Werner's Theory Of Coordination Compounds

* Alfred Werner (1866–1919) was a Swiss chemist and a professor at Zurich University. Werner won the Nobel Prize for Chemistry in 1913 for proposing a theory for co-ordination compounds.

The important postulates are:

(1) Metals possess two types of valencies, Primary (ionizable) and Secondary (non-ionizable).

(2) Primary valencies of the central metal ion are satisfied by negative ions. [In complex compounds its attachment to metal ion is shown by dotted lines]. P.V. corresponds to Oxidation State of metal atom or io

(3) The secondary valencies are satisfied by either negative ions or neutral molecules. [Its attachment to metal is shown by thick lines]. S.V. corresponds to the coordination number of ~~central~~ metal atom or ion

(4) Every metal atom or ion has a tendency to satisfy both its Primary and Secondary valenc In order to meet this requirement, a negati ion must satisfy both types of valencies.

(5) Secondary valencies are always directed towards fixed position in space around the central metal ion.

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* S. V. = 4 ⟹ Complex is tetrahedral or squarepla
eg. $[Zn(NH_3)_4]^{2+}$ $[Ni(CN)_4]^{2-}$

S. V. = 6 ⟹ Complex is Octahedral

eg. $[Co(NH_3)_6]^{3+}$

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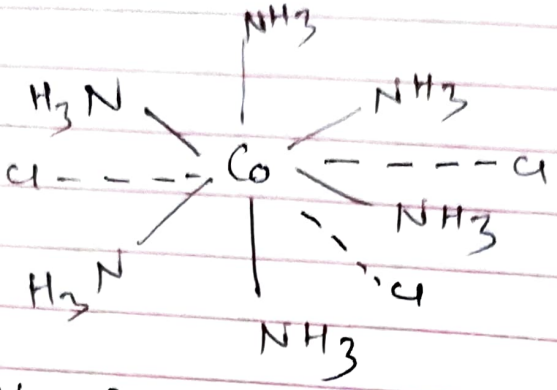
$[Co(NH_3)_6]Cl_3$



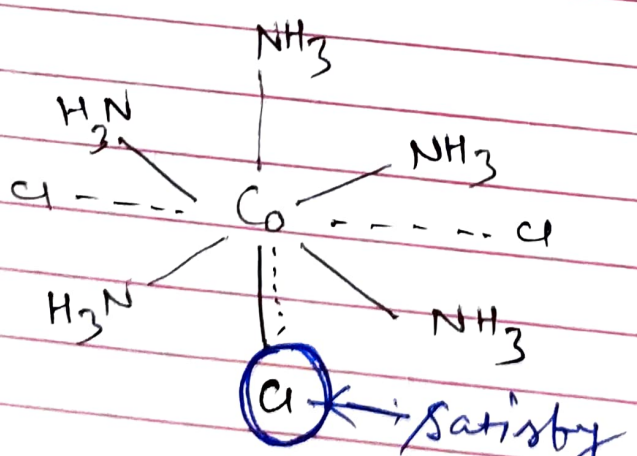
P.V = 3 ⇒ 3 Cl^-

Oxidation State = III

S.V = 6 ⇒ 6 NH_3

C.N = 6

$[Co(NH_3)_5Cl]Cl_2$



Satisfy both P.V & S.V

P.V = 3 ⇒ 3 Cl^-

O.S = III

S.V = 6 ⇒ ($5\ NH_3 + 1\ Cl^-$)

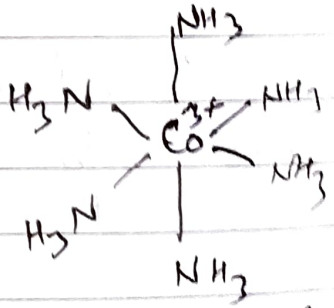
C.N = 6

* LIGAND: The ion or neutral molecules attached to central atom in a coordination compound, is called Ligand. eg. In $[Co(NH_3)_5Br]$ the ligands are NH_3 and Br^-.

* COORDINATION NUMBER: Total number of ligands which are directly attached to the central metal atom is known as coordination number of that metal ion. eg. The co-ordination number of Co in $[Co(NH_3)_5Br]$ is Six.

* COORDINATION SPHERE: The central metal atom and ligands that are directly attached to it enclosed in square brackets are collectively known as coordination sphere. The ionisable groups are written outside the bracket and are called counter ions. eg. In $[Co(NH_3)_6]Cl_3$, the coordination sphere is $[Co(NH_3)_6]^{3+}$ and the counter ion is Cl^-

* HOMOLEPTIC COMPLEXES: The complexes in which a metal ion is bound to only one types of ligands are known as homoleptic.
eg. $[Co(NH_3)_6]^{3+}$



* HETEROLEPTIC COMPLEXES: The complexes in which a metal ion is attached with more than one type of ligand is called heteroleptic.
eg. $[CoCl_2(en)_2]^+$ Ligands → Cl^-, en ($H_2NCH_2CH_2NH_2$)

CLASSIFICATION OF LIGANDS :

(A) CLASSIFICATION BASED ON CHARGE :

(a) Positive ligands :

NO^+ — nitrosonium

$H_2N\,NH_3^+$ — hydrazinium

(b) Negative ligands :

F^-	fluorido	NO_3^-	Nitrato
Cl^-	chlorido	SO_4^{2-}	sulphato
OH^-	hydroxo	$C_2O_4^{2-}$	Oxalato
CN^-	Cyano	CO_3^{2-}	Carbonato
CH_3COO^-	acetato	NH_2^-	amido
NO_2^-	Nitrito (or Nitro)	NH^{2-}	imido
H^-	hydrido	NCS^-	isothiocyanato
O^{2-}	Oxo		
O_2^{2-}	peroxo		

(c) Neutral ligands :

H_2O	aqua	NO	nitrosyl
NH_3	ammine	CO	Carbonyl

$H_2N\,CH_2\,CH_2\,NH_2$ (or en) → ethylenediamine

OR. ~~ethane-1,2-diamine~~ ethane-1,2-diamine

C_5H_5N Pyridine

$(C_6H_5)_3P$ triphenylphosphine.