# d-Block and f-block

The elements lying in the middle of the periodic table between group-2 and group-13 are known as d-block elements. These d-block elements are called transition elements because they exhibit transitional behaviour between s-block and p-block elements Transition elements may be defined as the elements whose atoms or simple ions have partially filled d-Qrbitals. Zinc, Cadmium and mercury are not considered as transition elements because their atom as well as ion does not have partially filled orbitals)

## Electronic Configuration

Depending upon the subshell ( 3d, 4d, 5d) involved, transition elements are mainly classified into three series:

## First transition series or 3d series:

Elements of this series involves the filling of 3d orbitals.

## Second transition series or 4d series:

Elements of this series involves the filling of the 4d orbitals

**Third transition series or 5d series:**

It consists of elements which involve the filling of 5d orbitals

There is also an incomplete fourth series starting with actinium.

**General Electronic Configuration:**

$(n - 1)\ d^{1-9}\ ns^{1-2}$

(n-1) stands for the penultimate shell and the d-orbital may have one to ninjelectrons and the s–orbital of the ultimate shell (n) may two (or in some cases one) electrons. .

**Metallic Character.**

All the transition elements are metallic in nature and nearly all of them have simple hcp, ccp or bcc lattices. Due to their greater effective nuclear charge and the large no. of valence electrons, the metallic bond is quite strong and hence they are hard, possess high densities and high enthalpies of atornisation.

**Oxidation States:**

Transition elements exhibit variable oxidation state due to the participation of ns as well as (n-1)d electrons.

- Except scandium, the most common oxidation state of the first row transition elements is +2 which arises from the loss of two 4s electrons, which means that after scandium, d-orbital become more stable than the s-orbital.
- In the +2 and +3 oxidation states, bonds formed are generally ionic while in higher oxidation states, the bond formed are essentially covalent. For example in Mn04- , Cr04 2- etc. the bonds formed between metal and oxygen are covalent.
- The highest oxidation state shown by transition elements is +8.

**Transition metal ions form variety of complexes due to the following reasons:**

• Small size and high nuclear charge.

• Availability of vacant d-orbitals of suitable energy, which can accept lone pair of electrons donated by the molecule or ion (ligand).

Compounds of transition elements are usually coloured due to the promotion of an electron from one d-orbital to another by the absorption of visible light. It can be clearly explained as follows:

The d-orbital in the transition elements do not have same energy in their complexes. Under the influence of the ligand attached, the d-orbital split into two sets of orbital of slightly different energies. In the transition elements which have partly filled d-orbitals, the transition of electron can take place from one of the lower d-orbitals to some higher d-orbital within the same subshell. The energy required for this transition falls in the visible region. So when white light falls on these complexes they absorb a particular colour from the radiation for the promotion of electron and the remaining colours are emitted. The colour of the complex is due to this emitted radiation)

**Transition metals and their compounds are known to act as good catalyst due to the following reasons:**

- Due to their variable oxidation state, they form unstable intermediate compounds and provide a new path with lower activation energy for the reaction (Intermediate compound formation theory)
- In some cases the finely divided metals or their compounds provide a large surface area for adsorption and the adsorbed reactants react faster due to the closer contact (Adsorption theory)

Two types of magnetic behaviour are found in substances diamagnetism and paramagetism. Paramagnetic substances are attracted by the magnetic field and weigh more while the diamagnetic substances are slightly repelled by the magnetic field and weigh less.

As the transition metal ions generally contain one or more unpaired electrons in them and hence their complexes are generally paramagnetic. Paramagnetic character increases with increase in no.of unpaired electrons. Further paramagnetism is expressed in terms of magnetic moment, which is related to the no. of unpaired electrons as follows:

$\mu = \sqrt{n(n+2)}$ B.M.

n - no. of unpaired electrons

B.M. - Bohr mageton, a unit of magnetic moment

More the magnetic moment, more will be the paramagnetic character.

## Formation of Alloys:

As the transition elements have similar atomic sizes hence in the crystal lattice, one metal can be readily replaced by another metal giving solid solution and smooth alloys. The alloys so formed are hard and have often high melting point.

## Interstitial Compound:

Transition metals form no. of interstitial compounds, in which they take up atoms of small size e.g. H, C and N in the vacant spaces in the lattices. The presence of these atoms results in decrease in malleability and ductility of the metals but increases their tensile strength.