(d) Fe $(Cp)_2$ is more stable than Co $(Cp)_2$ whereas Fe $(Cp)_2^+$ is less stable than Co $(Cp)_2^+$. Explain. (5,4,3,3)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5048 **J**

Unique Paper Code : 2174001203

Name of the Paper : GE: Coordination and Organometallic Compounds

Name of the Course : **All Undergraduate Courses Except with Chemistry**

Semester : II / IV / VI

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **four** questions.
3. **All** questions carry equal marks.

1. (a) With the help of orbital picture, explain the synergic model for Ziese's salt.

(b) What is tetragonal elongation of an octahedral complex? Show by means of a diagram, how the d-orbital splitting changes as an octahedral complex undergoes tetragonal elongation.

(c) What are non- classically bonded organometallic compounds? Give example.

(d) An octahedral complex of a certain metal ion has $\mu = 4.9$ BM. Another complex of the same metal ion of the same geometry has a dipole moment = 2.83 BM. The central metal ion could be which one of the following. Explain

Fe^{2+}, Fe^{3+}, Mn^{2+}, Mn^{3+}, Co^{2+} (5,4,3,3)

(d) The symmetric CO stretching frequency in the IR spectra are as follows :

$[Mn(CO)_6]^+$ 2090 cm^{-1}, $[Cr(CO)_6]$ 2000 cm^{-1}, $[V(CO)_6]^-$ I860 cm^{-1}, $[Ti(CO)_6]^{2-}$ 1750 cm^{-1}. Discuss the trend. (5,4,3,3)

6. (a) Discuss σ donor as well as π acceptor character of CO through carbon atom in metal carbonyls, with reference to MO diagram.

(b) Crystal field splitting energy for $[Cr(NH_3)_6]^{2+}$ is 10,200 cm^{-1}, while for $[Cr(NH_3)_4]^{2+}$ is 5,900 cm^{1}. Give reasons.

(c) Illustrate and explain the crystal field splitting diagram of the distorted elongation octahedral complex.

(d) Why does Cr forms Cr $(CO)_6$ whereas Fe forms Fe $(CO)_5$? (5,4,3,3)

5. (a) For Fe^{2+} ion, mean pairing energy P is found to be 17600 cm^{-1}, Δ_o values for the complex $[Fe(H_2O)6]^{2+}$ and $[Fe(CN)6]^{4-}$ are 10400 and 33000 cm^{-1} respectively. Do these complexes have low spin or high spin configuration? Also calculate CFSE for each of these complexes.

(b) Explain how metal carbonyls can be obtained upon direct reaction with the metal?

(c) Which complex in each of the following pairs will have greater crystal field splitting and why

(i) $[Co(NH_3)_6]^{3+}$ and $[Rh(NH_3)_6]^{3+}$

(ii) $[Cr(en)_3]^{3+}$ and $[Cr(C_2O_4)_3]^{3-}$

2. (a) (i) Define Jahn Teller Theorem.

(ii) Which of the ligands: F^- or CN^- will form octahedral complex with Ni (III) ion with significant Jahn Teller effects and why?

(b) Draw and explain the structure of ferrocene in solid state and in gaseous state.

(c) Co (III) is stabilized in the presence of strong field ligands while Co (II) is stabilized in the presence of weak field ligands. Explain with the help of CFT.

(d) Explain the reductive carbonylation method of synthesis of metal carbonyls. (5,4,3,3)

3. (a) How are organometallic compounds classified on the basis of type of bonding? Explain with examples.

(b) Draw the structures for the following :

$Cr(CO)_6$, $Mn_2(CO)_{10}$, $Ni(CO)_4$, $Fe_2(CO)_9$

(c) Write chemical formulae for the following compounds : **(any three)**

(i) Pentaamminenitrito-κ N cobalt (III) sulphate

(ii) Potassium pentacyanidocarbonylferrate (II)

(iii) Tetraammine copper (II) sulphate

(iv) Barium tetrafluoridobromate (III)

(d) What are the limitations of VBT? (5,4,3,3)

4. (a) Give the IUPAC names of the following complexes :

(i) $[Co(en)_2(ONO)Cl]Cl$

(ii) $[Pt(NH_3)_4(Cl)_2][PtCl_4]$

(iii) $[Ni(NH_3)_2(en)](CH_3COO)_2$

(iv) $[Co(NH_3)_6]Br_2$

(v) $[Cr(H_2O)_4Cl_2]NO_3$

(b) Using the 18-electron rule as a guide, identify the following :

(i) 3d metal M in $[\eta^5(C_5H_5)M(CO)_3]$

(ii) no. of CO ligands in $[Cr(\eta^6\text{-}C_6H_6)(CO)_n]$

(iii) no. of Fe-Fe bonds in $Fe_3(CO)_{12}$

(iv) Charge x on $[Mn(CO)_5(C_2H_4)]^x$

(c) The crystal field splitting in tetrahedral complexes is smaller than that in octahedral complexes. Explain.