In General inner orbital Complexes use $(n-1)d$, ns and np orbitals in $d^2sp^3$ hybridisation scheme.

These Complexes have been also called Low Spin (L.S) Complex (Orgel) and Spin Paired (Nyhlom) Complexes.

The inner orbital Complexes have greater numbers of paired electrons or less number of unpaired electrons.

Other Examples of inner orbital Complexes are:—

$[Fe^{III}(CN)_6]^{-3}$, $[Co(NH_3)_6]^{+3}$, $[Co(NO_2)_6]^{3-}$, $[Pt^{IV}(NH_3)_6]^{4+}$
$[Co^{III}(NH_3)_6]^{+3}$, $[Cr(CN)_6]^{-4}$, $[Mn^{II}(CN)_6]^{3-}$, $[Fe(H_2O)_6]^{+2}$ etc.

II $K_3[Fe(CN)_6]$ ⟶ It ionises in water as follows

$$K_3[Fe(CN)_6] \rightleftharpoons 3K^+ + [Fe(CN)_6]^{3-}$$

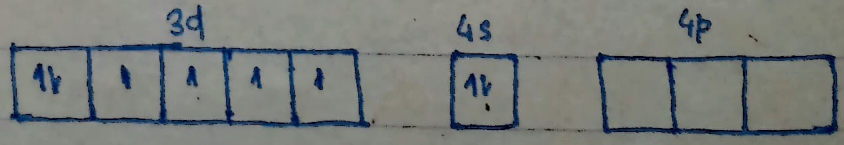
It shows that 3 Potassium atom are attached with $[Fe(CN)_6]^{3-}$ as ions.

On the basis of $d^2sp^3$ hybridisation the nature of bonding in Complex can easily be explained.

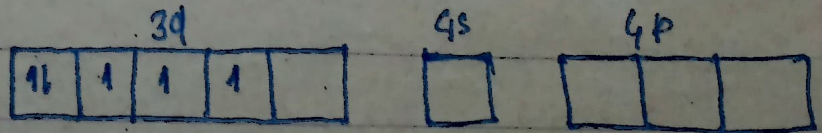
The electronic Configuration of Fe-atom and $Fe^{+3}$ ion have been Given below.

$_{26}Fe$ — $1s^2 2s^2 p^6 3s^2 p^6 d^6 4s^2$

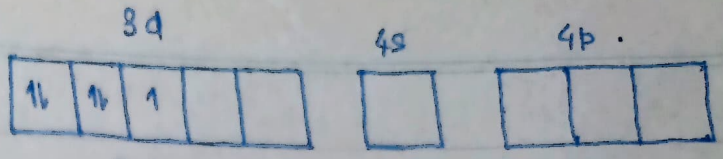
(a) Fe-atom -



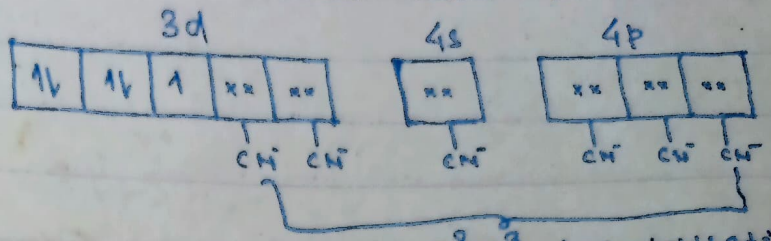

(b) $Fe^{+3}$ ion (free)



(c) $Fe^{+3}$ in $[Fe(CN)_6]^{3-}$ →



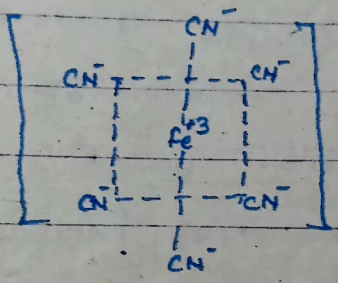

(d) $[Fe(CN)_6]^{3-}$ →




Formation of Octahedral Complexes by $[Fe(CN)_6]^{3-}$ by $d^2sp^3$ hybridisation.

From the above diagram it is evident that there is one unpaired electron in Complex, so Complex is Paramagnetic.

The Complex can be shown as $CN^-$




## III Luteo Cobaltic chloride (Hexa ammine Cobalt III Ch

$[Co(NH_3)_6]Cl_3$.

It is an orange yellow crystalline Compoun

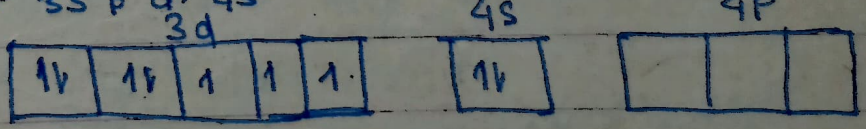
It ionises as follows:-

$$[Co(NH_3)_6]Cl_3 \longrightarrow [Co(NH_3)_6]^{3+} + 3Cl^-$$

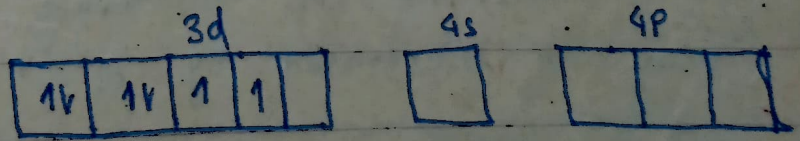
The nature of bonding in this Complex is shown below.

$27 \rightarrow 1s^2\ 2s^2p^6\ 3s^2p^6\ d^7\ 4s^2$

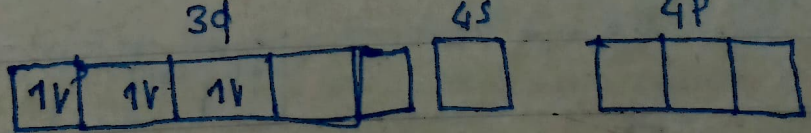
(a) Co $(3d^7 4s^2)$



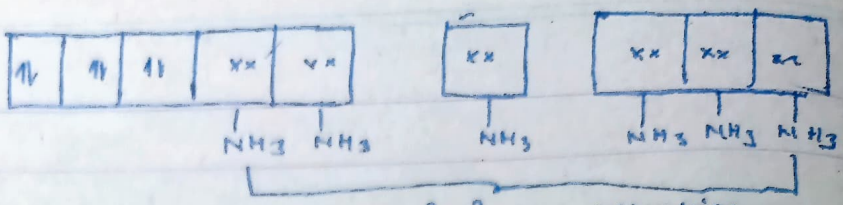

(b) $Co^{+3}$ (fraction)




(c) $Co^{+3}$ in $[Co(NH_3)_6]^{+3}$



(d) $[Co(NH_3)_6]^{+3}$ —




In this complex Cobalt is as $Co^{+3}$ whose valence shell configuration is shown above in b, When six Ammonia ligand approaches to $Co^{+3}$ the energy is realeased. This results in the pairing d electrons giving rise to two vaccant d-orbitals.

Now two vaccant d-orbitals, one 4S orbital and three 4p orbitals directed towards 6 (six) corners of a (regular) regular Octahedron. These hybride orbitals which are vaccant accept six lone pairs donated by ammonia molecule resulting in to the formation of $[Co(NH_3)_6]^{+3}$ ion.

Since there is no unpaired electron in the Complex, hence it is diamagnetic. It is an inner Orbital Complex.

## (iv) Potassium Cobaltic nitrate - $K_3[Co(NO_2)_6]$

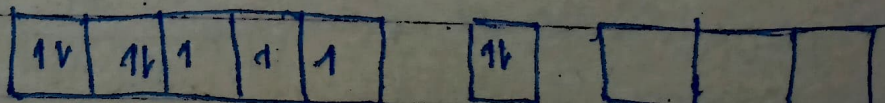
This Compound goes under ionisation as follows.

$$K_3[Co(NO_2)_6] \rightleftharpoons 3K^+ + [Co(NO_2)_6]^{-3}$$

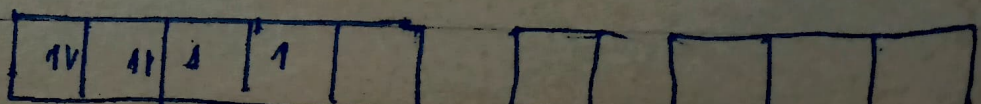
$n - 6 = -3$
$x = 6 - 3$
$= 3$

The nature of bonding in this Complex may be illustrated by $d^2sp^3$ hybridisation.

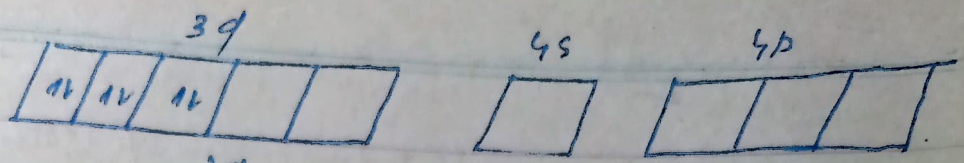
(a) Co (atom) $3d^7 4s^2$ ⟶



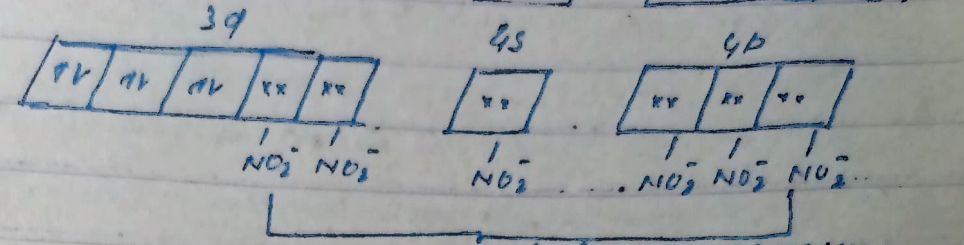
(b) $Co^{+3}$ ion, $3d^6 4s^0$ ⟶



(c) $Co^{+3}$ in $[Co(NO_2)_6]^{3-}$




(d) $[Co(NO_2)_6]^{-3}$



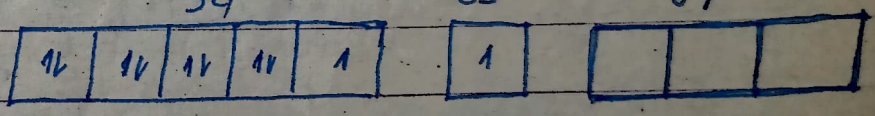

Formation of $[Co(NO_2)_6]^{-3}$ by $d^2sp^3$ Hybridisation.

There is no any unpaired electron. Hence this Compound is diamagnetic. It is an inner Orbital Complex.

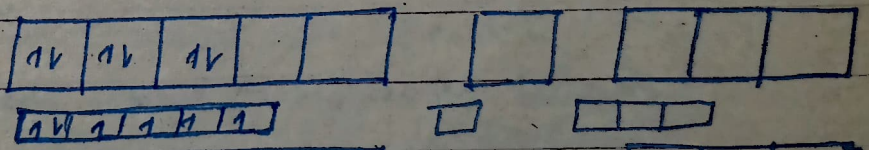
I. Hexa ammine Platinum IV Chloride. $[Pt(NH_3)_6]Cl_4$ during ionisation it Gives $[Pt(NH_3)_6]^{+4}$ ion.

The formation of $[Pt(NH_3)_6]^{+4}$ has been shown below:—

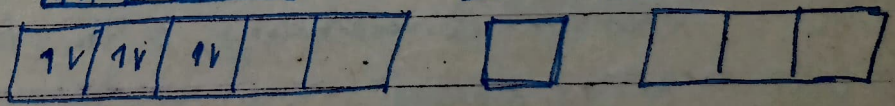
(a) Pt (free atom) $5d^9 6s^1$ →



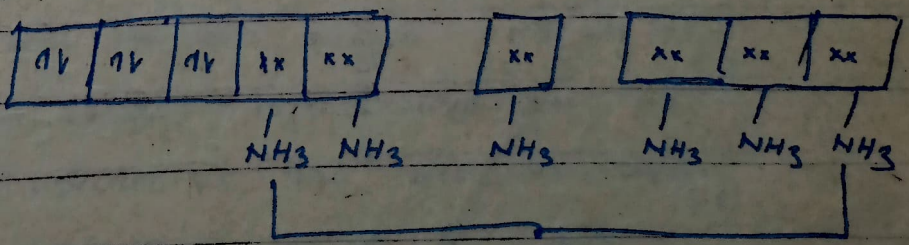

(b) $Pt^{+4}$ (free ion) $5^- d^6 6s^0$ →



(c) $Pt^{+4}$ (ion in) $[Pt(NH_3)_6]^{+4}$ →



(d) $[Pt(NH_3)_6]^{+4}$ →




N.B → In ions like $Co^{+3}$, $Fe^{+3}$, etc., the electronic Configuration in a sub-shell is written according to— Hund Rule.