My Mobile is not working thats why sending through Ajay

Co-ordination compound

By Shashi Kumari singh
L.S. College

Double salt :- Molecular or addition compounds are formed when stoichiometric amount of two or more stable compounds join together.

example

$KCl + MgCl_2 + 6H_2O \rightarrow KCl \cdot MgCl_2 \cdot 6H_2O$
carnallite

$K_2SO_4 + Al_2(SO_4)_3 + 24H_2O \rightarrow K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$
Potas-alum.

These fall into two categories:

(I) Those which lose their identity in soln. i.e gives test of ions which present. gives test of K^+, Al^{3+}, Mg^{++} etc.

(II) Those which retain their identity and inspite of giving the test of ions gives special test of whole compound.

cuproammonium ion $[Cu(H_2O)_2(NH_3)_4]^{++}$ and the Ferrocyanide ion $[Fe(CN)_6]^{4-}$.

These are complex ion and exist as a single entity. complex ion are detected by square bracket. Molecular compounds of this types are called Co-ordination Compound.

Werner's theory: According to this theory complex compounds have two types of valencies.

(I) Primary valency — Must be satisfied by negative ions. They are ionizable;
(ii) Non-directional i.e charge present complex ion

(II) Secondary valency → May be satisfied by either negative ions, neutral molecules and occasionally even positive ion.

Example, 1. $K_4[Fe(CN)_6]$
- K_4 — Pr. valency
- $(CN)_6$ — sec. valencies → Ligands (C.N.)

2. $[Cr(NH_3)_6]Cl_3$
- Cl_3 — pr. valency = (3)
- $(NH_3)_6$ — Neutral sec. valency (6)

3. $CoCl_2$ $[Co^{2+} + 2Cl^-]$ there are two pr. valencies i.e. two ionic bonds.

Sec valencies are directional and equal to the no. of ligands

-ve ligands — Cl^-, F^-, CN^- etc.

Neutral → NH_3, H_2O, organic ligands

+ve ligands — NO^+ NH_4^+

Sec. valencies are directional so, shape of complex depends upon it:

- C.N − 6 − octahedral
- C.N. − 4 − tetrahedral, square planner
- ~~C.N → 5 − trigonal bipyramidal or square pyramidal~~

Experimental evidence of Werner's Theory

(1) Werner treated cold solution of series of co-ordination compound with an excess of Silver Nitrate $AgNO_3$ and weighed the silver chloride precipitated.

example

$[Co(NH_3)_6]3Cl$ → $CoCl_3 \cdot 6NH_3$ → 3 AgCl → 3 Pr. val.

$[Co(NH_3)_5Cl]2Cl$ → $CoCl_3 \cdot 5NH_3$ → 2 AgCl → 2 Pr. val.

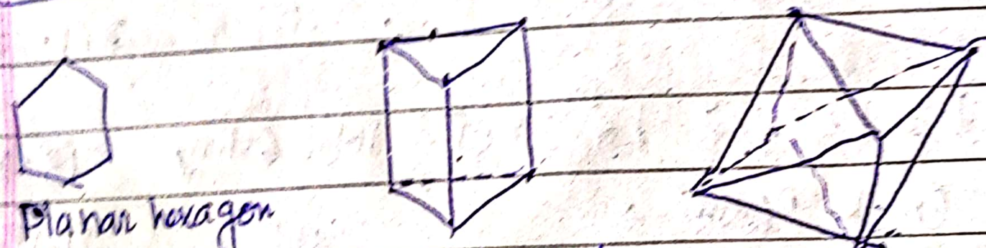
$[Co(NH_3)_4Cl_2]Cl$ → $CoCl_3 \cdot 4NH_3$ → 1 AgCl → 1 Pr. val.

~~Its~~ breaks

1. $[Co(NH_3)_6]^{3+} + 3Cl^-$
2. $[Co(NH_3)_5Cl]^{2+} + 2Cl^-$
3. $[Co(NH_3)_4Cl_2]^+ + Cl^-$

(2) Compared isomeric forms.

Complex	Observed	Predicted		
		Octahedral	Planar hexagon	Trigonal Prism
$[MX_6]$	1	1	1	1
$[MX_5Y]$	1	1	1	1
$[MX_4Y_2]$	2	2	3	3
$[MX_3Y_3]$	2	2	3	3



Planar hexagon — Trigonal prism — Octahedral

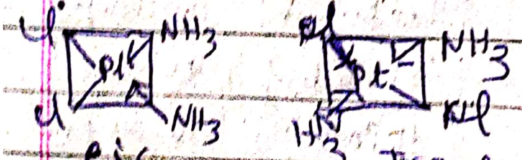
These results strongly suggested that these complexes have an octahedral shape.

Werner studied a range of complexes which included $[Pt^{II}(NH_3)_2Cl_2]$ and $[Pd^{II}(NH_3)_2Cl_2]$.

The C.N. - 4, and the shape could be either tetrahedral or square planar.

If tetrahedral — No isomer

If square planar — two isomers



cis — Trans

It proved the structure is square planar.

(3) Electrical conductivity → This depends on two factors because it is also an ionic relative

(i) The concentration of solution which is related to the salts and thus it can be removed.

(ii) The no. of charges present on the species which are formed

Example			cond $ohm^{-1} cm^2 mol^{-1}$
$LiCl$	→ $Li^+ Cl^-$	total of 2 charges	112.0
$CaCl_2$	→ $Ca^{++} 2Cl^-$	" " 4 charges	260.8
$CoCl_3 \cdot 5NH_3$ →			261.3
$LaCl_3$	→ $La^{3+}, 3Cl^-$	total 6 charges	393.5
$CoCl_3 \cdot 6NH_3$ →		"	431.6

(4) Molar conductivity → depend on particle present. Note that particle formed may be different from the total no. of charges

The freezing point of liquid is lower when a chemical substance is dissolved in it. The cryoscopic measurements involve measuring how much the freezing point lowered. The depression of freezing obtained depends no. of particle present.

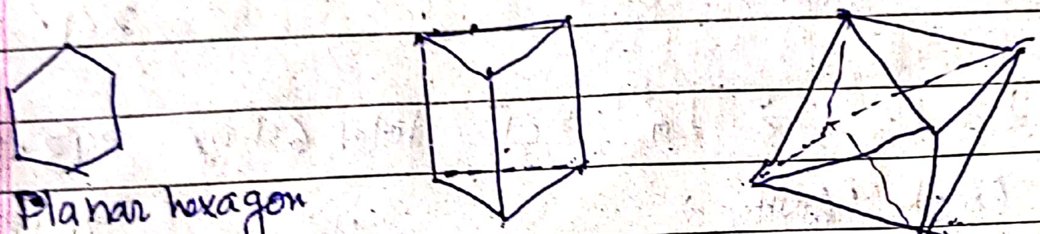
example

$LiCl$	→ $Li^+ + Cl^-$	[two particles]	[two charges]
$MgCl_2$	→ $Mg^{++} + 2Cl^-$	[3 particles]	[4 charges]
$LaCl_3$	→ $La^{+++} + 3Cl^-$	[4 particles]	[6 charges]

No of particles determined the size of depression of freezing point. No of particles may be vary wide from the

(2) Compared isomeric forms.

Complex	Observed	Predicted		
		Octahedral	Planar hexagon	Trigonal Prism
$[MX_6]$	1	1	1	1
$[MX_5Y]$	1	1	1	1
$[MX_4Y_2]$	2	2	3	3
$[MX_3Y_3]$	2	2	3	3



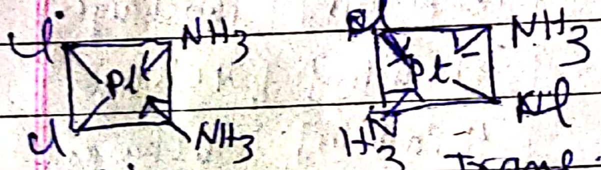
Planar hexagon   Trigonal prism   Octahedral

These results strongly suggested that these complexes have an octahedral shape.

Werner studied a range of complexes which included $[Pt^{II}(NH_3)_2Cl_2]$ and $[Pd^{II}(NH_3)_2Cl_2]$. The C.N. – 4, and the shape could be either tetrahedral or square planar.

If tetrahedral — No isomer

If square planar — two isomers



cis   Trans

It prove the structure is squareplanar.