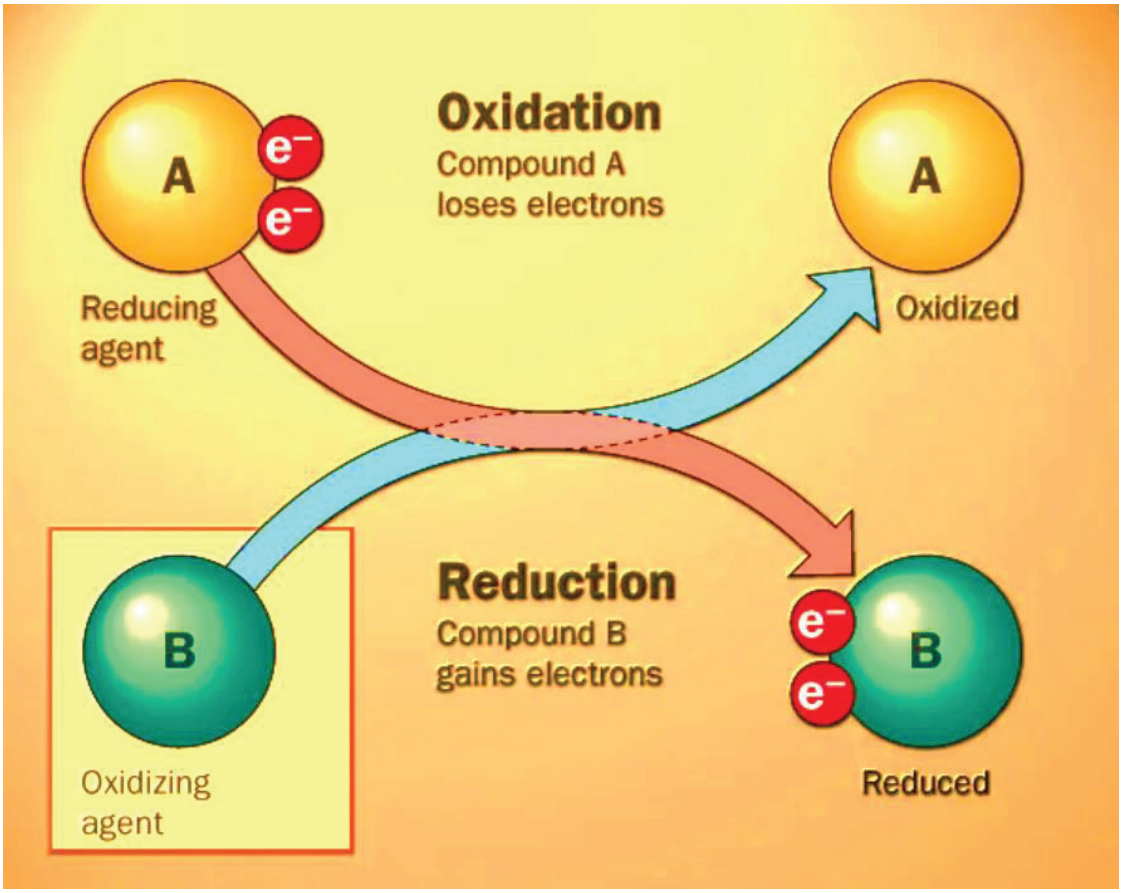
REDOX REACTIONS



REDOX REACTIONS

Introduction

Redox reaction is related to gain or loss of electrons. Reaction in which oxidation and reduction takes place simultaneously is called redox reaction. This chapter deals with problems based on redox reactions, oxidation number and balancing of redox reactions by ion, electron method and oxidation number method.

Oxidation Reactions

Oxidation is defined as the addition of oxygen/electronegative element to a substance or rememoval of hydrogen/ electropositive element from a susbtance.

$2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$

$Mg(s) + Cl_2(g) \longrightarrow MgCl_2(s)$

Reduction Reactions

Reduction is defined as the memoval of oxygen/electronegative element from a substance or addition of hydrogen or electropositive element to a substance.

$2FeCl_3(aq) + H_2(g) \longrightarrow 2FeCl_2(aq) + 2HCl(aq)$

$2HgO(s) \longrightarrow 2Hg(l) + O_2(g)$

Oxidation Number or Oxidation State

Oxidation number for an element is the arbitrary charge present on one atom when all other atoms bonded to it are removed. For example, if we consider a molecule of HCl, the Cl atom is more electronegative than H-atom, therefore, the bonded electrons will go with more electronegative chlorine atom resulting in formation of H^+ and Cl^- ions. So oxidation number of H and Cl in HCl are +1 and –1 respectively.

The following points are important to determine the oxidation number of an element.

1. The oxidation number of an atom in pure elemental form is considered to be zero. e.g., H_2, O_2, Na, Mg.
2. Oxidation number of any element in simple monoatomic ion will be equal to the

charge on that ion, for example, oxidation number of Na in Na^+ is +1.

3. Oxidation number of fluorine in its compound with other elements is always -1.
4. Oxidation number of oxygen is generally -2 but in case of peroxide (H_2O_2) oxygen has oxidation number -1. In a compound OF_2 the oxidation number of oxygen is +2.
5. The oxidation number of alkali metals (Na, K) and alkaline earth metals (Ca, Mg) are +1 and +2 respectively.
6. The oxidation number of halogens is generally -1 when they are bonded to less electronegative elements.
7. Oxidation number of hydrogen is generally +1 in most of its compounds but in case of metal hydride (NaH, CaH_2) the oxidation number is hydrogen is -1.
8. The algebraic sum of the oxidation numbers of all the atoms in a neutral compound is zero. In an ion, the algebraic sum of oxidation number is equal to the charge on that ion.

Oxidising and Reducing Agent

A substance which undergoes oxidation acts as a reducing agent while a substance which undergoes reduction acts as an oxidising agent. For example, we take a redox reaction,

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

In this reaction, Zn is oxidised to Zn^{2+} so Zn is reducing agent and Cu^{2+} is reduced to Cu so Cu^{2+} is an oxidising agent.

Types of Redox Reactions

1. **Combination reactions**

A combination reaction is a reaction in which two or more substances combine to form a single new substance. Combination reactions can also be called synthesis reactions. The general form of a combination reaction is:

$A + B \longrightarrow AB$

$Na(s) + Cl_2(g) \longrightarrow 2NaCl(s)$

2. **Decomposition reactions**

A decomposition reaction is a reaction in which a compound breaks down into two or more simpler substances. The general form of a decomposition reaction is:

$AB \longrightarrow A + B$

$2HgO(s) \longrightarrow 2Hg(l) + O_2(g)$

3. **Displacement reactions**

Displacement reaction is a chemical reaction in which a more reactive element displaces a less reactive element from its compound.

$CuSO_4(aq) + Zn(s) \longrightarrow ZnSO_4(aq) + Cu$

4. **Disproportionation reactions**

The reactions in which a single reactant is oxidized and reduced is known as Disproportionation reactions. The disproportionation reaction is given below.

$2H_2O_2 \longrightarrow 2H_2O + O_2$

Balancing of Redox Reactions

a. Oxidation Number Method

In this method number of electrons lost in oxidation must be equal to number of electrons gained in reduction. Following rules are followed for balancing of reactions:

1. Write the skeletal equation of all the reactants and products of the reaction.
2. Indicate the oxidation number of each element and identify the elements undergoing change in oxidation number.
3. Equalize the increase or decrease in oxidation number by multiplying both reactants and products undergoing change in oxidation number by a suitable integer.
4. Balance all atoms other than H and O, then balance O atom by adding water molecules to the side short of O-atoms.
5. In case of ionic reactions:

   i. **For acidic medium:** First balance O atoms by adding H_2O molecules to the side deficient in O atoms and then balance H-atoms by adding H+ ions to the side deficient in H atoms.

   ii. **For basic medium:** First balance O atoms by adding H_2O molecules to whatever side deficient in O atoms. The H atoms are then balanced by adding H_2O molecules equal in number to the deficiency of H atoms and an equal number of OH– ions are added to the opposite side of the equations.

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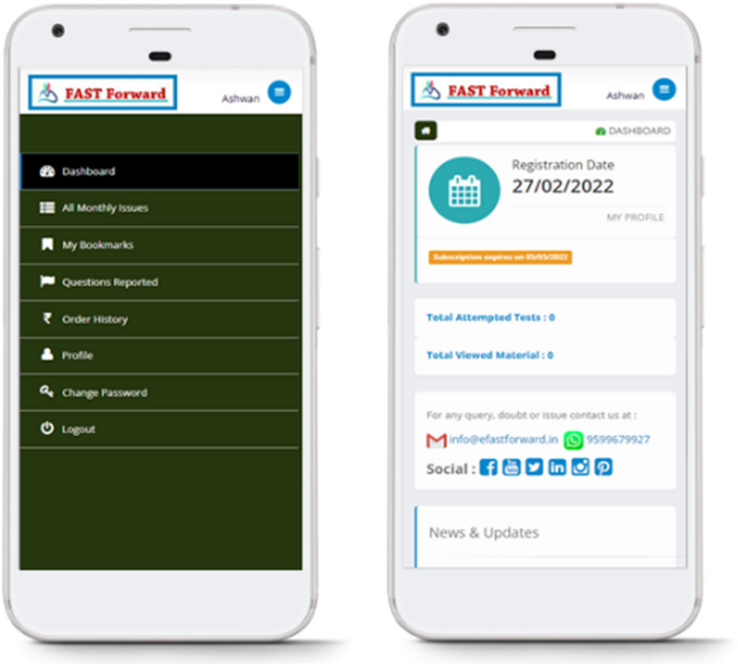

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