CHAPTER 1
INTRODUCTION

I. SYMBOLS OF ELEMENTS

Elements enter into many types of reactions and form large numbers of compounds. During some of these reactions many radicals are also formed. To follow these reactions chemical equations must be written. One such chemical equation is the formation of water by the combination of hydrogen and oxygen which can be written as below :-

Hydrogen + Oxygen = Water

Apart from the fact that writing the equation like this denoting the elements and compounds involved in the reaction is cumbersome, it does not convey any other information other than that of hydrogen and oxygen combining to form water. So symbols have been coined for denoting the elements in the shortest possible way.

A symbol is a concise representation of an element. Elements have been given symbols in three different ways :-

1. *Elements represented by a single letter:-*
   Examples : Carbon - C, Hydrogen - H, Boron - B, Sulphur - S, Oxygen - O, Iodine - I, Fluorine - F, Nitrogen - N, Phosphorus - P, Vanadium - V, Uranium - U.

2. *Elements represented by two letters :-*
   (The first letter is given in capital and the second in small)
   Chlorine - Cl, Bromine - Br, Calcium - Ca, Barium - Ba, Zinc - Zn, Silicon - Si, Cobalt - Co, Magnesium - Mg, Aluminium - Al, Helium - He.

3. *Elements which derive their symbols from their Latin names:-*

Mercury	-	Hg	(from Hydrargyrum)
Sodium	-	Na	(from Natrium)
Copper	-	Cu	(from Cuprum)
Iron	-	Fe	(from Ferrum)

As usual the intermediate product (CuO) is cancelled and each stage is balanced by the method of Balancing by Inspection.

(3) Balancing by Oxidation Number Change

(a) Oxidation Numbers

Oxidation is a process in which any atom or ion loses electrons, whereas reduction is the reaction in which any atom or ion gains or acquires electrons. So oxidation may also be called as de-eletronation (meaning removal of electrons) and reduction may also be called as electronation (meaning gaining of electrons).

In the classic example of the conversion of the ferrous ion to the ferric ion, oxidation takes place.

$$Fe^{2+} \longrightarrow Fe^{3+} + 1 \text{ electron}$$

Similarly stannous ion is oxidised to stannic ion and manganate is oxidised to permanganate.

$$Sn^{2+} \longrightarrow Sn^{4+} + 2 \text{ electrons } (2e^-)$$

$$\underset{\text{Manganate ion}}{MnO_4^{2-}} \longrightarrow \underset{\text{Permanganate ion}}{MnO_4^-} + 1 \text{ electron } (e^-)$$

The following are the examples of reduction :-

(i) Formation of chloride ion from chlorine etc.,

$$Cl + e^- \longrightarrow Cl^-$$

$$Br + e^- \longrightarrow Br^-$$

$$I + e^- \longrightarrow I^-$$

(ii) Formation of mercurous ion from mercuric ion.

$$\underset{\text{Mercuric ion}}{2Hg^{2+}} + 2e^- \longrightarrow \underset{\text{Mercurous ion}}{Hg_2^{2+}}$$

$$Hg_2^{2+} + 2e^- \longrightarrow 2Hg$$

mass of a proton is considered to be one atomic mass unit. So *a proton is a subatomic particle with 1 amu and one unit of positive charge.*

The third subatomic particle to be discovered is neutron. Its mass is the same as that of a proton but it carries no charge. So a neutron is a subatomic particle with 1 amu but it has no charge.

Other subatomic particles subsequently discovered are *mesons, positrons, antiprotons, quarks, pions, gluons* etc., but the most important are the electrons, protons and neutrons.

All matter has been found to have the same atomic structure. An atom is composed of a very small dense, positively charged nucleus surrounded by sufficient number of negatively charged electrons in different orbits so that the atom is electrically neutral. Practically all the mass of the atom is in the nucleus since the electrons have only very negligible mass.

The nucleus contains protons and neutrons. *Atomic number (Z) of an element is equal to the number of protons present in the nucleus of the atom of the element.* Since atom is electrically neutral, the atomic number is also equal to the number of electrons around the nucleus which are also known as extranuclear or planetary electrons. Hydrogen's atomic number is 1 since it contains one proton in the nucleus. Helium's atomic number is 2 since it contains two protons in the nucleus.

Mass number (A) of an atom is equal to the mass of the total number of nucleons, that is protons and neutrons in the nucleus. Thus hydrogen has a mass number of 1 and helium has a mass number of 4 since it contains two protons and two neutrons in its nucleus. Since the uranium atom has 92 electrons, 92 protons and 146 neutrons, its atomic number is 92 and its mass number is 238 (ie., 92 protons +146 neutrons).

ATOMIC SPECTRA

When any element in the gaseous or vapour state is heated either in a high temperature flame or in a discharge tube, the atoms of the element are excited and emit light radiations of characteristic colours and particular wavelengths. Thus sodium salts give out a *helium* contains two planetary electrons which are in the first orbit which is fully saturated. The next inert gas *neon* contains 10 planetary electrons. These are arranged as 2 in the first orbit and 8 in the second orbit fully saturating the two orbits. The next inert gas *argon* with 18 planetary electrons also is arranged as 2, 8, 8 in three orbits. For *krypton* (atomic number 36), the arrangement should be 2, 8, 18, 8. For *xenon* (atomic number 54), the arrangement is 2, 8, 18, 18, 8 and for *radon* with atomic number of 86, it is 2, 8, 18, 32, 18, 8. All the orbits are deemed to be saturated with these numbers of electrons. The other elements with different atomic numbers are having electronic arrangements with the outermost orbits being unsaturated. Langmuir's theory suffered from the defect that it failed to explain the physical and chemical properties of the higher elements completely.

BOHR-BURY SCHEME

This theory put forward by Bohr and Bury independently of each other in 1921 explained the physical and chemical properties of elements in a better way. The details of this scheme are

1. The maximum number of electrons which each orbit may contain may be given by the formula $2 \times n^2$ where n is the number of the orbit. According to this the first orbit contains $2 \times 1^2 = 2$, the second orbit $2 \times 2^2 = 8$, the third orbit $2 \times 3^2 = 18$, the fourth $2 \times 4^2 = 32$ etc.
2. The outermost orbit can contain only 8 electrons and the penultimate orbit (ie., the orbit next to the outermost) only 18.
3. A new orbit may begin to be formed even when the previous orbit is yet to the completed. A new orbit may also be formed after the outermost orbit has attained eight electrons.
4. The outermost orbit cannot contain more than 2 electrons and the penultimate one more than 9 electrons if the next inner orbit does not contain the maximum number of electrons as required under rule (1).

ZEEMAN EFFECT

Now we will revert back to the subject of emission spectrum and spectral lines. It was discovered by Zeeman in 1896 that *when the spectrum is subjected to or placed in a strong magnetic field,*