; the electrode at which reduction occurs is called cathode.

Q51: **What is an electrochemical cell?**

Ans: An electrochemical cell is a system consisting of electrodes that dip into an electrolyte and in which a chemical reaction either uses or generates an electric current.

These are of two types

- Electrolytic cell.
- A voltaic or galvanic current.

Q52: **Zn can displace Cu from CuSO4, while Zn does not displace Mg from $MgSO_4$ solution. Why?**

Ans: An element lies above in the electrochemical series can displace the element lies below in electrochemical series form its solution. Thus Zn metal which lies above in the electrochemical series has lower standard reduction potential than that of Cu. It will displace Cu from aqueous solution of CuSO4.

While Zn lies below in electrochemical series have greater standard reduction potential than of Mg and therefore Zn cannot displace Mg from aqueous solution of $MgSO_4$.

$$Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu$$

$$Zn + MgSO_4 \longrightarrow \text{No reaction}$$

Q53: **Transition elements act as Anode in alkaline battery?**

Ans: Most of transition elements have negative reduction potential. It means they have high tendency to lose electrons. Thus in alkaline batteries transition metal plate (Zn, Cd) act as source of electron and oxidation takes place so transition elements act as Anode in alkaline battery.

$$Zn \longrightarrow Zn^{2+} + 2e^-$$
$$Cd \longrightarrow Cd^{2+} + 2e^-$$

Some transition elements are highly inert like Pt, Pd. They are used as inert electrodes. An inert electrode conducts electron to and from external circuit without actually taking part in reaction.

Q54: **Explain electrolysis of fused $PbCl_2$.**

Ans: In case of lead chloride following electrolytic reactions occur at anode and cathode.

At anode: $PbCl_2 \longrightarrow Pb^{2+}_{(l)} + 2Cl_{(l)}$

At cathode: $2Cl^-_{(g)} \longrightarrow Cl_{2(g)} + 2e^-$

Overall reactions: $Pb^{2+}_{(g)} + 2e^- \longrightarrow Pb_{(g)}$

Q55: **Write down the construction of standard hydrogen electrode (SHE).**

Ans: It consists of platinum foil, which is coated electrolytically with finally divided platinum black, to give it a large surface area. It is suspended in one molar solution of HCl.

Pure hydrogen gas at one atmosphere pressure is continuously bubbled into 1M HCl solution. The platinum acts as an electrical conductor and also facilitates the attainment of equilibrium between the gas and its ions in the solution. The potential of this electrode is arbitrarily taken as zero.

Q56: **What is alkaline battery or dry alkaline cell?**

Ans: In dry alkaline cell, zinc rod acts as anode and manganese dioxide as cathode. The electrolyte is KOH. The voltage of cell is 1.5 volts. The reactions are:

At anode: $Zn + 2OH^- \longrightarrow Zn(OH)_2 + 2e^-$

At cathode: $2MnO_2 + 2H_2O + 2e^- \longrightarrow Mn_2O_3 + 2OH^-$

Overall reactions:

$$Zn + 2MnO_2 + 2H_2O \longrightarrow Zn(OH)_2 + Mn_2O_3$$

Q57: **What is fuel cell? How the fuel cell can be used as drinking water for an astronaut?**

Ans: A galvanic cell in which the reactants are continuously fed into the cell as the cell produces electrical energy is called a fuel cell. At the electrodes the hydrogen is oxidized to water and oxygen is reduced to OH^- ions.

This fuel cell is operated at high temperature so that the water formed as a product of the cell reaction evaporates and may be condensed and used as drinking water for an astronaut.

At anode: $[H_2 + 2OH^- \longrightarrow 2H_2O + 2e^-] \times +2$

At cathode: $O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$

Overall reactions: $2H_2 + O_2 \longrightarrow 2H_2O$

Q58: **Daniel cell represented?**

Ans: Galvanic cells are represented by a simple notation called cell diagram.

The notation for the Daniel cell is:

$$Zn / Zn^{2-}\ IM \parallel Cu^{2-} / Cu$$
$$E^o = 1.1V$$

The vertical lines represent phase boundaries and a double line "||" represents a salt bridge. The anode or oxidation half-cell (Zn anode) is always written to left. The cathode (Cu) or reduction half-cell is written on the right side.

Q59: **What are redox reactions?**

Ans: The chemical reactions in which oxidation and reduction processes takes place are called redox reactions.

For example:

Reaction of magnesium with oxygen.

The oxidation state of Mg increases from zero to +2, hence it is oxidation, while the oxidation state of oxygen decreases from zero to -2, hence it is reduction.

$$2Mg^0 + O_2^0 \longrightarrow 2Mg^{+2} + O^{-2}$$

Q60: **Describe the relative chemical reactivity of metals?**

Ans: Metals react by forming their positive ions. If the value of standard reduction potential is greater, the tendency to form positive ions is smaller and therefore less reactivity.

It means the elements with greater reduction potential are least reactive where as the elements with smaller reduction potential are more reactive.

Q61: **Zn can displace iron from its solution, how?**

Ans: Zn is a stronger reducing agent having standard reduction potential as (0.76) than iron which has standard reduction potential as (0.44). So, Zn can displace iron from its solution.

Q62: **What is Anodized Aluminum?**

Ans: When a thin layer of oxide is formed over the surface of aluminium metal it is called anodized aluminium.

Anodized aluminium is prepared by making it anode in an electrolyte cell containing sulphuric acid or chromic acid, which coats a thin layer of oxide on it. Aluminium oxide layer resist the attack by corrosive agents.

Q63: **How relative chemical reactivity of metals is studied with the help of electrochemical series.**

Ans: The value of the reduction potential of a metal or a non metal tells us the tendency to lose electrons and act a reducing agent. It also gives the information about the tendency of a specie to gain electrons and act as oxidizing agent.

Greater the value of standard reduction potential of a given specie, greater is its tendency to accept electrons to undergo reduction and hence to act as oxidizing agent.

Q64: **Give the reaction involved, when a lead accumulator (lead storage battery) is discharged?**

Ans: At anode: $Pb_1 + SO_{4(aq)}^{2-} \longrightarrow PbSO_{4(s)} + 2e^-$

At cathode: $PbO_2 + 4H^+ + SO_4^{2-} \longrightarrow PbSO_4 + 2H_2O$

Overall reactions: $PbO_2 + Pb_1 + 4H^+ + 2SO_4^{2-} \longrightarrow 2PbSO_4 + 2H_2O$

Q65: **Write down reactions taking place at the electrode on the discharging of Nickel-Cadmium cell?**

Ans: At anode: $Cd + 20H^- \longrightarrow Cd(OH)^2 + 2e^-$

At cathode: $NiO_2 + 2H_2O + 2e^- \longrightarrow Ni(OH)^2 + 2OH^-$ (Oxidation)

Overall reactions: $Cd + NiO_2 + 2H_2O \longrightarrow Ni(OH)_2 + Cd(OH)_2$ (Reduction)

Q66: **Give some advantages of fuel cells?**

Ans: Advantages of fuel cells:

- These cells run continuously as long as reactants are available.
- These are light, portable and source of electricity.
- These are very efficient. They convert about 75% of fuels energy into electricity.

Q67: **A porous plate or salt bridge is not required in lead storage cell. Why?**

Ans: A porous plate or a salt bridge is not required in Lead acid battery because all cells are dipped in the same electrolyte (30% H_2SO_4 solution d= 1.25 g.cm^{-3}). Salt bridge usually separates the two electrodes (half cells) in which different electrolytes are used.

Q68: **Define Oxidation and Oxidation Number.**

Ans: **Oxidation:**

Removal of electrons is called oxidation.

Oxidation Number:

It is the apparent charge on an atom of an element in a compound or a radical. The oxidation number of hydrogen in all its compounds except metal hydrides is +1. In metal hydrides it is -1, $Na^+ \ H^-$, $Mg^{2+} H_2^{2(-1)}$

Q69: **How does electrochemical series explain the displacement of one metal by another from its solution?**

Ans: An element lies above in the electrochemical series can displace the element lies below in electrochemical series form its solution. Thus Zn metal which lies above in the electrochemical series has lower standard reduction potential than that of Cu.

It will displace Cu from aqueous solution of $CuSO_4$. While Zn lies below in electrochemical series have greater standard reduction potential than of Mg and therefore Zn cannot displace Mg from aqueous solution of $MgSO_4$.

$$Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu$$

$$Zn + MgSO_4 \longrightarrow \text{No reaction}$$

Chapter : 10 Electrochemistry

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Imp.Long Questions

Q1: Balance the equation by oxidation number method.

$$K_2Cr_2O_7 + HCl \longrightarrow KCl + CrCl_3 + Cl_2 + H_2O$$

Q2: State rules for assigning oxidation number of elements with examples? (v.imp)

Q3: Balance the following equation by oxidation number method.

$$MnO_2 + HCl \longrightarrow MnCl_2 + H_2O + Cl_2$$

Q4: Balance the following equation by oxidation number method.

$$Zn + HNO_3 \longrightarrow Zn(NO_3)_2 + NO + H_2O$$

Q5: Balance the following equation by oxidation number method.

$$Cu + HNO_3 \longrightarrow Cu(NO_3)_2 + NO_2 + H_2O$$

Q6: Balance the following equation by ion electron method in acidic medium.

$$Cl + MnO_4^- \longrightarrow Cl_2 + Mn^{2+}$$

Q7: Describe the electrolysis of fused salts and aqueous solution of salts?

Q8: Define electrode potential. How electrode potential of is Zn measured?

Q9: Write construction and working of voltaic cell. (v.imp)

Q10: Describe the electrolysis of molten sodium chloride and a concentrated solution of sodium chloride?

Q11: Define electrolysis. Explain the electrolysis of very dilute solution of $NaNO_3$. (v.imp)

Q12: What are electrolytic cells? Explain with diagram and give an example of electrolysis of fused salt?

Q13: Give four industrial importance of electrolysis process in detail? (v.imp)

Q14: How can you measure electrode potential of an element with the help of standard hydrogen electrode (SHE)?

Q15: What is standard hydrogen electrode (SHE)? How is it used to measure the electrode potential of Zinc?

Q16: Define standard hydrogen electrode (SHE)? How is it used to measure the electrode potential of copper?

Q17: Describe a galvanic cell and explain the functions of salt bridge?

Q18: What is electrochemical series? Give its four applications? (v.imp)

Q19: Write a comprehensive note on Alkaline Battery, (non-rechargeable) and Nickel. Cadmium Cell (rechargeable)?

Q20: Explain the construction, working and uses of fuel cell? (v.imp)

Q21: Discuss the working and Chemistry of Alkaline Battery and Fuel Cells?

Q22: Briefly explain the working of Galvanic Cell.

Q23: Discuss lead accumulator, explaining its discharging and recharging. (v.imp)

Q24: What is lead accumulator battery? Discuss its discharging process?

Q25: Write a comprehensive note on silver oxide and "Nickel Cadmium" batteries?