



NCERT INTEXT QUESTIONS

9.1. 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- platinum(II)
- (v) Dichloridobis(ethane-1,2-diamine) platinum (IV) nitrate
- (vi) Iron(III)hexacyanoferrate(II)

Ans:

- (i) $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})_2]\text{Cl}_3$
- (ii) $\text{K}_2[\text{Ni}(\text{CN})_4]$
- (iii) $[\text{Cr}(\text{en})_3]\text{Cl}_3$
- (iv) $[\text{Pt}(\text{NH}_3)\text{BrCl}(\text{NO}_2)]^-$
- (v) $[\text{PtCl}_2(\text{en})_2](\text{NO}_3)_2$
- (vi) $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$

9.2. Write the IUPAC names of the following coordination compounds:

- (i) $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$
- (ii) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$
- (iii) $\text{K}_3[\text{Fe}(\text{CN})_6]$
- (iv) $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$
- (v) $\text{K}_2[\text{PdCl}_4]$
- (vi) $[\text{Pt}(\text{NH}_3)_2\text{Cl}(\text{NH}_2\text{CH}_3)]\text{Cl}$

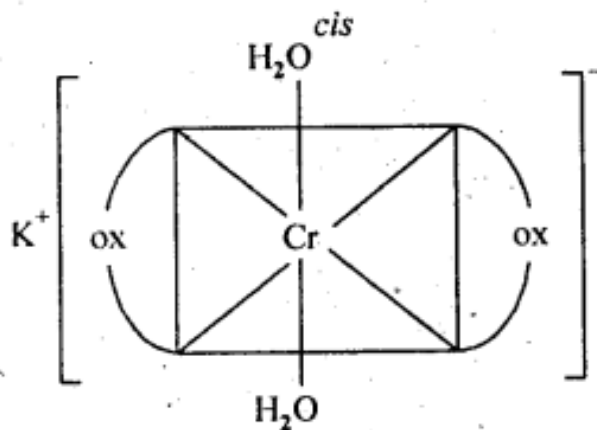
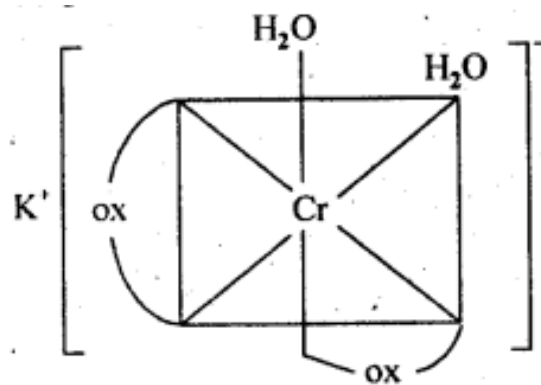
Ans:

- (i) Hexaamminecobalt (III) chloride
- (ii) Pentaamminechloridocobalt (III) chloride
- (iii) Potassium hexacyanoferrate (III)
- (iv) Potassium trioxalatoferrate(III)
- (v) Potassium tetrachloridopalladate (II)
- (vi) Diamminechloride (methylamine) platinum (II) chloride

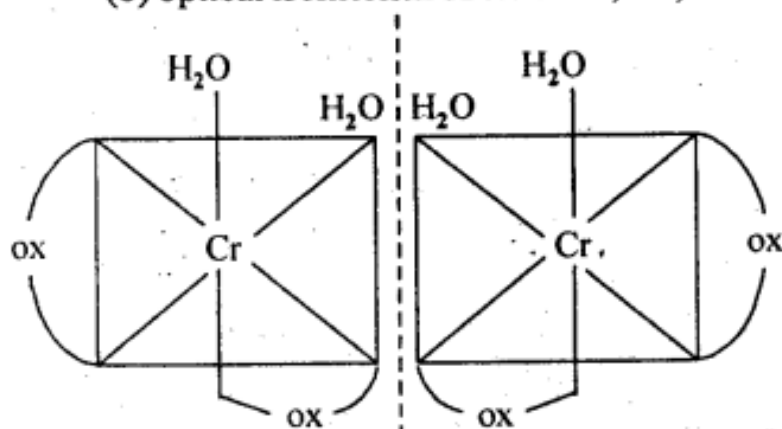
9.3. Indicate the types of isomerism exhibited by the following complexes and draw the structures for these isomers:

- (i) $\text{K}[\text{Cr}(\text{H}_2\text{O})_2(\text{C}_2\text{O}_4)_2]$
- (ii) $[\text{Co}(\text{en})_3]\text{Cl}_3$
- (iii) $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)(\text{NO}_3)_2]$
- (iv) $[\text{Pt}(\text{NH}_3)(\text{H}_2\text{O})\text{Cl}_2]$

Ans: (i) (a) geometrical isomerism (cis and trans)

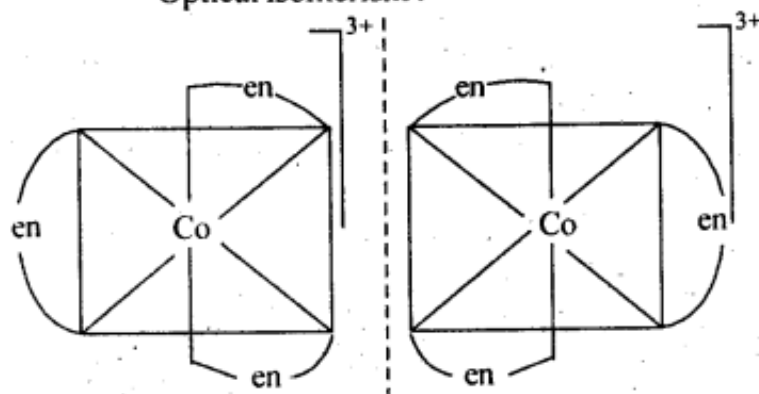


trans
(b) optical isomerism of cis-form, i.e.,



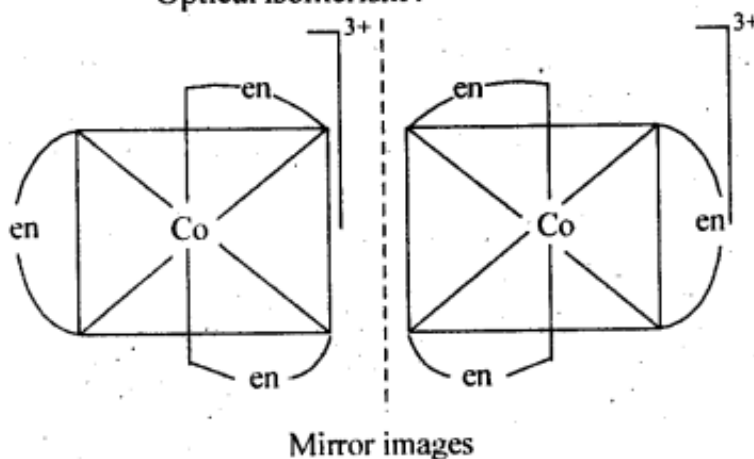
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(ii) $[Co(en)_3]Cl_3$
Optical isomerism :



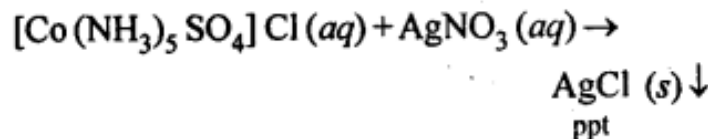
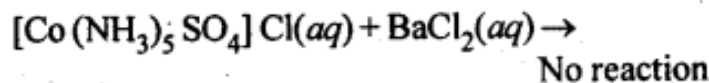
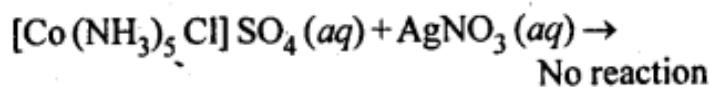
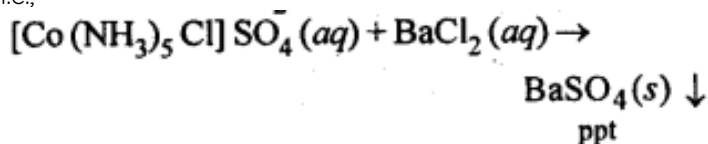
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(ii) $[\text{Co}(\text{en})_3]\text{Cl}_3$
Optical isomerism :



9.4. Give evidence that $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{SO}_4$ and $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Cl}$ are ionisation isomers.

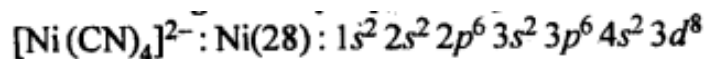
Ans: When dissolved in water, they give different ions in solution which can be tested by adding AgNO_3 solution and BaCl_2 solution, i.e.,



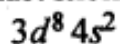
Hence, the two are ionisation isomers.

9.5. Explain on the basis of valence bond theory that $[\text{Ni}(\text{CN})_4]^{2-}$ ion with square planar structure is diamagnetic and the $[\text{Ni}(\text{CN})_4]^{2-}$ ion with tetrahedral geometry is paramagnetic.

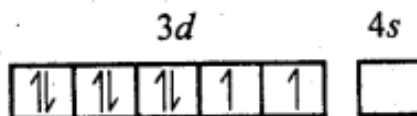
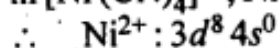
Ans:



or, last shell EC is

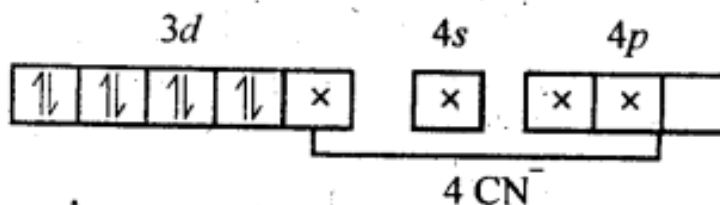


in $[\text{Ni}(\text{CN})_4]^{2-}$, Ni is in +2 state



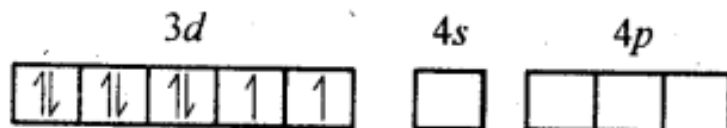
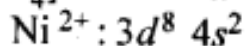
CN^- being a strong field ligand pairs up the e^- s, thus





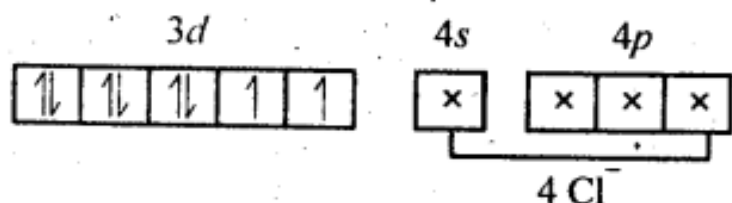
No unpaired e^- , hence $[\text{Ni}(\text{CN})_4]^{2-}$ is diamagnetic

$[\text{NiCl}_4]^{2-}$: Ni is in +2 state, thus



Cl^- being a weak field ligand cannot pair up the e^- s

$\therefore [\text{NiCl}_4]^{2-}$:

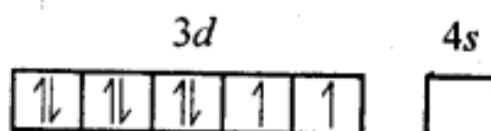
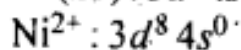
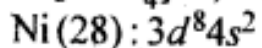


Due to unpaired e^- s, $[\text{NiCl}_4]^{2-}$ is paramagnetic

9.6. $[\text{NiCl}_4]^{2-}$ is paramagnetic while $[\text{Ni}(\text{CO})_4]$ is diamagnetic though both are tetrahedral. Why?

Ans:

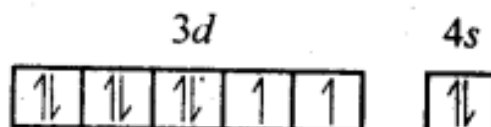
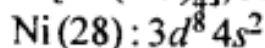
In $[\text{NiCl}_4]^{2-}$, Ni is in +2 oxidation state



Cl^- is weak field ligand. It does not pair up e^- s.

Hence, it is paramagnetic

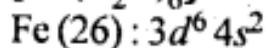
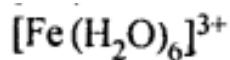
In $[\text{Ni}(\text{CO})_4]$, Ni is in 0 O.S.



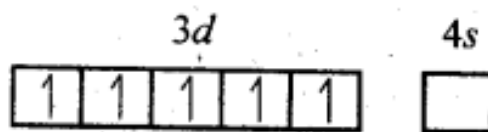
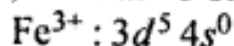
CO is strong field ligand, as it pairs the $4s e^-$ s with $3d e^-$ s to give $3d^{10} 4s^0$. So, no unpaired e^- and hence, the complex is diamagnetic.

9.7. $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ is strongly paramagnetic whereas $[\text{Fe}(\text{CN})_6]^{3-}$ is weakly paramagnetic. Explain.

Ans:

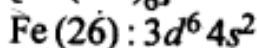
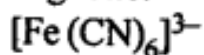


Here, Fe is in +3 state. Thus,

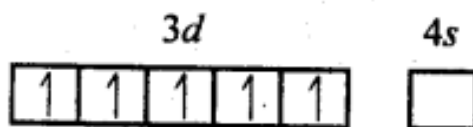
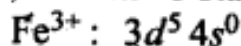


H_2O being a weak field ligand does not pair up

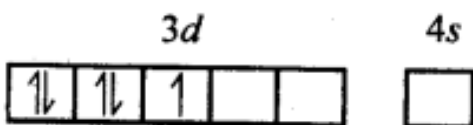
the e^- s and hence the complex is strongly paramagnetic.



Here, Fe is in +3 state, So



CN^- being a strong field ligand pairs up the e^- s so that we have

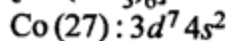


Due to only one unpaired e^- , the complex is weakly paramagnetic

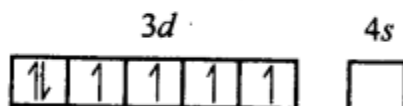
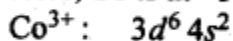
9.8. Explain $[\text{Co}(\text{NH}_3)_6]^{2+}$ is an inner orbital complex, whereas

$[\text{Ni}(\text{NH}_3)_6]^{2+}$ is an outer orbital complex.

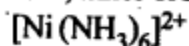
Ans:



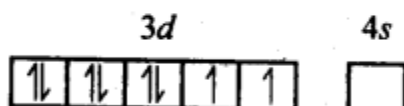
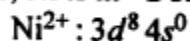
Here, Co is in +3 state, so



In presence of NH_3 , two d e^- s pair up leaving two d -orbitals empty. Hence, hybridisation is d^2sp^3 i.e., inner orbital complex.

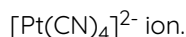


Here, Ni is in +2 state. Thus,



In presence of NH_3 , d e^- s do not pair up. The hybridisation is sp^3d^2 i.e., outer orbital complex.

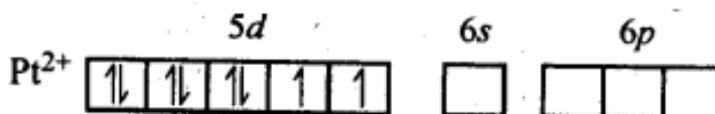
9.9. Predict the number of unpaired electrons in the square planar



Ans:

$[\text{Pt}(\text{CN})_4]^{2-}$: The outer shell electronic configuration of Pt is $5d^9 6s^1$.

In +2 state of Pt, it is $5d^8$, i.e.,

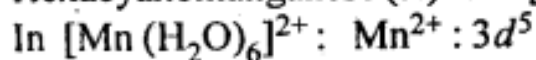
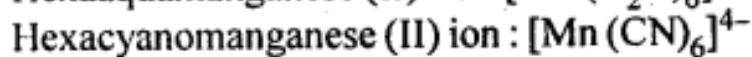
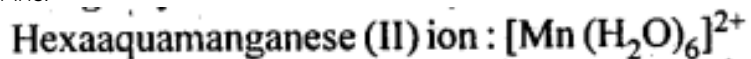


For square planar geometry, hybridisation is dsp^2 .

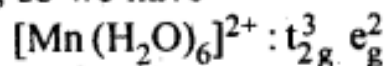
Hence, the two d e^- s pair up to make one d -orbital empty. So, there is no unpaired e^- .

9.10. The hexaquaomanganese(II) ion contains five unpaired electrons, while the hexacyano ion contains only one unpaired electron. Explain using Crystal Field Theory.

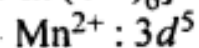
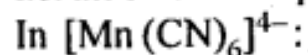
Ans:



H_2O being a weak field ligand does not pair up e^- s, so we have



i.e. all e^- s are unpaired



CN⁻ being a strong field ligand pairs up the e⁻s
so that we have

$[\text{Mn}(\text{CN})_6]^{4-} : t_{2g}^5 e_g^0$
i.e., the t_{2g} orbital contains only one unpaired e⁻.

9.11. Calculate the overall complex dissociation equilibrium constant for the $\text{Cu}(\text{NH}_3)_4^{2+}$ ion, given that β_4 for this complex is 2.1×10^{13} .

Ans:

Overall stability constant (β_4) = 2.1×10^{13} .

Thus, the overall dissociation constant is

$$= \frac{1}{\beta_4} = \frac{1}{2.1 \times 10^{13}} = 4.7 \times 10^{-14}.$$

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