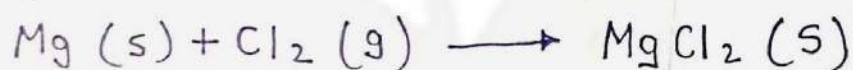


Chapter ⇒ 8

Redox Reactions

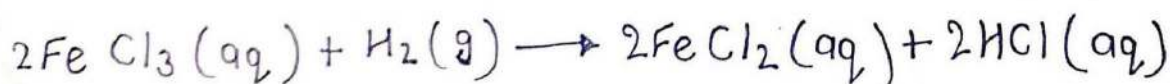
⇒ Oxidation :-

Oxidation is defined as the addition of oxygen / electronegative element to a substance or removal of hydrogen / electropositive element from a substance, for example,



⇒ Reduction :-

Reduction is defined as the removal of oxygen / electronegative element from a substance or addition of hydrogen or electropositive element to a substance. for example,



⇒ Redox Reaction in Term of Electron Transfer Reaction :-

A few example of redox reaction on the basis of electronic concept are given below:

According to electronic concept every redox reaction consist of two steps known as half reactions.

(i) Oxidation reaction: Half reaction that involve loss of electrons are called Oxidation reaction.

oxidising agent: Acceptor of electrons.

Reducing agent: Donor of electrons.



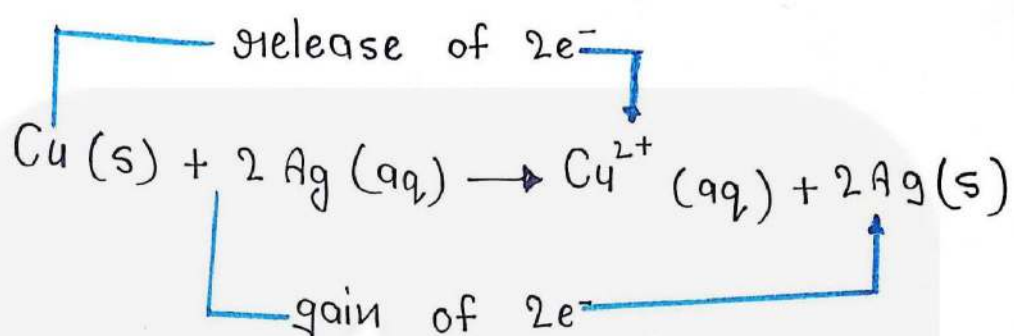
⇒ Competitive Electron Transfer Reactions :-

To understand this Concept let us do an experiment.

Place a strip of metallic Zinc in aqueous solution of copper nitrate as shown in fig. After one hour following changes will be noticed.

- (i) Strips becomes coated with reddish metallic copper.
- (ii) Blue colour of the solution disappears.
- iii) If hydrogen sulphide gas is passed through

the solution appearance of white ZnS can be seen on making the solution alkaline with ammonia.



⇒ Oxidation Number :-

It is the oxidation state of an element in a compound which is the charge assigned to an atom of a compound is equal to the number of electrons in the valence shell of an atom that are gained or lost completely or to a large extent by that atom while forming a bond in a compound.

⇒ Rules for Assigning Oxidation Number :-

(i) The oxidation number of an element in its elementary form is zero

For example, H_2 , O_2 , N_2 etc. have oxidation number equal to zero.

(ii) In a single monoatomic ion, the oxidation number is equal to the charge on the ion

For example, Na^+ ion has oxidation number of +1 and Mg^{2+} ion has +2.

(iii) Oxygen has oxidation number -2 in this compounds. However, there are some exceptions.

Compounds such as peroxides. $\text{Na}_2\text{O}_2, \text{H}_2\text{O}_2$

Oxidation number of oxygen = -1 in O_2

O.N. of oxygen = +2 O_2Fe

O.N. of oxygen = +1

(iv) In non-metallic compounds of hydrogen like $\text{HCl}, \text{H}_2\text{S}, \text{H}_2\text{O}$ oxidation number of hydrogen = +1 but in metal hydrides oxidation number of hydrogen = -1

[$\text{LiH}, \text{NaH}, \text{CaH}_2$ etc.]

(v) In compounds of metals and non-metals metal has positive oxidation number while non-metals have negative oxidation number.

For example, in NaCl . Na has +1 oxidation number while chlorine has -1.

(vi) If in a compound there are two non-metallic atoms the atom with high electronegativity is assigned negative oxidation number

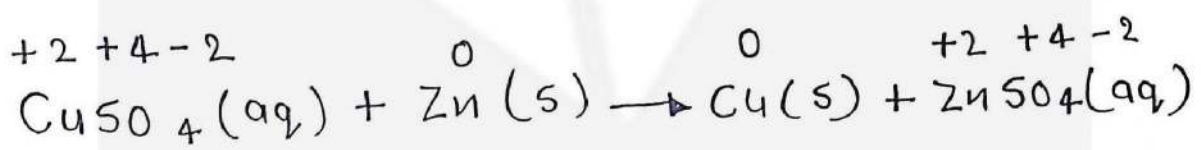
While other atoms have positive oxidation number.

(vii) The algebraic sum of the oxidation numbers of all atoms in a compound is equal to zero.

(viii) In poly atomic ion the sum of the oxidation no. of all the atoms in the ion is equal to the net charge on the ion.

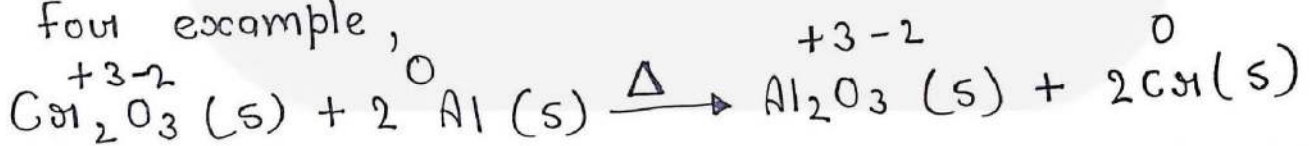
For example, in $(\text{CO}_3)^{2-}$ sum of Carbon atoms and three oxygen atoms is equal to -2.

Fluorine (F_2) is so highly reactive non-metal that it displaces oxygen from water



Disproportionation Reaction. In a disproportionation reaction an element in one oxidation state is simultaneously oxidised and reduced.

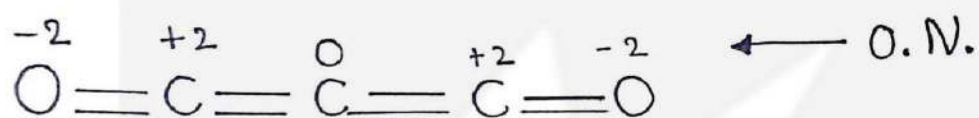
For example,



Hence, the oxygen of peroxide, which is present in -1 oxidation state is converted to zero oxidation state and in O_2 and in H_2O decreases to -2 oxidation state.

⇒ Fractional Oxidation Number :-

Element as such do not have any fractional Oxidation numbers. When the same element are involved in different bonding in a species, their actual Oxidation States are whole a Number but an average of these is fractional. For example, In C_3O_2



Fractional O.N. of a particular element can be calculated only if we know about the structure of the compound or in which it is present.

⇒ Balancing of Redox Reaction :-

- (i) Oxidation Number Method: following steps are involved:
- (ii) Write the correct formula for each reactant and product.
- (b) By assigning the oxidation charge in oxidation number can be identified.
- (c) Calculate the increase and decrease in oxidation

Number per atom with respect to the reactants. If more than one atom is present then a multiply by suitable coefficient.

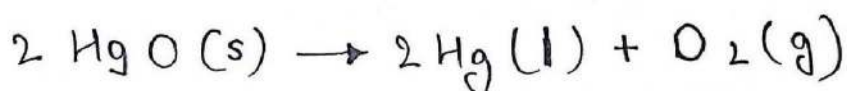
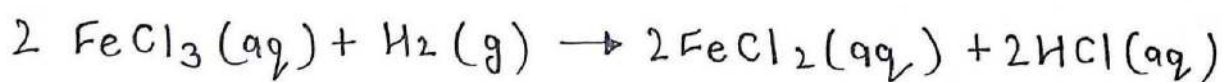
(d) Balance the equation with respect to all atom. Balance hydrogen and oxygen atoms also.

(e) If the reaction is carried out in acidic medium, use H^+ ions in the equation. If it is in basic medium use OH^- ions.

(f) Hydrogen atoms in the expression can be balanced by adding (H_2O) molecules to the reactants or products.

If there are same number of oxygen atoms on the both side of equation then it represents the balanced redox Reaction.

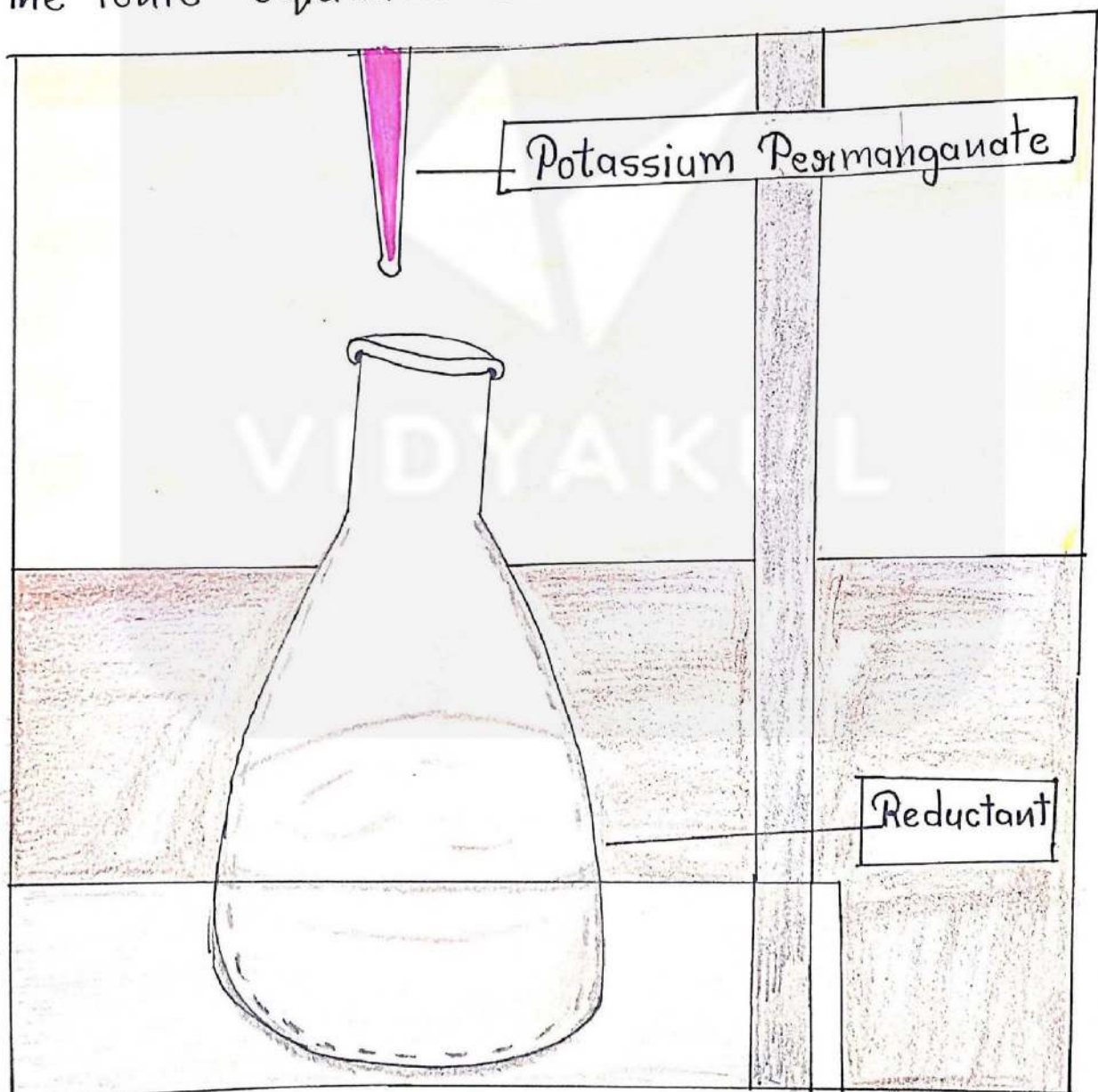
(ii) Half Reaction Method. In this method two half equation are balanced separately and then added together to give balanced equation.



→ Redox Reaction as the Basis for Titration:-

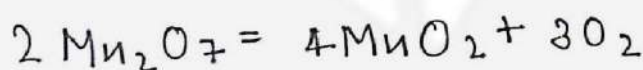
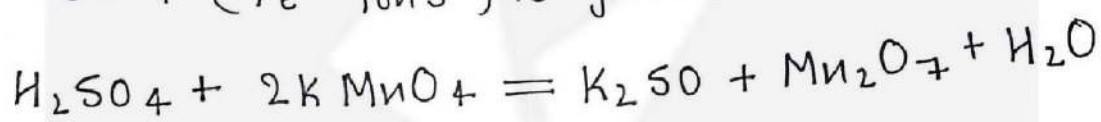
Potassium Permanganate Titration: In these titration potassium permanganate (pink in colour) acts as an oxidation agent in the acidic medium while oxalic acid or some ferrous salts acts as a reducing agents.

The ionic equation can be written as:



These are the example of redox titration. In both these titrations, potassium permanganate itself acts as an indicator. The appearance of pink colour in the solution represents the end point.

potassium Dichromate Titration: In place of potassium permanganate, potassium dichromate can also be used in the presence of dil. H_2SO_4 . The ionic equation for the redox reaction with $FeSO_4$ (Fe^{2+} ions) is given.



⇒ Limitation of Concept of Oxidation Number:-

According to the concept of Oxidation number, Oxidation means increase in oxidation number - by loss of electrons and reduction by means decrease in Oxidation number by the gain of electrons. However, during oxidation there is decrease in electron density while increase in electron density around the atom undergoing reduction.

→ Redox Reactions and Electrode Processes - Electrochemical Cells :-

A device in which the redox reaction is carried indirectly and the decrease in energy appears as the electrical energy are called electrochemical cell.

Electrolytic Cell. The cell in which electrical energy is converted into chemical energy.

Example, When lead storage battery is recharged, it acts as electrolytic cell.

→ Redox Reaction and Electrode Process:-

When zinc rod is dipped in copper sulphate solution redox reaction begins hence, zinc is oxidised to Zn^{2+} ion and Cu^{2+} ion are reduced to metal.

→ Redox Reactions :-

Reactions in which Oxidation and reduction occur simultaneously are called redox Reaction.

→ Oxidation Involves loss of one or more electrons.

⇒ Reduction :- Involves gain of one or more electrons.

⇒ Oxidising agent :- Accepting electrons.

⇒ Reducing agent :- Losing electrons.

⇒ Electrochemical Cell :- It is a device in which redox reaction is carried indirectly and decrease in energy gives electrical energy.

⇒ Electrode Potential :- It is the potential difference between the electrode and its ions in solution.

⇒ Standard electrode potential :- It is potential of an electrode with respect to standard hydrogen electrode.

⇒ Electrochemical Series :-

It is activity series. It has been formed by arranging the metals in order of increasing standard reduction potential value.