



MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

P.O. Box 972-60200 – Meru-Kenya.

Tel: +254 (0)799529958, +254 (0)799529959, +254 (0)712524293

Website: www.must.ac.ke Email: info@must.ac.ke

University Examinations 2023/2024

FIRST YEAR, FIRST SEMESTER EXAMINATION FOR THE DEGREE OF MASTER OF
SCIENCE CHEMISTRY

SCH7112: ADVANCED COORDINATION CHEMISTRY

DATE: DECEMBER 2023

TIME:3 HOURS

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

TANABE SUGANO DIAGRAMS ARE ATTACHED.

QUESTION ONE (30 MARKS)

- Explain why $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$ is pale colored while $[\text{MnCl}_4]^{2-}$ is intensely colored. (4 marks)
- Consider the electronic structure of the complex $[\text{Fe}(\text{CN})_6]^{4-}$ and $[\text{Fe}(\text{F})_6]^{4-}$ to answer the following questions
 - What is the ground state term of $[\text{Fe}(\text{CN})_6]^{4-}$? (2 marks)
 - What is the ground state term of $[\text{Fe}(\text{F})_6]^{4-}$? (2 marks)
 - Which transitions are spin allowed for $[\text{Fe}(\text{F})_6]^{4-}$? Which transitions are spin allowed for $[\text{Fe}(\text{CN})_6]^{4-}$? (6 marks)
- Determine the electronic transition responsible for the purple color of the complex ion $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$. If the wavelength light required for this transition is 492.61nm calculate the amount energy associated with the electronic transition. ($h=6.626 \times 10^{-34}\text{j.s}$; $3.0 \times 10^8\text{m/s}$) (4 marks)
- State franck-condon principle and explain its significance in absorption spectroscopy.
- Explain why the emission spectra of molecules can be used in chemical analysis of substances.
- Discuss three criteria of identifying the charge transfer band

- g) Discuss the following two types of charge transfer
- Ligand-to-metal charge transfer
 - Metal-to-ligand charge transfer
- h) Explain 'nephelauxetic effect'? (2 marks)
- i) Place the following ligands in order of increasing nephelauxetic effect H_2O , I^- , F^- , en, CN^- , NH_3 (2 marks)

QUESTION TWO (15 MARKS)

- a) With examples, explain what is meant by pi acceptor and pi donor ligands (4 marks)
- b) Using relevant molecular orbital energy level diagrams of octahedral metal complexes, illustrate how ligand field theory accounts for spectrochemical series (11 marks)

QUESTION THREE (15 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 (6 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)

QUESTION FOUR (15 MARKS)

- a) Use the value of pascal's constant in the table below to answer questions that follow.

The value of pascal's constant for different atoms and bonds	
$\text{XM}^{\text{D-atomic}}(10^{-6}\text{cm}^3\text{mol}^{-1})$	
H	-2.9
C	-6.0
C(aromatic)	-6.2
N	-5.6
N(aromatic)	-4.6
O	-4.6
Cl	-20.1

Calculate the molar diamagnetic susceptibility (XM^{D}) for

- i) Pyridine (2 marks)
- ii) Acetone (2 marks)

- b) Explain the following terms
- i) Magnetic permeability (1 mark)
 - ii) Magnetic Susceptibility (1 mark)
- c) 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)