ELECTRO CHEMISTRY

TOPIC-1
Conductance in electrolytic solutions

VERY SHOR ANSWER QUESTIONS

1. What is electrolysis? Illustrate?

Ans: The substances whose aqueous solutions allow the passage of electric current and are chemically decomposed, are termed electrolytes. The process of decomposition of an electrolyte in to its corresponding ions, when current is passed through that is called electrolysis.

Electrolysis of sodium chloride solution: The solution of sodium chloride besides Na^+ and Cl^- ions possesses H^+ and OH^- ions due to ionization of water. However, the number is small as water is a weak electrolyte. When potential difference is established across the two electrodes, Na^+ and H^+ ions move towards cathode and Cl^- and OH^- ions move towards anode. At cathode H^+ ions are discharged in preference to Na^+ ions as the discharge potential of H^+ ions is lower than Na^+ ions. Similarly at anode, Cl^- ions are discharged in preference to OH^- ions.

$$NaCl <--> Na^+ + Cl^-$$

$$H_2O <--> H^+ + OH^-$$

At cathode	At Anode
$H^+ + e^- \rightarrow H$	$Cl^- \rightarrow Cl + e^-$
$2H \rightarrow H_2$	$2Cl \rightarrow Cl_2$

Thus, Na^+ and OH^- ions remain in solution and the solution when evaporated yields crystals of sodium hydroxide.

2. What products are obtained in the electrolysis of fused KCl and aqueous KCL between Pt electrodes?

Ans: Electrolysis of **molten** KCl liquid between Pt electrodes, the following reactions occur.

$$\mathbf{2}\ KCl <--> 2K^+ + 2Cl^-$$

At cathode **At Anode**

$2K^+ + 2e^- \rightarrow 2K$ $\qquad$ $2Cl^- \rightarrow Cl_2 + 2e^-$

Thus, KCl decomposes to form K and Cl_2 gas.

Electrolysis of **molten** KCl aqueous solution between Pt electrodes, the following reactions occur.

$$KCl \leftrightarrow K^+ + Cl^-$$

$$H_2O \leftrightarrow H^+ + OH^-$$

At cathode $\qquad$ **At Anode**

$4H_2O + 4e^- \rightarrow 2H_2 + 4e$ $\qquad$ $4Cl^- \rightarrow 2Cl_2 + 4e^-$

Thus, K^+ and OH^- ions remain in solution and the solution when evaporated yields crystals of Potassium hydroxide.

SHORT ANSWER QUESTIONS

1. **Explain metallic conductors?**

Ans:

Metallic or electronic conductors: Conductors which transfer electric current by transfer of electrons, without transfer of any matter, are known as metallic or electronic conductors. Metals such as copper, silver, aluminum, etc., non-metals like carbon (graphite - an allotropic form of carbon) and various alloys belong to this class. These materials contain electrons which are relatively free to move. The passage of current though these materials have no observable effect other than a rise in their temperature.

2. **Explain electrolytic conductors?**

Ans: Electrolytic conductors:

Conductors like aqueous solutions of acids, bases and salts in which the flow of electric current is accompanied by chemical decomposition are known as electrolytic conductors. The substances whose aqueous solutions allow the passage of electric current and are chemically decomposed, are termed electrolytes. In order to pass the current through an electrolytic conductor (aqueous solution or fused electrolyte), two rods or plates (metallic conductors) are always needed which are connected with the terminals of a battery. These rods or plates are known as electrodes. The electrode through which the current enters the electrolytic solution is called the anode (positive electrode) with the electrode through which the current leaves the electrolytic solution is known as cathode (negative

electrode). The electrolytic solution conductors electricity not by virtue of the electrolytic as in metallic conductors but as a result of movement of charged particles called ions towards the respective oppositely charged electrodes. The ions which carry positive charge and move towards cathode are termed cations while ions carrying negative charge which move towards anode are called anions. When these ions reach the boundary between a metallic and an electrolytic conductor, electrons are being either attached to or removed from the ions. Removal of electrons is termed oxidation (de-electronation) which occurs at anode while addition of electrons is called reduction (electronation) that takes place at cathode. Hence, flow of electrons through the outer circuit from anode to cathode across the boundary is accompanied by oxidation and reduction.

LONG ANSWER QUESTIONS

1. Explain Electrolysis and Electrolytic cell?

Electrolysis and Electrolytic cell

Preferential Discharge Theory: If an electrolytic solution consists of more than two ions and the electrolysis is done, it is observed that all the ions are not discharged at the electrodes simultaneously but certain ions are liberated at the electrodes in preference to others. This is explained by preferential discharge theory. It states that if more than one type of ions is attracted towards a particular electrode, then the one discharged is the ion which requires least energy. The potential at which the ion is discharge or deposition potential. The values of discharge potential are different for different ions. For example, the discharge potential of H+ ions is lower than Na+ ions when platinum or most of the other metals* are used as cathodes. Similarly, discharge potential of Cl^- ions is lower than that of OH^- ions. This can be explained by some examples given below:

(i) Electrolysis of sodium chloride solution: The solution of sodium chloride besides Na^+ and Cl^- ions possesses H^+ and OH^- ions due to ionization of water. However, the number is small as water is a weak electrolyte. When potential difference is established across the two electrodes, Na^+ and H^+ ions move towards cathode and Cl^- and OH^- ions move towards anode. At cathode H^+ ions are discharged in preference to Na^+ ions as the discharge potential of H^+ ions is lower than Na^+ ions. Similarly at anode, Cl^- ions are discharged in preference to OH^- ions.

$$NaCl <--> Na^+ + Cl^-$$

$$H_2O <--> H^+ + OH^-$$

At cathode	At Anode
$H^+ + e^- \rightarrow H$	$Cl^- \rightarrow Cl + e^-$
$2H \rightarrow H_2$	$2Cl \rightarrow Cl_2$

Thus, Na^+ and OH^- ions remain in solution and the solution when evaporated yields crystals of sodium hydroxide.

(ii) Electrolysis of copper sulphate solution using platinum electrodes:

$$CuSO_4 <--> Cu^{2+} + SO_4^{2-}$$

$$H_2O <--> H^+ + OH^-$$

At cathode	**At Anode**
$Cu^{2+} + 2e^- \text{ --> } Cu$	$2OH^- \text{ --> } H_2O + O + 2e^-$
	$O + O \text{ --> } O_2$

Copper is discharged at cathode as Cu^{2+} ions have lower discharge potential than H^+ ions. OH^- ions are discharged at anode as these have lower discharge potential than ions. The relationship between the quantity of electric charge passed through an electrolyte and the amount of the substance deposited at the electrodes was presented by Faraday in 1834, in the form of laws of electrolysis.