

CH-9 Coordination Compounds

Ques 1. How is a double salt different from a complex?

Ans 1. Double salt dissociates completely into its constituent ions in their aqueous solution.

Example: $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ dissociates into K^+ , Cl^- , Mg^{2+} and H_2O

Complex does not dissociate into its constituent ions.

Example: $\text{K}_4[\text{Fe}(\text{CN})_6] \rightarrow 4\text{K}^+ + [\text{Fe}(\text{CN})_6]^{4-}$

Ques 2. Using IUPAC norms write the systematic name of the following:

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

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

(c) $[\text{Co}(\text{en})_3]^{3+}$

(d) $\text{Na}_3[\text{Co}(\text{NO}_2)_6]$

(e) $\text{K}_3[\text{Fe}(\text{CN})_5\text{NO}]$

(f) $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$

(g) $[\text{Co}(\text{NH}_3)_4\text{SO}_4]\text{NO}_3$

(h) $[\{\text{C}_6\text{H}_5\}_3\text{P}]_3\text{RhCl}$

(i) $[\text{CoBr}_2(\text{en})_2]\text{Cl}$

(j) $[\text{Ni}(\text{CO})_4]$

(k) $[\text{Co}(\text{ONO})_6]^{3-}$

(l) $\text{Na}_2[\text{Ni}(\text{EDTA})]$

(m) $\text{Mn}_3(\text{CO})_{12}$

(n) $[\text{Co}(\text{NH}_3)_5\text{Cl}]^{2+}$

(o) $[\text{CoCl}_2(\text{NH}_3)_4][\text{Cr}(\text{CN})_6]$

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

(q) $[\text{Zn}(\text{NCS})_4]^{2-}$

(r) $[\text{Pt}(\text{NH}_3)_4\text{Cl}_2][\text{PtCl}_4]$

(s) $\text{K}_4[\text{Ni}(\text{CN})_2(\text{OH})_2]$

(t) $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl}$

Ans 2. (a) $[\text{Pt}(\text{NH}_3)_2\text{Cl}(\text{NH}_2\text{CH}_3)]\text{Cl}$ – diamminechloridomethylamineplatinum(II) chloride

(b) $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$ – hexaamminecobalt(III) chloride

(c) $[\text{Co}(\text{en})_3]^{3+}$ – tris-(ethane-1,2-diamine)cobalt(III) ion

(d) $\text{Na}_3[\text{Co}(\text{NO}_2)_6]$ – sodium hexanitrito-N-cobaltate(III)

- (e) $\text{K}_3[\text{Fe}(\text{CN})_5\text{NO}]$ – Potassium pentacyanonitrito-N-ferrate(III)
- (f) $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$ – Potassium trioxalatoferrate (III)
- (g) $[\text{Co}(\text{NH}_3)_4\text{SO}_4]\text{NO}_3$ – tetraamminesulphatocobalt(III) nitrate
- (h) $[\{\text{C}_6\text{H}_5\}_3\text{P}\}_3\text{Rh}]\text{Cl}$ – triphenylphosphinerhodium(I) chloride
- (i) $[\text{CoBr}_2(\text{en})_2]\text{Cl}$ – dibromidobis (ethane-1,2 diammine)cobalt(III) chloride
- (j) $[\text{Ni}(\text{CO})_4]$ – tetracarbonylnickel(0)
- (k) $[\text{Co}(\text{ONO})_6]^{3-}$ – hexanitrito-O-cobaltate(III)
- (l) $\text{Na}_2[\text{Ni}(\text{EDTA})]$ – 2, 2', 2'', 2''' – (ethane 1,2 – diyldinitrilo) tetraacetato nickelate
- (m) $\text{Mn}_3(\text{CO})_{12}$ – dodecacarbonyltrimangenes(0)
- (n) $[\text{Co}(\text{NH}_3)_5\text{Cl}]^{2+}$ – pentaamminechloridocobalt(III) ion
- (o) $[\text{CoCl}_2(\text{NH}_3)_4][\text{Cr}(\text{CN})_6]$ – tetraamminedichloridocobalt(III) hexacyanidochromate(III)
- (p) $\text{K}_4[\text{Fe}(\text{CN})_6]$ – potassium hexacyanidoferrate (II)
- (q) $[\text{Zn}(\text{NCS})_4]^{2-}$ – tetrakisothiocyanidozincate(II)
- (r) $[\text{Pt}(\text{NH}_3)_4\text{Cl}_2][\text{PtCl}_4]$ – tetraamminedichloridoplatinum(IV) tetrachloridoplatinate(II)
- (s) $\text{K}_4[\text{Ni}(\text{CN})_4(\text{OH})_2]$ – potassium tetracyanidodihydroxidonickelate(II)
- (t) $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl}$ – tetraaquadichloridochromium(III) chloride

Ques 3. Using IUPAC norms write the formula for the following:

- (a) tetrahydroxozincate(II)
- (b) hexaamminecobalt(III) sulphate
- (c) pentaamminenitrito-O-cobalt(III)
- (d) potassium diaquadioxalatochromate(III)
- (e) bis(ethane-1,2-diamine)difluoridocobalt(III) chloride
- (f) sodium pentacyanonitrosoniumferrate(II)
- (g) chloridobis(ethane-1,2diamine)nitroplatinum(IV) chloride
- (h) potassium tetrachloridonickelate(II)
- (i) tetraamminechloridonitrite-N-cobalt(III)chloride
- (j) tris(ethane-1,2diamine)cobalt(III)
- (k) Tetraamineaquachloridocobalt(III) chloride
- (l) Hexaamminenickel (II) chloride
- (m) Hexaamminecobalt (III) ion
- (n) Tetrachloridonickelate (II) ion
- (o) Dichloridobis ethylenediamine cobalt (III) ion
- (p) Sodium dicyanidoaurate (I)

- (q) Tetraamminechloridonitrito-N-platinum (IV) sulphate
- (r) Tris(ethane-1,2-diamine) chromium (III) chloride
- (s) Potassium tetrahydroxozincate(II)
- (t) Potassium trioxalatoferrate (III)

Ans 3.

- (a) Tetrahydroxidozincate(II) – $[\text{Zn}(\text{OH})_4]^{2-}$
- (b) hexaamminecobalt(III) sulphate – $[\text{Co}(\text{NH}_3)_6]_2(\text{SO}_4)_3$
- (c) pentaamminenitrito-O-cobalt(III) – $[\text{Co}(\text{NH}_3)_5\text{ONO}]^{2+}$
- (d) potassium diaquadioxalatochromate(III) – $\text{K} [\text{Cr}(\text{H}_2\text{O})_2(\text{ox})_2]$
- (e) bis(ethane-1,2-diamine)difluoridocobalt(III) chloride – $[\text{CoF}_2(\text{en})_2]\text{Cl}$
- (f) sodium pentacyanonitrosoniumferrate(II) – $\text{Na}_2[\text{Fe}(\text{CN})_5(\text{NO})]$
- (g) chloridobis(ethane-1,2-diamine)nitroplatinum(IV) chloride – $[\text{Pt}(\text{en})_2(\text{Cl})(\text{NO}_2)]\text{Cl}_2$
- (h) potassium tetrachloridonickelate(II) – $\text{K}_2[\text{Ni}(\text{Cl})_4]$
- (i) tetraamminechloridonitrite-N-cobalt(III)chloride – $[\text{Co}(\text{NH}_3)_4(\text{Cl})(\text{NO}_2)]\text{Cl}$
- (j) tris(ethane-1,2-diamine)cobalt(III) – $[\text{Co}(\text{en})_3]_2(\text{SO}_4)_3$
- (k) Tetraamineaquachloridocobalt(III) chloride - $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})\text{Cl}]\text{Cl}_2$
- (l) Hexaamminenickel (II) chloride – $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$
- (m) Hexaamminecobalt (III) ion - $[\text{Co}(\text{NH}_3)_6]^{3+}$
- (n) Tetrachloridonickelate (II) ion - $[\text{NiCl}_4]^{2-}$
- (o) Dichloridobis ethylenediamine cobalt (III) ion - $[\text{CoCl}_2(\text{en})_2]^+$
- (p) Sodium dicyanidoaurate (I) - $\text{Na}[\text{Au}(\text{CN})_2]$
- (q) Tetraamminechloridonitrito-N-platinum (IV) sulphate - $[\text{Pt}(\text{NH}_3)_4\text{Cl}(\text{NO}_2)](\text{SO}_4)$
- (r) Tris(ethane-1,2-diamine) chromium (III) chloride - $[\text{Cr}(\text{en})_3]\text{Cl}_3$
- (s) Potassium tetrahydroxozincate(II) - $\text{K}_2[\text{Zn}(\text{OH})_4]$
- (t) Potassium trioxalatoferrate (III) - $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$

Ques 4. What is meant by chelate effect?

Ans 4. Chelate effect: When a bidentate or a polydentate ligand contains donor atoms positioned in such a way that when they coordinate with the central metal ion, a five or a six membered ring is formed. This effect is called Chelate effect. As a result, the stability of the complex increases.

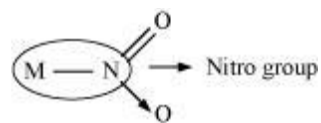
Example: the complex of Ni^{2+} with ‘+ion’ is more stable than NH_3 .

Ques 5. Why are low spin tetrahedral complexes not formed?

Ans 5. Low spin tetrahedral complexes are rarely observed because orbital splitting energies for tetrahedral complexes are sufficiently large for forcing pairing.

Ques 6. What are ambidentate ligands? Give two examples .

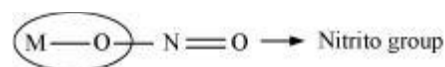
Ans 6. Ambidentate ligands are ligands that can attach themselves to the central metal atom through two different atoms. For example:



Ligand linked with N



Ligand linked with S



Ligand linked with oxygen



Ligand linked with N

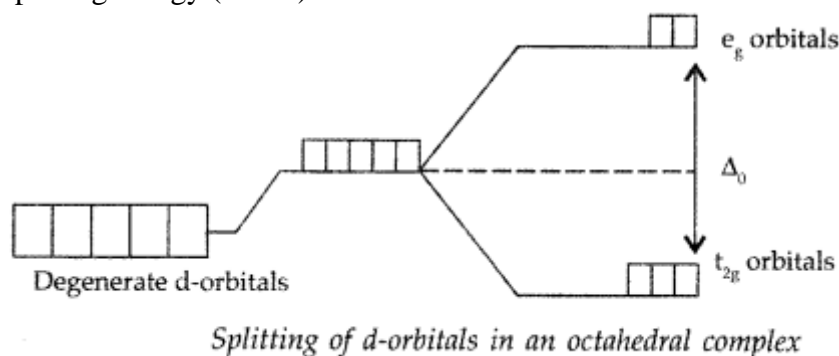
Ques 7. What do you mean by denticity of a ligand?

Ans 7. The number of donor atoms in a ligand which forms coordinate bond with the central metal atom are called denticity of a ligand.

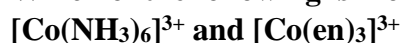
Example : If donor atom is one then it is called Monodentate ligand, if it is two, then it is called Bidentate and so on.

Ques 8. Explain crystal field splitting .

Ans 8. It is the splitting of the degenerate energy levels due to the presence of ligands. When ligand approaches a transition metal ion, the degenerate d-orbitals split into two sets, one with lower energy and the other with higher energy. This is known as crystal field splitting and the difference between the lower energy set and higher energy set is known as crystal field splitting energy (CFSE)



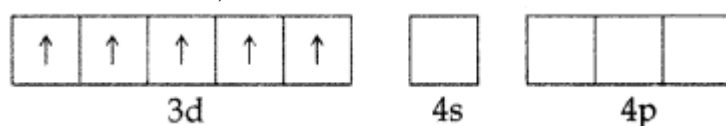
Ques 9. Which of the following is more stable complex and why?



Ans 9. [Co(en)₃]³⁺ is more stable complex than [Co(NH₃)₆]³⁺ because of chelate effect.

Ques 10. [Fe(H₂O)₆]³⁺ is strongly paramagnetic whereas [Fe(CN)₆]³⁻ is weakly paramagnetic. Explain. (At. no. Fe = 26)

Ans 10. In both the cases, Fe is in oxidation state +3. Outer electronic configuration of Fe³⁺ is :

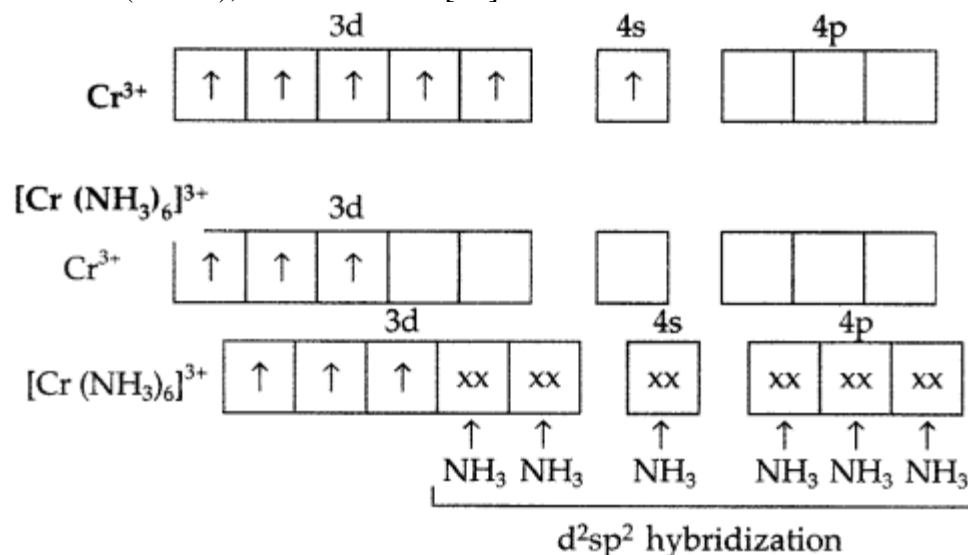


In the presence of CN⁻, the 3d electrons pair up leaving only one unpaired electron. The hybridisation involved is d²sp³ forming inner orbital complex which is weakly

paramagnetic. In the presence of H_2O (a weak ligand), 3d electrons do not pair up. The hybridisation involved is sp^3d^2 forming an outer orbital complex. As it contains five unpaired electrons so it is strongly paramagnetic.

Ques 11. Using Valence bond theory explain the geometry and magnetic behaviour by $[\text{Cr}(\text{NH}_3)_6]^{3+}$. (At. no. Cr = 24)

Ans 11. Cr atom ($Z = 24$), Ground state = $[\text{Ar}] 3\text{d}^5 4\text{s}^1$



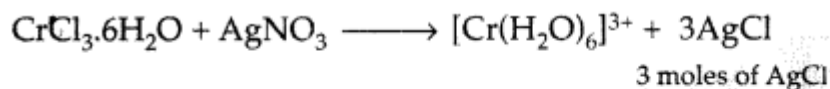
Geometry : Octahedral

Magnetic property : Paramagnetic

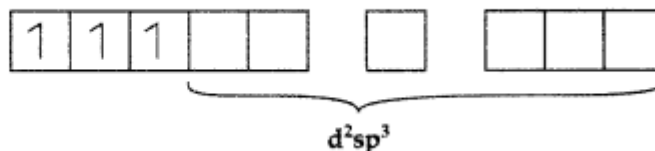
Ques 12. When a coordination compound $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$ is mixed with AgNO_3 solution, 3 moles of AgCl are precipitated per mole of the compound. Write :

- (i) Structural formula of the complex
- (ii) IUPAC name of the complex
- (iii) Magnetic and spin behaviour of the complex

Ans 12.



- (i) $[\text{Cr}(\text{H}_2\text{O})_6]^{3+} \text{Cl}_3^-$
- (ii) IUPAC name : Hexaaquachromium (III) chloride
- (iii) E.C. of $\text{Cr}^{3+} = 3\text{d}^3 4\text{s}^0 4\text{p}^0$; unpaired electrons = 3



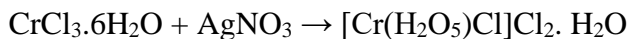
Inner orbital complex so it is low spin complex.

Since 3 unpaired electrons are present, it is paramagnetic in nature.

Ques 13. When a co-ordination compound $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$ is mixed with AgNO_3 , 2 moles of AgCl are precipitated per mole of the compound. Write

- (i) Structural formula of the complex.
(ii) IUPAC name of the complex.

Ans 13. (i) The complex formed on mixing a coordination compound $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$ with AgNO_3 is as follows



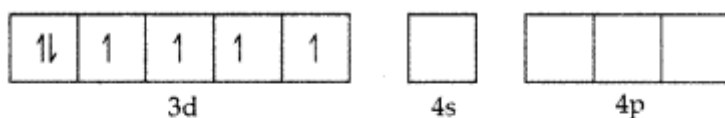
(ii) Pentaquachloridochromium (III) chloride monohydrate

Ques 14. Describe the shape and magnetic behaviour of following complexes :

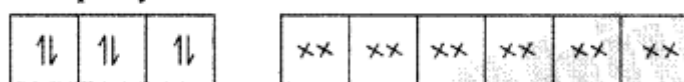
- (i) $[\text{Co}(\text{NH}_3)_6]^{3+}$
(ii) $[\text{Ni}(\text{CN})_4]^{2-}$ (At. No. Co = 27, Ni = 28)

Ans 14. (i) $[\text{Co}(\text{NH}_3)_6]^{3+}$:

Orbitals of Co^{3+} ion :



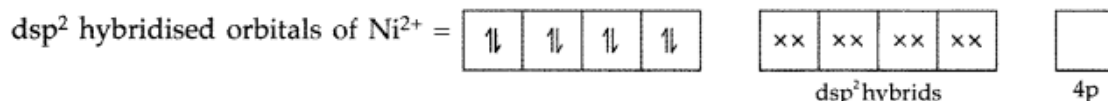
*, d^2sp^3 hybridised orbitals of Co^{3+} :



Six pair of electrons
from six NH_3 molecules

Hybridization : d^2sp^3 Shape : Octahedral Magnetic behaviour : Diamagnetic (absence of unpaired electrons)

(ii) $[\text{Ni}(\text{CN})_4]^{2-}$



Containing 4 pairs of electrons from 4 CN molecules

Shape : Square planar

Hybridisation : dsp^2

Magnetic behaviour : Diamagnetic (no unpaired electrons)

Ques 15. Explain why $[\text{Co}(\text{NH}_3)_6]^{3+}$ is an inner orbital complex whereas $[\text{Ni}(\text{NH}_3)_6]^{2+}$ is an outer orbital complex. (At. no. Co = 27, Ni = 28)

Ans 15. In $[\text{Co}(\text{NH}_3)_6]^{3+}$, the d-electrons of Co^{3+} ($[\text{Ar}]3d^6 4s^0$) get paired leaving behind two empty d-orbital and undergo d^2sp^3 hybridization and hence inner orbital complex, while in $[\text{Ni}(\text{NH}_3)_6]^{2+}$ the d-electrons of Ni^{2+} ($[\text{Ar}]3d^8 4s^0$) do not pair up and use outer 4d subshell hence outer orbital complex.

Ques 16. For the complex $[\text{Fe}(\text{en})_2\text{Cl}_2]$, Cl, (en = ethylene diamine), identify

- (i) the oxidation number of iron,
(ii) the hybrid orbitals and the shape of the complex,

- (iii) the magnetic behaviour of the complex,
 (iv) name of the complex. (At. no. of Fe = 26)

Ans 16. (i) $[\text{Fe}(\text{en})_2\text{Cl}_2]$ Cl or $x + 0 + 2(-1) + (-1) = 0$
 $x + (-3) = 0$ or $x = +3$

\therefore Oxidation number of iron, $x = +3$

(ii) The complex has two bidentate ligands and two monodentate ligands. Therefore, the coordination number is 6 and hybridization will be d^2sp^3 and shape will be octahedral.

(iii) In the complex ${}_{26}\text{Fe}^{3+} = 3d^5 4s^0 4p^0$



Due to presence of one unpaired electrons in d orbitals the complex is paramagnetic.

(iv) Name of complex: Dichloridobis (ethane-1, 2- diamine) Iron (III) chloride.

Ques 17. Compare the following complexes with respect to their shape, magnetic behaviour and the hybrid orbitals involved:

(i) $[\text{CoF}_4]^{2-}$

(ii) $[\text{Cr}(\text{H}_2\text{O})_2(\text{C}_2\text{O}_4)_2]^-$

(iii) $[\text{Ni}(\text{CO})_4]$ (Atomic number : Co = 27, Cr = 24, Ni = 28)

Ans 17. (i) $[\text{CoF}_4]^{2-}$: Tetrafluorido cobalt (III) ion

Coordination number = 4 Shape = Tetrahedral Hybridisation = sp^3

$$\therefore \text{Magnetic moment } (\mu) = \sqrt{n(n+2)} \text{ BM} = \sqrt{3(3+2)} = \sqrt{15} = 3.87 \text{ BM}$$

(ii) $[\text{Cr}(\text{H}_2\text{O})_2(\text{C}_2\text{O}_4)_2]^-$: Diaquadioxalato chromium (III) ion

Coordination number = 6 Shape = Octahedral Hybridisation = d^2sp^3

$$\therefore \text{Magnetic moment } (\mu) = \sqrt{n(n+2)} \text{ BM} = \sqrt{15} = 3.87 \text{ BM}$$

(iii) $[\text{Ni}(\text{CO})_4]$: Tetracarbonyl nickel (0)

Coordination no. = 4 Shape = Tetrahedral Hybridisation = sp^3

$$\therefore \text{Magnetic moment } (\mu) = \sqrt{n(n+2)} \text{ BM} = \sqrt{0(0+2)} = 0$$

Ques 18. Explain the following cases giving appropriate reasons:

(i) Nickel does not form low spin octahedral complexes.

(ii) The π -complexes are known for the transition metals only.

Ans 18. (i) The electronic configuration of Ni is $[\text{Ar}] 3d^8 4s^2$ which shows that it can only form two types of complexes i.e. square planar (dsp^2) in presence of strong ligand and tetrahedral (sp^3) in presence of weak ligand. There are four empty orbitals in Ni while octahedral complexes require six empty orbitals.

(ii) Due to presence of empty d-orbitals in transition metals, they can accept electron pairs from ligands containing π electrons and hence can form π -bonding complexes.

Example : ligands like C_5H_5 , C_6H_6 etc.

(iii) Due to greater magnitude of Δ_0 , CO produces strong fields which cause more splitting of d-orbitals and moreover it is also able to form π bond due to back bonding.

Ques 19. Explain the following :

(i) Low spin octahedral complexes of nickel are not known.

(ii) The π -complexes are known for transition elements only.

(iii) CO is a stronger ligand than NTL, for many metals.

Ans 19. (i) The electronic configuration of Ni is $[\text{Ar}] 3d^8 4s^2$ which shows that it can only form two types of complexes i.e. square planar (dsp^2) in presence of strong ligand and tetrahedral (sp^3) in presence of weak ligand. There are four empty orbitals in Ni while octahedral complexes require six empty orbitals.

(ii) Due to presence of empty d-orbitals in transition metals, they can accept electron pairs from ligands containing π electrons and hence can form π -bonding complexes.

Example : ligands like C_5H_5 , C_6H_6 etc.

(iii) Due to greater magnitude of Δ_0 , CO produces strong fields which cause more splitting of d-orbitals and moreover it is also able to form π bond due to back bonding.

Ques 20. Write the name, stereochemistry and magnetic behaviour of the following : (At. nos. Mn = 25, Co = 27, Ni = 28)

(i) $K_4[Mn(CN)_6]$

(ii) $[Co(NH_3)_5 Cl]Cl_2$

(iii) $K_2 [Ni(CN)_4]$

Ans 20. (i) $K_4[Mn(CN)_6]$: IUPAC name : Potassium Hexacyano manganate (II)

Geometry : Octahedral

Magnetic behaviour: Paramagnetic (one unpaired electron)

(ii) $[Co(NH_3)_5 Cl]Cl_2$:

Name : Pentaammine chlorido cobalt (III) chloride

Shape : Octahedral (\because Coordination number = 6)

Hybridization : d^2sp^3 Magnetic behaviour : Diamagnetic (no unpaired electrons)

(iii) $K_2 [Ni(CN)_4]$:

Name : Potassium tetracyanonickelate (II)

Shape : Square planar Hybridization : dsp^2 (\because Coordination number = 4)

Hybridization : dsp^2 Magnetic behaviour : Diamagnetic

Ques 21. State a reason for each of the following situations :

(i) Co^{2+} is easily oxidized to Co^{3+} in presence of a strong ligand.

(ii) CO is a stronger complexing reagent than NH_3 .

(iii) The molecular shape of $[Ni(CO)_4]$ is not the same as that of $[Ni(CN)_4]^{2-}$

Ans 21. (i) Because in the presence of strong ligands, the crystal field splitting energy is more than the energy required to oxidise Co^{2+} .

(ii) This is due to the formation of π – bond by back donation of electrons from metal to carbon of CO or due to synergic bonding.

(iii) CO is a stronger field ligand than CN. Ni is in zero oxidation state in $Ni(CO)_4$ and has tetrahedral geometry. But, Ni is in +2 oxidation state in $[Ni(CN)_4]^{2-}$ and has dsp^2 hybridization (different geometry than tetrahedral sp^3).

Ques 22. Compare the following complexes with respect to structural shapes of units, magnetic behaviour and hybrid orbitals involved in units:

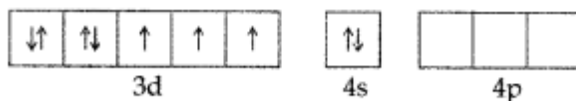
$[Co(NH_3)_6]^{3+}$, $[Cr(NH_3)_6]^{3+}$, $Ni(CO)_4$

(At. nos. : Co = 27, Cr = 24, Ni = 28)

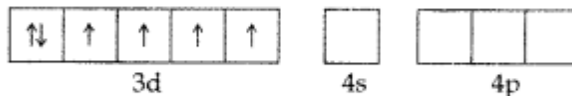
Ans 22. (i) $[\text{Co}(\text{NH}_3)_6]^{+3} \rightarrow$ Octahedral shape, d^2sp^3 hybridisation, diamagnetic

Formation of $[\text{Co}(\text{NH}_3)_6]^{+3} \rightarrow$ oxidation state of Co is +3.

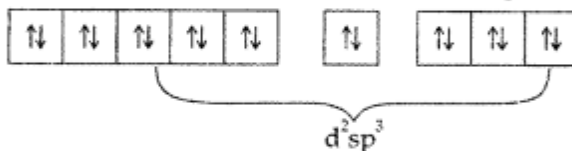
Co (Z = 27)
in ground state



Formation Co^{+3}



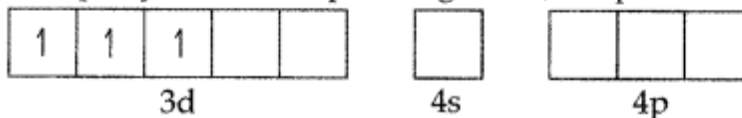
Formation of
 $[\text{Co}(\text{NH}_3)_6]^{+3}$



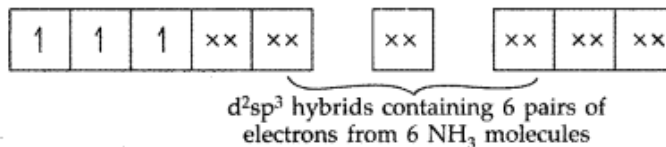
(ii) $[\text{Cr}(\text{NH}_3)_6]^{3+}$

Octahedral shape, d^2sp^3 hybridisation paramagnetic (3 unpaired electrons)

Orbitals of Cr^{3+}



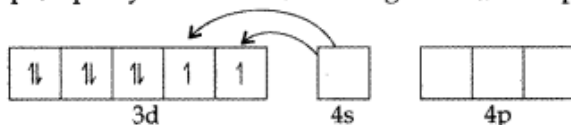
d^2sp^3 hybridised orbitals of Cr^{3+}



(iii) $[\text{Ni}(\text{CO})_4]$

Tetrahedral shape, sp^3 hybridisation, diamagnetic (no unpaired electrons)

Orbitals of Ni



sp^3 hybridised orbitals of Ni



sp^3 hybrids containing 4 pairs of electrons from 4 CO molecules

Ques 23. For the complex $[\text{NiCl}_4]^{2-}$, write

(i) the IUPAC name

(ii) the hybridization type

(iii) the shape of the complex. (Atomic no. of Ni = 28)

Ans 23. (i) IUPAC name : $[\text{NiCl}_4]^{2-}$ Tetrachloridonickelate (II) ion

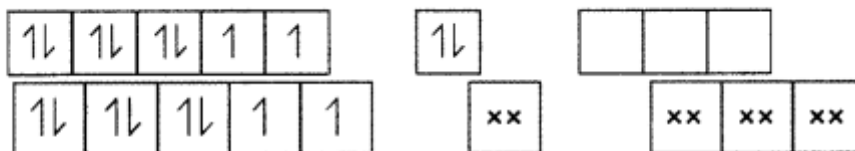
(ii) Hybridization type : The above complex shows sp^3 hybridization

$^{28}\text{Ni}_{\text{G.S.}} =$

$3d^8$

$4s^2 4p$

Ni^{2+} ion



sp^3 hybrid orbitals
4 electron pairs donated by 4 Cl molecules

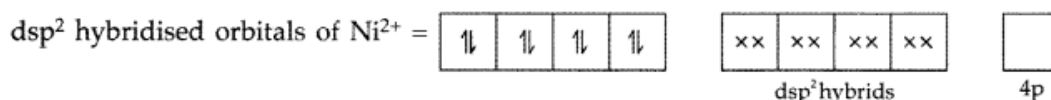
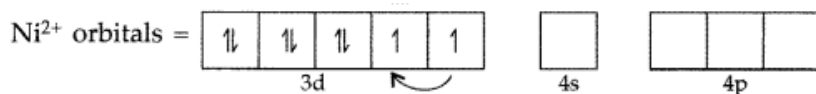
(iii) Shape : The above complex shows tetrahedral shape due to sp^3 hybridization.

Ques 24. Compare the following complexes' with respect to structural shapes of units, magnetic behaviour and hybrid orbitals involved in units :

(i) $[\text{Ni}(\text{CN})_4]^{2-}$ (ii) $[\text{NiCl}_4]^{2-}$ (iii) $[\text{CoF}_6]^{3-}$

[At. Nos. : Ni = 28; Co = 27]

Ans 24. (i) $[\text{Ni}(\text{CN})_4]^{2-}$



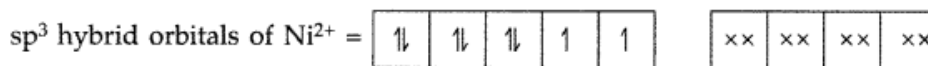
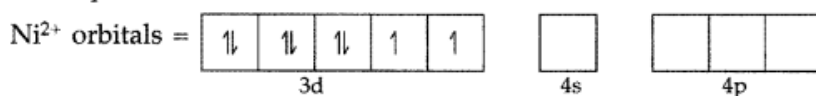
Containing 4 pairs of electrons from 4 CN molecules

Shape : Square planar

Hybridisation : dsp^2

Magnetic behaviour : Diamagnetic (no unpaired electrons)

(ii) $[\text{NiCl}_4]^{2-}$



sp^3 hybrid orbitals containing 4 pairs of electrons from 4 Cl atoms

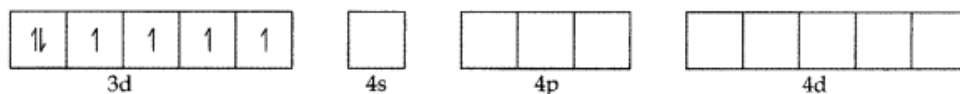
Shape : Tetrahedral

Hybridisation : sp^3

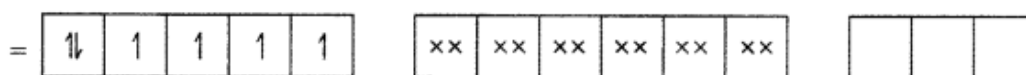
Magnetic behaviour : Paramagnetic (2 unpaired electrons)

(iii) $[\text{CoF}_6]^{3-}$

Co^{3+} orbitals =



sp^3d^2 hybrid orbitals of Co^{3+}



sp^3d^2 hybrid orbitals containing 6 pairs of electrons from 6 F atoms

Shape : Octahedral outer orbital complex

Hybridisation : sp^3d^2

Magnetic behaviour : Paramagnetic (4 unpaired electrons)

Ques 25. Write the name, the state of hybridization, the shape and the magnetic behaviour of the following complexes :

$[\text{CoCl}_4]^{2-}$, $[\text{Ni}(\text{CN})_4]^{2-}$, $[\text{Cr}(\text{H}_2\text{O})_2(\text{C}_2\text{O}_4)_2]^-$

(At No. : Co = 27, Ni = 28, Cr = 24)

Ans 25. (i) $[\text{CoCl}_2]^-$:

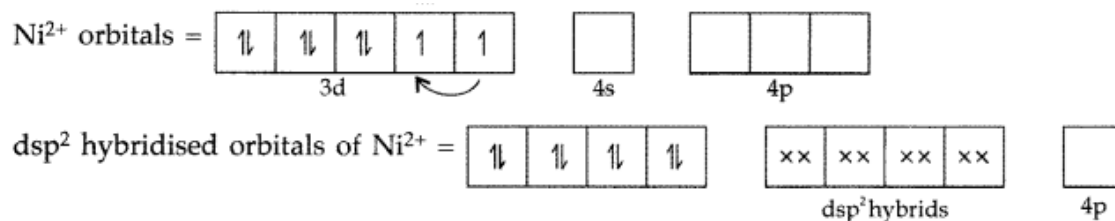
Name – Tetra chlorido Cobalt (II) ion

Shape = Tetrahedral

Hybridization = sp^3

Magnetic property = Paramagnetic

(ii) $[\text{Ni}(\text{CN})_4]^{2-}$



Containing 4 pairs of electrons from 4 CN molecules

Shape : Square planar

Hybridisation : dsp^2

Magnetic behaviour : Diamagnetic (no unpaired electrons)

(iii) $[\text{Cr}(\text{H}_2\text{O})_2(\text{C}_2\text{O}_4)_2]^-$:

Name = Diaquabis (oxalato) chromium (III) ion

Shape = Octahedral

Hybridization = d^2sp^3

Magnetic property = Paramagnetic