Chapter 7 Electrochemistry

Section A Multiple Choice Questions (M.C.Qs)

Tick mark (✓) the correct answer:

01. *Alloy of Cu – Sn is called:*
(a) Brass (b) Bronze (c) Monel (d) Bell metal

02. *Which one is Alloy?*
(a) Graphite (b) Mercury (c) Steel (d) Water

03. *Value of 1 Faraday is equal to:*
(a) 9.65 C (b) 9650 C (c) 96500 C (d) 965 C

04. *Which one is non–electrolyte?*
(a) Aqueous HCl (b) Aqueous NaCl (c) Molten KCl (d) Urea

05. *Which one is oxidizing agent?*
(a) Al (b) H_2S (c) Cl_2 (d) NaH

06. *Which one is a reducing agent?*
(a) H_2SO_4 (b) HNO_3 (c) Al (d) I_2

07. *Which one forms a weak electrolyte solution with water?*
(a) HCl (b) KOH (c) NaCl (d) CH_3COOH

08. *In Daniel cell, it is used as a cathode.*
(a) Zn (b) Cu (c) Sn (d) Pb

09. *1 g equivalent weight of Al is equal to:*
(a) 9 g (b) 27 g (c) 54 g (d) 1 g

10. *Which one is a correct statement?*
(a) Oxidation occurs at the cathode. (b) Reduction occurs at the anode
(c) Reduction occurs at cathode (d) Ions lose electrons at cathode

11. *Electrochemistry deals with the conversion of:*
(a) electrical energy into chemical energy (b) chemical energy into electrical energy
(c) Both of 'a' and 'b' (d) None of them

12. *From a chemical substance, oxidation may involve:*
(a) introduction of oxygen (b) removal of hydrogen
(c) Both 'a' & 'b' (d) None of these

13. *From a chemical substance, reduction may involve:*
(a) removal of oxygen (b) addition of oxygen
(c) removal of hydrogen (d) All of them

14. *The electrochemical reaction in which atom, molecule or ion loses electrons is called:*
(a) reduction reaction (b) oxidation reaction
(c) electrolytic reaction (d) cathodic reaction

15. *In oxidation reaction, oxidation number:*
(a) becomes zero (b) remains the same (c) decreases (d) increases

16. *The electrochemical reaction in which atom, molecule or ion accepts electron is called:*
(a) reduction reaction (b) oxidation reaction
(c) electrolytic reaction (d) cathodic reaction

17. *In reduction reaction, oxidation number:*
(a) becomes zero (b) remains the same (c) decreases (d) increases

18. *Which one of these is a reducing agent?*
(a) Cl_2 (b) $KMnO_4$ (c) H_2SO_4 (d) Zn

19. *Which one of these is NOT a reducing agent?*
(a) Zn (b) HNO_3 (c) Al (d) KH

20. *The reaction occurs at each electrode is called:*
(a) zero cell reaction (b) quarter cell reaction
(c) half cell reaction (d) full cell reaction

21. *Types of electrochemical cells are:*
(a) two (b) three (c) four (d) five

22. *Which of the following is a strong electrolyte?*
(a) H_2CO_3 (b) NH_4OH (c) AgCl (d) NaCl

23. *Which of the following is NOT an electrolyte?*
(a) Benzene (b) Glucose (c) Both of 'a' & 'b' (d) None of these

24. *The substance used for electrolysis is called:*
(a) electrolyte (b) cell (c) electricity (d) None of them

25. *The device that converts chemical energy into electrical energy or electrical energy into chemical energy is called:*
(a) electrochemical cell (b) electrolytic cell
(c) photocell (d) pencil cell

26. *In which type of cells, oxidation (loss of electrons) occurs at anode and reduction (gain of electrons) occurs at the cathode?*
(a) Electrochemical (b) Electrolytic (c) Primary (d) Secondary

27. *Faraday's First Law of Electrolysis states that the amount of any substance that is deposited or liberated at an electrode during electrolysis is directly proportional to the:*
(a) charge deposited on electrodes
(b) mass of the substance or electrolyte
(c) their chemical equivalent masses
(d) quantity of electricity passed through the electrolyte

28. *Coulomb (C) =:*
(a) Ampere (A) + time (t) (b) Ampere (A) – time (t)
(c) Ampere (A) × time (t) (d) Ampere (A) ÷ time (t)

29. *The mass of the substance liberated or deposited per unit charge that passes is called:*
(a) electrochemical equivalent (b) mass equivalent
(c) physio–chemical equivalent (d) volume equivalent

30. *Equivalent mass =:*
(a) Atomic mass × Valency (b) $\frac{\text{Atomic mass}}{\text{Valency}}$
(c) Atomic mass + Valency (d) Atomic mass × $(\text{Valency})^2$

31. ***According to Faraday's Second Law of Electrolysis, the amount of different substances deposited or liberated due to passage of the same quantity of current through different electrolysis are proportional to:***
    - *(a)* charge deposited on electrodes
    - *(b)* mass of the substance or electrolyte
    - *(c)* their chemical equivalent masses
    - *(d)* quantity of electricity passed through the electrolyte

32. ***Quantity of charge which deposits or liberates 1 gm equivalent weight of a substance is called:***
    (a) 1 Farad *(b)* 1 Ampere *(c)* 1 Coloumb *(d)* 1 Faraday

33. ***Dry cell is also called:***
    - *(a)* Leclanche cell
    - *(b)* secondary battery
    - *(c)* lead storage battery
    - *(d)* None of these

34. ***Dry cell uses:***
    - *(a)* magnese dioxide as anode & zinc as cathode
    - *(b)* zinc as anode & magnese dioxide as cathode
    - *(c)* lead as anode & lead oxide as cathode
    - *(d)* lead oxide as anode & lead as cathode

35. ***In a dry cell, this is used as an electrolyte.***
    (a) NH_2Cl paste *(b)* $ZnCl_2$ paste *(c)* either 'a' or 'b' *(d)* Both 'a' & 'b'

36. ***Lead storage battery is an example of:***
    (a) Leclanche cell *(b)* secondary battery *(c)* primary battery *(d)* None of them

37. ***Lead storage battery uses:***
    - *(a)* magnese dioxide as anode & zinc as cathode
    - *(b)* zinc as anode & magnese dioxide as cathode
    - *(c)* lead as anode & lead oxide as cathode
    - *(d)* lead oxide as anode & lead as cathode

38. ***In lead storage battery, this is used as electrolyte.***
    (a) NH_2Cl paste *(b)* $ZnCl_2$ paste *(c)* solution of H_2SO_4 *(d)* None of these

39. ***Number of alloys, used for different purposes, are:***
    (a) 70 *(b)* 700 *(c)* 7000 *(d)* 70000

40. ***Brass is an alloy of:***
    (a) Cu – Zn *(b)* Cu – Sn *(c)* Cu – Zn – Sn *(d)* Ag – Cu

41. ***Alloy of iron and carbon is called:***
    (a) Brass *(b)* Bronze *(c)* Duralumin *(d)* Steel

42. ***It is called 100% pure gold.***
    (a) 24 karat *(b)* 22 karat *(c)* 18 karat *(d)* 10 karat

43. ***To make stainless steel, iron is mixed with:***
    (a) Cu – Zn *(b)* Cu – Sn *(c)* Cr – Ni *(d)* Ag – Cu

44. ***The coating of metal at the surface of other metal by the electrolytic process is called:***
    (a) electrolysis *(b)* electrolyte *(c)* galvanizing *(d)* electroplating

45. ***The process in which zinc is electrolytically coated at the surface of other base metal is called:***
    (a) electrolysis *(b)* electrolyte *(c)* galvanizing *(d)* electroplating

46. ***In W = ZAt, 'Z' is called:***
    - *(a)* constant
    - *(b)* product
    - *(c)* electrochemical equivalent
    - *(d)* None of them

Answers

01.	(d)	07.	(d)	13.	(a)	19.	(b)	25.	(a)	31.	(c)	37.	(c)	43.	(c)
02.	(c)	08.	(b)	14.	(b)	20.	(c)	26.	(b)	32.	(d)	38.	(c)	44.	(d)
03.	(c)	09.	(a)	15.	(d)	21.	(a)	27.	(d)	33.	(a)	39.	(c)	45.	(c)
04.	(d)	10.	(c)	16.	(a)	22.	(d)	28.	(c)	34.	(b)	40.	(a)	46.	(c)
05.	(c)	11.	(c)	17.	(c)	23.	(c)	29.	(a)	35.	(c)	41.	(d)		
06.	(c)	12.	(c)	18.	(d)	24.	(a)	30.	(b)	36.	(b)	42.	(a)		

Section B&C — Short & Detailed Answer Questions

Q.1 What is electrochemistry?

Ans: In our daily life we use digital watches, calculators, cars and mobile phones. powered by batteries or dry cells. Extraction of metals like aluminium, copper and electroplating of metals are few applications of electrochemistry.

Definition: It can be defined as the branch chemistry which deals with electrochemical reactions, electrolyte and electrochemical cells is called electrochemistry. OR

It deals with the conversion of electrical energy into chemical energy and chemical energy into electrical energy.

Q.2 Define electrochemical reactions.

Ans: *Electrochemical Reactions:* The chemical reactions in which chemical energy changes into electrical energy or vice versa are called electrochemical reactions.

Oxidation and reduction reactions are electrochemical reactions. In electrochemistry oxidation and reduction, reactions involve the transfer of electrons.

Q.3 Define oxidation and reduction reactions with examples.

Ans: *Oxidation Reactions:* Oxidation may involve the introduction of oxygen or the removal of hydrogen from a chemical substance.

Examples:

$C + O_2 \longrightarrow CO_2$ (burning of coal)

$2C_8H_{18} + 25O_2 \longrightarrow 16CO_2 + 18\,H_2O$ (combustion of octane)

$N_2H_4 + O_2 \longrightarrow N_2 + 2H_2O$ (removal of hydrogen from hydrazine)

The electrochemical reaction in which atom molecule or ion loses electron and its oxidation number increases is called oxidation reaction.

Example: $Cu \longrightarrow Cu^{++} + 2\bar{e}$ (Oxidation)

Reduction Reactions: Reduction may involve the addition of Hydrogen or removal of oxygen from a chemical substance.

Examples:

$CuO + C \longrightarrow Cu + CO$ (reduction of copper oxide)

$CH_2 = CH_2 + H_2 \xrightarrow[200°C]{Ni} CH_3 - CH_3$ (reduction of ethene)

$Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe + Heat$ (reduction of iron oxide)

The electrochemical reaction in which atoms, molecule or ion accepts electron and its oxidation number decreases is called reduction reaction.

Example: $S + 2\bar{e} \longrightarrow S^{2-}$ (reduction reaction)

Q.4 *Define oxidizing and reducing agents.*

Ans: ***Oxidizing and Reducing Agents:*** Oxidation occurs due to oxidizing agent. Oxidizing agents are substances that accept electrons and a reducing agent is responsible for the reduction. Similarly reducing agents are substances that lose electrons.

Example: $Zn + Cl_2 \longrightarrow ZnCl_2$

Zinc undergoes oxidation by losing electrons and acts as a reducing agent while chlorine undergoes reduction by accepting electrons and act as an oxidizing agent.

A table of oxidizing agents and reducing agents are given below.

Oxidizing Agent	*Reducing Agnet*
H_2SO_4, HNO_3, $KMnO_4$, $K_2Cr_2O_7$, Cl_2, Br_2, I_2, etc.	Alkali metals, Al, H_2S, Zn, NaH, KH etc.

Q.5 *What are electrochemical cells? Define half cell reactions.*

Ans: ***Electrochemical Cells:*** The device which converts chemical energy into electrical energy or vice versa using redox reaction is called electrochemical cells.

The electrochemical reactions are carried out in electrochemical cells. It consists of two electrodes at which a redox reaction occurs. The electrode at which oxidation takes place is called Anode and the electrode at which reduction occurs is called Cathode. Each electrode is in contact with the battery and electrolyte is present in a cell.

Half Cell Reaction: The reactions that occur at each electrode is called half cell reaction. The overall cell reaction is the combination of two half cell reactions.

Q.6 *How many electrochemical cells are there? Write their names.*

Ans: ***Types of Electrochemical Cells:*** Electrochemical cells are of two types.

(i) Electrolytic Cells (ii) Galvanic Cells or Voltaic Cells

Q.7 *Define electrolytes and non-electrolytes.*

Ans: ***Electrolytes:*** An electrolyte consists of free-moving ions and conducts electricity. Acids, bases and salts in molten or in aqueous solution form are electrolytes.

Non–Electrolytes: The substances which are unable to conduct electricity in molten state or aqueous solution form are called non-electrolytes.

Examples: Benzene, Glucose, Sucrose and Urea etc are non–electrolytes.

Q.8 *Describe different types of electrolytes.*

Ans: ***Types of Electrolytes:***

(i) ***Strong Electrolytes:*** Strong electrolytes are fully ionized and undergo electrolysis. When a strong electrolyte is dissolved, a large portion of the solute exists as ions e.g. Sodium chloride is a strong electrolyte. All the dissolved sodium chloride in a solution exists as Na+ and Cl– ions.

Examples: HCl, H_2SO_4, HNO_3, NaOH, KOH, etc.

$$NaCl(s) + H_2O \longrightarrow Na^+(aq) + Cl^-(aq)$$

(ii) ***Weak Electrolyte:*** A weak electrolyte is partially ionized but undergoes electrolysis. In

solution, only a fraction of the solute exists as ions. In a solution of mercuric chloride, most of the solute exists as unionized $HgCl_2$.

Examples: H_2CO_3, NH_4OH, etc.

$$CH_3COOH + H_2O \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$$

(iii) Non-Electrolyte: Compounds that do not conduct an electric current in aqueous solution or the molten state are non-electrolytes. Many molecular compounds are non-electrolytes because they are non-ionic. Substances which do conduct electricity but are not decomposed by it, e.g. mercury, are also non-electrolytes.

Examples: Sugar, Petrol, Benzene, etc.

Some strong and weak electrolytes are shown below:

	Strong Electrolyte	Weak Electrolyte
Acids	HCl, HNO_3, HI, H_2SO_4	H_2S, H_2CO_3, CH_3COOH
Bases	KOH, NaOH, LiOH	NH_4OH, $Ca(OH)_2$, $Mg(OH)_2$
Salts	KI, NaCl, $CuSO_4$	PbI, $KHCO_3$, AgCl

Q.9 ***Define electrolysis.***

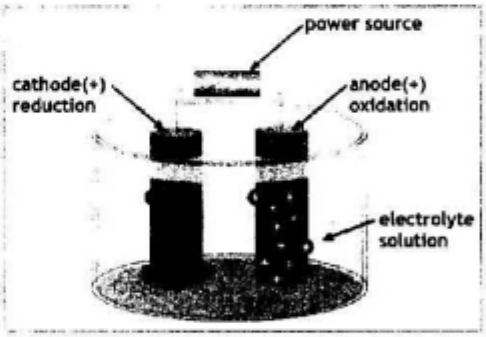
Ans: ***Electrolysis:*** The electrolysis involves redox reactions carried out in the electrolytic cell. In electrolysis current passes through an electrolyte, due to this migration of positive and negative ions towards cathode and anode takes place. As result ions are discharged at their respective electrodes.

Q.10 ***What is an electrolytic cell?***

Ans: ***Electrolytic Cell:*** The type of cell which uses electricity for a non-spontaneous reaction to occur is called electrolytic cell.

An electrolytic cell consists of electrolyte in a vessel, electrodes and a battery.

The sketch of an electrolytic cell is shown in the given figure.



The figure shows that electrons from the battery enter through the cathode at which positive ions are reduced by accepting electrons. At the anode, negative ions lose electrons and undergo oxidation. It means at cathode reduction occurs and oxidation takes place at the anode.

At Cathode $M^+ + \bar{e} \longrightarrow M$ (Reduction = Gain of electron)

At Anode $X \longrightarrow X + \bar{e}$ (Oxidation = loss of electron)

Q.11 ***What are the applications of electrolytic cells?***

Ans: ***Applications of Electrolytic Cells:*** Important uses of electrolytic cells are given below.

(i) It is used to prepare sodium metal from molten sodium chloride using the down's cell.

(ii) It is used to prepare caustic soda (NaOH) from aqueous sodium chloride by Nelson's cell. It is also used to obtain chlorine gas.

(iii) It is used to extract the aluminium metal.

(iv) It is used in the electro refining of copper.

(v) Electrolytic cell is used for electroplating of metals.

Q.12 ***State and explain Faraday's law of electrolysis.***

Ans: ***Faraday's Law of Electrolysis:*** Micheal Faraday was a British chemist who greatly contributed

to the field of electrochemistry. He observed the quantitative relationship between current and the amount of substance collected at electrodes.

He conducted several experiments regarding electrolysis and put forward two laws of electrolysis based on his observation.

Faraday's First Law of Electrolysis: It states that the amount of any substance that is deposited or liberated at an electrode during electrolysis is directly proportional to the quantity of electricity passed through the electrolyte.

$$W \propto A \times t$$

or

$$W = Zat$$

In this equation, W = weight of the substance deposited or liberated at the electrode,
A = Current in Ampere and t = Time in second

Ampere (A) x time(t) = Coulomb (C)

If A = 1 amp, t= 1 sec then W = Z (Electrochemical equivalent)

Electrochemical Equivalent: Electrochemical equivalent is the weight of the substance collected at the electrodes when one coulomb of electric charge is passed through the electrolyte.

Faraday's Second Law of Electrolysis: The amount of different substances deposited or liberated due to passage of the same quantity of current through different electrolytes are proportional to their chemical equivalent masses.

For an element

$$\text{Equivalent mass} = \frac{\text{Atomic weight}}{\text{valency}}$$

Example: Chemical equivalent of Al $= \frac{27}{3} = 9g$

Chemical equivalent of Ag $= \frac{108}{1} = 108g$

Example: If we take three electrolytic solutions of silver nitrate, copper sulphate and aluminium nitrate in three electrolytic cells and the same quantity of current (96,500 coulombs) is passed through them. As a result, 108 gm of silver, 31.75 gm of copper and 9 gm of aluminium are collected at their respective electrodes.

Q.13 ***Define the unit, Faraday.***

Ans: Quantity of charge which deposits or liberates **1** gm equivalent weight of a substance is called 1 Faraday (F).

1 F = 96500 Coulombs

Q.14 ***What are batteries? How many types of batteries are there?***

Ans: ***Batteries:*** We use a lot of electrical devices having batteries as a source of electricity. A battery consists of a group of galvanic cells connected in a series. Examples of batteries include dry cell, lead storage battery, mercury battery etc.

Types of Batteries: Batteries are classified as primary (non-rechargeable) and secondary (rechargeable) batteries.

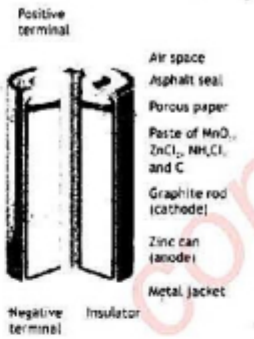
Scientists are working for enhancing the high energy, safety, cyclability of batteries for mobile phones, transportation, computer technology etc.

Q.15 ***What is a dry cell?***

Ans: ***Dry Cell:*** It is also known as Leclanche cell. It is a type of primary cell which produce electricity using a redox reaction between the chemical substances placed in it. It uses zinc as an anode, manganese dioxide as cathode and aqueous ammonium chloride (NH_4Cl) or zinc chloride ($ZnCl_2$) as electrolyte.

A copper cap is fixed on the top of the carbon rod for the conduction of electricity.

Zinc and graphite are then connected by a metal wire as a result following chemical reactions take place.



Reaction at Anode: $Zn \rightarrow Zn^{+2} + 2\bar{e}$

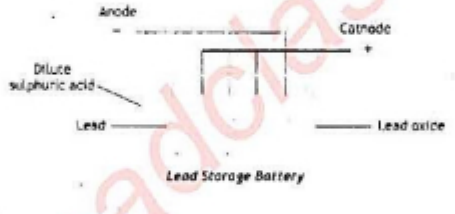
Reaction at Cathode: $2NH^{+4} + 2MnO_2 + 2\bar{e} \rightarrow Mn_2O_2 + 2NH_3 + H_2O$

It produces a potential of 1.5 volt.

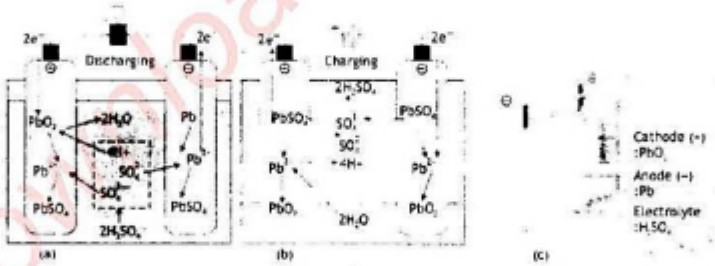
Q.16 ***Describe the lead Storage battery.***

Ans: ***Lead Storage Battery:*** A battery is a device that produces electricity through electrochemical reactions. The lead storage battery is an example of a secondary cell in which chemical changes can be reversed. It has several voltaic cells connected in series. It contains lead plates which serve as anode and lead oxide (PbO_2) which acts as a cathode. These electrodes are immersed in an electrolytic solution of dilute sulphuric acid (H_2SO_4). Chemical changes during charging and discharging processes can be shown as

$$Pb + PbO_2 + 2H_2SO_4 \underset{\text{Charge}}{\overset{\text{Discharge}}{\rightleftharpoons}} 2PbSO_4 + 2H_2O$$



Lead Storage Battery

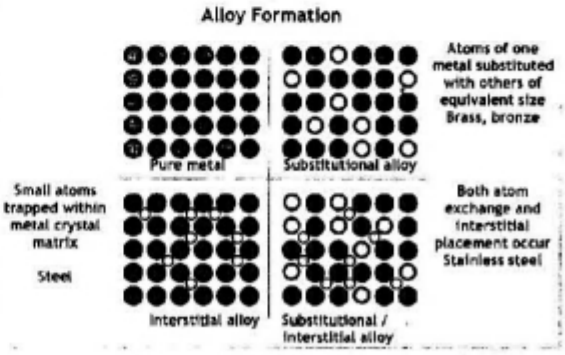


Q.17 ***Define alloy. How is an alloy formed? Explain its classification.***

Ans: ***Alloy:*** Alloy is the mixture of metal with metal or metal with non-metal. There are about 7000 alloys that are used for different purposes in the world.

Alloy Formation: Brass is an alloy of copper (Cu) and Zinc (Zn), Steel is a alloy of iron and carbon. Alloy can be prepared by mixing elements in different proportions. In alloy, it becomes difficult for layers of metal atoms to slide over each other. So alloy is harder and stronger than the pure metal.

Some important alloys are summarized below:



Name of Alloy	Components	applications
Bell metal	Cu–Sn	Casting of bell
Brass	Cu–Zn	Door knobs and hand rails due to antibacterial nature, hose nozzles, stamping dies.
Bronze	Cu–Zn–Sn	Coins, medals tools, etc.
Monel	Ni–Cu–Fe	Corrosion resistant containers
Duralumin	Al–Cu–Mg–Ni	Boat, Air craft etc
Solder	Sn–Pb–Cu–Sb	Joining electrical components into circuits.
Alnico	Fe–Al–Ni–Co	Magnets used in loud speakers
Amalgam	Hg–Ag–Cu–Zn	Dental filling
Cupronickel	Cu–Ni–Mn	Coins
Pewter	Sn–Cu–Pb–Sb–B	Ornaments
Sterling silver	Ag–Cu	Cutlery set, Medical tools
White gold (18 carat)	Au–Pb–Ag–Cu	Jewelry

Classification of Alloys: Alloys are usually classified as substitutional or interstitial alloys, depending on the atomic arrangement that forms the alloy. They can be further classified as homogeneous (consisting of a single phase), or heterogeneous (consisting of two or more phases) or intermetallic.

When a molten metal is mixed with another substance, two mechanisms can cause an alloy to form, called atom exchange and the interstitial mechanism. The relative size of each element in the mix plays a primary role in determining which mechanism will occur. When the atoms are relatively similar in size, the atom exchange method usually happens, where some of the atoms composing the metallic crystals are substituted with atoms of the other constituent. This is called a substitutional alloy. Examples of substitutional alloys include bronze and brass, in which some of the copper atoms are substituted with either tin or zinc atoms respectively.

In the case of the interstitial mechanism, one atom is usually much smaller than the other and can not successfully substitute for the other type of atom in the crystals of the base metal. Instead, the smaller atoms become trapped in the spaces between the atoms of the crystal matrix, called the interstices. This is referred to as an interstitial alloy. Steel is an example of an interstitial alloy because the very small carbon atoms fit into the interstices of the iron matrix.

Stainless steel is an example of a combination of interstitial and substitutional alloys because the carbon atoms fit into the interstices, but some of the iron atoms are substituted by nickel and chromium atoms.

Q.18 ***What is pure gold? Briefly describe the alloys of gold?***

Ans: 24 karat gold is called 100% pure gold. Addition of metals to gold forms different colour.

Alloys of Gold:

Yellow Gold (22 Karat gold): It contains 91.67% gold with Ag, Cu, Zinc as other components.

Red Gold (18 Karat gold): It contains 75% gold with Cu as other components.

White Gold (18 Karat gold): It contains gold with Cu, Ag as other components.

Q.19 ***What is corrosion of metals?***

Ans: ***Corrosion:*** Metals react with oxygen in presence of moisture and can form harmful metal oxide. These metal oxide layers are porous and expose metal for further reaction with oxygen to form harmful metal oxide. It is called corrosion of metal.

Q.20 Describe rusting of iron.

Ans: **Rusting of Iron:** Corrosion of iron is an electro-chemical process. Iron undergoes a redox reaction in presence of air or water to form iron (III) oxide ($Fe_2O_3 . nH_2O$) called rusting of iron. The rusted surface of iron does not protect the underlying iron and eventually convert whole iron into reddish–brown rust. Rusting occurs at different places on the metal surface. A metal surface area of less moisture acts as an anode and oxidizes iron in this region.

$$Fe_{(s)} \longrightarrow Fe^{+2}_{(aq)} + 2\bar{e}$$

Metal surface with high moisture contents act as a cathode and reduces atmospheric oxygen to OH^- ions.

$$O_2 + 2H_2O + 4\bar{e} \longrightarrow 4OH^-$$

The Fe^{+2} ions further react with oxygen to form rust iron (III) oxide ($Fe_2O_3 . nH_2O$).

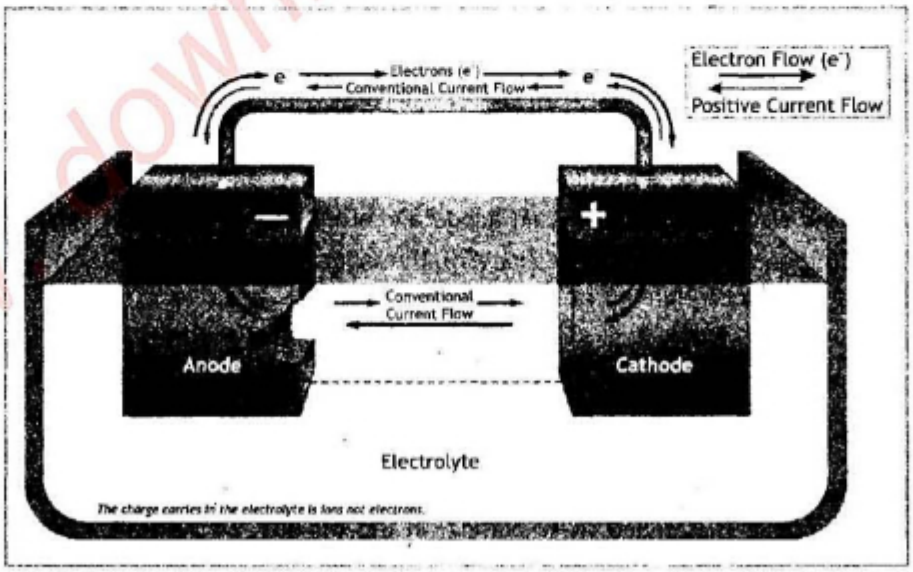
Q.21 Name the methods which are used to protect the metal from corrosion.

Ans: **Prevention From Corrosion:** All metals can be prevented from corrosion by following methods.

(i) **Alloying:** Formation of alloy prevents metal from corrosion by reducing its ability of oxidation.
Example: Iron (Fe) can be changed into stainless steel by mixing with chromium (Cr) and Nickle (Ni). Thus iron (Fe) is prevented from corrosion.

(ii) **Metallic Coating (Electroplating):** All metals can be protected from corrosion by coating their surface with other metal like tin (Sn) or zinc (Zn). The coating of metal at the surface of other metal by an electrolytic process is called electroplating. Metals like iron can be electroplated with chromium (Cr), Nickle (Ni) and silver (Ag).

(iii) **Cathodic Protection:** It is applied to protect underground pipes tanks, oil rigs etc from corrosion by making these materials as a cathode. The active metal like magnesium (Mg) or aluminium (Al) is used as Anode and connected with iron (Fe). These active metals itself oxidizes and prevent other metal from corrosion.



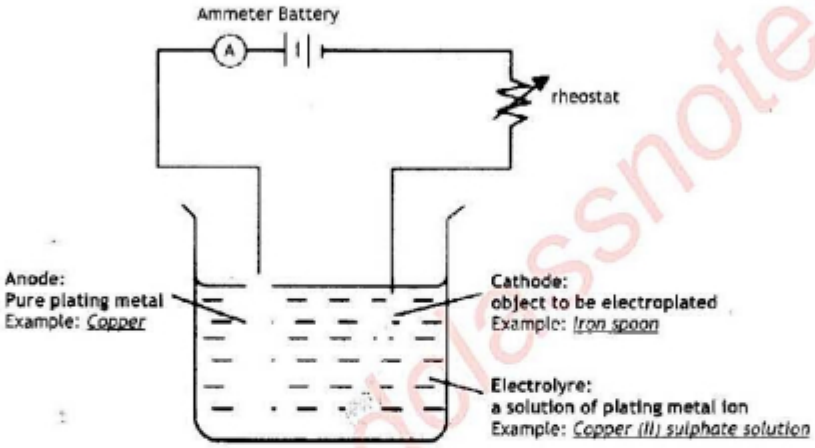
(iv) **Coating with Paint:** A metal is commonly coated with paint to protect it from corrosion. Paint prevents the reaction of metal with oxygen moisture and other harmful chemical agents.

Q.22 ***What is electroplating?***

Ans: ***Electroplating:*** The process of deposition of metal at the surface of other metal through electrolysis is called electroplating.

Q.23 ***Describe the process of tin plating on steel.***

Ans: ***Tin Plating:*** A steel spoon can be tin-plated by using acidified tin sulphate as an electrolyte. Tin (Sn) metal is used as anode and steel spoon is used as cathode. When current passes through electrolyte tin ions (Sn^{+2}) deposits at the cathode as tin (Sn) metal. The tin (Sn) electrode is then changed into a tin ion (Sn^{+2}).



Tin plating of a steel spoon

$SnSO_{4(aq)}$	$Sn^{++} + SO_4$	
Sn	$Sn^{++} + 2e$	(Anode reaction)
$Sn^{2+} + 2\bar{e}$	Sn	(Cathode reaction)

Q.24 ***Describe the process of Zinc plating OR galvanizing.***

Ans: ***Zinc Plating:*** The process in which zinc is electrolytically coated at the surface of other base metal is called galvanizing. Potassium zinc cyanide is used as an electrolyte to produce zinc ions (Zn^{+2}). Zinc (Zn) metal serves as an anode and steel object is used as cathode. During electrolysis Zn^{++} deposits at cathode and Zinc (Zn), the anode is then changed into zinc ion Zn^{2+}. Following reactions occur during zinc electroplating.

Zn	$Zn^{2+} + 2\bar{e}$	(Reaction at anode)
$Zn^{+2} + 2\bar{e}$	Zn	(Reaction at cathode)

Q.25 ***Describe the process of electroplating silver.***

Ans: ***Electroplating of Silver:*** In this process, silver (Ag) is coated electrolytically at the surface of steel or other metal. It is called silver plating. In this process, an aqueous solution of silver chloride (AgCl) is used as an electrolyte to produce silver (Ag^+) ions. Silver (Ag) metal is used as anode and steel object like spoon used as cathode. Silver (Ag^+) ions are reduced at the cathode by accepting electrons. Silver anode loses an electron and oxidized to silver (Ag^+) ion. Following chemical changes takes place.

$AgCl \rightarrow Ag^+ + Cl^-$ (Reaction at cathode)

At cathode: $Ag+ + e^- \rightarrow Ag$

At anode: $Ag \rightarrow Ag^+ + e^-$

Q.26 ***Describe the process of chromium plating.***

Ans: **Chromium Plating:** The process in which chromium (Cr) is coated electrolytically at the surface of other base metal is called chromium plating. Acidified chromium sulphate $Cr_2(SO_4)_3$ is taken as an electrolyte to produce chromium (Cr^{+3}) ion. Chromium metal serves as an anode and another metal object is used as a cathode.

Following chemical changes take place in chromium plating.

$Cr_2(SO_4)_{3(aq)} \rightarrow 2Cr^{3+}_{(aq)} + 3SO^{2-}_{4(aq)}$

Reaction at anode: $Cr \rightarrow Cr^{3+} + 3e^-$

Reaction at cathode: $Cr^{3+} + 3\bar{e} \rightarrow Cr$

Chromium-plated objects are used in auto parts industries.

Q.27 ***What are the advantages of electrochemistry?***

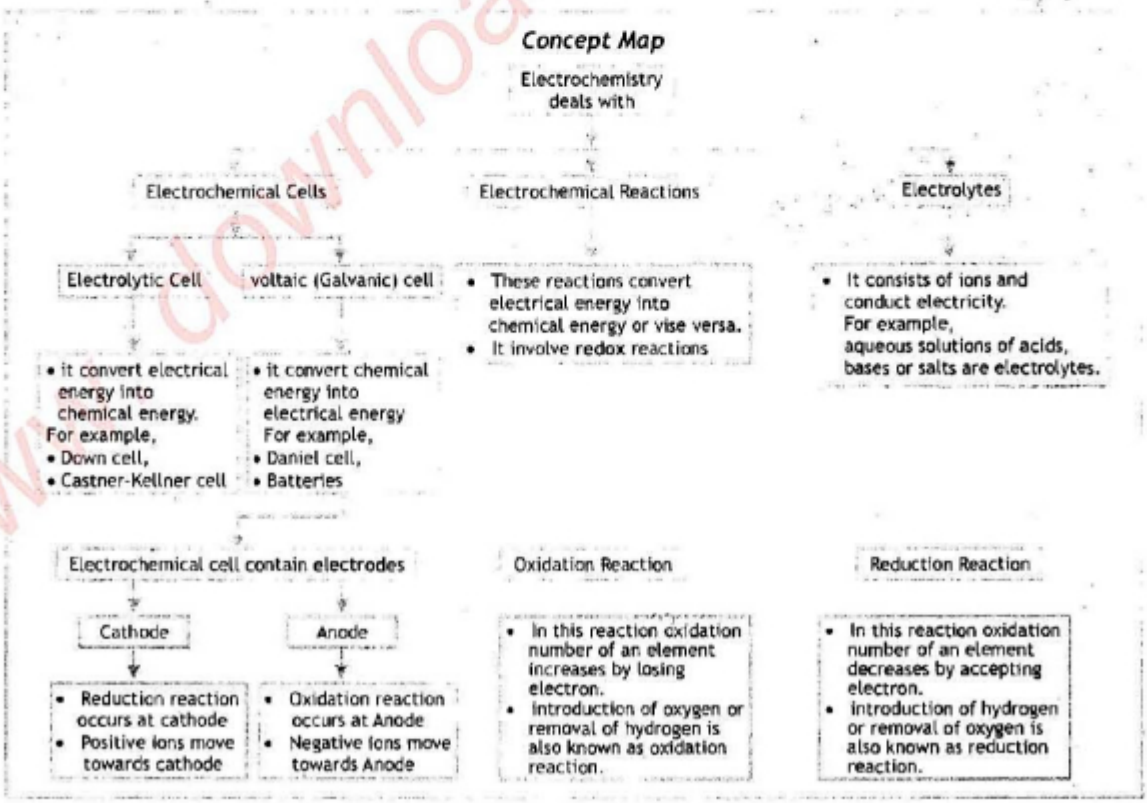
Ans: Iron is reactive metal. It can react with food items and can spoil food.

Tin is non-toxic, less reactive and resistant to corrosion. Tin can not react with organic acids or salt present in food so tin-plated cans are used for beverages and for storing foods.

Silver is lustrous white metal. Many metal objects are silver-plated to enhance their beauty and strength against corrosion.

A thin layer of silver on the metal surface form durable layers. A thick coating of silver on the metal surface is soft and gradually turns black, due to the formation of silver sulphide (Ag_2S).

Concept Map



Differences

1. Differentiate between oxidation and reduction reactions.

Ans: Difference Between Oxidation and Reduction Reactions

Oxidation	Reduction
Addition of oxygen	Addition of hydrogen
Removal of hydrogen	Removal of oxygen
Loss of electron by a substance	Gain of electrons by a substance
Increase in the oxidation number of a substance	Decrease in oxidation number of a substance

2. Differentiate between Electrolytes and Non-electrolytes:

Ans:

Electrolytes	Non-electrolytes
They conduct electricity in aqueous or molten state.	They do not conduct electricity in aqueous or molten state.
They decompose on the passage of electricity.	They do not decompose on the passage of electricity.
Electrolytes are ionic or polar compounds.	Non-electrolytes are non polar covalent compounds.

3. Differentiate between Primary Cell and Secondary Cell:

Ans:

Primary Cell	Secondary Cell
It converts chemical energy into electricity energy.	It converts chemical energy into electrical energy.
It is irreversible.	It is reversible.
It can not be recharged.	It can be recharged.
They are thrown away when chemicals are used up.	The electrical energy can be stored as chemical energy whenever it stops working.
Examples, Voltaic cell, Daniel cell, Dry cell etc.	Examples, Car battery or lead storage battery.

4. Differentiate between Electrochemical Cell and Electrolytic Cell:

Ans:

Electrochemical Cell	Electrolytic Cell
It converts chemical energy into electrical energy or electrical energy into chemical energy.	Electrolytic cells carry chemical change through electrical energy.
At anode oxidation takes place and at cathode reduction takes place.	At anode oxidation takes place and at cathode reduction takes place.
Electrochemical cell undergoes spontaneous redox reaction.	Electrolytic cell undergoes non-spontaneous redox reaction.
Cathode is the positive electrode and anode is the negative electrode.	Cathode is the negative electrode and anode is the positive electrode.

Reasons

1. ***Photosynthesis is an example of a redox reaction.***

Ans: Photosynthesis produces glucose.

$$6CO_2 + 6H_2O + \text{sunlight} \longrightarrow C_6H_{12}O_6 + 6O_2$$

Water (H_2O) undergoes oxidation by losing electrons and form hydrogen ions. Carbon dioxide (CO_2) accepts electrons and hydrogen ions to form glucose ($C_6H_{12}O_6$).

2. ***Metals are conductors but not electrolytes.***

Ans: Metals are conductors because they can conduct electricity and electrolytes are also able to conduct electricity. However, metals do not decompose when electricity passes through them while electrolytes decompose when electricity passes through them, so metals are not electrolytes.

3. ***In a dry cell, cathode is positive and anode is negative, while in a electrolytic cell cathode is negative and anode is positive.***

Ans: Anode and cathodes are not determined by charges. Anode is that electrode on which oxidation occurs and cathode is that electrode on which reduction occurs.

4. ***Pure water does not conduct electricity.***

Ans: Pure water does not dissociate in ions. It ionizes only slightly so it can not conduct electricity. However, on adding a little acid, base or salt, it can start conducting electricity due to ionizing of water.

5. ***Ionic compounds do not conduct electricity in the solid state.***

Ans: Ionic compounds do not conduct electricity in the solid state because their ions are tightly packed through electrostatic forces of attraction between positive and negative ions. However, in molten or aqueous state, the ions are free to move and they can conduct electricity.

Section D Numericals:

Solved Examples of the Textbook

1. ***Identify the oxidizing and reducing agents from the following:***
   (1) Al (2) Na (3) H_2S (4) H_2SO_4 (5) $KMnO_4$ (6) Zn

Ans:

(1)	Al	Reducing agent	(2)	Na	Reducing agent
(3)	H_2S	Reducing agent	(4)	H_2SO_4	Oxidizing agent
(5)	$KMnO_4$	Oxidizing agent	(6)	Zn	reducing agent

2. ***Identify the oxidizing and reducing agents for the following reaction.***

$$H_2 + Cl_2 \longrightarrow 2HCl$$

Ans: H_2 is a reducing agent and Cl_2 is an oxidizing agent.

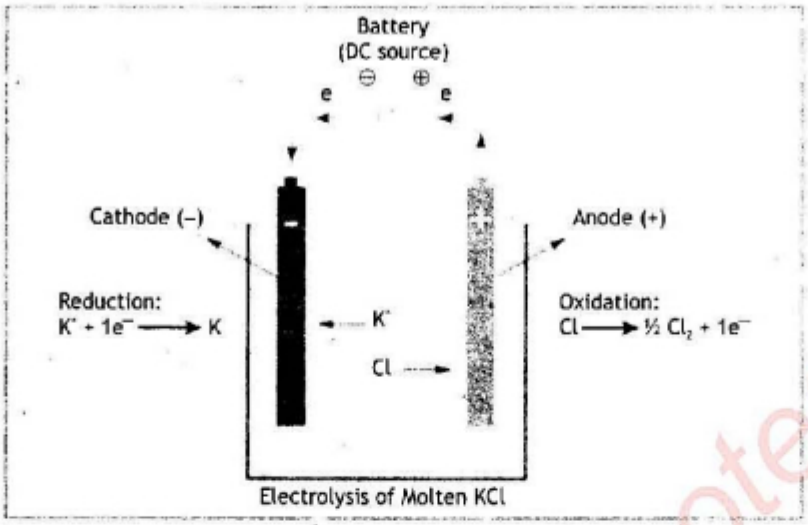
3. ***Identify strong and weak electrolytes from the following:***
   (1) $HCl_{(aq)}$ (2) $KI_{(aq)}$ (3) $NaOH_{(aq)}$
   (4) $H_2S_{(aq)}$ (5) $CH_3COOH_{(aq)}$ (6) $NH_4OH_{(aq)}$

Ans:

(1)	$HCl_{(aq)}$	Strong electrolyte	(2)	$KI_{(aq)}$	Strong electrolyte
(3)	$NaOH_{(aq)}$	Strong electrolyte	(4)	$H_2S_{(aq)}$	Weak electrolyte
(5)	$CH_3COOH_{(aq)}$	Weak electrolyte	(6)	$NH_4OH_{(aq)}$	Weak electrolyte

4. ***(i) Sketch electrolytic cell for electrolysis of molten potassium chloride.***
   (ii) Identify cathode and anode, oxidation-reduction reaction, movement of electrons from the following sketch of an electrolytic cell.

Ans:



Summary

- Oxidation is the loss of electrons by a chemical substance.
- Reduction is the gain of electrons by a chemical substance.
- An electrolyte consists of free-moving ions and conducts electricity.
- An electrode is an electrical conductor.
- The electrode at which oxidation occurs is called an anode.
- The electrode at which reduction occurs is called a cathode.
- Electrolysis is a process of migration of ions towards cathode and anode when current passes through an electrolyte.
- An oxidizing agent helps in oxidation by accepting electrons.
- A reducing agent helps in reduction by losing electrons.
- A galvanic cell converts chemical energy into electrical energy.
- An electrolytic cell uses electrical energy to derive a non spontaneous reaction.
- Corrosion of iron is called rusting.
- Corrosion of metal can be prevented by alloying, paint or electroplating metal with zinc, tin, silver, chromium etc.
- An alloy is a mixture of metal with metal or metal with non-metal

Solution of Textbook Exercise

SECTION-A: MULTIPLE CHOICE QUESTIONS

Tick Mark (✓) the correct answer:

See "Multiple Choice Questions (M.C.Qs)" - (i) to (x)

SECTION-B: SHORT QUESTIONS:

1. Define oxidation, reduction reactions with examples.

Ans: See 'Short & Detailed Answer Questions' - Q.3

2. Why ionic compounds conduct electricity in molten or in aqueous solutions only?

Ans: See 'Reasons' - Q.5

3. What is an electrolytic cell? Explain with diagram.

Ans: See 'Short & Detailed Answer Questions' - Q.10

4. ***Define oxidizing and reducing agent with examples.***

Ans: See 'Short & Detailed Answer Questions' - Q.4

5. ***Examine the following chemical equations and identify them.***

(i) Oxidizing agent (ii) Reducing agent
(iii) Substance undergoes oxidation (iv) Substance undergoes reduction

1. $Zn + Cl_2 \rightarrow ZnCl_2$
2. $Br_2 + H_2S \rightarrow 2HBr + S$
3. $2Ca + O_2 \rightarrow 2CaO$
4. $2Li + S \rightarrow Li_2S$

Ans:

Oxidizing Agent	Reducing Agent	Substance undergoes oxidation	Substance undergoes reduction
Cl_2	Zn	Zn	Cl
Br_2	H_2S	S	Br
O_2	Ca	Ca	O
S	Li	Li	S

6. ***Identify the Alloy.***

Ans:

Components	Alloy
Cu–Zn	Brass
Cu–Al–Mg–Ni	Duralumin
Cu–Zn–Sn	Bronze

SECTION - C: DETAILED QUESTIONS:

1. ***Describe the dry cell with a diagram.***

Ans: See 'Short & Detailed Answer Questions' - Q.15

2. ***What is a battery? How lead storage battery works?***

Ans: See 'Short & Detailed Answer Questions' - Q.14 & Q.16

3. ***Explain the process of electrolysis in an electrolytic cell.***

Ans: See 'Short & Detailed Answer Questions' - Q.10

4. ***What is Alloy? Explain its classification with examples.***

Ans: See 'Short & Detailed Answer Questions' - Q.17

5. ***What is rusting? How it can be prevented.***

Ans: See 'Short & Detailed Answer Questions' - Q.20 & Q.21

6. ***What is electroplating? How steel object can be electroplated with Tin, Zinc and Silver?***

Ans: See 'Short & Detailed Answer Questions' - Q.22, 23, 24, & 25

7. ***State and explain Faraday first and the second law of electrolysis.***

Ans: See 'Short & Detailed Answer Questions' - Q.12