

CHEMISTRY DEPARTMENT

- **Name of the teacher** : *Dr. Nandini Kumari*
- **Subject:** *Chemistry (Inorganic)*
- **Course:** B.Sc (Hon's)
- **Year** : Second year
- **Semester** : IV (CC-408)
- **College** : Patna Women's College, Patna University, Patna
- **Topic:** *Co-ordination Chemistry (Part I)*

Coordination Chemistry

- **Molecular or addition compound**: Addition compounds are formed When stoichiometric amount of two or more stable compounds.
- Example: $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$
- Addition compounds are two types

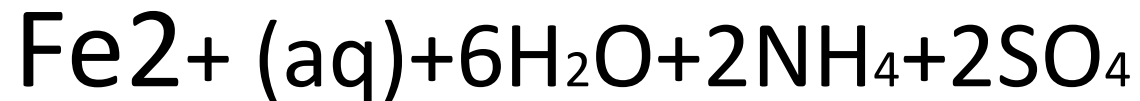
Addition Compound

Two types

Double Salt

Coordination compound

- *Double Salt*: Double salt are those which lose their identity in solution.
- Example: $\text{FeSO}_4 (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$



- *Co-ordination compound* : Those which retain their identity in solution.
- Example: $[(\text{Co}(\text{NH}_3)_6)]^{3+}$
- *Complex ion*: Complex ion may be defined as
- an electrically charged ion which consists of central metal ion surrounded by group of ions or neutral molecules.

- Central metal ion and Ligand : Cation which one or more neutral molecule or ions coordinated is called central ion while the molecule or ions attached are called ligands.
- Example: $[\text{Ni}(\text{NH}_3)_6]^{2+}$
- Ni^{2+} is a central metal ion and NH_3 is a ligand. Ligand is also called donor atoms.

- *Coordination Number*: Total no. of ligands attached to the central ion are called coordination number.
- Example: $[\text{Ni}(\text{NH}_3)_6]^{2+}$
- Coordination no. is 6.
- *Coordination sphere* : Central ion together with molecules or ions coordinated to it constitute is termed as coordination sphere.

- *Types of ligands* : Ligand contains one or more than one donor atoms for coordination with the central ion.
- Ligands classified on the basis of donor atoms.

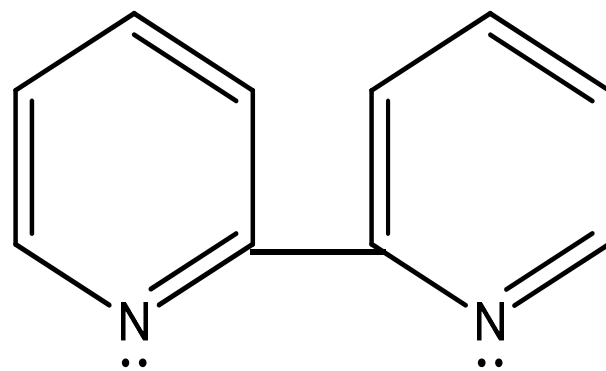
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Types of ligands

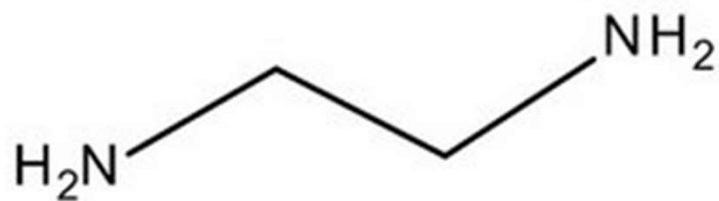
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graph TD; A[Types of ligands] --> B[Monodentate]; A --> C[Bidentate]; A --> D[Polydentate]; A --> E[chelating]
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Monodentate Bidentate Polydentate chelating

- *Monodentate ligands*: Ligands which donate only one pair of electrons.
- Example: NH_3 , H_2O , Cl
- *Bidentate ligands*: Ligands which donate two pair of electrons.
- Example: Bipyridine, Ethylenediamine

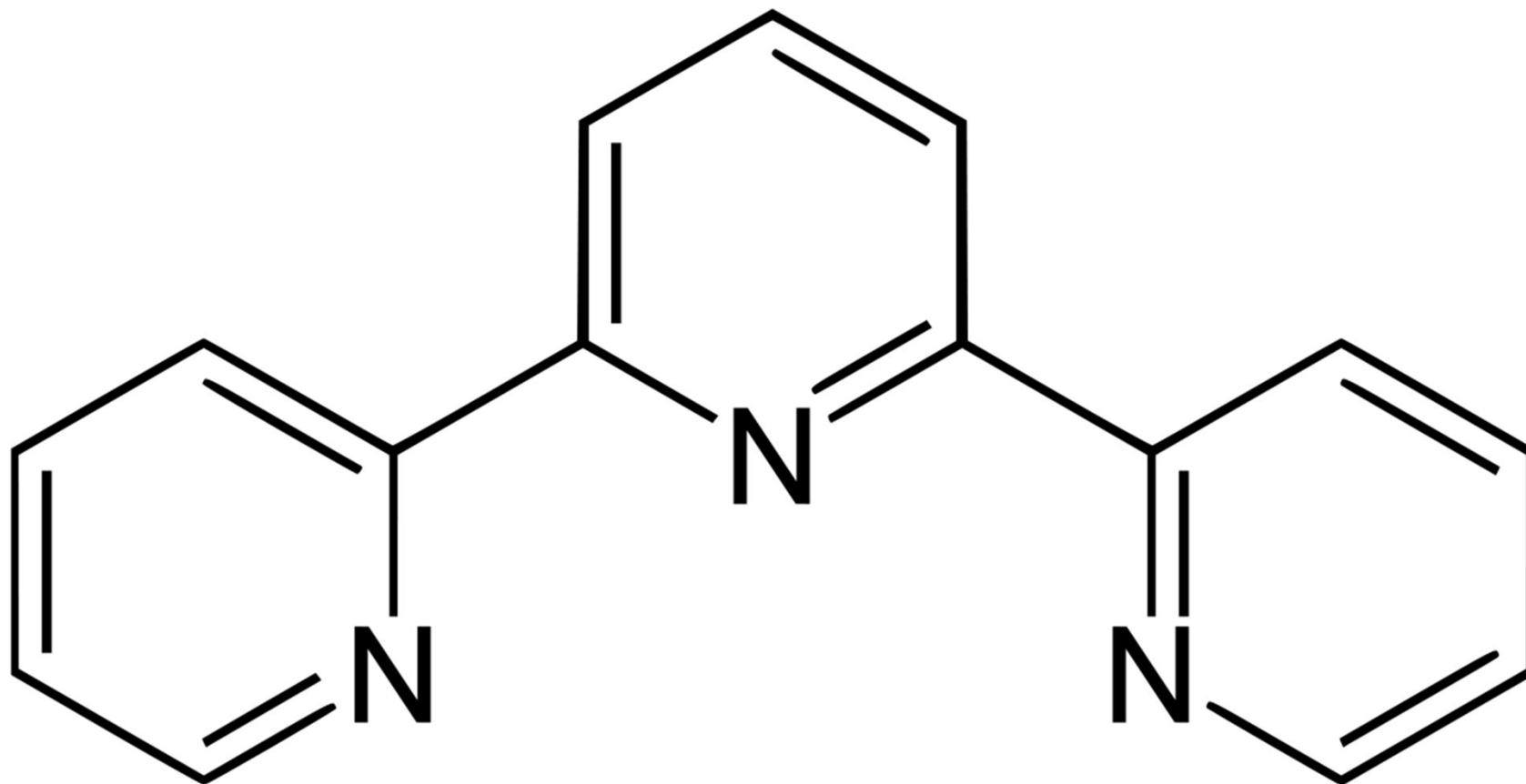


Bipyridine

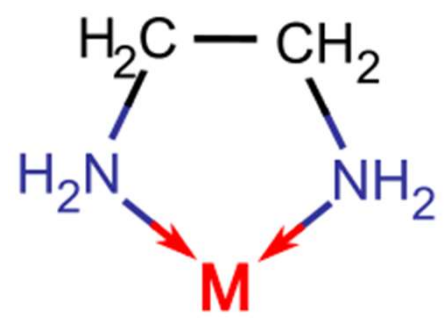


Ethylenediamine

- *Polydentate ligand*: More than two donor atoms present in the molecule are called polydentate ligand.
- Example: Terpyridine



- **Chelating ligand:** Bidentate or polydentate ligand attached through two or more donor atoms to the same metal ion forms ring structure is called chelating ligand.
- Example: Ethylenediamine



- *Werner's Theory of coordination:*
- The main postulates of werner's theory as follows:
- In coordination compound metal shows two types of valency
- (a) primary valency
- (b) Secondary valency.

- Primary valencies are ionisable and satisfied by negative ions corresponds to oxidation. Number.
- Secondary valencies are non-ionisable and are satisfied by negative ions or neutral molecules. Secondary valency is equal to the C.N. and is fixed for a metal.
- The ions or group bound by the secondary linkage to the metal have characteristics

- Spatial arrangement corresponds to different C.N.
- Explain the structure of different cobalt ammines on the basis of Werner's theory:
- Primary valency satisfied by (dotted lines) and six secondary valency are satisfied by six NH_3 molecules (solid lines).

- Silver nitrate was added to $\text{CoCl}_3 \cdot 6\text{NH}_3$ all the the chloride ions were converted to AgCl .
- When AgNO_3 was added to $\text{CoCl}_3 \cdot 5\text{NH}_3$ only two mole of AgCl was formed.
- When AgNO_3 was added to $\text{CoCl}_3 \cdot 4\text{NH}_3$ one mole of AgCl was formed.
- When AgNO_3 was added to $\text{CoCl}_3 \cdot 3\text{NH}_3$, AgCl was not formed.

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Structure of Cobalt ammine complexes

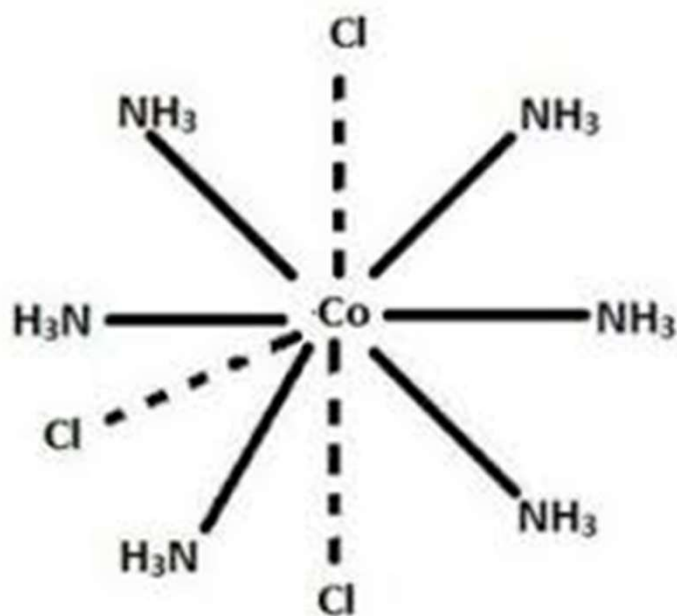


Fig.) $\text{CoCl}_3 \cdot 6\text{NH}_3$ Complex
No of Cl^- precipitated = 3
Total No of ions = 4

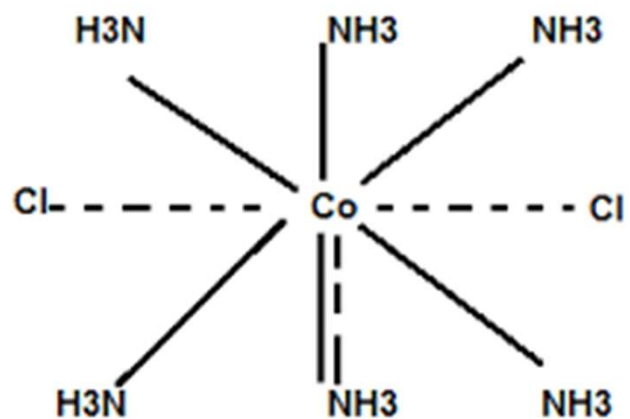


fig. structure of $\text{CoCl}_3 \cdot 5\text{NH}_3$ complex
 Number of Cl^- ions precipitated = 2
 total numbers of ions = 3

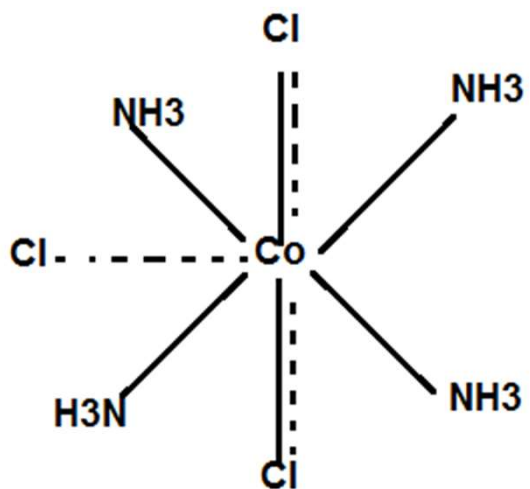


fig. Structure of $\text{CoCl}_3 \cdot 4\text{NH}_3$ complex
Number of Cl^- ions precipitated = 1
Total numbers of ions = 2

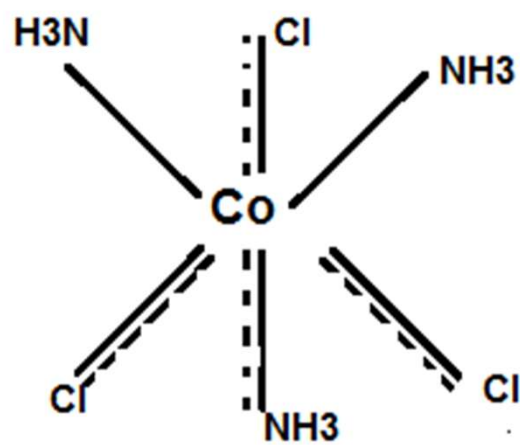


fig. structure of $\text{CoCl}_3 \cdot 3\text{NH}_3$ complex.
number of Cl^- ion precipitated = nil
It is a neutral molecule