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University Examinations 2023/2024

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN CHEMISTRY

SCH 3450: COORDINATION CHEMISTRY

DATE: APRIL 2024 **TIME: 2 HOURS**

INSTRUCTIONS: *Answer question **one** and any other **two** questions*

QUESTION ONE (30 MARKS)

a) Determine the number of microstate in each of the following:
   i. ^4F (3 marks)
   ii. $^5D_4$ (3 marks)
   iii. f^3 (3 marks)

b) Using Tanabe Sugano diagram attached, determine which transitions are spin allowed for [$Fe(OH_2)_6]^{2+}$? And Which transitions are spin allowed for $[Fe(CN)_6]^{4-}$? (7 marks)

c) What transition is responsible for the intense red color of $Mo(CO)_4$(phenanthroline)? (2 marks)

d) With reasons, place the following ligands in order of increasing nephelauxetic effect H_2O, I^-, F^-, en, CN^-, NH_3 (3 marks)

e) For each of the following state $^2D_{3/2}$, $^3F_2$, and $^5D_0$, determine effective magnetic moment where:
   i) The resultant orbital motion (L) and resultant spin motion (s) contribute independently (3 marks)

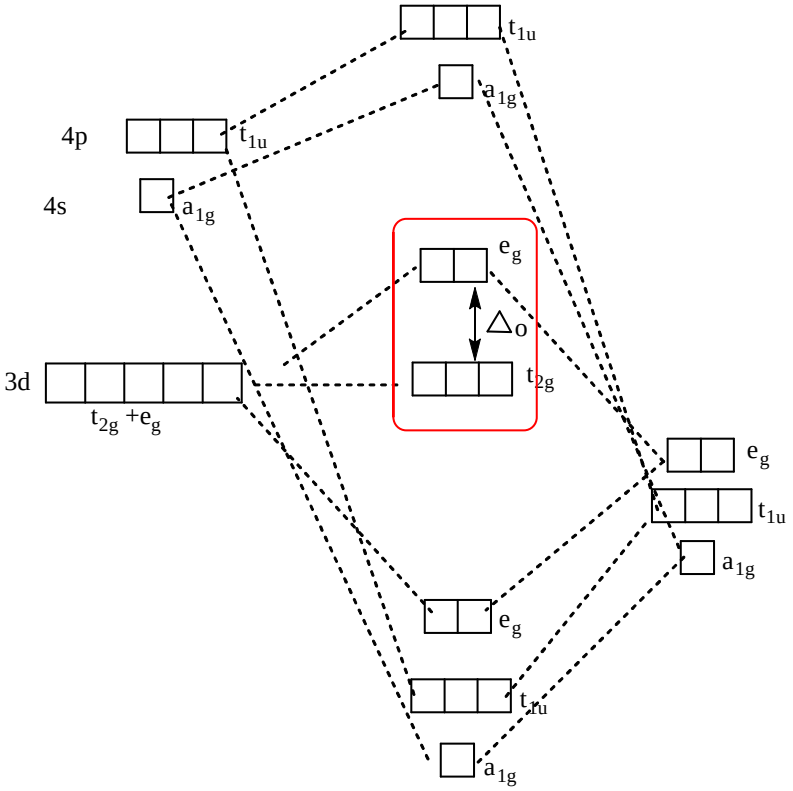
ii) The resultant orbital motion (L) and resultant spin motion (s) couple with each other (3 marks)

iii) The resultant spin motion (s) contribute but resultant orbital motion (L) is quenched (3 marks)

QUESTION TWO (20 MARKS)

a) Highlight one difference between pi donor and pi acceptor ligands (4 marks)

b) Using a molecular orbital diagrams for an octahedral complex shown below, show the electron occupancy of $[Co(NH_3)_6]^{3+}$ and hence or otherwise determine, both HOMO and LUMO of the complex (6 marks)



c) Draw molecular orbital diagrams for the following homonuclear diatomic molecules and hence determine their bond order (6 marks)

i) O_2

ii) N_2

d) i) Which of the two (O_2 or N_2) is paramagnetic? Justify your answer (2 marks)

ii) Which of the two is pi-acceptor ligands? Justify your answer (2 marks)

QUESTION THREE (20 MARKS)

a) What is nephelauxetic effect (2 marks)

How can you relate nephelauxetic parameter, β with Racah parameter, B (1 marks)

b) Account for each of the following observation.

i. The spectral bands arising as a results of charge transfer are very intense (2 marks)

ii. There is no Tanabe -Sugano diagram for d^1 and d^9 (2 marks)

iii. $[Mn(H_2O)_6]^{2+}$ complex is pale pink in color and its spectral band are very weak. (2 marks)

iv. $[Co(H_2O)_6]^{2+}$ has $\Delta o = 9{,}100\ cm^{-1}$ and $B = 980\ cm^{-1}$. How many electronic absorptions do you expect for the complex and at what energies? (5 marks)

c) How is metal to ligand charge transfer (MLCT) different from ligand to metal charge transfer (LMCT) (6 marks)

QUESTION FOUR (20 MARKS)

a) Determine the number of microstate in V^{3+} (4 marks)

b) Derive the microstates in V^{3+} and classify them into terms and provide their term symbols (11 marks)

c) Use hund's rule to arrange the terms obtained in (b) above in order of increasing energy (3 marks)

d) Splits the ground state terms into state using spin-orbital coupling and identify the new ground state term. (2 marks)