

CHEMISTRY STUDY MATERIALS FOR CLASS 12

(NCERT BASED NOTES OF CHAPTER - 09)

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Coordination Compounds

1. **Werner's coordination theory:** Werner was able to explain the nature of bonding in complexes. The postulates of Werner's theory are:

- a. Metal shows two different kinds of valencies: primary valence and secondary valence.

Primary valence	Secondary valence
This valence is normally ionizable.	This valence is non – ionizable.
It is equal to positive charge on central metal atom.	The secondary valency equals the number of ligand atoms coordinated to the metal. It is also called coordination number of the metal.
These valencies are satisfied by negatively charged ions.	It is commonly satisfied by neutral and negatively charged, sometimes by positively charged ligands.
Example: in CrCl_3 , the primary valency is three. It is equal to oxidation state of central metal ion.	

- b. The ions/ groups bound by secondary linkages to the metal have characteristic spatial arrangements corresponding to different coordination numbers.

- c. The most common geometrical shapes in coordination compounds are octahedral, square planar and tetrahedral.

2. **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.
3. **Homoleptic complexes:** Those complexes in which metal or ion is coordinate bonded to only one kind of donor atoms. For example:
 $[\text{Co}(\text{NH}_3)_6]^{3+}$
4. **Heteroleptic complexes:** Those complexes in which metal or ion is coordinate bonded to more than one kind of donor atoms. For example:
 $[\text{CoCl}_2(\text{NH}_3)_4]^+$, $[\text{Co}(\text{NH}_3)_5\text{Br}]^{2+}$
5. **Isomers.** Two or more compounds which have same chemical formula but different arrangement of atoms are called isomers.
6. **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
7. **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 potential ligands and can displace ligands 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 ligands. 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 $[\text{Cr}(\text{NH}_3)_6][\text{Co}(\text{C}_2\text{O}_4)_3]$
8. **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 super imposable mirror images.
