Oxidation and Reduction

1. Introduction

- **Oxidation** is a chemical change during which an atom or an ion loses one or more electrons. The atom or ion which loses the electrons is said to be **oxidised**. The species capable of losing electron is known as **reducing agent** or **reductant**.

$$Na - e^- \longrightarrow Na^+$$

or

$$Na \longrightarrow Na^+ + e$$

$$Zn - 2e^- \longrightarrow Zn^{2+}$$

or

$$Zn \longrightarrow Zn^{2+} + 2e$$

$$Fe^{2+} - e^- \longrightarrow Fe^{3+}$$

or

$$Fe^{2+} \longrightarrow Fe^{3+} + e^-$$

- **Reduction** is a chemical change during which an atom or ion gains one or more electrons. The atom or ion which gains electrons is said to be **reduced**. The species capable of accepting electrons acts as **oxidising agent** or **oxidant**.

$$Cu^{2+} + 2e^- \longrightarrow Cu$$

$$Cl_2 + 2e^- \longrightarrow 2\,Cl^-$$

2. Points of Remember

- In potassium superoxide the oxidation number of oxygen atom is $-\frac{1}{2}$ and in potassium ozonide (KO_3) it is $-\frac{1}{3}$. Super oxide ion (O_2^-) is coloured (orange red) and paramagnetic. Similarly ozonide ion (O_3^-) is also coloured and paramagnetic due to the presence of unpaired electrons in them.
- In metal carbonyls, the oxidation number of metal atom is zero. For example in $Ni(CO)_4$, $Fe(CO)_5$, $Cr(CO)_6$, $Mn_2(CO)_{10}$, the oxidation number of Ni, Fe, Cr and Mn is zero.
- $H_2S_2O_8$ is known as peroxydisulphuric acid (Marshalls acid) and H_2SO_5 is peroxomonosulphuric acid (Caro's acid). In the presence of peroxo linkage in the both.

3. Acidic nature of oxides of a metal increases with the increase in oxidation number of metal. For example:

$\overset{+2}{FeO}$	$\overset{+3}{Fe_2O_3}$	
Less acidic	More acidic	
$\overset{+2}{CrO}$	$\overset{+3}{Cr_2O_3}$	$\overset{+6}{CrO_3}$
Basic	Amphoteric	Acidic

4. The acidic nature of oxides of a non-metal also increases with increase in oxidation number of non-metal. For exam:

$\overset{+4}{SO_2}$	$\overset{+6}{SO_3}$
Less acidic	More acidic
$\overset{+2}{CO}$	$\overset{+4}{CO_2}$
Neutral	Acidic

- Acid strength of oxyacids of a non-metal increases with the increase in oxidation number of non-metal. For example

$\overset{+1}{H_2N_2O_2}$	<	$\overset{+3}{HNO_2}$	<	$\overset{+5}{HNO_3}$		
Hyponitrous acid		Nitrous acid		Nitric acid		
$\overset{+1}{HOCl}$	<	$\overset{+3}{HClO_2}$	<	$\overset{+5}{HClO_3}$	<	$\overset{+7}{HClO_4}$
Hyponitrous acid		Chlorous acid		Chloric acid		Perchloric acid

Note: The thermal stability of oxyacids of an element also increases with increase in oxidation number of element.

- The oxidation number of Cr in CrO_5 is + 6 because four of oxygen atoms are involved in peroxide linkage.