ELECTRO CHEMISTRY

TOPIC-5

Galvanic and voltaic cells, Cell notation with and with out salt bridge, salt bridge and its applications

VERY SHORT ANSWER QUESTIONS

1. What are galvanic cells?

It is a device in which a redox reaction is used to convert chemical energy into electrical energy, i.e., electricity can be obtained with the help of oxidation and reduction reaction. The chemical reaction responsible for production of electricity takes place in two separate compartments. Each compartment consists of a suitable electrolyte solution and a metallic conductor. The metallic conductor acts as an electrode. The compartments containing the electrode and the solution of the electrolyte are called half-cells. When the two compartments are connected by a salt bridge and electrodes are joined by a wire through galvanometer the electricity begins to flow. This is the simple form of voltaic cell.

2. **What are electrolytic cells?**

Ans: It is a device in which electrolysis (chemical reaction involving oxidation and reduction) is carried out by using electricity or in which conversion of electrical energy into chemical energy is done.

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3. What is electrochemical cell?

ELECTROCHEMICAL CELL: Electrochemical cell is a system or arrangement in which two electrodes are fitted in the same electrolyte or in two different electrolytes which are joined by a salt bridge. Electrochemical cells are of two types:

(a) Electrolytic cell

(b) Galvanic or voltaic cell

4. **What is Salt Bridge?**

Ans: SALT BRIDGE: Salt bridge is usually an inverted U-tube filled with concentrated solution of inert electrolytes. An inert electrolyte is one whose ions are neither involved in any electrochemical change nor do they react chemically with the electrolytes in the two half-cells. Generally salts like KCl, $KN0_3$, NH_4N0_3, etc., are used. For the preparation of salt bridge, gelatin or agar-agar is dissolved in a hot concentrated aqueous solution of an inert electrolyte and the solution thus formed is filled in the U-tube. On cooling the solution sets in the form of a gel in the U-tube. The ends of the U-tube are plugged with cotton wool as to minimize diffusion effects. This is used as a salt bridge.

SHORT ANSWER QUESTIONS

1. What is the significance of Salt Bridge?

Ans: Significance of salt bridge: The following are the functions of the salt bridge:

(i) It connects the solutions of two half-cells and completes the cell circuit.

(ii) It prevents transference or diffusion of the solutions from one half-cell to the other.

(iii) It keeps the solutions in two half-cells electrically neutral. In anodic half cell, positive ions pass into the solution and there shall be accumulation of extra positive charge in the solution around the anode which will prevent the flow of electrons from anode. This does not happen because negative ions are provided by salt bridge. Similarly, in cathodic half-cell negative ions will accumulate around cathode due to deposition of positive ions by reduction. To neutralize these negative ions, sufficient number of positive ions is provided by salt bridge. Thus, salt bridge maintains electrical neutrality.

(iv) It prevents liquid-liquid junction-potential, i.e., the potential difference which arises between two solutions when in contact with each other.

A broken vertical line or two parallel vertical lines in a cell reaction indicates the salt bridge.

$$Zn|Zn^{2+}||Cu^{2+}|Cu$$

Salt bridge can be replaced by a porous partition which allows the migration of ions without allowing the solutions to intermix.

2. What are the electrode signs used in an electrochemical cell?

Ans: Electrode Signs

The signs of the anode and cathode in the voltaic or galvanic cells are opposite to those in the electrolytic cells (Fig. 12.8).

ELECTROLYTIC CELL **VOLTAIC OR GALVANIC CELL**

(e.m.f. is applied to cell) (e.m.f. is generated by cell)

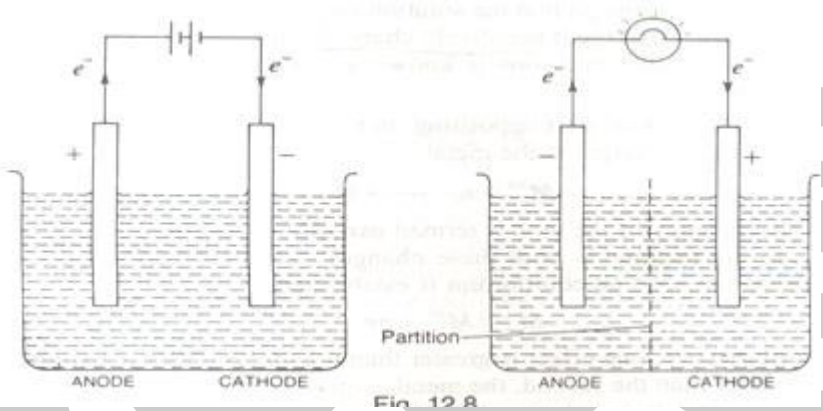


Fig. 12.8

	Electrolytic cell		Voltaic or Galvanic cell	
	Anode	**Cathode**	**Anode**	**Cathode**
Sign	+	-	-	+
Electron flow	Out	in	Out	in
Half-reaction	Oxidation	reduction	Oxidation reduction	

3. How an electrochemical cell is represented?

REPRESENTATION OF AN ELECTROCHEMICAL CELL (GALVANIC CELL)

The following universally accepted conventions are followed in representing an electrochemical cell:

(i) The anode (negative electrode) is written on the left hand side and cathode (positive electrode) on the right hand side.

(ii) A vertical line or semicolon (;) indicates a contact between two phases. The anode of the cell is represented by writing metal first and then the metal ion present in the electrolytic solution. Both are separated by a vertical line or a semicolon. For example,

$$\mathbf{Zn|Zn^{2+}} \quad \mathbf{or\ Zn;\ Zn^{2+}}$$

The molar concentration or activity of the solution is written in brackets after the formula of the ion. For example:

$$Zn|Zn^{2+}(1\ M) \quad or \quad Zn\ |\ Zn^{2+}(0.1\ M)$$

(iii) The cathode of the cell is represented by writing the cation of the electrolyte first and then metal. Both are separated by a vertical line or semicolon. For example,

$$\mathbf{Cu^{2+}|Cu} \quad \mathbf{or} \quad \mathbf{Cu^{2+};Cu} \quad \mathbf{or} \quad \mathbf{Cu^{2+}(1\ M)|Cu}$$

(iv) The salt bridge which separates the two half-cells is indicated by two parallel vertical lines.

(v) Sometimes negative and positive signs are also put on the electrodes

4. How a Daniel cell is represented?

Ans: The Daniel cell can be represented as:

$$Zn|ZnS0_4(aq)||CuS0_4(aq)|C^{+}u$$

Anode Salt bridge Cathode

Oxidation half-cell Reduction half-cell

or $Zn|Zn^{2+}||Cu^{2+}|Cu$

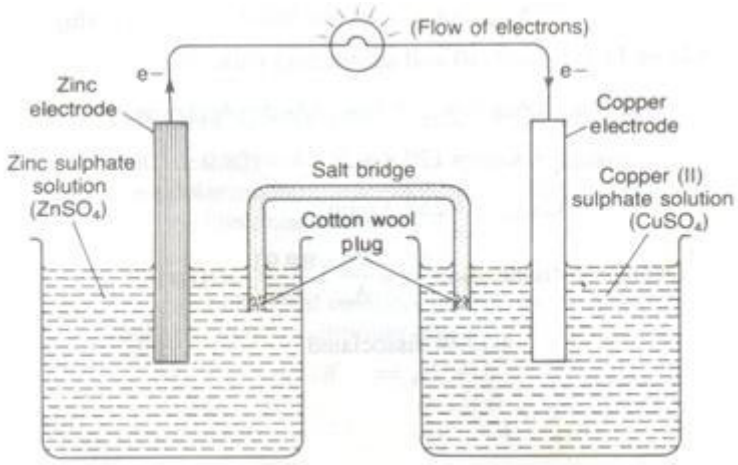
or $Zn|Zn^{2+}(1\ M)||Cu^{2+}(1\ M)|Cu$

LONG ANSWER QUESTIONS

1. Explain Daniel Cell.?

Ans: DANIEL CELL

It is designed to make use of the spontaneous redox reaction between zinc and cupric ions to produce an electric current (Fig.12.7). It consists of two half-cells. The half-cells on the left contains a zinc metal electrode dipped in $ZnSO_4$ solution.



The half-cell on the right consists of copper metal electrode in a solution $CuSO_4$. The half-cells are joined by a salt bridge that prevents the mechanical mixing of the solution.

When the zinc and copper electrodes are joined by wire, the following observations are made:

(i) There is a flow of electric current through the external circuit.

(ii) The zinc rod loses its mass while the copper rod gains in mass.

(iii) The concentration of ZnSO4 solution increases while the concentration of copper sulphate solution decreases.

(iv) The solutions in both the compartments remain electrically neutral.

During the passage if electric current through external circuit, electrons flow from the zinc electrode to the copper electrode. At the zinc electrode, the zinc metal is oxidized to zinc ions which go into the solution. The electrons released at the electrode travel through the external circuit to the copper electrode where they are used in the reduction of Cu^{2+}

ions to metallic copper which is deposited on the electrode. Thus, the overall redox reaction is:

$Zn(s) + Cu^{2+}$ $Cu(s) + Zn^{2+}(aq)$

Thus, indirect redox reaction leads to the production of electrical energy. At the zinc rod, oxidation occurs. It is the anode of the cell and is negatively charged while at copper electrode, reduction takes, place; it is the cathode of the cell and is positively charged.

Thus, the above points van be summed up as:

(i) Voltaic or Galvanic cell consists of two half-cells. The reactions occurring in half-cells are called half-cell reactions. The half-cell in which oxidation taking place in it is called oxidation half-cell and the reaction taking place in it is called oxidation half-cell reaction. Similarly, the half-cell occurs is called reduction half-cell and the reaction taking place in it is called reduction half-cell reaction.

(ii) The **electrode where oxidation occurs is called anode** and the **electrode where reduction occurs is termed cathode.**

(iii) Electrons flow from anode to cathode in the external circuit.

iv) Chemical energy is converted into electrical energy.

(v) The net reaction is the sum of two half-cell reactions. The reaction is Daniel cell can be represented as

Oxidation half reaction, **$Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$**

Reduction half reaction, **$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$**

Net reaction **$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$**
