# Chemical Reactions & Equations OXIDATION AND REDUCTION

### **OXIDATION AND REDUCTION:**

## (a) Oxidation:

Oxidation is a chemical reaction in which a substance gains oxygen or loses hydrogen. Since oxygen is an electronegative element and hydrogen is an electropositive element, so, oxidation is defined as a reaction in which a substance gains and electronegative radical or loses and electropositive radical.

(i) A reaction in which a substance gains oxygen is known as oxidation.

## For eg.

- $S + 0_2 \longrightarrow S0_4$
- $2SO_2 + O_2 \longrightarrow 2SO_3$
- $2Ca + 0_2 \longrightarrow 2Ca0$
- $Pbs + 20_2 \longrightarrow PbSO_4$

(ii) Gain or addition of a electronegative radical For eg.

- $2\text{FeCl}_2 + \text{Cl}_2 \longrightarrow 2\text{FeCl}_3$
- $Mg + CI_2 \longrightarrow MgCI_2$
- $2\text{FeSO}_4 + \text{H}_2\text{SO}_4 + [0] \longrightarrow \text{Fe}_2(\text{SO}_4)_3 + \text{H}_2\text{O}_4$

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•  $SnCI_2 + CI_2 \longrightarrow SnCI_4$ 

(iii) Removal of a hydrogen atom.

For eg.

- 2HCI  $\longrightarrow$  CI<sub>2</sub> + H<sub>2</sub>
- $\operatorname{Zn} + \operatorname{H}_2 \operatorname{SO}_4 \longrightarrow \operatorname{ZnSO}_4 + \operatorname{H}_2$
- (iv) Removal or loss of electropositive radical or element.

For e.g.

•  $2KI + H_2O_2 \longrightarrow 2KOH + I_2$ 

## (b) Reduction :

It is a chemical reaction in which there is a gain of hydrogen or any electropositive radical or a loss of oxygen or electronegative radical.

(i) Gain of hydrogen.

For eg.

- $CI_2 + H_2S \longrightarrow 2HCI + S$
- $0_2 + 2H_2 \longrightarrow 2H_20$
- $C_2H_4 + H_2 \longrightarrow C_2H_6$

(ii) Gain of any electropositive radical or element.

#### For eg.

•  $\operatorname{SnCl}_2 + 2\operatorname{HgCl}_2 \longrightarrow \operatorname{Hg}_2\operatorname{Cl}_2 + \operatorname{SnCl}_4$ 

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•  $CuCI_2 + Cu \longrightarrow Cu_2CI_2$ 

(iii) Loss of oxygen atom.

For eg.

- $CuO + H_2 \longrightarrow Cu + H_2O$
- $ZnO + C \longrightarrow Zn + CO$

(iv) Loss of electronegative radical.

For eg.

- $Fe_2(SO_4)_3 + H_2 \longrightarrow 2FeSO_4 + H_2SO_4$
- $SnCI_4 + Hg_2CI_2 \longrightarrow 2HgCI_2 + SnCI_2$

#### **REDOX REACTIONS :**

Reduction is loss of electronegative element or radical. From all above example it is clear that oxidation and reduction occur side by side, i.e. there can be no oxidation without and equivalent reduction. In a reaction whenever one substance is oxidised the other is definitely reduced. The reverse is also true whenever one substance is reduced the other is oxidized. Such reactions in which oxidation and reduction take place simultaneously are known as **redox reactions**.



#### Oxidation

When hydrogen gas is passed through not cupric oxide, hydrogen is oxidised to water  $(H_2O)$  while cupric oxide is reduced to metallic copper by loss of oxygen. Hydrogen gas helps in reduction of cupric oxide to metallic copper so it is known as reducing agent, where as cupric oxide helps in oxidation of hydrogen so it is known as oxidizing agent. A

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substance, which brings about reduction, is called reducing agent. A substance, which brings about oxidation, is called an oxidizing agent.

## (a) Electronic Interpretation of Oxidation:

The electronic theory attempts to interpret oxidation on the basis of electron transfer. According to octet rule, atom will try to complete its octet by losing gaining or sharing electrons. Sodium chloride is an electrovalent compound and consists of an ion pair (Na<sup>+</sup>) (CI<sup>-</sup>) even in the solid state. In its formation, the neutral sodium loses and electron and becomes positively charged sodium ion. Sodium is said to be oxidised and loss of electrons is termed as oxidation.

$$2Na \rightarrow 2Na^+ + 2e^-$$
  
 $2Na^+ + 2CI^- \rightarrow 2NaCI$ 

#### (b) Electronic Interpretation of Reduction :

Reduction which is also referred to as electronation is a process involving the gain of electrons and is the reverse of oxidation.

### For example

Mg combines with oxygen and is oxidized to MgO. According to electronic theory magnesium atom loses two electrons from its outermost shell (M) and is oxidised to mG which oxygen atom gains these two electrons and gets reduced to oxide anion, hence oxidation involves loss of electrons and it is also referred as de- electronation. Reduction involves gain of electrons so it is referred to as electronation.

$$2Mg+O_2 \rightarrow 2MgO$$

$$Mg \rightarrow Mg^{+2} + 2e^-$$

$$0 + 2e^- \rightarrow 0^{2-}$$

$$Mg^{+2} + 0^{2-} \rightarrow MgO$$

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#### EFFECT OF OXIDATION REACTIONS IN EVERYDAY LIFE:

We are all aware of the fact that oxygen is most essential for sustaining life. One can live without food or even water for a number of days but not without oxygen. It is involved in a variety of actions which have wide range of effects on our daily life. Most of them are quite useful while a few may be harmful in nature. Some of these effects are briefly discussed. Some examples are-

#### (a) Combustion Reactions:

A chemical reaction in which a substance burns or gets oxidised in the presence of air or oxygen in called combustion reaction. For example, kerosene, coal, charcoal, wood etc. burn in air and thus, undergo combustion. Methane ( $CH_4$ ) a major constituent of natural gas undergoes combustion in excess of oxygen upon heating.

 $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell)$ 

#### Methane

Similarly, butane ( $C_4H_{10}$ ) the main constituent of L.P.G. also undergoes combustion.

 $C_4H_{10}(g) + 13/2O_2(g) \rightarrow 4CO_2(g) + 5H_2O(g)$ 

#### Butane

All combustion reactions are of exothermic nature and are accompanied by release of heat energy. The human body may be regarded as a furnace or machine in which various food stuffs that we eat undergo combustion or oxidation. The heat energy evolved keeps our body working. Carbohydrates such as glucose, fructose, starch etc. Are the major source of energy to the human body. They undergo combustion with the help of oxygen that we inhale to form carbon dioxide and water. For example.

 $C_5H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(\ell) + energy$ 

All combustion reactions are not accompanied by flame. Combustion is basically oxidation accompanied by release of energy.

## (b) Respiration:

Respiration is the most important biochemical reaction which releases energy in the cells. When we breathe in air, oxygen enters our lungs and passes into thousands of smalls air sacs (alveoli). These air sacs occupy a large area of membranes and oxygen diffuses from the membranes into blood. It binds itself to hemoglobin present in red blood cells and is carried to millions of cells in the body. Respiration occurs in these cells and is accompanied by the combustion of glucose producing carbon dioxide and water. Since the reaction is of exothermic nature, the energy released during respiration carry out many cell reactions and also keeps our hart and muscles working. It also provides the desired warmth to the body. Both carbon dioxide and water pas back into the blood and we ultimately breathe them out. Respiration takes place in the cells of all living beings.

Fish takes up oxygen dissolved in water through their gills while plants take up air through small pores (stomata) present in their leaves.