# REDOX REACTIONS

# OXIDATION NUMBER

## ❖ OXIDATION NUMBER

A. **Definition:** It represents the number of electrons gained or lost by atom when it changes in compound from a free state.

(a) If electron is lose by an atom in the formation of compound, oxidation number is given (+) ve sign.

(b) If electrons are gain by an atom in the formation of compound oxidation number given is (–) ve sign.

(c) It represents the real charge in case of ionic compounds and represents the imaginary charge in case of covalent compounds.

(d) Maximum oxidation no. of an element is equal to group no. in the periodic table

(e) Minimum oxidation no. of an element is equal to group no. – 8.

I A group elements always shows +1 oxidation no.

II A group elements always shows +2 oxidation no.

III A group elements show +3 oxidation no.
but +1 becomes more stable going down the group (due to inert pair effect)

IV A group shows –4 to +4 oxidation no.

V A group shows –3 to +5 oxidation no.

VI A group shows –2 to +6 oxidation no.

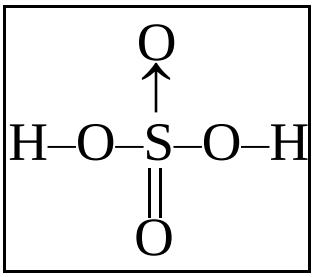
VII A group shows –1 to +7 oxidation no.

Inert gases show zero oxidation no.

## ◆ Oxidation no. for Coordinate bond

**(a)** When coordinate bond is formed from low electronegative element to high electronegative element then the $e^-$ donor element shows +2 oxidation number whereas $e^-$ acceptor element shows –2, oxidation no. in this type of bonded compounds.

For example, in $H_2SO_4$.

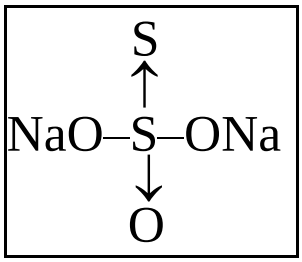



Here 'S' is low electronegative element than O. therefore,

number of S = +2 and O. N. of O = –2

**(b)** When coordinate bond is formed between the two same electronegative elements then the $e^-$ donor element shows +2 oxidation number where $e^-$ acceptor element shows –2 oxidation number in this type of bonded compound.

For example: – In $Na_2S_2O_3$




Here O.N. of 'S' is +2, Because it is $e^-$ donor and the other 'S' is –2, Because it is $e^-$ acceptor.

**(C)** When coordinate bond is formed from high electronegative element to low electronegative element then no change will be shown by both the elements, which is bonded by coordinate bond. e.g., $CH_3NC$

◆ **OXIDATION STATE**

Oxidation state of an atom is defined as oxidation number per atom for all practical purposes. Oxidation state is often expressed as oxidation number.

The rules to derive oxidation number or oxidation state

(a) The O.S. of an element in its free state is zero. Example O.S.' s of Na, Cu, $I_2$, $Cl_2$, $O_2$ etc. are zero

(b) Sum of O.S.' s of all the atoms in neutral molecule is zero.

(c) Sum of O.S.' s of all the atoms in a complex ion is equal number of charges present on it.

(d) In complex compounds, O.S. of some neutral molecules (ligands) is zero.
Example CO, NO, $NH_3$, $H_2O$.

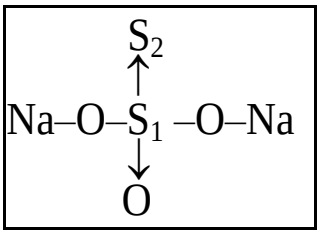
(e) Generally, O.S. of oxygen is –2 but in $H_2O_2$ it is –1 and in $OF_2$ it is +2.

(f) Generally, O.S. of Hydrogen is +1 but in metallic hydrides it is –1.

(g) Generally, O.S. of halogen atoms is –1 but in interhalogen compounds it changes.

**NOTE**: Sometimes same atom in a compound has different O.S.

For example, structure of $Na_2S_2O_3$ is




Here $S_1$ and $S_2$ both are sulphur atoms but they have different O.S.

O.S. of $S_1 = 6$

O.S. of $S_2 = -2$ (it is accepting two electrons from $S_1$)

Average O.S. of $S = \frac{6-2}{2} = 2$

(h) Generally, O.S. of alkali metals is +1 and that of alkaline earth metals is +2.

(i) O.S. of transition elements vary from compound to compound. Mn has O.S. from +1 to +7.

$Mn_2O \rightarrow +1$, $MnO \rightarrow +2$, $Mn_3O_4 \rightarrow 8/3$, $MnO_2 \rightarrow +4$, $Mn_2O_5 \rightarrow +5$, $MnO_4^{2-} \rightarrow +6$,

$MnO_4^{-} \rightarrow +7$

(j) O.S. of an atom may be fractional, negative, zero as well as Positive.

**Oxidation State As A periodic Property**

Oxidation state of an atom depends upon the electronic configuration of atom it is periodic properties.

(a) I A group or alkali metals shows +1 oxidation state.

(b) II A group or alkaline earth metals show +2 O.S.

(c) The maximum normal oxidation state, show by III A group elements is +3. These elements also show +2 to +1 oxidation states also.

(d) Elements of IVA group show their max & min. oxidation states +4 & - 4 respectively.

(e) Non-metals shows number of oxidation states, the relation between max & min. oxidation states for non-metals is equal to maximum O.S. –minimum O.S. = 8

For example, sulphur has maximum oxidation number +6 as being in VI A group element.

**Fractional Oxidation States**

Lot of elements shows fractional oxidation states.

For example, oxidation state of oxygen in superoxides of alkali metals ($KO_2$, $RbO_2$) is -1/2.

e.g.In $Fe_3O_4$, Fe shows its oxidation state as 8/3 as it is a mixed oxide and can be written as $Fe^{II}\,Fe_2^{III}O_4$.