Birla Institute of Technology and Science, Pilani (Rajasthan)
Second Semester 2022-23, March 13, 2023
Mid-Semester Test (Closed Book)
CHEM F241, Inorganic Chemistry II

Time: 90 minutes **Max. Marks: 60**

Note: There are **five** questions in all. Attempt all the questions**. Start answering each question on a fresh page and answer all parts of a question together.**

Q. 1 (a) Fe^{3+} forms tetrahedral complexes with weak field ligands and low spin octahedral complexes with strong field ligands whereas Co^{3+} generally forms low spin octahedral complexes. Explain. **[3]**

(b) (i) What type of tetragonal distortion Cr^{3+} in weak octahedral ligand field would undergo? Justify your answer with the help of calculations, if required, in the light of Crystal Field Theory.
(ii) Which symmetry elements would be present if the molecule undergoes trigonal distortion? Mention its point group. **[4+2]**

(c) $[Cu(H_2O)_6]^{2+}$ and $[Cu(NH_3)_4]^{2+}$ both appear blue in solution. However, the appearances of these two solutions are quite different. What is/are the difference(s) will you notice amongst these solutions and why? **[3]**

Q. 2 (a) Take a case of $MA_2B_2C_2D_2$ in a cubic arrangement having only a symmetry element i, certer of inversion. And the metal, M is at the central position. Show with figures that i = S_2. What other kind of geometry you can think of for this molecule? **[3+1]**

(b) Write the IUPAC name for the following compounds:
(i) $[CuCl_2(CH_3NH_2)_2]$
(ii) $K_2[Cr(CN)_2O_2(O_2)NH_3]$ **[3]**

(c) What is the abscissa always taken in Tanabe-Sugano diagram? What is the relationship between the Racah parameters B and B´ of a metal? How do you justify that? **[3]**

(d) Draw the Orgel diagram for a metal-ion with d^6 electronic configuration in weak octahedral field. **[2]**

Q.3 (a) Draw the structure and comment on optical activity of *cis*-dichlorobis(ethlenediamine)cobalt(III) complex with justification. **[2]**

(b) What would be d orbital splitting in trigonal bipyramidal splitting? Assign the Mulliken's designation for them. In $[Mn(CO)_4NO]$ has trigonal bipyramidal structure where NO+ occupies the one of the equatorial positions. Amongst CO and NO^+, which one is the better π-acceptor ligand and why? **[2+1+2]**

(c) How many isomers do you expect for $[(Ph_3As)_2Pd(SCN)_2]$? Amongst them, write down the most stable one and explain its stability. **[1+1+3]**

Q.4 (a) For C_{2v} point group, justify that two vertical symmetry planes belong to two different classes. **[3]**

(b) For a BF_3 molecule, find out the orbitals which will be allowed by symmetry to participate in the σ bonding and orbitals who can be further involved for π bonding. **[5+4]**

Q.5 (a) (i) How many total microstates are associated with Mn^{2+} ion (d^5 electronic configuration and with ground term? (ii) What would be the ground state of Mn(II) in weak tetrahedral field? How many spin allowed electronic transition(s) will be observed for such Mn(II) complex? **[1+2+2]**

(b) (i) Ligand group orbitals (LGO) of which symmetry are involved in the σ bonding of octahedral metal complex? Draw the doubly degenerate LGOs.
(ii) Which symmetry is required for the π bonding from the ligand side? Draw the MO diagram showing π bonding of an octahedral complex when the ligands are PR_3 and comment on the strength of the ligand.
[3+4]

Useful Data:

D_{3h}	E	$2C_3$	$3C_2'$	σ_h	$2S_3$	$3\sigma_v$		
A_1'	1	1	1	1	1	1		x^2+y^2, z^2
A_2'	1	1	-1	1	1	-1	R_z	
E'	2	-1	0	2	-1	0	(x, y)	(x^2-y^2, xy)
A_1''	1	1	1	-1	-1	-1		
A_2''	1	1	-1	-1	-1	1	z	
E''	2	-1	0	-2	1	0	(R_x, R_y)	(xz, yz)

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