

Electrochemistry

Electrolysis

- The process in which a non-spontaneous reaction is carried out by using electrical energy, is called **Electrolysis**.
- Electroplating, (deposition of a thin layer of one metal over the surface of other metal by passing electric current) electrometallurgy and anodisation are examples of electrolytic processes.
- Electrolysis is used
 - (a) To produce oxygen for space craft and nuclear submarines.
 - (b) To produce hydrogen for fuel.
 - (c) In electrolytic etching of metal surfaces like tools or knives with a permanent mark.
- In electrorefining impure metal is made anode and a strip of pure metal acts as cathode.

Electrochemical Series or Reactivity Series

- It is a series obtained when metal/ elements are arranged in their decreasing order of electrode potential (or reactivity).
 $K > Ca > Na > Mg > Al > Zn > Cr > Fe > Ni > H > Cu > Hg > Ag > Au$
- Thus, Au is least reactive.

Battery	Anode	Cathode	Electrolyte	Used in
Lecanche cell	Zinc	Graphite	Paste of ammonium chloride (NH_4Cl) and zinc chloride ($ZnCl_2$)	Transistors, clocks
Mercury cell	Zinc-mercury amalgam	Paste of HgO and C	Paste of KOH and (ZnO)	Hearing aids and camera
Lead storage battery	Lead	Lead packed in lead dioxide	38% solution of sulphuric acid	Automobiles, invertors

* Lead storage battery contains 6 cells each producing a voltage of 2V.

Corrosion

- The oxidative deterioration of a metal surface by the action of environment is called corrosion. It is an electrochemical process.
- When exposed to air, iron surface turns brown due to the formation of hydrated ferric oxide ($Fe_2O_3 \cdot xH_2O$), silver turns black due to the formation of silver sulphide (Ag_2S) and copper or bronze turns green due to the formation of basic copper carbonate, $Cu(OH)_2 \cdot CuCO_3$.
- Corrosion of iron is called **rusting** and hydrated ferric oxide ($Fe_2O_3 \cdot xH_2O$) is called **rust**. Process of rusting is accelerated by the presence of impurities, H^+ , electrolyte such as $NaCl$ and gases like CO_2 , SO_2 , NO_2 etc.

Electrochemical Cell

- It is a device, used to convert chemical energy into electrical energy. e.g. galvanic cell or voltaic cell, Daniell cell.
- An electrochemical cell contains two electrodes; one anode (the site of oxidation) and other cathode, the site of reduction.
- Between the electrodes, electrolyte solution is filled.

Battery

- It is a device which contains one or more cells connected in series.
- Batteries are of two types :
 - (a) Primary batteries (non-rechargeable) act as galvanic cell e.g. dry cell, mercury cell etc.
 - (b) Secondary batteries (rechargeable) act as galvanic as well as electrolytic cell e.g. lead storage battery, nickel, cadmium battery etc.

Points to be Remember

- Fuel cells convert energy obtained by fuel into electricity e.g. hydrogen-oxygen fuel cell.
- Electrolysis of fused $NaCl$ gives Cl_2 at anode and Na at cathode.
- Life span of Daniell cell is increased by using large zinc electrode.

Exercise

- Corrosion is basically an
 - interaction
 - union between two light metals and a heavy metal
 - altered reaction in presence of H_2O
 - electrochemical phenomenon
- Which of the following cell is a secondary cell?
 - Dry cell
 - Mercury cell
 - Fuel cell
 - Nickel cell
- The source of electrical energy on the Appolo moon flights was
 - a generator set
 - fuel cell
 - Ni-Cd cell
 - lead storage batteries
- When a lead storage battery is charged, it acts as
 - a primary cell
 - a galvanic cell
 - a concentration cell
 - an electrolytic cell
- Iron rusts in the presence of
 - vacuum
 - moisture
 - oxygen
 - Both (b) and (c)
- Which of the following metals is not attacked by the environment?
 - Gold
 - Copper
 - Silver
 - Iron
- The device which converts chemical energy of fuels directly into electrical energy is
 - concentration cell
 - galvanic cell
 - fuel cell
 - Both (b) and (c)
- When items or jewellery made of metals such as copper or nickel are placed in a solution having a salt of gold, a thin film of gold is deposited by
(CDS 2011 I)
 - cooling to below $0^\circ C$
 - heating above $100^\circ C$
 - passing an electric current
 - just keeping it for 10 mm
- The life span of a Daniell cell may be increased by
 - larger Zn electrode
 - larger Cu electrode
 - lowering the temperature
 - lowering the concentrations
- During the electrolysis of fused NaCl which reaction will take place at anode?
 - Na^+ ions are oxidised
 - Cl^- ions are oxidised
 - Na^+ ions are reduced
 - Cl^- ions are reduced
- In a galvanic cell which of the following statements is correct?
 - Anode is negatively charged
 - Cathode is positively charged
 - Reduction occurs at cathode
 - Standard emf of the cell is always zero
- Pure water does not conduct electricity because it is
 - almost not ionised
 - low boiling
 - neutral
 - readily decomposed
- Which of the following aqueous solutions will conduct an electric current quite well?
 - Glycerol
 - HCl
 - Sugar
 - Pure water
- Sacrificial anode protects iron or ships, underground pipelines etc., from rusting, a process known as cathodic protection. Which one of the following metals cannot be used as a sacrificial anode? (CDS 2011 I)
 - Tin
 - Zinc
 - Magnesium
 - Aluminium
- The rusting of iron nail
(CDS 2005 I)
 - decreases its weight
 - increases its weight
 - does not affect weight but iron is oxidised
 - does not affect weight but iron is reduced
- During electrolysis the reaction at the anode is
 - oxidation
 - reduction
 - hydrolysis
 - hydration
- Assertion (A) Zinc displaces copper and silver from solutions of their salts.
Reason (R) Zinc has a lower oxidation potential than copper and silver.
 - Both A and R are true and R is the correct explanation of A.
 - Both A and R are true but R is not the correct explanation of A.
 - A is true but R is false.
 - A is false but R is true.
- Which of the following statements about the commonly used automobile battery are true?
 - It is usually a lead-acid battery.
 - It has six cells with a potential of 2 V each.
 - Its cells work as galvanic cells while discharging power.
 - Its cells work as electrolytic cells while recharging.
 Select the correct answer using the codes given below.
(CDS 2009 II)
 - I, II, III and IV
 - I, II and III
 - II and IV
 - III and IV
- Which one of the following metals is less reactive than hydrogen? (CDS 2007 II)
 - Barium
 - Copper
 - Lead
 - Magnesium
- Assertion (A) Zinc is used for galvanisation of iron.
Reason (R) Zinc is an amphoteric element.
 - Both A and R are true and R is the correct explanation of A.
 - Both A and R are true but R is not the correct explanation of A.
 - A is true but R is false.
 - A is false but R is true.

11. In order to prevent corrosion, iron pipes are often coated with a layer of zinc. This process is known as
 (a) electroplating
 (b) annealing
 (c) galvanisation
 (d) vulcanization

22. To protect iron against corrosion, the durable metal plating on it, is

- (a) tin plating (b) copper plating
 (c) zinc plating (d) nickel plating

23. The depolarizer used in dry cell batteries is

- (a) manganese dioxide (b) NH_4Cl
 (c) sodium triphosphide (d) potassium hydroxide

Answers

- | | | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (d) | 2. (d) | 3. (b) | 4. (d) | 5. (d) | 6. (a) | 7. (c) | 8. (c) | 9. (a) | 10. (b) |
| 11. (c) | 12. (a) | 13. (b) | 14. (a) | 15. (b) | 16. (a) | 17. (c) | 18. (a) | 19. (b) | 20. (c) |
| 21. (c) | 22. (c) | 23. (a) | | | | | | | |

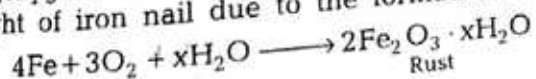
SSC POT.COM

Hints and Solutions

8. Electroplating is the process of depositing a thin layer of one metal over the surface of other metal by the process of electrolysis. Hence, when items or jewellery made of metals such as copper or nickel are placed in a solution having a salt of gold, a thin film of gold is deposited by passing an electric current.

14. The protection of iron against corrosion, by using a more reactive metal is known as sacrificial protection or cathodic protection. Zinc, magnesium and aluminium metals are more reactive than iron hence, they are used as a sacrificial anode while tin is less reactive than iron hence, it cannot be used as a sacrificial anode.

15. The rusting of iron nail takes place in the presence of air (oxygen) and water (moisture). It increases the weight of iron nail due to the formation of rust.



17. Zinc being more reactive displaces copper and silver from their salt solutions as its oxidation potential is higher than copper and silver.

18. Automobile battery used in vehicles provide a 12V potential difference by connecting six galvanic cells in series. Each cell provides 2 V for a total 12 V at full charge. Lead acid batteries are made up of plates of lead and separate plates of lead dioxide, which are submerged into an electrolyte solution of about 35% sulphuric acid and 65% water. Automobile battery or storage battery acts as voltaic cell (or galvanic cell) as well as electrolytic cell. Its cells work as galvanic cells during discharging power and during recharging, it acts as an electrolytic cell.

19. In the reactivity series of metals, copper is placed below the hydrogen hence, it is less reactive than hydrogen. On the other hand barium, lead and magnesium are placed above the hydrogen hence, these are more reactive than hydrogen.