

CBSE Class 12 physics
Important Questions
Chapter 9
Coordination Compounds

3 Marks Questions

1. What is geometric isomerism? When can a compound show.

(1) Cis – Trans isomerism

(2) Fac and Mer isomerism.

Ans. The isomerism that arises in heteroleptic complexes due to different possible geometric arrangements of the ligands is called geometric isomerism.

1) Cis and Trans isomerism can occur in square planar complexes of formula $[MX_2L_2]$ (X & L are unidentate ligands), square planar complexes of formula MA_2B_2 & octahedral complexes of formula MA_2L_4 .

2) Fac and mer isomerism can occur in octahedral complexes of formula MA_3B_3 .

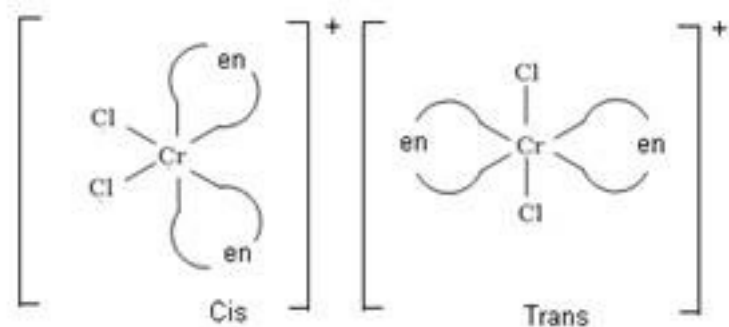
2. How do optical isomers differ from each other?

Ans. Optical isomers differ in the direction in which they rotate the plane of polarized light in a polarimeter.

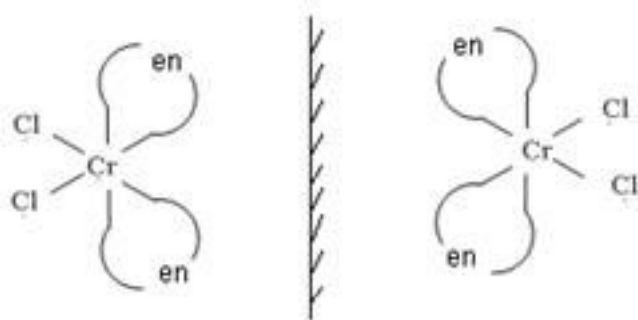
3. Make the cis and trans forms of the complex $[CrCl_2(en)_2]^+$. Which one of these will be optically active?

Ans. $[CrCl_2(en)_2]^+$

Cis and trans forms.



The cis form will be optically active.



mirror

4. Which isomerism is shown by a compound having ambidentate ligand? Give example.

Ans. A complex having ambident ligand will show linkage isomerism e.g

$[Cr (NH_3)_5 (NO_2)] Cl_2$ has NO_2^- as ambident Ligand and its Linkage isomer will be $[Cr (NH_3)_5 (ONO)] Cl_2$.

5. What is ionization isomerism? Give an example.

Ans. Ionisation isomerism arises when the counter ion in a complex salt is itself a potential Ligand and can displace a Ligand which can then become counter ion e.g.

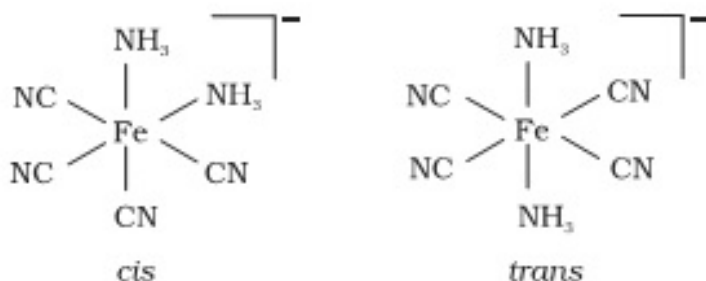
$[Co (NH_3)_5 SO_4] Br$ and $[Co (NH_3)_5 Br] SO_4$ are ionization isomer.

6. How do solvate isomers differ from each other?

Ans. The solvate isomers differ by whether or not a solvent molecule is directly bonded to the metal ion or is merely present on free solvent molecules in the crystal.

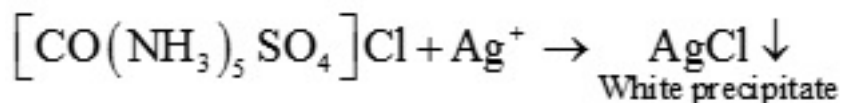
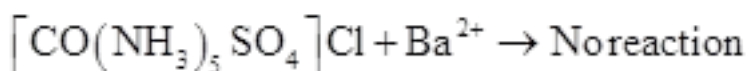
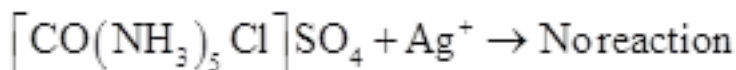
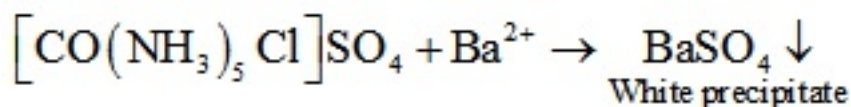
7. Draw the geometrical isomers of $[Cr (NH_3)_2 (CN)_4]^-$?

Ans. Geometrical isomers



8. Give evidence that $[Co(NH_3)_5 Cl]SO_4$ and $[Co(NH_3)_5 SO_4]Cl$ are ionization isomers.

Ans. When ionization isomers are dissolved in water, they ionize to give different ions. These ions then react differently with different reagents to give different products.

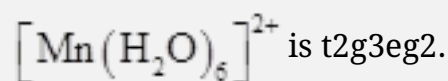


9. The hexaquo manganese (II) ion contains five unpaired electrons, while the hexacyanoion contains only one unpaired electron. Explain using Crystal Field Theory.

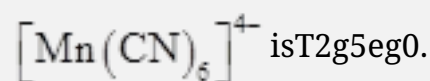
Ans.

$[Mn(H_2O)_6]^{2+}$	$[Mn(CN)_6]^{4-}$
Mn is in the +2 oxidation state.	Mn is in the +2 oxidation state.
The electronic configuration is d^5 .	The electronic configuration is d^5 .

The crystal field is octahedral. Water is a weak field ligand. Therefore, the arrangement of the electrons in

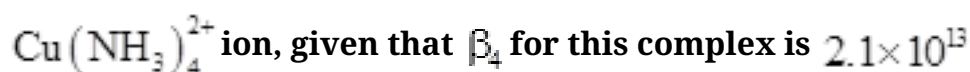


The crystal field is octahedral. Cyanide is a strong field ligand. Therefore, the arrangement of the electrons in



Hence, hexaquo manganese (II) ion has five unpaired electrons, while hexacyano ion has only one unpaired electron.

10. Calculate the overall complex dissociation equilibrium constant for the



Ans. $\beta_4 = 2.1 \times 10^{13}$

The overall complex dissociation equilibrium constant is the reciprocal of the overall stability constant, β_4 .

$$\frac{1}{\beta_4} = \frac{1}{2.1 \times 10^{13}}$$

$$= 4.7 \times 10^{-14}$$

11. Explain the bonding in coordination compounds in terms of Werner's postulates.

Ans. Werner's postulates explain the bonding in coordination compounds as follows:

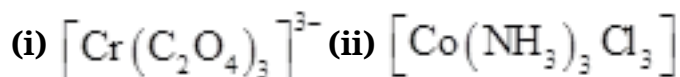
(i) A metal exhibits two types of valencies namely, primary and secondary valencies. Primary valencies are satisfied by negative ions while secondary valencies are satisfied by both negative and neutral ions.

(In modern terminology, the primary valency corresponds to the oxidation number of the metal ion, whereas the secondary valency refers to the coordination number of the metal ion.

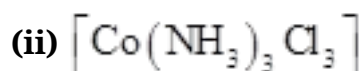
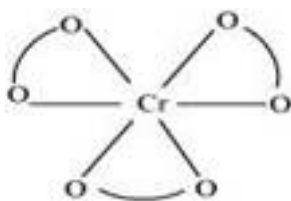
(ii) A metal ion has a definite number of secondary valencies around the central atom. Also, these valencies project in a specific direction in the space assigned to the definite geometry of the coordination compound.

(iii) Primary valencies are usually ionizable, while secondary valencies are non-ionizable.

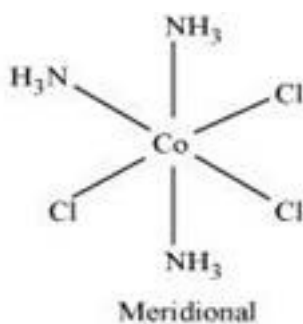
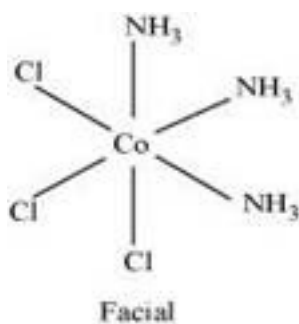
12. How many geometrical isomers are possible in the following coordination entities?



Ans. (i) For $[\text{Cr}(\text{C}_2\text{O}_4)_3]^{3-}$, no geometric isomer is possible as it is a bidentate ligand.



Two geometrical isomers are possible.



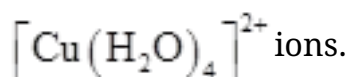
13. Aqueous copper sulphate solution (blue in colour) gives:

(i) a green precipitate with aqueous potassium fluoride, and

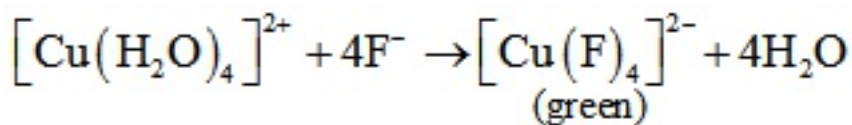
(ii) a bright green solution with aqueous potassium chloride

Explain these experimental results.

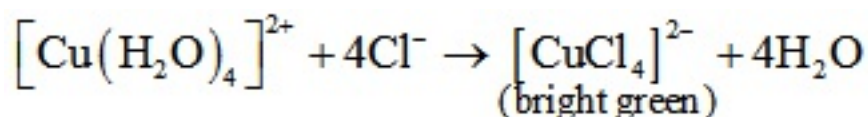
Ans. Aqueous CuSO_4 exists as $[\text{Cu}(\text{H}_2\text{O})_4]\text{SO}_4$. It is blue in colour due to the presence of



(i) When KF is added:

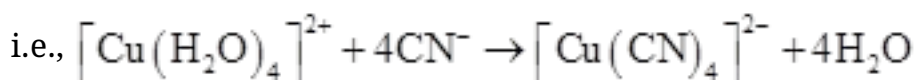
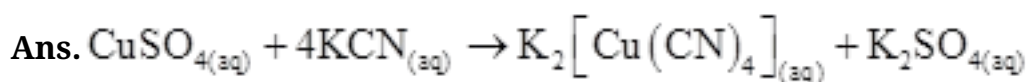


(ii) When KCl is added:



In both these cases, the weak field ligand water is replaced by the F^- and Cl^- ions.

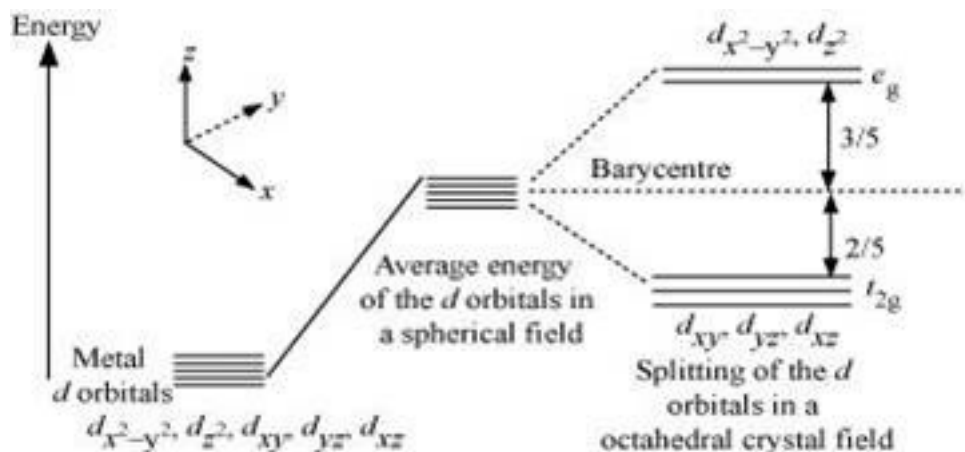
14. What is the coordination entity formed when excess of aqueous KCN is added to an aqueous solution of copper sulphate? Why is it that no precipitate of copper sulphide is obtained when $\text{H}_2\text{S}_{(\text{g})}$ is passed through this solution?



Thus, the coordination entity formed in the process is $\text{K}_2[\text{Cu}(\text{CN})_4]$. $\text{K}_2[\text{Cu}(\text{CN})_4]$ is a very stable complex, which does not ionize to give Cu^{2+} ions when added to water. Hence, Cu^{2+} ions are not precipitated when $\text{H}_2\text{S}_{(\text{aq})}$ is passed through the solution.

15. Draw figure to show the splitting of d orbitals in an octahedral crystal field.

Ans.

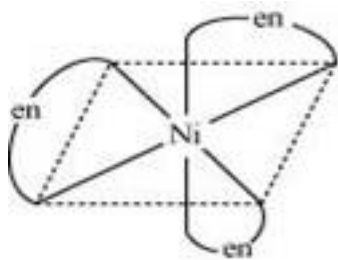
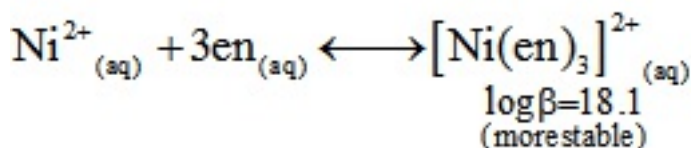
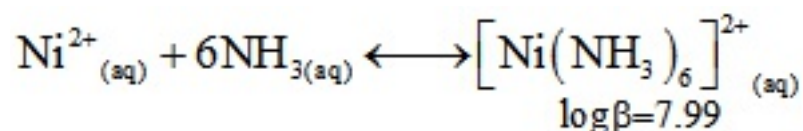


The splitting of the d orbitals in an octahedral field takes place in such a way that $d_{x^2-y^2}, d_{z^2}$ experience a rise in energy and form the e_g level, while d_{xy}, d_{yz} and d_{zx} experience a fall in energy and form the t_{2g} level.

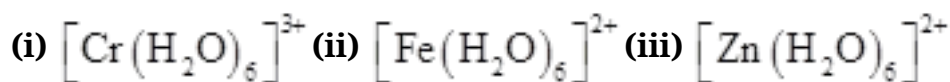
16. What is meant by the chelate effect? Give an example.

Ans. When a ligand attaches to the metal ion in a manner that forms a ring, then the metal-ligand association is found to be more stable. In other words, we can say that complexes containing chelate rings are more stable than complexes without rings. This is known as the chelate effect.

For example:



17. Amongst the following ions which one has the highest magnetic moment value?



Ans.(i) No. of unpaired electrons in $[\text{Cr}(\text{H}_2\text{O})_6]^{3+} = 3$

$$\text{Then, } \mu = \sqrt{n(n+2)}$$

$$= \sqrt{3(3+2)}$$

$$= \sqrt{15}$$

$$= \sim 4\text{BM}$$

(ii) No. of unpaired electrons in $[\text{Fe}(\text{H}_2\text{O})_6]^{2+} = 4$

$$\text{Then, } \mu = \sqrt{4(4+2)}$$

$$= \sqrt{24}$$

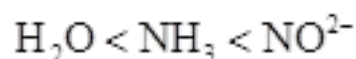
$$= \sim 5\text{BM}$$

(iii) No. of unpaired electrons in $[\text{Zn}(\text{H}_2\text{O})_6]^{2+} = 0$

Hence, $[\text{Zn}(\text{H}_2\text{O})_6]^{2+}$ has the highest magnetic moment value.

18. What will be the correct order for the wavelengths of absorption in the visible region for the following: $[\text{Ni}(\text{NO}_2)_6]^{4-}$, $[\text{Ni}(\text{NH}_3)_6]^{2+}$, $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$

Ans. The central metal ion in all the three complexes is the same. Therefore, absorption in the visible region depends on the ligands. The order in which the CFSE values of the ligands increases in the spectrochemical series is as follows:



Thus, the amount of crystal-field splitting observed will be in the following order:

$$\Delta_o(\text{H}_2\text{O}) < \Delta_o(\text{NH}_3) < \Delta_o(\text{NO}_2^-)$$

Hence, the wavelengths of absorption in the visible region will be in the order:

$$[\text{Ni}(\text{H}_2\text{O})_6]^{2+} > [\text{Ni}(\text{NH}_3)_6]^{2+} > [\text{Ni}(\text{NO}_2)_6]^{4-}$$