



CO-ORDINATION COMPOUNDS

TERMS USED IN COORDINATION COMPOUNDS

(a) **Central Ion, Centre of coordination:** a coordination complex consists of a central atom or ion. It is a cation or neutral metal atom to which one or more neutral molecules or anions are attached.

(b) **Ligand.** A ligand is an ion or molecule that binds to a central metal atom.

(c) **Co-ordination number (CN).** The number of atoms or ions immediately surrounding a central atom in a complex or crystal is known as co-ordination number of that ion/atom.

(d) **Co-ordination sphere.** The array of molecules and ions (the ligands) directly attached to the central metal atom is known as the co-ordination sphere.

(e) **Oxidation number.** It is a number (numerical value) which represents the electric charge on the central metal atom of a complex ion.



(f) Complex Ion or Complex species: It is an electrically charged or even a neutral species, A complex ion is a species formed between a central metal ion and one or more surrounding ligands, molecules or ions that contain at least one lone pair of electrons.

VBT FOR BONDING IN CO-ORDINATION COMPOUNDS.

This theory was proposed by Linus Pauling.

The important features of Valence Bond Theory are as follows,

- (a) The metal-ligand bond is generated by the donation of pairs of electrons from the metal atom / ion to the ligand.
- (b) These orbitals of metal atom/ion undergo hybridization to give a set of hybrid orbitals of equal energy.
- (c) In complex formation, Hund's rule of maximum multiplicity is strictly followed.
- (d) These bonds are of equal strength and directional in nature.



ISOMERISM IN CO-ORDINATION COMPOUNDS

. Isomerism in coordination compounds may be divided into two main types:

- (1) Structural isomerism, (2) Stereo-isomerism

Structural Isomerism

It is displayed by compounds that have different ligands within their coordination spheres.

(i) Ionization isomerism: This type of isomerism arises when the coordination compound give different ions in solution. For example, there are two isomers of the formula $\text{Co}(\text{NH}_3)_5\text{BrSO}_4$.

(ii) Hydrate isomerism: This type of isomerism arises when different number of water molecules are present inside and outside the coordination sphere.

(a) $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$: Violet

(b) $[\text{Cr}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}_2 \cdot \text{H}_2\text{O}$: Green

(c) $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl} \cdot 2\text{H}_2\text{O}$: Green

(iii) Coordination isomerism: Coordination isomerism is a form of structural isomerism in which the composition of the complex ion varies. The ligands are interchanged in both the cationic and anionic ions to form isomers.



(iv) **Linkage isomerism:** This type of isomerism occurs in complex compounds which contain **ambidentate** ligands like NO_2^- , SCN^- , CN^- , $\text{s}_2\text{O}_3^{2-}$ and CO .

(v) **Polymerisation isomerism:** This type of isomerism exists in those complexes that have the same empirical formula, but differ in molecular mass by integral multiples of empirical mass.

(vi) **Coordination position isomerism:** In a coordination isomer, the total ratio of ligand to metal remains the same, but the ligands attached to a specific metal ion change.

cobalt ions)

Stereo-Isomerism

Compounds are stereo-isomers when they contain the same ligands in their coordination spheres but differ in the way that these ligands are arranged in space. Stereo-isomerism is of two types, *viz.*, geometrical isomerism and optical isomerism.

(I) **Geometrical isomerism:** This type of isomerism is also known as *cis-trans* isomerism.

(II) **Optical isomerism:** A coordination compound which can rotate the plane of polarized light is said to be optically active. When the coordination compounds have same formula but differ in their abilities to rotate directions of the plane of polarized light are said to exhibit optical isomerism



and the molecules are optical isomers. The optical isomers are pair of molecules which are non superimposable mirror images of each other. The essential requirement for a substance to be optically active is that the substance should not have a plane of symmetry in its structure. The isomer which rotates the plane of polarized light to right direction is termed dextro (*d*-form) while the isomer which rotate the plane of polarised light to left direction is termed laevo (*l*-form). The two optically active isomers are collectively called enantiomers. Enantiomers are mirror image of each other but their physical properties are different.

In Metallurgical operations: (a) Silver and gold are extracted by the use of complex formation.

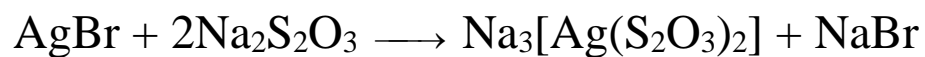
Nickel is extracted by converting it into a volatile complex, nickel carbonyl by use of carbon monoxide (Mond's process). The complex decomposes on heating again into nickel and carbon monoxide.



(Associated with
other metals)



In Photography: In photography, the image on the negative is fixed by dissolving all the remaining silver halides with hypo solution in the form of a soluble complex.



(Soluble) (Soluble)

In Electroplating: Metal complexes release metal slowly and thus give a uniform coating in electroplating of the metal on the desired object. Cyano complexes of silver, gold, copper *etc.*, are used for the electrodeposition of these metals.

In Biological processes: Metal complexes are of immense importance in biological processes. Haemoglobin, the red blood pigment, which acts as oxygen carrier to different parts of the body in animals is a complex of iron (II). Vitamin B₁₂ is a complex of cobalt metal. The green colouring matter of plants, called chlorophyll, is a complex of magnesium.