

# CHEMISTRY STUDY MATERIALS FOR CLASS 12 (NCERT BASED REVISION NOTES)

**GANESH KUMAR**

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## Coordination Compounds

### 1. Valence bond theory:

According to this theory, the metal atom or ion under the influence of ligands can use its  $(n-1)d$ ,  $ns$ ,  $np$  or  $ns$ ,  $np$ ,  $nd$  orbitals for hybridisation to yield a set of equivalent orbitals of definite geometry such as octahedral, tetrahedral, and square planar.

These hybridised orbitals are allowed to overlap with ligand orbitals that can donate electron pairs for bonding.

Coordination no.	Type of hybridisation	Distribution of hybrid orbitals in space
4	$sp^3$	tetrahedral
4	$dsp^2$	Square planar
5	$sp^3d$	Trigonal bipyramidal
6	$sp^3d^2$ (nd orbitals are involved – outer orbital complex or high spin or spin free complex)	Octahedral
6	$d^2sp^3$ ((n-1) d orbitals are involved –inner orbital or low spin or spin paired complex)	Octahedral

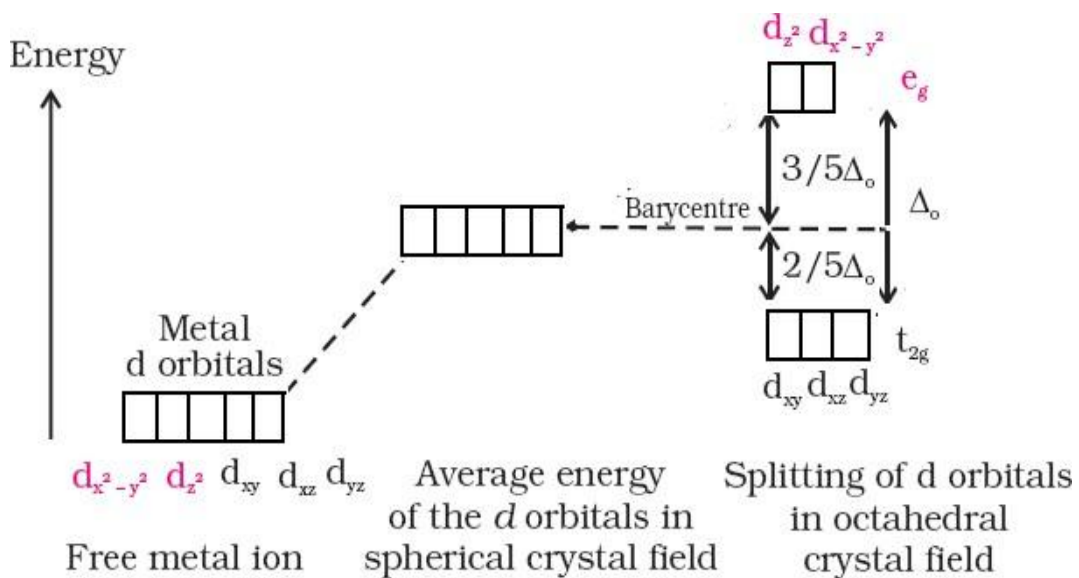
2. **Magnetic properties of coordination compounds:** A coordination compound is paramagnetic in nature if it has unpaired electrons and diamagnetic if all the electrons in the coordination compound are paired.

$$\text{Magnetic moment} = \sqrt{n(n+2)}$$

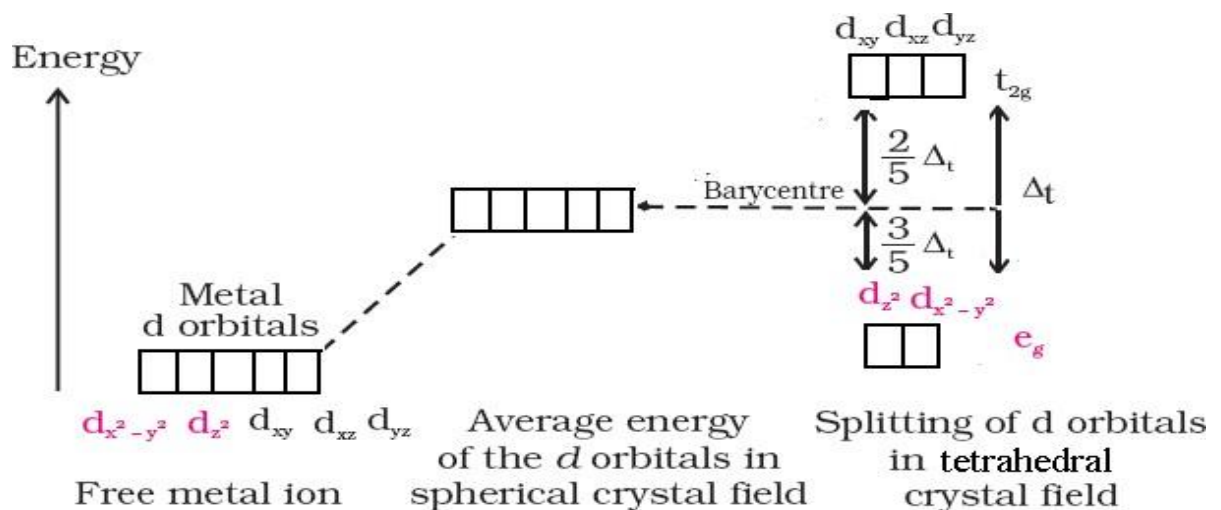
Where n is number of unpaired electrons.

3. **Crystal Field Theory:** It assumes the ligands to be point charges and there is electrostatic force of attraction between ligands and metal atom or ion. It is theoretical assumption.

4. **Crystal field splitting in octahedral coordination complexes:**



5. **Crystal field splitting in tetrahedral coordination complexes:**



6. For the same metal, the same ligands and metal-ligand distances, the difference in energy between  $e_g$  and  $t_{2g}$  level is 3

$$\Delta t = -\frac{4}{9} \Delta_0$$

7. **Metal carbonyls.** Metal carbonyls are homoleptic complexes in which carbon monoxide (CO) acts as the ligands. For example:  
 $Ni(CO)_4$

The metal – carbon bond in metal carbonyls possesses both  $\sigma$  and  $\pi$  characters. The metal-carbon bond in metal carbonyls possess both  $s$  and  $p$  character. The M–C  $\sigma$  bond is formed by the donation of lone pair of electrons from the carbonyl carbon into a vacant orbital of the metal. The M–C  $\pi$  bond is formed by the donation of a pair of electrons from a filled  $d$  orbital of metal into the vacant antibonding  $\pi^*$  orbital of carbon monoxide. The metal to ligands bonding creates a synergic effect which strengthens the bond between CO and the metal.

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