Co-Ordination Number & Geometry.

Werner explained the nature of bonding in complexes. and he concluded that in complexes, the metal shows 2 diff. sorts of valency.

Primary Valency : It is the no. of charges on the complex ion. In compds this charge is matched by the same no. of charges from the ⊖ve ion. Ex: $CoCl_2 \Rightarrow Co^{2+}$ & $2Cl^-$ $\therefore V = 2$

$[Co(NH_3)_6]Cl_3 \Rightarrow [Co(NH_3)_6]^{3+}$ & $3Cl^-$ $\therefore V = 3$

There are 3 ionic bonds.

Secondary Valency : The no. of ligand atoms coordinated to the metal is called the secondary valencies and also known as Co-Ord. No. It varies from 1 - 16. But more common are 4 & 6.

Werner treated cold soln of a series of co-ord. complexes with an excess of $AgNO_3$. He deduced that in

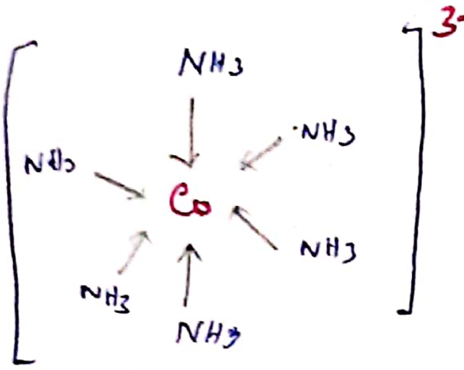
$CoCl_3 \cdot 6NH_3 \Rightarrow$ or $[Co(NH_3)_6]Cl_3$

The 3 Cl acts as primary valencies & 6 NH_3 acts as sec. valencies. Thus the $3Cl^-$ ions are ionic & hence precipitated as AgCl by $AgNO_3$

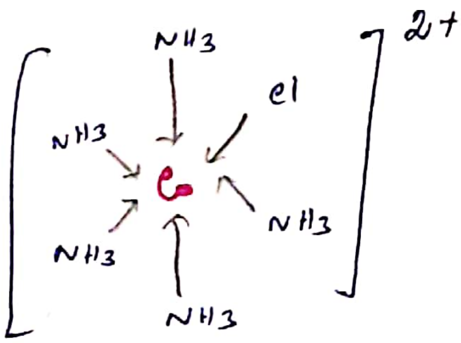
He also deduced that loss of one NH_3 from $CoCl_3 \cdot 6NH_3$ should give $CoCl_3 \cdot 5NH_3$ and at the same time one Cl changed from primary to sec. valency. Thus this complex had 2 Prim. Valency & 6 Sec. valencies i.e.

$[Co(NH_3)_5Cl]Cl_2$ ionizes $\rightarrow [Co(NH_3)_5Cl]^{2+}$ & $2Cl^-$

Thus only 2 of 3 Cl atoms are ionic & thus only 2 Cl^- are ppted as AgCl with $AgNO_3$.



$3Cl^-$



$2Cl^-$

GEOMETRY.

C.N. 2

$[Ag(NH_3)_2]^+$ ion

$\ddot{N}$—Ag—$\ddot{N}$

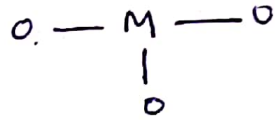
Linear

CN - 3 This is not very common

Trigonal planar $[Cu(CN)_3]^{2-}$

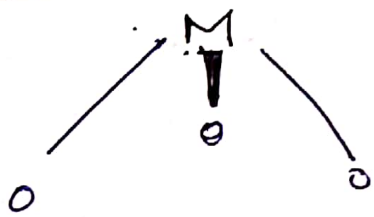
$[Rh(PPh_3)_3]^+$

T-shaped ~~T G Planar~~

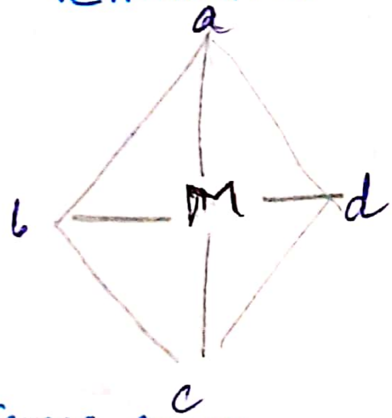


Trigonal Pyramid

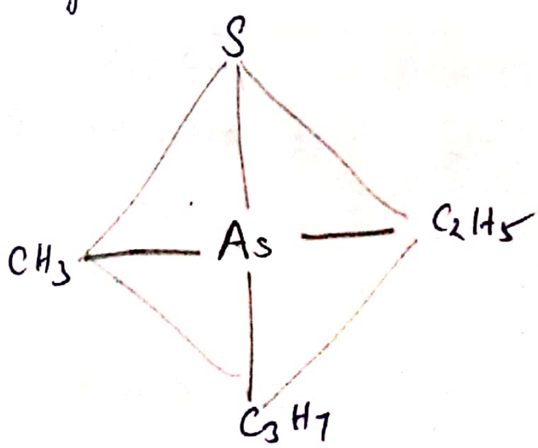
$[Cu(PPh_3)_2Br]$



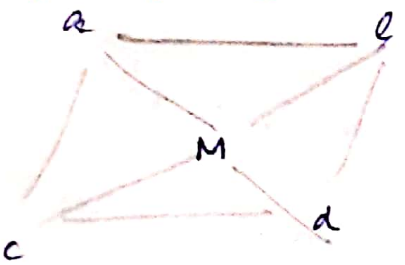
C.N.4 Tetrahedral

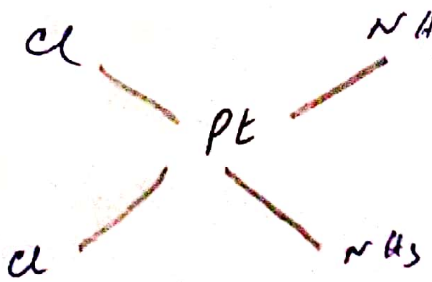


Ethyl methyl Propyl Sulfido Arsenic (V)



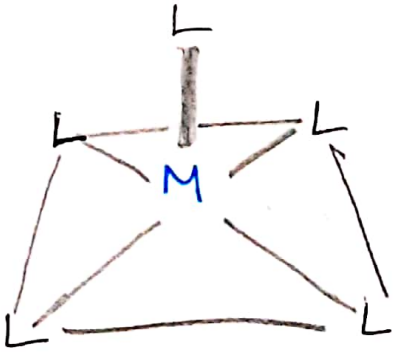
Square planar



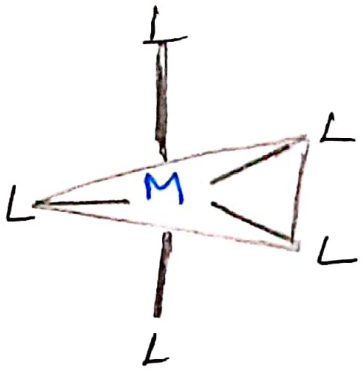


Cis-Platin $[Pt(NH_3)_2Cl_2]$

C.N.5



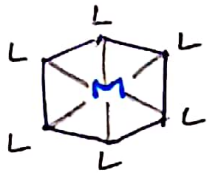
Square pyramid



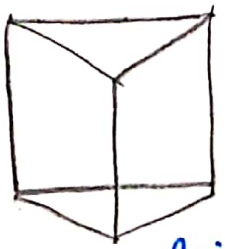
Trigonal Bipyramid

Eg: $[Ni^{\circ}(CN)_5]^{3-}$ $[Cr(en)_3][Ni(CN)_5]\cdot 1.5H_2O$ is a remarkable eg of a complex exhibiting both types of geometry.

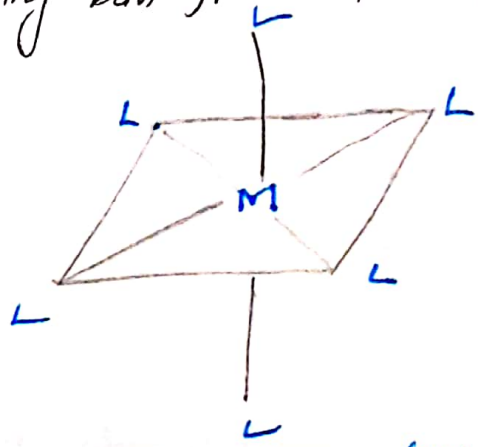
C.N.6



Hexagonal planar



Trigonal Pyrism



Octahedral complex

$[Co(NH_3)_4Cl_2]^+$

$[Co(NH_3)_5CO_3]^+$