

Transition Metal Compounds

Lets look at the electron configurations for the first ten transition metals.

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
4s 3d	4s 3d	4s 3d	4s 3d	4s 3d	4s 3d	4s 3d	4s 3d	4s 3d	4s 3d

Note they do not follow the pattern you may predict!

These are all very similar in size and give interesting reactions!

Complex Ion

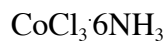
Ligand



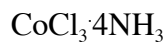
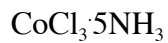
How these compounds were arranged was a very big question

Alfred Werner

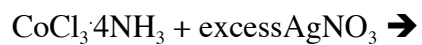
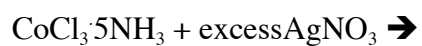
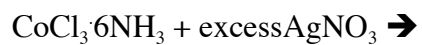
Formula



Color of Compound



We have experimental evidence that needs to be addressed:



The first proposed structures from Joergensen:

These are wrong. Why?

Werner's Structures:

Coordination Compound:

Counter Ion:

Coordinate Covalent Bond:

Ligands:

unidentate:

bidentate:

polydentate:

Nomenclature

Rules for naming coordination compounds

1.

2.

3.

4.

5.

6.

7.

Ligand Names

Prefixes

Name the following compounds:

1. $[\text{Ag}(\text{NH}_3)_2]\text{Cl}$
2. $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$
3. $[\text{Co}(\text{NH}_3)_3\text{Cl}_2]\text{Cl}$
4. $[\text{Co}(\text{NH}_3)_6]\text{Cl}_2$
5. $\text{K}_4[\text{Fe}(\text{CN})_6]$
6. $[\text{Ni}(\text{NH}_3)_4]^{2+}$
7. $[\text{PtCl}_4]^{2-}$
8. $[\text{Pt}(\text{NO}_2)_4]^{2-}$
9. $\text{K}[\text{Pt}(\text{NH}_3)\text{Cl}_5]$
10. $[\text{Co}(\text{NO}_2)(\text{NH}_3)_4] \text{Br}_2$
11. $[\text{Cu}(\text{NH}_3)_4]^{2+}$
12. $[\text{CrCl}(\text{NH}_3)_4]\text{Cl}$
13. $\text{K}_2[\text{Pt}(\text{SO}_4)_2(\text{NH}_3)_4]$
14. $[\text{Fe}(\text{OH})_6]^{4-}$
15. $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4$

Isomerism

Isomers

This gives different chemical and physical properties.

Coordination Isomer

Linkage Isomer

Geometric Isomers

Stereo Isomer

Crystal Field Theory

Diamagnetic

Paramagnetic

Our focus will be on the d orbitals:

What happens to the energy of these d orbitals is what governs inorganic chemistry!

The orbitals experience a splitting due to repulsion when a ligand approaches it.

Octahedral

e_g

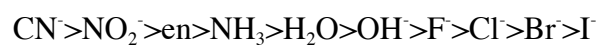
t_{2g}

What is $10Dq$?

Strong Field versus Weak Field
Strong Field Case

Weak Field Case

Spectrochemical Series



How does charge affect splitting?

Low Spin

High Spin

Other Geometries

Tetrahedral

Square Planar

How do we count the number of electrons in a transition metal ion?



1. Draw the d-orbital splitting diagram for the octahedral complex ions for V^{2+} .
2. The complex ion $Mn(OH)_6^{3-}$ is paramagnetic and octahedral. Draw the d-orbital splitting diagram and show why it is paramagnetic. OH^- is a very STRONG ligand.
3. Draw the d-orbital splitting diagram for the octahedral complex ions for Ni^{2+} .
4. Draw the d orbital splitting diagram for Co^{2+} in an octahedral field. Do this for both spin cases. Is it paramagnetic or diamagnetic.
5. The complex ion $Fe(CN)_6^{3-}$ is paramagnetic and octahedral. Draw the d-orbital splitting diagram and show why it is paramagnetic. CN^- is a very STRONG ligand.