

IMPORTANT QUESTIONS CLASS – 12 CHEMISTRY

CHAPTER – 5 COORDINATION COMPOUNDS

Question 1.

When a coordination compound $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$ 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

Answer:

For one mole of the compound, 2 moles of AgCl are precipitated with AgNO_3 , which indicates 2 ionisable Cl^- ions in the complex.

1. Structural formula: $[\text{Ni}(\text{H}_2\text{O})_6]\text{Cl}_2$
2. IUPAC name: Hexaaquanickel (II) chloride

Question 2.

Write IUPAC name of the complex $[\text{Cr}(\text{NH}_3)_4\text{Cl}_2]^+$. Draw structures of geometrical isomers for this complex.

OR

Using IUPAC norms write the formulae for the following:

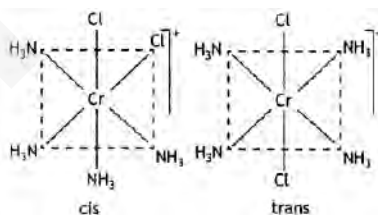
(i) Pentaamminenitrito-O-cobalt(III) chloride

(ii) Potassium tetracyanonickelate(II) (CBSE Delhi 2019)

Answer:

IUPAC name: Tetramminedichloridochromium(III) ion.

Geometrical isomers:



OR

(i) $[\text{Co}(\text{NH}_3)_5(\text{ONO})]\text{Cl}_2$

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

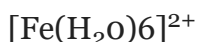
Question 3.

Write the hybridisation and magnetic character of the following complexes:

(i) $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$

(ii) $[\text{Fe}(\text{CO})_5]$ (Atomic no. of Fe = 26)

Answer:



Hybridisation: sp^3d^2

Magnetic character: Paramagnetic due to 4 unpaired electrons.



Hybridisation: dsp^3

Question 4.

Draw one of the geometrical isomers of the complex $[\text{Pt}(\text{en})_2\text{Cl}_2]^{2+}$ which is optically inactive. Also, write the name of this entity according to the IUPAC nomenclature.

Or

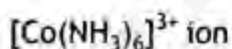
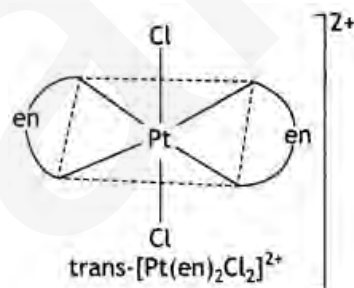
Discuss the bonding in the coordination entity $[\text{Co}(\text{NH}_3)_6]^{3+}$ on the basis of valence bond theory. Also, comment on the geometry and spin of the given entity. (Atomic no. of Co = 27) (CBSE Sample Paper 2019)

Answer:

IUPAC Name of the entity:

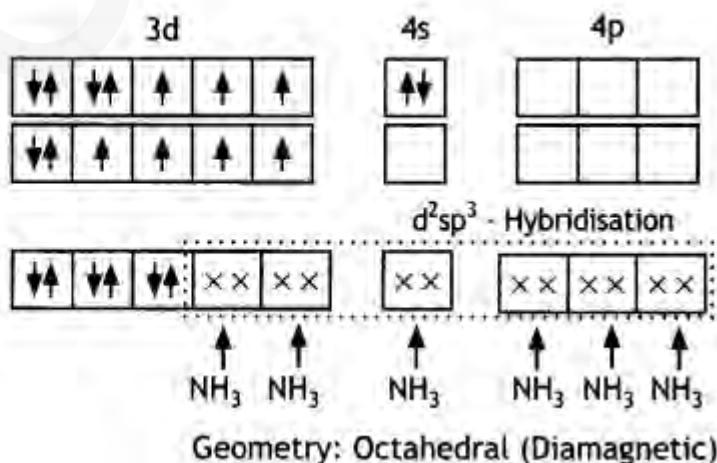
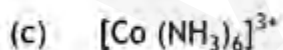
Dichloridobis(ethane – 1,2-diamine) platinum(IV) ion

Or



(a) Co-atom

(b) Co (III)



Question 5.

(a) Draw the structures of geometrical isomers of $[\text{Fe}(\text{NH}_3)_2(\text{CN})_4]^-$

(b) $[\text{NiCl}_4]^{2-}$ is paramagnetic while $[\text{Ni}(\text{CO})_4]$ is diamagnetic though both are tetrahedral. Why? [Atomic number of Ni = 28]

OR

Define the following:

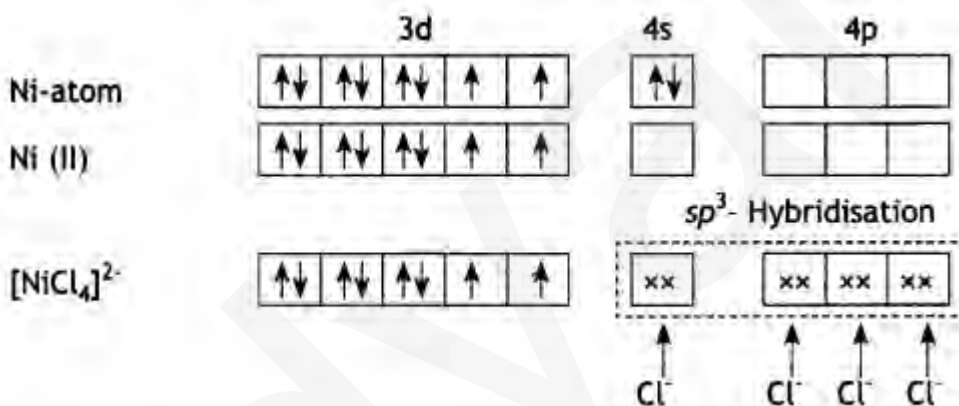
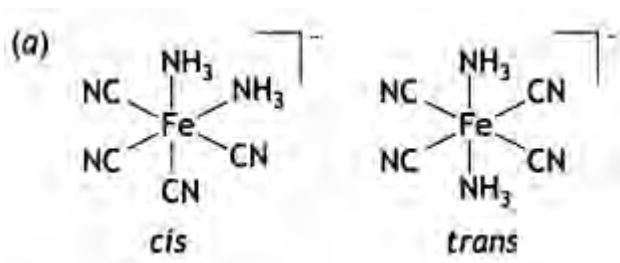
(a) Ambidentate ligands

(b) Spectra chemical series

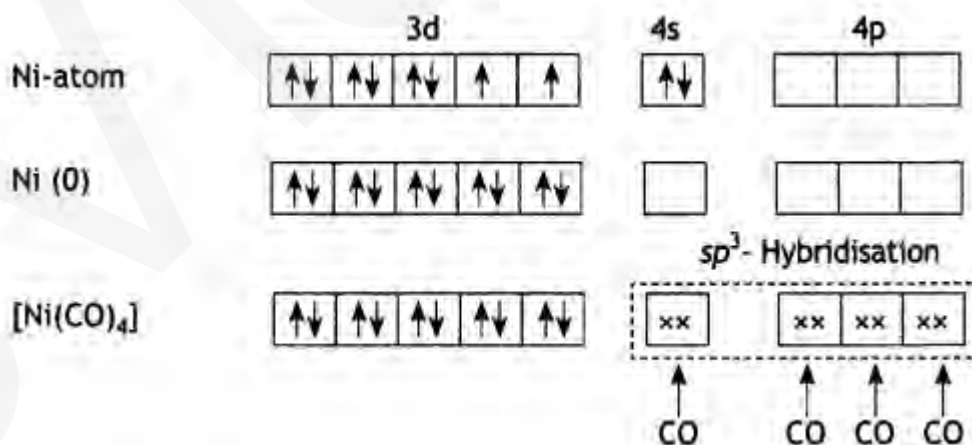
(C) Heteroleptic complexes

Answer:

(b) In the presence of strong field ligand CO, the unpaired d-electrons of Ni pair up so $[\text{Ni}(\text{CO})_4]$ is diamagnetic but Cl^- being a weak ligand is unable to pair up the unpaired electrons, so $[\text{Ni}(\text{Cl}_4)]^{2-}$ is paramagnetic.



and



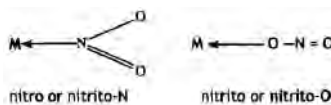
OR

Answer:

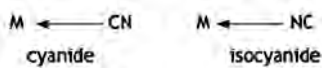
(a) Ambidentate ligands: The monodentate ligands which can coordinate with the central atom through more than one site are called ambidentate ligands.

These ligands contain more than one coordinating atoms in their molecules.

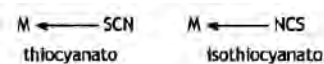
For example, NO_2 can coordinate to the metal atom through N or O as



Similarly, CN^- can coordinate through C or N as



Thiocyanato (SCN) can coordinate through S or N



(b) The arrangement of ligands in the increasing order of crystal field splitting is called spectrochemical series. This is shown below:

$\text{I}^- < \text{Br}^- < \text{SCN}^- < \text{Cl}^- < \text{F}^- < \text{OH}^- < \text{Ox}^{2-} < \text{O}^{2-} < \text{H}_2\text{O} < \text{NCS}^- < \text{py} = \text{NH}_3 < \text{en} < \text{NO}_2^- < \text{CN}^- < \text{CO}$.

Weak field ligands are those which cause less crystal field splitting. These form high spin complexes. For example, Cl^- , F^- , etc.

Strong field ligands are those which cause greater crystal field splitting. These form low spin complexes. For example, CN^- , NO_2^- , CO .

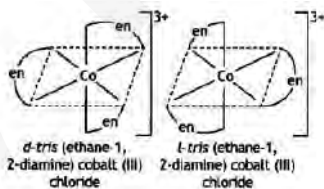
(c) The complexes in which the metal is bound to more than one kind of donor groups (ligands) are called heteroleptic complexes. Some common examples of heteroleptic complexes are $[\text{NiCl}_2(\text{H}_2\text{O})_4]$, $[\text{CoCl}_2(\text{NH}_3)_4]^+$, etc.

Question 6.

Write the structures and names of all the stereoisomers of the following compounds:

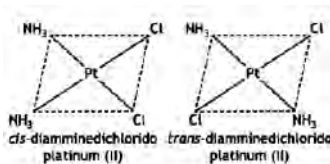
(i) $[\text{Co}(\text{en})_3]\text{Cl}_3$

Answer:



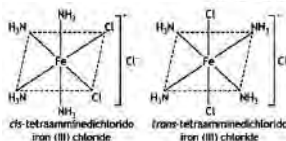
(ii) $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$

Answer:



(iii) $[\text{Fe}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$ (CBSE 2011)

Answer:



Question 7.

Write the name, stereochemistry and magnetic behaviour of the following:



Answer:

Complex	Name	Stereochemistry	Magnetic behaviour
(i) $K_4[Mn(CN)_6]$	Potassium hexacyanomanganate (I)	Octahedral	Paramagnetic
(ii) $[Co(NH_3)_5Cl]Cl_2$	Pentaamminechlorido cobalt (III) chloride	Octahedral	Diamagnetic
(iii) $K_2[Ni(CN)_4]$	Potassium tetracyanonickelate (II)	Square planar	Diamagnetic

Question 8.

For the complex $[Fe(en)_2Cl_2]Cl$ identify the following:

(i) Oxidation number of iron

Answer:

III.

(ii) Hybrid orbitals and shape of the complex

Answer:

d^2sp^3 hybridisation, octahedral

(iii) Magnetic behaviour of the complex

Answer:

Paramagnetic due to one unpaired electron

(iv) Number of its geometric isomers

Answer:

Two

(v) Whether there may be optical isomer also

Answer:

One optical, an isomer of cis-geometrical isomer.

(vi) Name the complex. (CBSE 2011)

Answer:

Dichloridobis(ethylenediamine) iron (III) chloride.

Question 9.

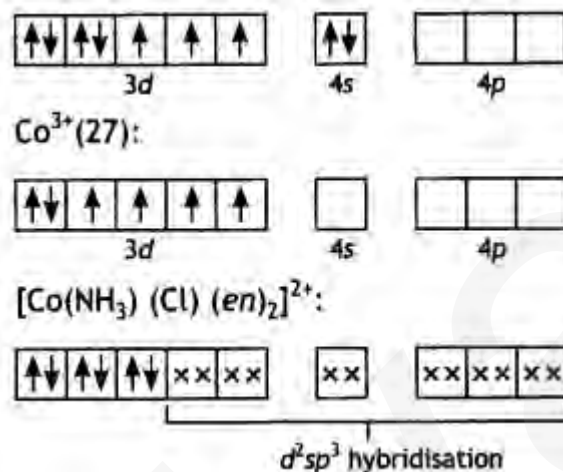
Give the formula of each of the following coordination entities:

(i) Co^{3+} ion is bound to one Cl^- , one NH_3 molecule and two bidentate ethylene diamine (en) molecules.

(ii) Ni^{2+} ion is bound to two water molecules and two oxalate ions. Write the name and magnetic behaviour of each of the above coordination entities. (At. nos. $\text{Co} = 27$, $\text{Ni} = 28$) (CBSE 2012)

Answer:

(i) $[\text{Co}(\text{NH}_3)(\text{Cl})(\text{en})_2]^{2+}$ Amminechlorido bis-(ethane -1, 2-diamine) cobalt (III) ion $\text{Co}(27)$:

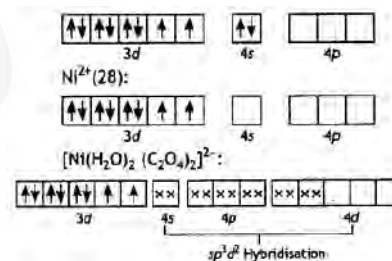


Since there are no unpaired electrons, complex is diamagnetic.

(ii)

$[\text{Ni}(\text{H}_2\text{O})_2(\text{C}_2\text{O}_4)_2]^{2-}$ Diaquadioxalatatonickelate (II) ion $\text{Ni}(28)$:

The complex has two unpaired electrons, therefore, it will be paramagnetic.



Question 10.

State a reason for each of the following situations:

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

Answer:

The configuration of CO^{2+} is $t_{2g}^6 e_g^1$ and for CO^{3+} , it is t_{2g}^6 . The crystal field stabilisation energy is more than compensated for the third ionisation enthalpy. Therefore, CO^{2+} is easily oxidised to CO^{3+} in the presence of a strong ligand.

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

Answer:

CO is a stronger complexing ligand than NH_3 because it contains both σ and π character and can form a back bond ($\text{M} \rightarrow \text{CO}$) also. Therefore, CO forms a stronger bond with the metal. It is also called a strong field ligand.

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

(CBSE Delhi 2012)

Answer:

The molecular shape of $[\text{Ni}(\text{CO})_4]$ is tetrahedral because this complex nickel involves sp^3 hybridisation. In $[\text{Ni}(\text{CN})_4]^{2-}$, nickel involves dsp^2 and its shape is square planar.