

**B.Sc. (Honours) Part-II
Paper-IIIA**

Topic: General features of Transition Elements

UG

Subject-Chemistry

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General Features of Transitions Elements

1. Complex Formation Tendency:

The cations of d-block elements are unique in their tendency to form complexes with several molecules such as ammonia, water, etc. or different ions such as cyanide, NO^-

2, halide ions, etc. These molecules or ions are called ligands. The complex forming tendency of these elements is attributed to the following factors:

- (a) Small size and high positive charge density,
- (b) Availability of vacant d-orbitals of right energy to accept the lone pairs of electrons from the approaching ligands,
- (c) Exhibition of variable oxidation states.

2. Magnetic Properties:

Many compounds of d-block elements exhibit magnetic properties. Qualitatively speaking, there are several kinds of magnetism. The substances which are weakly repelled by the strong magnetic field are termed as **diamagnetic** while those which are weakly attracted by the strong magnetic field are called **paramagnetic**. These substances lose their magnetism on removing the magnetic field. Diamagnetism is the property of the completely filled electronic subshells and is shown by all substances to more or less extent. Paramagnetism is produced by the presence of unpaired electrons and because most of the d-block metal atoms and ions have unpaired electrons, they are paramagnetic in behaviour.

In some transition metals (e.g. Fe, Co, Ni) unpaired electron spins are more pronounced and show much more paramagnetism than the other d-block metals. Such metals are called **ferromagnetic metals** and magnetic property shown by them is known as ferromagnetism. Such metals can be permanently magnetized.

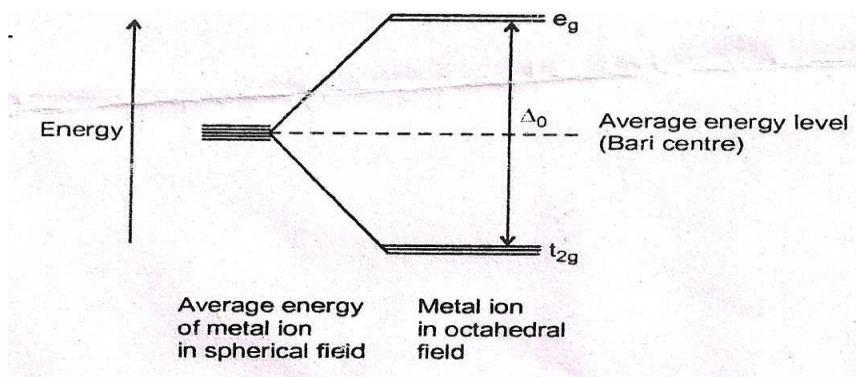
3. Formation of Coloured Ions/ Compounds:

The majority of compounds of d-block elements, whether ionic or covalent, are coloured in solid or solution state. This property of d-block elements is in marked difference from those of s or p-block elements which are white or light coloured.

The colour of a substance arises from the property of the substance to absorb light of certain wavelength in the region of visible light (white light) when the latter interacts with the substance. The colour of the substance is the colour of the transmitted light component and is complementary to the colour of light component absorbed. The colour of d-block metal ions is associated with

- (a) an incomplete d-subshell in the metal ion,
- (b) the nature of surrounding groups around the metal ion.

The whole act of exhibition of colour by d-block ions/compounds can be explained as follows. In a free gaseous or isolated ion the five d-orbitals are degenerate, i.e. of same energy. Since five d-orbitals are oriented differently in space, the surrounding groups affect the energy of some orbitals more than others in the compounds. This destroys their degeneracy. For example, in the simplest case of an octahedral complex, they form two groups of orbitals of different energy:



Bary centre

Thus, in d-block metal ions with partially filled d-subshell, it is possible to promote electron(s) from one set of d-orbitals to another set (group) of higher energy by fairly small energy absorbed from the visible light. The colour of the compounds depends on the energy difference (gap) between the two groups (sets) of d-orbitals. This in turn depends on the nature of ligands and their arrangement around the metal ion in the compound / complex.

4. Catalytic Activity:

The catalytic activity of d-block elements and their compounds is associated with their variable oxidation states and their capability of forming interstitial compounds. A number of d-block metals and their compounds are known to catalyse various reactions of industrial importance, e.g., vanadium (V) oxide in the manufacture of sulphuric acid by contact process, etc. An important view of the mechanism of catalysis is that at solid surface of the catalyst, bonds would be formed between the molecules of the reactants and atoms of the catalysts thereby increasing the concentration of the reactants at the surface. This weakens the bonds of the reactant molecules due to lowering of the activation energy.

5. Formation of Interstitial and Non-stoichiometric Compounds:

The d-block elements form interstitial compounds with small non-metal atoms such as H, C, N, B, Si, etc. due to the ability of metal lattice to accommodate these non-metal atoms between the metal atoms without distortion of structure. One of the striking properties of these metals is the formation of non-stoichiometric compounds which often exhibit semi conductivity, fluorescence and behave as heterogeneous catalysts. This non-stoichiometry is due to the defects in the solid structures.

6. Metallic Character and Alloy Formation:

All the d-block elements are metals, good conductors of heat and electricity, are malleable and ductile. All are solids except Hg (mercury) which exists as liquid at ordinary temperature. These metals form alloys with each other due to almost similar sizes of the atoms. Thus the atoms of one metal can easily take up positions in the crystal lattice of the other. The alloys are usually harder and have higher melting points than the parent metals, are more resistant to corrosion than their constituents.