

CHAPTER NO 08

ELECTRO CHEMISTRY

Q1. Define the following terms:

- | | | |
|-----------------------|---------------------|---------------------|
| 1. Electrochemistry | 2. Electrolytes | 3. Non- Electrolyte |
| 4. Electrolysis | 5. Conductors | 6. Non-conductors |
| 7. Strong electrolyte | 8. Weak electrolyte | 9. Ampere |
| 10. Coulomb | 11. Faraday | |

1. ELECTROCHEMISTRY:

"The branch of chemistry that deals with the relationship between electricity and chemical reaction."

2. ELECTROLYTES:

"Those substances which dissociate into their ions and conduct

Electricity in an aqueous solution or in molten state are called electrolytes."

Examples:

HCl , NaOH , NaCl(Sol),H₂SO₄ etc.

3. NON ELECTROLYTES:

"Those substances which do not dissociate into their ions and do not conduct electricity in an aqueous solution or molten state are called non electrolytes."

Examples:

Petrol, benzene, ethyl alcohol.

4. ELECTROLYSIS:

"A process in which electric current is pass through the ionic solution of electrolyte then dissociated ions travel towards their respective electrodes is called electrolysis."

5. CONDUCTORS:

"Those substances through which electric current can pass are called conductors."

Example:

All metals are conductors.

6. NON CONDUCTORS:

"Those substances through which electric current cannot pass are called non conductor".

Example:

Plastic and wood are non conductors.

7. STRONG (Capital):

“Those substances which are highly soluble and completely ionized are called strong electrolyte.”

Example:

Strong acid ,strong base and salt are strong electrolytes.

8. WEAK (Capital):

“Those substances which are not highly soluble and remained in unionized form are called weak electrolyte.”

Example:

All organic acids are weak electrolytes.

9. AMPERE:

“If one coulomb electric charge flows through a conductor in one second the amount of electric current is called Ampere.”

10. COULOMB:

“The quantity of charge when one ampere of current is passed for one second is called Coulomb.”

$$1C=1A \times 1S$$

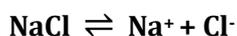
11. FARADAY:

“The current of 96500coulomb charge is called one faraday (F) charge.”

Q2. Write down the electrolysis of molten NaCl. Also write the reactions at anode, at cathode and overall reaction.

1. ELECTROLYSIS OF MOLTEN NaCl:

In solid state NaCl is a bad conductor of electricity but when it melts at 800 °C then it split into $Na^+ + Cl^-$.



2. STRUCTURE OF ELECTROLYTIC CELL:

Electrolytic cell is a glass vessel with platinum electrodes (Cathode and anode). These electrodes are connected to the battery. (Cathode connected to the negative end of the battery and anode connected to the positive end)

3. DETAILED OF THE PROCESS:

When electric current is passed through the molten NaCl. Electrolysis starts the positive ions (Na^+) are attracted towards cathode and the negative ions (Cl^-) are attracted towards anode.

AT CATHODE:

When Na^+ ion move towards cathode and gain electron to get neutralized.

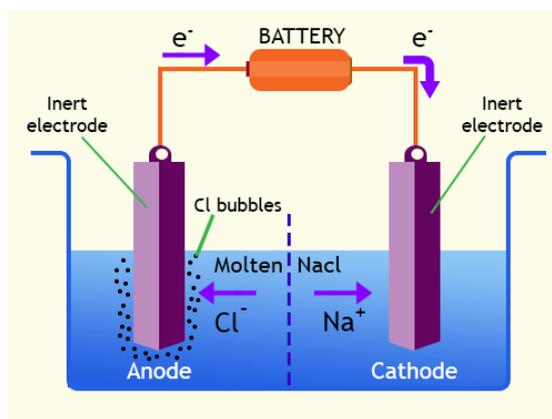


AT ANODE:

When Cl^- ion move towards anode and lose electron to get neutralized.



Over all reaction:



Electrolysis of molten NaCl

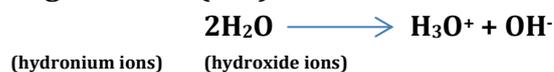
Q3. Write down the electrolysis of water with diagram?

ELECTROLYSIS OF WATER:

"Pure water does not conduct electricity because it ionizes partially into ions, but when few drops of acid or base or very few amount of salt is added in water it makes water to conduct electricity."

DETAILED OF PROCESS:

An electrolytic cell containing acidulated water. Two electrodes are dipped in the acidulated water. When electricity is passed through this water the positive ions (H_3O^+) move towards cathode and negative ions (OH^-) move towards anode.



AT CATHODE:

When H_3O^+ move towards cathode and they gain electron to get neutralized.

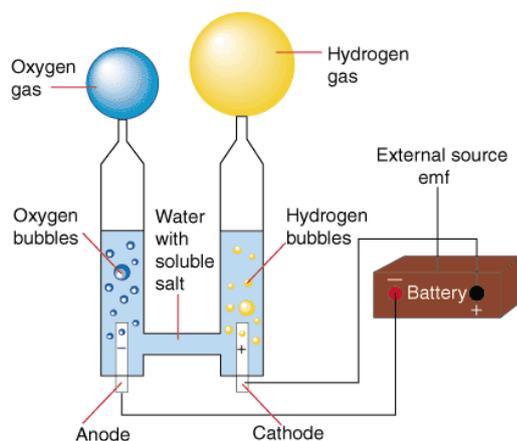


AT ANODE:

When OH^- ion move towards anode and lose electron to get neutralized to liberate O_2 gas



Over all reaction:



Electrolysis of Water

Q4. What is electrochemical cell? Write down its types and define them.

ELECTROCHEMICAL CELL:

"A device that produces electrical energy (current) through chemical energy is called electrochemical cell."

TYPES OF ELECTROCHEMICAL CELLS:

There are two types of electrochemical cell.

1. Galvanic or voltaic cell
2. Dry cell

GALVANIC OR VOLTAIC CELL:

An electrochemical cell which contains water as solvent is called galvanic or voltaic cell. It is a primary as well as reversible cell.

DRY CELL:

An electrochemical cell which contains paste or viscous mixture but does not contain water as solvent is called dry cell, dry cell is a primary as well as reversible cell.

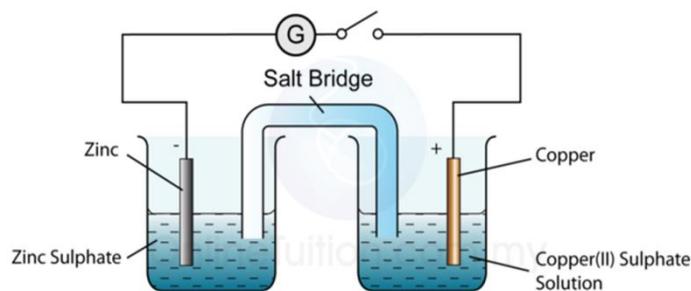
Q5. What is denial cell? Also define the function of salt bridge in denial cell?

DENIAL CELL:

A denial cell is an example of galvanic or voltaic cell, which is used to convert chemical energy into electrical energy.

FUNCTION OF SALT BRIDGE:

The function of salt bridge is to prevent the mixing of two solutions (ZnSO_4) and (CuSO_4) allows the ions to move through it from one part to another. It maintain the electrical conductivity in the two electrolytic solutions.



Q6. What is dry cell? Write down its construction and working with diagram.

DRY CELL:

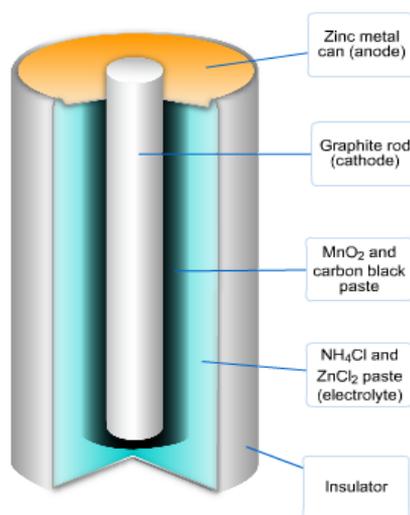
“An electrochemical cell which contains paste or viscous mixture but does not contain water as solvent is called dry cell, dry cell is a primary as well as reversible cell.”

CONSTRUCTION:

In a dry cell there is an outer zinc vessel which act anode and inner carbon (graphite) rod which acts as cathode. The graphite rod is surrounded by a mixture of MnO_2 and carbon powder. The electrolyte is a moist paste of NH_4Cl and $ZnCl_2$. The upper top position of the cell, is sealed with wax. A copper cap is fitted at the top of the carbon rod (Cathode) to make electrical contact. The whole cell is covered with safety cover.

WORKING:

When zinc and graphite electrodes are connected by a metallic wire, Zn gets oxidized to form Zn^{2+} ions which pass into the wet paste leaving behind electrons on the Zn contain and electrons move from Zn electrode to carbon electrode through the external circuit. The cell reactions are complex.



Dry Cell

Q7. What is battery? Write down the construction and working of lead storage battery with diagram.

BATTERY:

“A battery is a collection of two or more galvanic or voltaic cells which are connected in series. Batteries are secondary as well as reversible cells”.

LEAD STORAGE BATTERY: (CAR BATTERY)

Lead storage battery is used in auto mobiles. It is secondary battery and reversible cell.

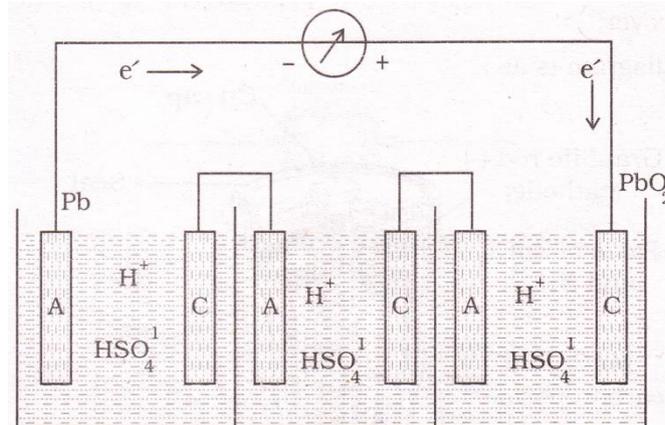
CONSTRUCTION:

There are several cathodes and several anodes which are connected together in series. Anodes are the lead alloy and cathodes are made up of red lead dioxide (PbO_2). The electrolyte used in lead storage battery is sulphuric acid having 30% concentration.

WORKING:

As the cell reaction proceeds lead sulphate (PbSO_4) precipitates are partially coats both electrodes and (H_2SO_4) is diluted because more and more water is formed. The battery is said to be discharged.

Now by connecting the battery to an external electrical source we can force the electrons to flow in opposite direction, i.e the net cell reaction can be reversed and the battery is recharged.



Lead storage battery

Q8. What is electroplating? Write down the process of Nickel plating with diagram.

ELECTROPLATING:

"It is a process of electrolysis which is used to coat one metal on to another."

NICKEL PLATING:

STRUCTURE OF CELL:

A piece of pure nickel metal is used as anode and the spoon or any object to be nickel plated is made as cathode. A solution of Nickel sulphate (NiSO_4) is used as electrolyte in the electrolytic cell. The two electrodes are joined with the battery.

DETAILED OF PROCESS:

On passing electric current the anode which is pure Nickel metal dissolve in the electrolytic solution by forming Ni^{2+} ions by the loss of electrons (Oxidation). Ni^{2+} ion from the solution move towards cathode where they gain electrons (reduction) and Ni metal deposited on the surface of the spoon (Cathode).

AT ANODE: (OXIDATION):

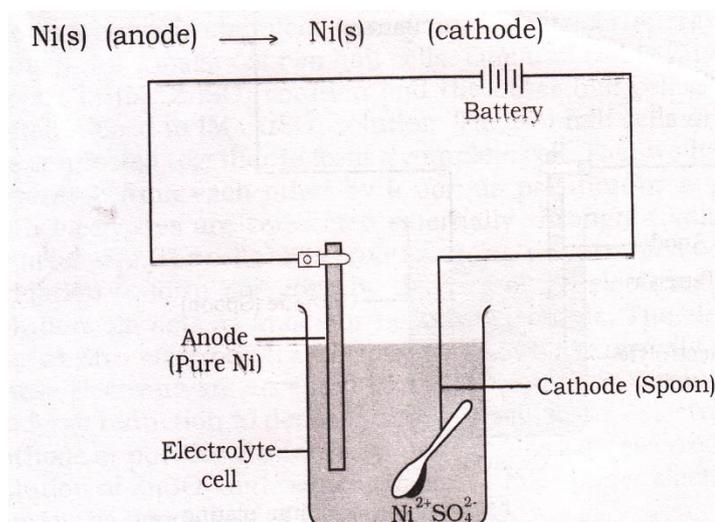


AT CATHIODE: (REDUCTON):



FINAL RESULT:

The overall reaction is simply the transfer of Ni as Ni^{2+} through NiSO_4 solution towards the cathode. i.e spoon is coated with Ni metal on the surface of the spoon.



Nickel Plating

Q9. Write down the process of chromium plating with diagram.

CHROMIUM PLATING:

STRUCTURE OF CELL:

A piece of pure chromium metal is used as anode and the spoon or any object to be chromium plate is made as cathode. A solution of chromium sulphur ($\text{Cr}(\text{SO}_4)_3$) is used as the electrolyte in the electrolytic cell. The two electrodes are joined with battery.

DETAILED OF PROCESS:

On passing the electric current the anode which is pure chromium metal dissolved in the electrolytic solution by forming Cr^{3+} ions by the loss of electrons (Oxidation) towards cathode where they gain electrons (reduction) and Cr metal deposited on the surface of the spoon (cathode)

AT ANODE (Oxidation):

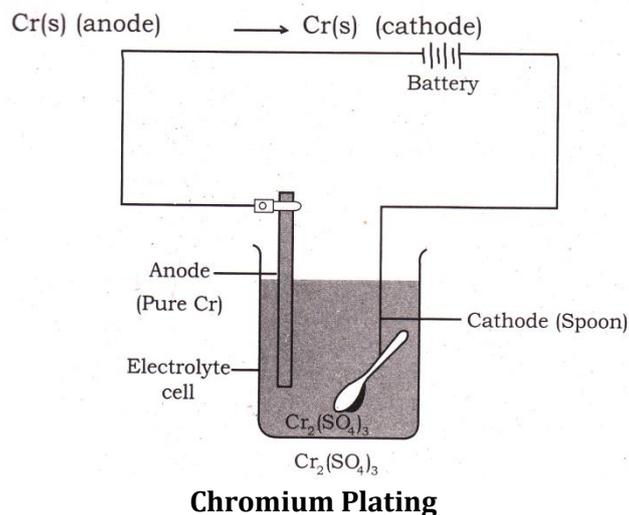


AT CATHODE (reduction):



FINAL RESULT:

The overall reaction is simply the transfer of Cr as Cr^{3+} through $\text{Cr}(\text{SO}_4)_3$ solution towards the cathode i.e, spoon is coated with Cr metal.



Q10. What is electro chemical equivalent(Z)?

ELECTRO CHEMICAL EQUIVALENT(Z):-

“The amount of substance deposited or liberated at electrodes when one coulomb electric charge is passed through an electrolyte.”

It is denoted by “Z”.

UNIT:

Its unit is kg/coulomb

Q11. State and explain faraday’s laws of electrolysis?

INTRODUCTION:

Micheal Faraday’s in 1833 discovered the laws governing the process of electrolysis, which are known as Faraday’s laws of electrolysis.

FARADAY’S FRIST LAW OF ELECTROLYSIS:

STATEMENT:

“The amount of any substance deposited or liberated at an electrode during electrolysis is directly proportional to the quantity of current passed through an electrolyte”.

MATHEMATICALLY:

$$W \propto A \times t$$

$$W = Z \times A \times t$$

Where,

W= amount of mass

Z= electrochemical equivalent

A= ampere (current)

T= time

FARDAY'S SECOND LAW OF ELECTROLYSIS:-

STATEMENT:

“The masses of different substances deposited or liberated when same quantity of current is passed through different electrolytes connected in series are proportional to their chemical equivalent masses”.

Explanation:

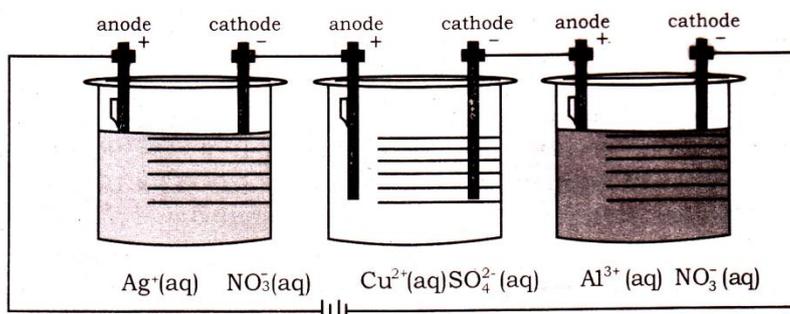
Equivalent mass of an element = atomic mass/ valency

Equivalent mass of Ag = $108/1 = 108\text{gm}$

Equivalent mass of Cu = $63.5/2 = 31.75\text{ mg}$

Equivalent mass of Al = $27/3 = 9\text{gm}$

Consider three different electrolytes AgNO_3 , CuSO_4 and $\text{Al}(\text{NO}_3)_3$ solutions are connected in series. Same quantity of current is passed through them, then the masses of Ag, Cu and Al deposited on their respective electrodes would be directly proportional to their equivalent mass.



Electrolytic cell connected in series

Q12. Write down some uses of electrolysis?

USES OF ELECTROLYSIS:

1. Electrolysis is a process used for extraction of metals from their ores.
2. This process is used for electroplating.
3. Many metals are extracted by the electrolysis from their molten compounds.
4. Many metals are purified into pure metals by this process.

Q13. Numericals