Class 12 CBSE Chemistry - Coordination Compounds - SOLUTIONS

Maximum Marks: 20 Time: 45 minutes

1. MCQ (1 mark)

Which of the following is a bidentate ligand?

(a) NH_3

(b) H_2O

(c) en (ethylenediamine)-Answer

(d) Cl^-

2. Assertion-Reason Type Question (1 mark)

Assertion (A): The complex $[Co(NH_3)_6]^{3+}$ is paramagnetic.

Reason (R): Co^{3+} has three unpaired electrons in its d-orbitals.

Options:

(a) Both A and R are true and R is the correct explanation of A - Answer

(b) Both A and R are true but R is not the correct explanation of A

(c) A is true but R is false

(d) A is false but R is true

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

(a) $[Co(NH_3)_5Cl]Cl_2$ - Pentaamminechlorocobalt(III) chloride

(b) $K_3[Fe(CN)_6]$ - Potassium hexacyanoferrate(III)

(c) $[Cr(H_2O)_6]Cl_3$ - Hexaaquachromium(III) chloride [3 marks]

4. (a) Define geometric isomerism in coordination compounds.

(b) Draw and name the geometric isomers of $[Pt(NH_3)_2Cl_2]$.

(c) Give one example of ionization isomerism. [3 marks]

(a) Geometric isomerism occurs when ligands can be arranged differently in space around the central metal ion, resulting in different spatial arrangements (cis-trans isomers in square planar and octahedral complexes).

(b) $[Pt(NH_3)_2Cl_2]$ has two geometric isomers:

cis-isomer: cis-diamminedichloroplatinum(II)

trans-isomer: trans-diamminedichloroplatinum(II)

(c) Example of ionization isomerism: $[Co(NH_3)_5SO_4]Br$ and $[Co(NH_3)_5Br]SO_4$

5(a) Explain the concept of inner orbital and outer orbital complexes with examples.

(b) Using VBT, explain the magnetic behavior of $[Ni(CN)_4]^{2-}$ ($\mu = 0$ BM). [4 marks]

(a) Inner orbital complexes use inner (n-1)d orbitals for bonding, forming low spin complexes (e.g., $[Co(NH_3)_6]^{3+}$). Outer orbital complexes use outer nd orbitals, forming high spin complexes (e.g., $[CoF_6]^{3-}$).

(b) $[Ni(CN)_4]^{2-}$ has dsp^2 hybridization using inner d orbitals, resulting in square planar geometry with all electrons paired (diamagnetic, $\mu = 0$ BM).

6. (a) What is crystal field splitting energy (Δ_0)? How does it affect the color of coordination compounds?

(b) Draw the d-orbital splitting diagram for an octahedral complex and explain the high spin and low spin configurations.

(c) Calculate the CFSE for $[Fe(H_2O)_6]^{2+}$ ($t_2g^4eg^2$ configuration). [4 marks]

(a) Crystal field splitting energy (Δ_0) is the energy difference between eg and t_2g orbitals in octahedral complexes. It causes absorption of visible light, resulting in coloured complexes.

(b) In octahedral complexes, d-orbitals split into lower energy t_2g (d_{xy}, d_{yz}, d_{xz}) and higher energy eg (dx^2-y^2, dz^2) orbitals. High spin complexes have maximum unpaired electrons (weak field ligands), low spin have minimum unpaired electrons (strong field ligands).

(c) CFSE = $(-0.4 \times 4 + 0.6 \times 2)\ \Delta_0 = -0.4\Delta_0$

7. (a) Explain the postulates of Werner's coordination theory.

(b) Discuss the factors affecting the stability of coordination compounds.

(c) Compare VBT and CFT in explaining the properties of coordination compounds.

[4 marks]

(a) Werner's theory postulates:

Metals exhibit two types of valencies: primary (oxidation state) and secondary (coordination number)

Ligands satisfy secondary valency in definite directions (geometry)

Ionization of coordination sphere produces complex ions

(b) Factors affecting stability:

Nature of metal ion (charge, size, electronic configuration)

Nature of ligand (charge, size, field strength)

Chelation effect

Macrocyclic effect

(c) VBT explains bonding using hybridization and magnetic properties but doesn't account for colour and spectral properties. CFT explains colour, magnetism, and stability through d-orbital splitting in ligand field, providing better explanation of spectral and magnetic properties.