

COORDINATION COMPOUNDS - II

18. **Oxidation number of central atom:** The oxidation number of the central atom in a complex is defined as the charge it would carry if all the ligands are removed along with the electron pairs that are shared with the central atom.
19. **Homoleptic complexes:** Those complexes in which metal or ion is coordinate bonded to only one kind of donor atoms. For example: $[\text{Co}(\text{NH}_3)_6]^{3+}$
20. **Heteroleptic complexes:** Those complexes in which metal or ion is coordinate bonded to more than one kind of donor atoms. For example: $[\text{CoCl}_2(\text{NH}_3)_4]^+$, $[\text{Co}(\text{NH}_3)_5\text{Br}]^{2+}$
21. **Isomers.** Two or more compounds which have same chemical formula but different arrangement of atoms are called isomers.
22. **Types of isomerism:**
 - a. Structural isomerism
 - i. Linkage isomerism
 - ii. Solvate isomerism or hydrate isomerism
 - iii. Ionisation isomerism
 - iv. Coordination isomerism
 - b. Stereoisomerism
 - i. Geometrical isomerism
 - ii. Optical isomerism
23. **Structural isomerism:** This type of isomerism arises due to the difference in structures of coordination compounds. Structural isomerism, or constitutional isomerism, is a form of isomerism in which molecules with the same molecular formula have atoms bonded together in different orders.
 - a. **Ionisation isomerism:** This form of isomerism arises when the counter ion in a complex salt is itself a potential ligand and can displace a ligand which can then become the counter ion. Example: $[\text{Co}(\text{NH}_3)_5\text{Br}] \text{SO}_4$ and $[\text{Co}(\text{NH}_3)_5 \text{SO}_4] \text{Br}$

- b. **Solvate isomerism:** It is isomerism in which solvent is involved as ligand. If solvent is water it is called hydrate isomerism, e.g., $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$ and $[\text{CrCl}_2(\text{H}_2\text{O})_4]\text{Cl}_2 \cdot 2\text{H}_2\text{O}$
- c. **Linkage isomerism:** Linkage isomerism arises in a coordination compound containing ambidentate ligand. In the isomerism, a ligand can form linkage with metal through different atoms. Example: $[\text{Co}(\text{NH}_3)_5\text{ONO}]\text{Cl}_2$ and $[\text{Co}(\text{NH}_3)_5\text{NO}_2]\text{Cl}_2$
- d. **Coordination isomerism:** This type of isomerism arises from the interchange of ligands between cationic and anionic entities of different metal ions present in a complex. Example: $[\text{Co}(\text{NH}_3)_6][\text{Cr}(\text{C}_2\text{O}_4)_3]$ and $[\text{Cr}(\text{NH}_3)_6][\text{Co}(\text{C}_2\text{O}_4)_3]$
24. **Stereoisomerism:** This type of isomerism arises because of different spatial arrangement.
- a. **Geometrical isomerism:** It arises in heteroleptic complexes due to different possible geometrical arrangements of ligands.
- b. **Optical isomerism:** Optical isomers are those isomers which are non superimposable mirror images.

25. **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.

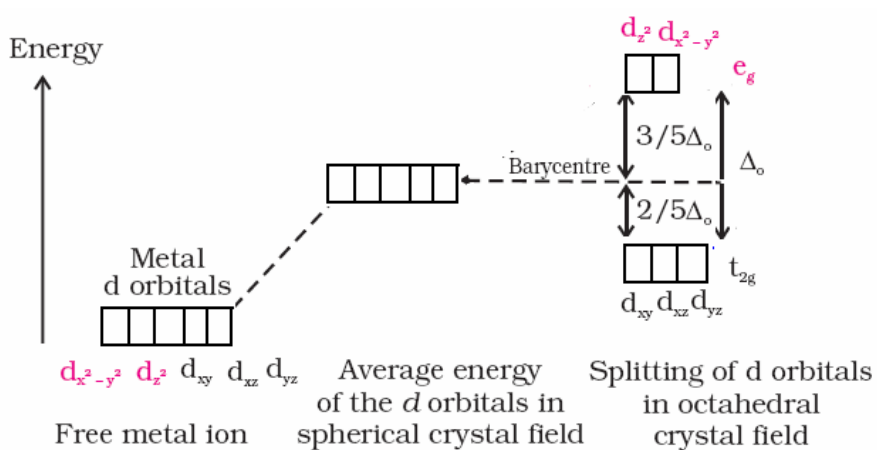
Coordination number	Type of hybridisation	Distribution of hybrid orbitals in space
4	sp^3	tetrahedral
4	dsp^2	Square planar
5	sp^3d	Trigonal bipyramidal
6	sp^3d^2 (nd orbitals are involved – outer orbital complex or high spin or spin free complex)	Octahedral

6	d^2sp^3 ((n-1) d orbitals are involved –inner orbital or low spin or spin paired complex)	Octahedral
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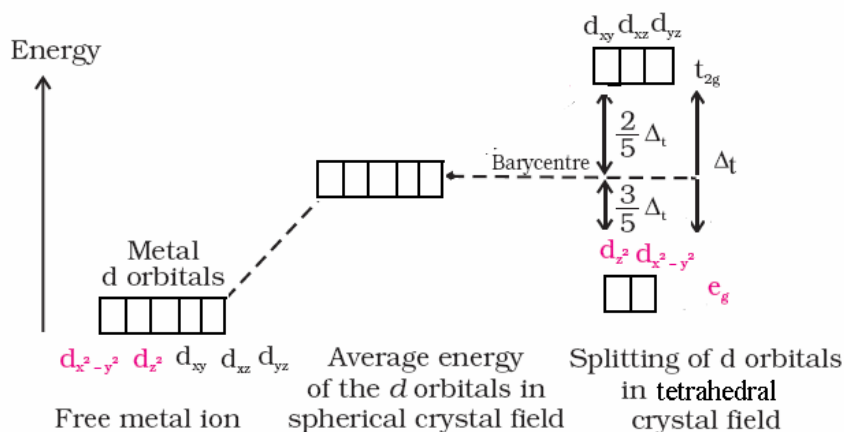
26. **Magnetic properties of coordination compounds:** A coordination compound is paramagnetic in nature if it has unpaired electrons and diamagnetic if all the electrons in the coordination compound are paired.

Magnetic moment $\mu = \sqrt{n(n+2)}$ where n is number of unpaired electrons.

27. **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.
28. **Crystal field splitting in octahedral coordination complexes:**



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



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

$$\Delta_t = -\frac{4}{9} \Delta_0$$

31. **Metal carbonyls.** Metal carbonyls are homoleptic complexes in which carbon monoxide (CO) acts as the ligand. For example: $\text{Ni}(\text{CO})_4$

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