

Coordination Chemistry

Sunday, 6 September 2020

4:35 PM

Father of Coordination Chemistry \rightarrow Alfred Werner

Prussian Blue: $\text{KFe}[\text{Fe}(\text{CN})_6]$ Blue

Aureolin: $\text{K}_3[\text{Co}(\text{NO}_2)_6] \cdot 6\text{H}_2\text{O}$ Yellow

Coordination Compounds: Compounds composed of a metal atom or ion and one or more ligands.

e.g. $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$

Co^{3+} = Metal ion

NH_3 = ligand

Cl^- = Counter Anion

\rightarrow The name coordination compounds comes from the coordinate covalent bond.

\rightarrow Coordinate covalent bonds are identical to covalent bonds.

\rightarrow Coordination compounds are also acid-base adducts.

\rightarrow

$[\text{Fe}(\text{CO})_5]$
 $[\text{Cr}(\text{CO})_6]$ } Complex

$[\text{Co}(\text{NH}_3)_6]^{3+}$
 $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$
 $[\text{Ni}(\text{CN})_6]^{2-}$
 $[\text{CoF}_6]^{3-}$ } Complex ions

[] Coordination sphere

$[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$
Metal ion Ligand Ionization sphere / Counter ion
Coordination sphere

Coordination Number: Total number of ligands attached to the central metal ion.

Complex

$[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$

Coordination Number

4

$[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$

6

$[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$

6

$\text{K}_4[\text{Fe}(\text{CN})_6]$

6

$[\text{Pt}(\text{NH}_3)_4]^{2+}$

4

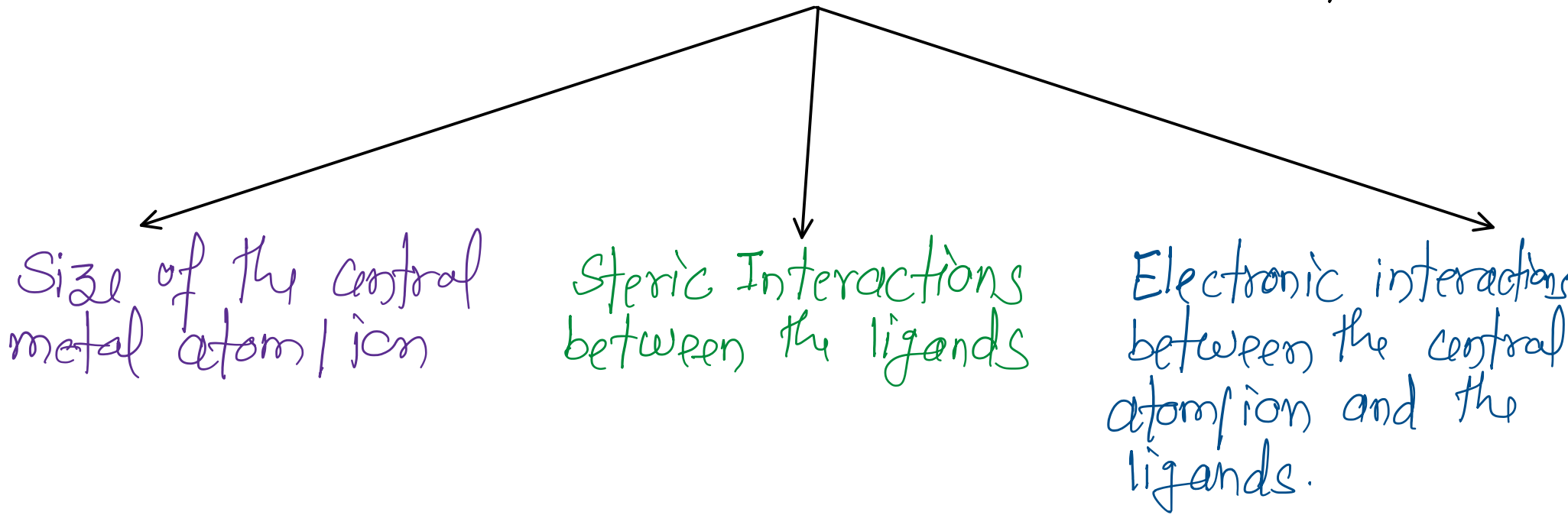
$[\text{PtCl}_4]^{2-}$

4

$[\text{Ag}(\text{NH}_3)_2]^+$

2

Factors on which Coordination Number Depends:



Classification of Ligands

Monodentate Ligands

\rightarrow Ligand bind with a central atom/ion by a single lone pair of electrons.

e.g. F^- , Cl^- , Br^-
 NO_2^- , OH^- , CN^-
 CO , H_2O , NH_3
 NO , C_2H_4
etc.

Polydentate Ligands

\rightarrow Ligand that bind to the central metal atom/ion through electron pairs present on more than one donor atoms.

e.g. $\text{C}_2\text{O}_4^{2-}$ (oxalato)
 $\text{H}_2\text{NCH}_2\text{COO}^-$ (glycinato)

$\text{H}_3\text{C}-\text{C}=\text{N}-\text{O}^-$

$\text{H}_3\text{C}-\text{C}(\text{OH})=\text{N}-\text{OH}$
dimethylglyoximate

EDTA, CH_2-CH_2
 NH_2 NH_2
ethylenediamine

Other Categories of Ligands

Ambidentate Ligands:

\rightarrow Monodentate ligands which have more than one donor atoms

e.g. NO_2^- $\text{M} \leftarrow \text{N}=\text{O}$

$\text{M}-\text{O}-\text{N}=\text{O}$

$-\text{SCN}^-$

$\text{M} \leftarrow \text{S} \text{---} \text{C} \text{---} \text{N}^-$

$\text{M}-\text{NCS}$

Bridging Ligands:

\rightarrow Ligand which bind with two metal atom/ions simultaneously.

e.g. CO , CN^- , SCN^- , NH_2-NH_2
 H_2O , OH^- etc.

Flexidentate Ligands:

\rightarrow Ligands which have two or more donor atoms can coordinate with metal atom/ion either through one donor atom forming non-chelated complex or two donor atom forming a chelate.

\rightarrow e.g. CO_3^{2-} , SO_3^{2-} , SO_4^{2-} , NH_2-NH_2 etc.