Registration Number:
Date & session:

ST JOSEPH'S UNIVERSITY, BENGALURU -27
M.Sc (CHEMISTRY) – 2nd SEMESTER
SEMESTER EXAMINATION: APRIL 2024
(Examination conducted in May / June 2024)
CH 8122 – INORGANIC CHEMISTRY II
(For current batch students only)

Time: 2 Hours **Max Marks: 50**

This paper contains TWO printed pages and THREE parts

PART-A

Answer any EIGHT of the following questions. **8 X 2 = 16**

1. Mention the coordination number and geometry of Re in $Ca[ReH_9]$.
2. Sketch the crystal field splitting diagram for $[Ni(CN)_4]^{2-}$.
3. Which of the following complexes is more stable? Give reason.
   $[Cu(trien)(H_2O)_2]^{2+}$ or $[Cu(cyclen)(H_2O)_2]^{2+}$,
   where trien: tri(ethylenediamine), cyclen: 1,4,7,10-Tetraazacyclododecane
4. Compare the IR spectra of *fac*- and *mer*-$[MA_3B_3]$ isomers.
5. Calculate the number of microstates for d^4 configuration.
6. Many lanthanide complexes display weak but sharp absorption spectra. Give reasons.
7. List the factors contributing to the bandwidth of electronic absorption spectra.
8. With a suitable diagram, illustrate the super exchange mechanism of antiferromagnetic coupling between two metal centers by a bridging ligand.
9. Depict the binding modes of hydride ligands in metal hydrides showing i) 3*c*-2*e* and ii) 4*c*-2*e* interactions.
10. Draw the optical isomers of *cis*-$[CoCl(NH_3)(en)_2]^{2+}$ complex ion.

PART-B

Answer any TWO of the following questions. **2 X 12 = 24**

11. a) Account for the higher lattice energy value of NiF_2 (3060 $kJmol^{-1}$) compared to ZnF_2 (2985 $kJmol^{-1}$).
    b) Sketch a qualitative molecular orbital energy level diagram for an octahedral ML_6 complex with only σ- bonding.
    c) Which of the following ligands will form a more stable complex with a M(II) ion under basic conditions? Malonic acid $CH_2(COOH)_2$ or acetylacetone $CH_2(COCH_3)_2$. Give reason.
    d) Calculate the magnetic moment of $K_3[FeF_6]$ using the following data:
    χ_M (corrected) $=14.6 \times 10^{-3}$ $(B.M.)^2K^{-1}$ at 300 K. What is the calculated spin-only magnetic moment for this complex? (3+3+3+3)

12. a) Identify the type of unidentate coordination mode of NO_2 ligand in complexes (A) and (B) using the IR spectral data given below. Explain.

Compound	ν(NO), cm^{-1}
$K_3[Co(NO_2)_6]$ (A)	1386, 1332
$[Co(NH_3)_5(NO_2)]Cl_2$ (B)	1468, 1065

b) A solution of $[Cr(OH_2)_6]^{3+}$ is pale green-blue (ε_{max} = 15 $dm^3mol^{-1}cm^{-1}$), but a solution of $[CrO_4]^{2-}$ is intense yellow (ε_{max} = 4500 $dm^3mol^{-1}cm^{-1}$). Identify the origins of electronic transitions in these complexes and explain their relative intensities.

c) Arrange the following terms in the order of increasing energy: ^1G, ^1S, ^3F, ^3P. Give reasons for your answer.

d) Explain spin-crossover with an example. (3+3+3+3)

13. a) Compare the C-O and M-C bond distances in $[V(CO)_6]^-$ and $[Mn(CO)_6]^+$. Explain.

b) Deduce the total electron count and predict the skeletal structure of $HRu_4N(CO)_{12}$.

c) What is Tolman cone angle? Between the following, identify the one with a larger Tolman cone angle.

i) P(*n*-propyl)$_3$ or ii) P(*i*-propyl)$_3$

d) Proton NMR spectra of titanocene, $[Ti(C_5H_5)_4]$ shows a single peak at 62°C and two peaks at -27°C. Explain this on the basis of hapticity of the ligand. (3+3+3+3)

PART-C

Answer any TWO of the following questions. 2 X 5 = 10

14. a) Predict the type of distortion in $[Ti(H_2O)_6]^{3+}$ based on stabilization energy.

b) Which of the following conversions is accompanied by a larger change in metal-ligand bond distance? Justify.

i) $[Fe(CN)_6]^{3-} \rightarrow [Fe(CN)_6]^{2-}$

ii) $[Co(NH_3)_6]^{3+} \rightarrow [Co(NH_3)_6]^{2+}$ (2+3)

15. Assign the electronic transitions in $[MCl_4]^-$ ion using an Orgel diagram, where M is a first-row transition metal ion with two unpaired electrons in 'e' orbitals.

16. a) Predict the feasibility of formation of the following complexes (X and Y) using the log K values given below. (R = 8.314 $kJmol^{-1}$) Justify.

Compound	log K at 300 K
$[Cu(NH_3)_4(H_2O)_2]^{2+}$ (X)	2.0
$[Cu(NH_3)_5(H_2O)]^{2+}$ (Y)	0.5

b) Identify the one with a higher magnetic moment among the following based on the given data. (Hint: Both ions have a single unpaired electron each)

i) Ce^{3+} (L = 3, S = ½, g = 0.857)

ii) Ti^{3+} (L = 2, S = ½, g = 2) (2+3)
