CBSE Test Paper-05

Class - 12 Chemistry (Coordination Compounds)

1. Which of the following is paramagnetic?
   a. $K_3[Fe(CN)_6]$
   b. $K_4[Fe(CN)_6]$
   c. $Ni(CO)_4$
   d. $[Co(NH_3)_6]Cl_3$
2. A complex involving dsp^2 hybridisation has
   a. Octahedral geometry
   b. Trigonal planar geometry
   c. Tetrahedral geometry
   d. Square planar geometry
3. The theory which uses the concept of hybridised orbitals to explain the nature of bonding in coordination compounds is:
   a. Molecular Orbital Theory
   b. Ligand field theory
   c. Crystal Field Theory
   d. Valence Bond Theory
4. The IUPAC name of $KAl(SO_4)_2.12H_2O$ is
   1. Aluminium potassium sulphate – 12 – water
   2. Aluminium potassium sulphate dodecahydrate
   3. Aluminium (III) potassium sulphate hydrate – 12
   4. Potassium aluminate(III) sulphate hydrate
5. The type of hybridisation possible with a coordination number of 6 can be
   a. sp^3d^2
   b. dsp^2
   c. sp^3
   d. sp^3d
6. In the geometry of a complex compound the molecule is trigonal bipyramidal. What is

the hybridization of the central atom?

7. What is the shape of $[Fe(CO)_5]$?
8. Write an anion whose shape can be explained by the scheme of sp^3d^2 hybridisation.
9. Name the following complex using IUPAC norms: $[Co(en)_2(ONO)Cl]Cl$.
10. Amongst the following the most stable complex is:
    i. $[Fe(H_2O)_6]^{3+}$
    ii. $[Fe(NH_3)_6]^{3+}$
    iii. $[Fe(C_2O_4)_3]^{3-}$
    iv. $[FeCl_6]^{3-}$
11. What is a ligand? Give an example of a bidentate ligand.
12. Briefly describe the importance of coordination compounds in:
    i. Qualitative analysis
    ii. Extraction of metals
    iii. Biological systems
13. a. Give names of two complexes which are used in medicines.
    b. Using valence bond theory of complexes explain the geometry and magnetic nature of $[Ni(CN)_4]^{2-}$(At No. of Ni = 28)
14. What is meant by the chelate effect? Give an example.
15. i. Illustrate the geometrical isomerism with the help of an example : $[Pt(NH_3)_4Cl_2]^{2+}$.
    ii. Answer the following:
        a. Differentiate between a bidentate ligand and a monodentate ligand.
        b. Write the IUPAC name of $[Pt(NH_3)_4Cl_2]Cl_2$.
        c. Draw the structures of geometrical isomers of $[Co(NH_3)_4Cl_2]^+$.

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Solutions

1. (a) $K_3[Fe(CN)_6]$

   Explanation: In given complex, there are 3 K^+ ions and so the anion has overall -3 charge. In $[Fe(CN)_6]^{3-}$, there are 6CN^- ligands and an overall charge of -3 on the complex and hence Fe is in +3 oxidation state so its electronic configuration is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$. Since CN^- is a strong field ligand and it causes pairing of electrons. But there is one unpaired electron which makes this complex paramagnetic.
2. (d) Square planar geometry

   Explanation: dsp^2 hybridisation results in a square planar geometry.
3. (d) Valence Bond Theory

   Explanation: According to Valence Bond Theory, the metal atom or ion under the influence of ligands can use its (n-1)d, ns, np or ns, np, nd orbitals for hybridisation to yield a set of equivalent orbitals of definite geometry such as octahedral, tetrahedral, square planar and so on. These hybridised orbitals are allowed to overlap with ligand orbitals that can donate electron pairs for bonding. So Valence bond theory uses the concept of hybridised orbitals to explain the bonding in complexes.
4. (b) Aluminium potassium sulphate dodecahydrate

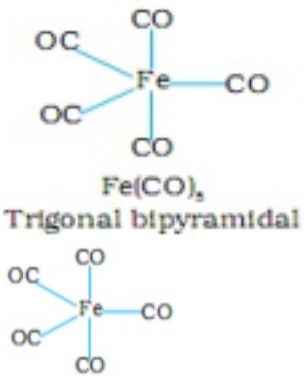
   Explanation: This is a double salt so its name is written in alphabetical order and the number of molecules of water of crystallisation are mentioned in the end. So the name is aluminium potassium sulphate dodecahydrate.
5. (a) sp^3d^2

   Explanation: sp^3d^2 hybridisation means there are 6 orbitals involved in hybridisation (1 ns, 3 np and 2 nd) and 6 hybrid orbitals are formed. So with a coordination number 6, this hybridisation is possible.

6. dsp^3 or sp^3d.

7. $[Fe(CO)_5]$

   Geometry = Trigonal bipyramidal



8. $[CoF_4]^{3-}$

9. Chlorobis (ethylene diammine) nitro cobalt (III) chloride

10. In each of the given complex Fe is in +3 state.

    As $C_2O_4^{2-}$ is didentate chelating ligand, it forms chelate rings and hence is the most stable complex.

11. Ligands. The ions or molecules bound to the central atom ion in the coordination entity are called ligands. Example of bidentate ligand:
    $H_2NCH_2CH_2NH_2$ (ethylene diammine)

12. 1. **Qualitative analysis:**

       EDTA is used for estimation of $Ca^{2+}$and Mg^{2+} in hard water.

       Ni^{2+} is tested and estimated by DMG (dimethyl glyoxime)

    2. **Extraction of metals**

       Silver and gold are extracted by heating zinc with their cyanide complexes.

       Bauxite is purified by forming complex with NaOH.

       Impure nickel is converted to $[Ni(CO)_4]$, which is decomposed to yield pure nickel.

    3. **Biological system**

       The pigment responsible for photosynthesis chlorophyll is a coordination compound of Mg.

       Haemoglobin is a coordination compound of iron.

Vitamin B_{12}, cyanocobalamine, the antipernicious anemia factor is a coordination compound of cobalt.

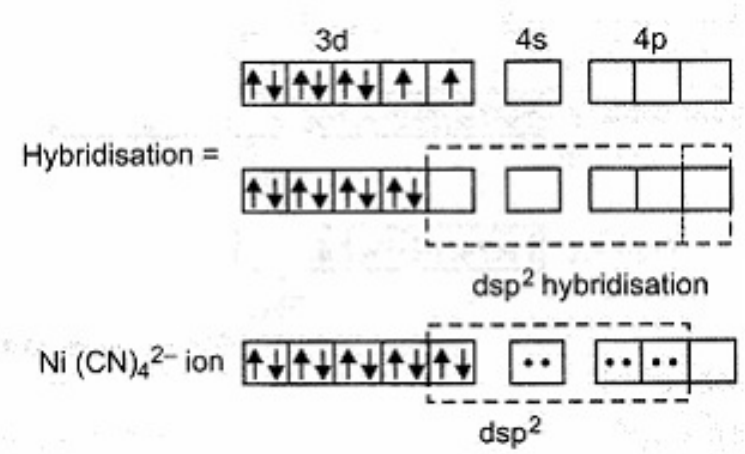
13. a. i. EDTA is used in the treatment of lead poisoning.

ii. $[Pt(NH_3)_2Cl_2]$ known as cis platin is used as an anti tumour agent in the treatment of cancer.

b. Ni atom (z = 28)

E.C of Ni. = $[Ar]4s^2 3d^8$

E.C. of Ni^{2+} = $[Ar]4s^0 3d^8$



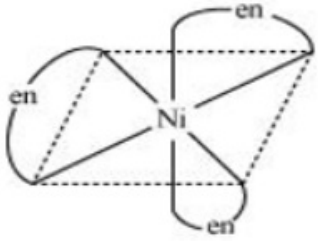
It is diamagnetic, due to absence of unpaired electrons.

Shape - square planar.

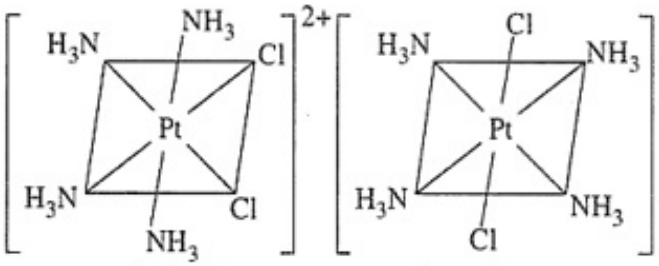
14. When a ligand attaches to the metal ion in a manner that forms a ring, then the metal - ligand association is found to be more stable. In other words, we can say that complexes containing chelate rings are more stable than complexes without rings. This is known as the chelate effect. For example:

Ni^{2+} (aq) + $6NH_3$ (aq) $\leftrightarrow$ $[Ni(NH_3)_6]^{2+}$ (aq) [log β =7.99]

Ni^{2+} (aq) + 3en (aq) $\leftrightarrow$ $[Ni(en)_3]^{2+}$ (aq) [log β =18.1 (more stable)]



15. i. When the identical groups are on the same side of the metal ion, it is cis-isomer. When they are on opposite sides of the metal ion, it is trans-isomer.

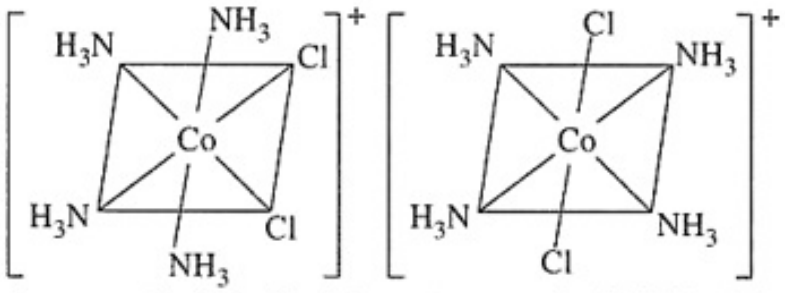


cis-form *trans*-form

ii. a. Bidentate ligand has two donor atoms and can form two bonds whereas monodentate ligand has only one donor atom and can form only one bond with the metal ion.

b. Diamminedichloridoplatinum(IV) chloride.

c. Structures of geometrical isomers are given below:



cis-tetraamminedichloridocobalt (III) ion

trans-tetraamminedichloridocobalt (III) ion