Chemistry Study Materials for Class 12
(NCERT Based Questions - Answers of Chapter - 09)
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Co-ordination Compounds

Question 1: Write the formulas for the following coordination compounds:

(i) Tetraamminediaquacobalt (III) chloride

(ii) Potassium tetracyanonickelate(II)

(iii) Tris(ethane-1,2-diamine) chromium(III) chloride

(iv) Amminebromidochloridonitrito-N-platinate(II)

(v) Dichloridobis(ethane-1,2-diamine)platinum(IV) nitrate

(vi) Iron(III) hexacyanoferrate(II)

Solution 1:

(i) $CO[(H_2O)(NH_3)_4]\ Cl_3$

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

(iii) $Cr[(en)_3]Cl_3$

(iv) $Pt[(NH)_3BrCl(NO_2)]$

(v) $Pt[Cl_2(en)_2(NO_3)_2]$

(vi) $Fe_4[Fe(CN)_6]_3$

Question 2: Write the IUPAC names of the following coordination compounds:

(i) $[CO(NH_3)_8]\ Cl_3$

(ii) $[CO(NH_3)_6\ Cl]Cl_3$

(iii) $K_3[Fe(CN)_8]$

(iv) $K_3[Fe(C_2N_4)_3]$

(v) $K_2[PdCl_4]$

(vi) $[Pt(NH_3)_2Cl(NH_2CH_3)]\ Cl$

Solution 2:

(i) Hexaamminecobalt(III) chloride

(ii) Pentaamminechloridocobalt (III) chloride

(iii) Potassium hexacyanoferrate(III)

(iv) Potassium trioxalatoferrate(III)

(v) Potassium tetrachloridopalladate(II)

(vi) Diamminechlorido(methylamine)platinum(II) chloride

Question 3: Indicate the types of isomerism exhibited by the following complexes and draw the structures for these isomers:

(i) $K [Cr (H_2O)_2 (C_2O_4)_2]$

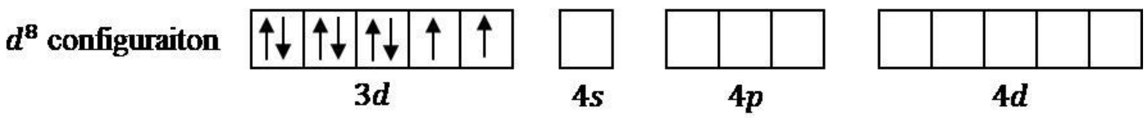
(ii) $[CO(en)_2] Cl_2$

(iii) $[Co(NH_3)_6 (NO_2) (NO_3)_2]$

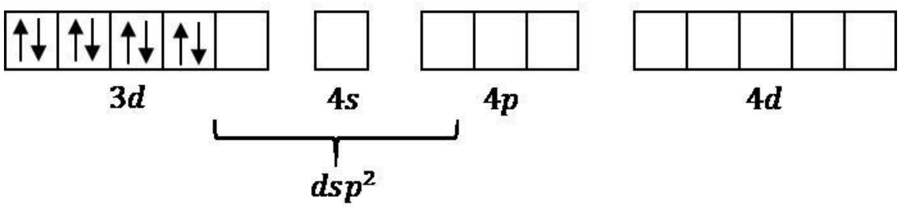
(iv) $[Pt(NH_2)(H_2O)Cl_2]$

Question 4: Explain on the basis of valence bond theory that $Ni\,(CN\,)_4{}^{2-}$ ion with square planer structure is diamagnetic and the $Ni\,(Cl)_4{}^{2-}$ ion with tetrahedral geometry is paramagnetic.

Solution 4: Ni is in the +2 oxidation state i.e., in d^8 configuration.

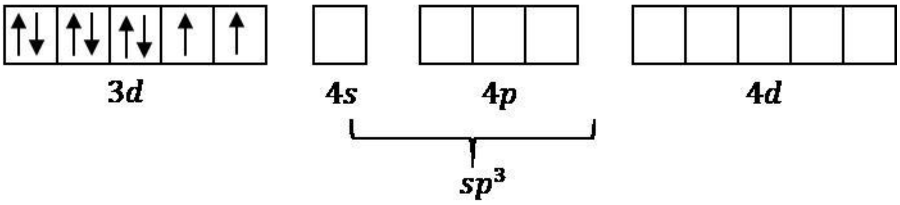


There are 4 CN^- ions. Thus, it can either have a tetrahedral geometry or square planar geometry. Since CN^- ion is a strong field ligand, it causes the pairing of unpaired 3*d* electrons.



It now undergoes dsp^2 hybridization. Since all electrons are paired, it is diamagnetic. In case of $[NiCl4]^{2-}$, Cl^- ion is a weak field ligand. Therefore, it does not lead to the pairing of unpaired 3*d* electrons.

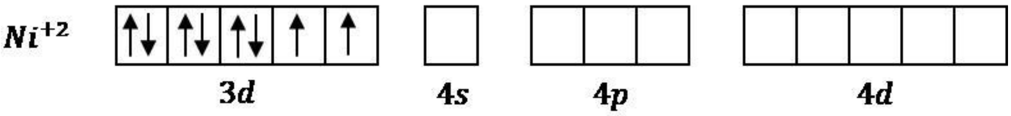
Therefore, it undergoes sp^3 hybridization.



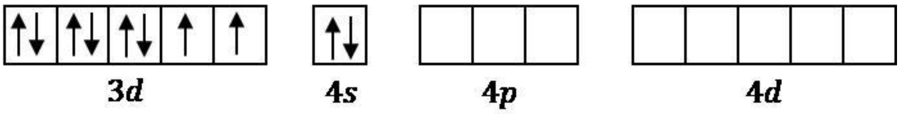
Since there are 2 unpaired electrons in this case, it is paramagnetic in nature.

Question 5: $[NiCl4]^{2-}$ is paramagnetic while $[Ni(CO)4]$ is diamagnetic though both are tetrahedral. Why?

Solution 5: Though both $[NiCl4]^{2-}$ and $[Ni(CO)4]$ are tetrahedral, their magnetic characters are different. This is due to a difference in the nature of ligands. Cl^- is a weak field ligand and it does not cause the pairing of unpaired 3*d* electrons. Hence, $[NiCl4]^{2-}$ is paramagnetic.



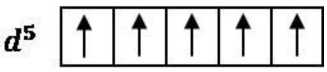
In $[Ni(CO)4]$, Ni is in the zero oxidation state i.e., it has a configuration of $3d^8\ 4s^2$.



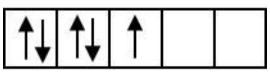
But CO is a strong field ligand. Therefore, it causes the pairing of unpaired 3*d* electrons. Also, it causes the 4s electrons to shift to the 3d orbital, thereby giving rise to sp^3 hybridization. Since no unpaired electrons are present in this case, $[Ni(CO)4]$ is diamagnetic.

Question 6: $[Fe(H2O)6]^{3+}$ is strongly paramagnetic whereas $[Fe(CN)6]^{3+}$ is weakly paramagnetic. Explain.

Solution 6: In both $[Fe(H2O)6]^{3+}$ and $[Fe(CN)6]^{3+}$, Fe exists in the +3 oxidation state i.e., in d^5 configuration



Since CN^- is a strong field ligand, it causes the pairing of unpaired electrons. Therefore, there is only one unpaired electron left in the *d*-orbital.



Therefore magnetic moment is given by,

$\mu = \quad n(n+2) \quad = \quad 1(1+2) \quad = \quad 3 \ = 1.732BM$

On the other hand, *H*2*O* is a weak field ligand. Therefore, it cannot cause the pairing of electrons. This means that the number of unpaired electrons is 5.

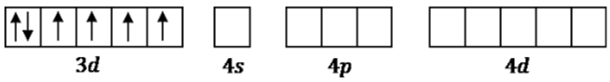
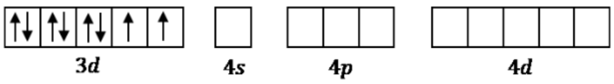
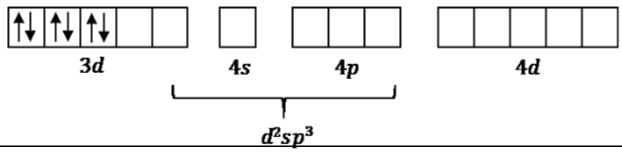
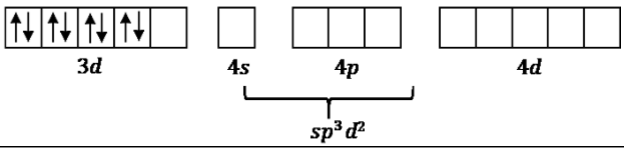
Therefore, magnetic moment is given by,

$$\mu = \sqrt{n(n+2)} = \sqrt{5(5+2)} = \sqrt{35} = 5.91BM$$

Thus, it is evident that $[Fe(H2O)6]^{3+}$ is strongly paramagnetic, while $[Fe(CN)6]^{3+}$ is weakly paramagnetic

Question 7: Explain $[Co(NH_3)_6]^{3+}$ is an inner orbital complex whereas $[Ni(NH_3)_6]^{2+}$ is an outer orbital complex.

Solution 7:

$[Co(NH3)6]^{3+}$	$[Ni(NH3)6]^{2+}$
Oxidation state of cobalt = +3	Oxidation state of Ni = +2
Electronic configuration of cobalt = d^6	Electronic configuration of nickel = d^8
	
*NH*3 being a strong field ligand causes the pairing. Therefore, Cobalt can undergo d^2sp^3 hybridization.	If *NH*3 causes the pairing, then only one 3*d* orbital is empty. Thus, it cannot undergo d^2sp^3 hybridization. So in this complex NH3 acts as weak field ligand. Therefore, it undergoes $sp3d^2$ hybridization.
	
Hence, it is an inner orbital complex.	Hence, it forms an outer orbital complex.

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