Chemistry Study Materials for Class 12
(NCERT Based Notes of Chapter -03)
Ganesh Kumar Date:- 12/05/2021

Electrochemistry

Electrochemistry

Electrochemistry is the study of production of electricity from the energy released during a spontaneous chemical reaction and the use of electrical energy to bring about non-spontaneous chemical transformations

Electrochemical Cell

A spontaneous chemical process is the one which can take place on its own and in such a process the Gibb's energy of the system decreases. It is this energy that gets converted to electrical energy. The reverse process is also possible in which we can make non-spontaneous processes occur by supplying external energy in the form of electrical energy. These inter conversions are carried out in equipments called Electrochemical Cells

Types

Electrochemical Cells are of two types:

1. Galvanic Cell:-Converts chemical energy into electrical energy
2. Electrolytic Cell:-Converts electrical energy into chemical energy.

Galvanic Cell

Cell energy is extracted from a spontaneous chemical process or reaction and it is converted to electric current. For example,

Daniell Cell is a Galvanic Cell in which Zinc and Copper are used for the redox reaction to take place.

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

$$\mathbf{Oxidation\ Half : Zn\ (s) \longrightarrow\ Zn^{2+}\ (aq) + 2e^-}$$

$$\mathbf{Reduction\ Half : Cu^{2+}(aq) + 2e^- \longrightarrow\ Cu(s)}$$

Zn is the reducing agent and Cu^{2+} is the oxidising agent. The half cells are also known as Electrodes. The oxidation half is known as Anode and the reduction half is called Cathode. Electrons flow from anode to cathode in the external circuit. Anode is assigned negative polarity and cathode is assigned positive polarity. In Daniell Cell, Zn acts as the anode and Cu acts as the cathode.

(i) 1M concentration of each ion in the solution

(ii) A temperature of 298 K.

(iii)1 bar pressure for each gas.

Electrolytic Cell

These electrodes are dipped in and electrolytic solution containing cations and anions. On supplying current the ions move towards electrodes of opposite polarity and simultaneous reduction and oxidation takes place.

Preferential Discharge of ions

Where there is more than one cation or anion the process of discharge becomes competitive in nature. Discharge of any ion requires energy and in case of several ions being present the discharge of that ion will take place first which requires the energy.

Electrode potential

It may be defined as the tendency of an element, when it is placed in contact with its own ions to either lose or gain electrons and in turn become positively or negatively charged.
The electrode potential will be named as oxidation or reduction potential depending upon whether oxidation or reduction has taken place.

Characteristics:-

(i) Both oxidation and reduction potentials are equal in magnitude but opposite in sign.
(ii) It is not a thermodynamic property, so values of E are not additive.

Standard Electrode potential E^0

It may be defined as the electrode potential of an electrode determined relative to standard hydrogen electrode under standard conditions. The standard conditions taken are :

$$Zn(s) \mid Zn^{2+}\ (1\ M) \parallel Cu^{2+}\ (1\ M) \mid Cu \quad EMF = +1.1V$$

(f) If an inert electrode like platinum is involved in the construction of the cell, it may be written along with the working electrode in bracket say for example, when a zinc anode is connected to a hydrogen electrode.

Cell Potential or EMF of a Cell

The difference between the electrode potentials of two half cells is called cell potential. It is known as electromotive force (EMF) of the cell if no current is drawn from the cell.

$$E_{cell} = E_{cathode} + E_{anode}$$

For this equation we take oxidation potential of anode and reduction potential of cathode.
Since anode is put on left and cathode on right, it follows therefore,

$$E_{cell} = E_R + E_L$$

For a Daniel cell, therefore

$$E^o_{cell} = E^o_{Cu^{2+}/Cu} - E^o_{Zn/Zn^{+2}} = 0.34 + 0.76 = 1.10\ V$$

Cell Diagram OR Representation of Cell

The following conventions or notations are applied for writing the cell diagram in accordance with IUPAC recommendations. The Daniel cell is represented as follows:

$$Zn(s)_1 \mid Zn^{2+}(C_2) \parallel Cu^{2+}(C\ ) \mid Cu\ (s)$$

(a) Anode half cell is written on the left hand side while cathode half cell on right hand side.

(b) A single vertical line separates the metal from aqueous solution of its own ions.

$$Zn\ (s)\ \mid Zn^{2+}\ (aq); \qquad Cu^{2+}\ (aq)\ /\ Cu\ (s)$$

Anodic chamber — Cathodic chamber

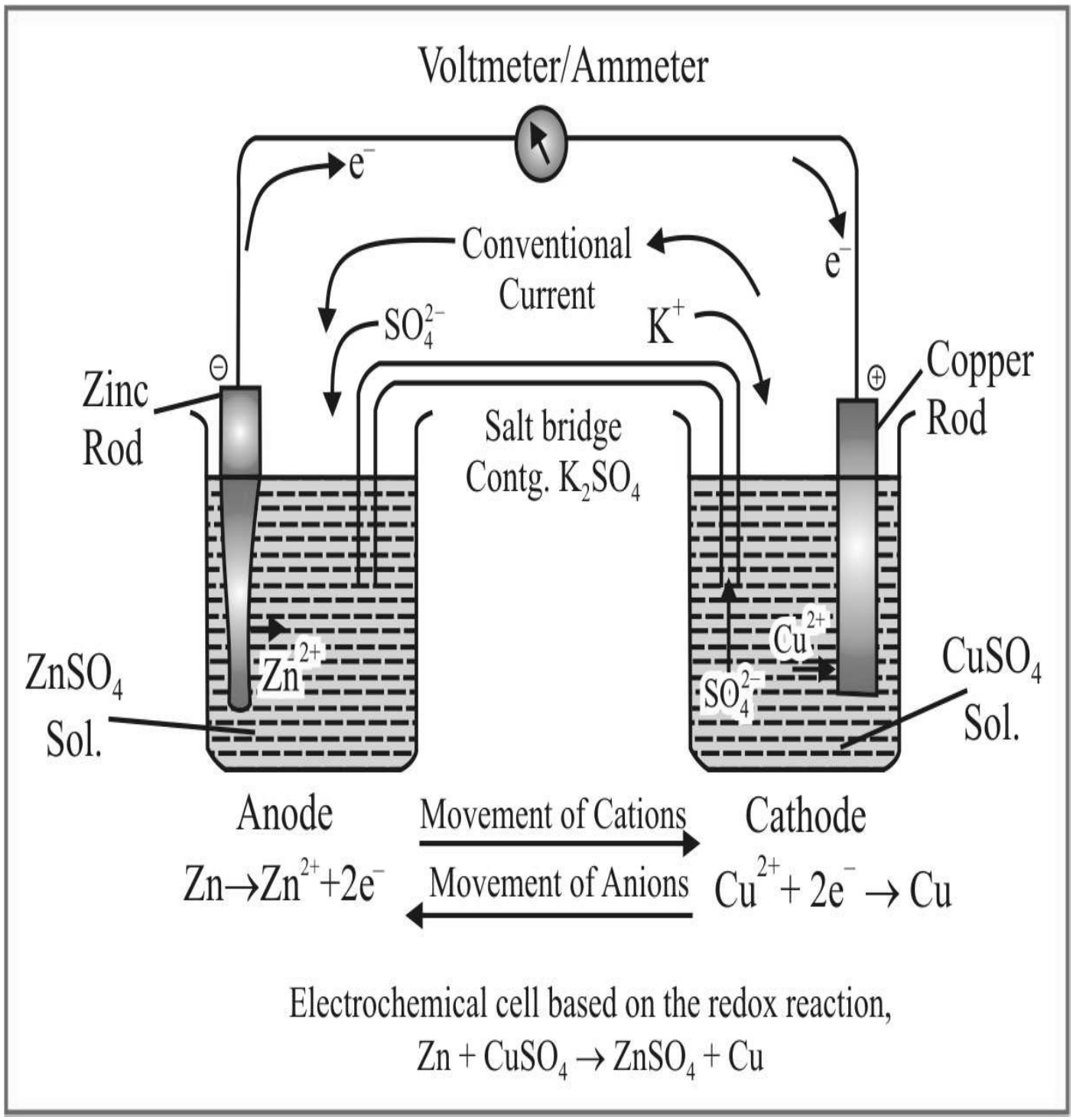
(c) A double vertical line represents salt bridge

(d) The molar concentration (C) is placed in brackets after the formula of the corresponding ion.

(e) The value of emf. of the cell is written on the extreme right of the cell. For example,

SALT BRIDGE

Salt bridge is used to maintain the charge balance and to complete the circuit by facilitating the flow of ions through it. It contains a gel in which an inert electrolyte likes Na_2SO_4 or KNO_3 etc are mixed. Negative ions flow to the anode and positive ions flow to the cathode through the salt bridge and charge balance is maintained and cell keeps on functioning.



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