

CHE 410



OFFICE OF THE DEPUTY PRINCIPAL
ACADEMICS, STUDENT AFFAIRS AND RESEARCH

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

FOURTH YEAR FIRST SEMESTER REGULAR EXAMINATION

**FOR THE DEGREE OF BACHELOR OF
EDUCATION SCIENCE**

COURSE CODE: CHE 410

**COURSE TITLE: TRANSITION METAL
CHEMISTRY**

DATE: 27TH JANUARY, 2022

TIME: 0900 – 1200 HRS

INSTRUCTION TO CANDIDATES

- SEE INSIDE

THIS PAPER CONSISTS OF PRINTED PAGES 3

PLEASE TURN OVER

REGULAR – MAIN EXAM**CHE 410: TRANSITION METAL CHEMISTRY****STREAM: BED (Scie)****DURATION: 3 Hours**

INSTRUCTIONS TO CANDIDATES

- i. Answer *ALL* questions.
- ii. Diagrams may be used whenever they serve to illustrate the answer.
- iii. Do not write on the question paper.

Question One

- a. State the origin of the color of transition-metal complexes (2 marks).
- b. Chloride ions form the tetrahedral complex ion $[\text{AlCl}_4]^-$ but fluoride ions form the octahedral complex ion $[\text{AlF}_6]^{3-}$. Suggest a reason for this difference. (1 mark)
- c. Iron (II) forms a complex in hemoglobin. For each of the two octahedral complex ions $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Fe}(\text{CN})_6]^{4-}$, draw an energy diagram showing orbital splitting, predict the number of unpaired electrons, and identify the ion as low spin or high spin (5 marks).
- d. What are the systematic names of;
 - i. $\text{Na}_3[\text{AlF}_6]$? (1 marks)
 - ii. $[\text{Co}(\text{en})_2\text{Cl}_2]\text{NO}_3$? (1 marks)
- e. What is the formula of;
 - i. tetraamminebromochloroplatinum(IV) chloride? (1 marks)
 - ii. hexaamminecobalt(III) tetrachloroferrate(III)? (1 marks)

Question Two

- a. Discuss the following with respect to trends in the properties of transition metals
 - i. Atomic size (1 marks)
 - ii. Electronegativity (1 marks)
 - iii. Ionization energy (1 marks)
 - iv. Density (1 marks)

- b. Using appropriate examples, discuss the classification of ligands (3 marks)
- c. Describe the ligand field theory (5 marks)

Question Three

Explain the following types of isomerism in coordination compounds.

- i. Constitutional isomers (2 marks)
- ii. Stereoisomers (2 marks)
- iii. Coordination isomers (2 marks)
- iv. Linkage isomers (2 marks)
- v. Geometric isomers (2 marks)
- vi. Optical isomers (2 marks)

Question Four

- a. Explain the following terms;
 - i. transition elements (1 marks)
 - ii coordination compounds (1 marks)
- b. Explain why the alloy SmCo_5 forms a permanent magnet (2 marks)
- c. Write electron configurations for the following: Zr , Mo^{3+} , V^+ , V^{2+} , V^{3+} , V^{4+} , (6 marks)
- d. Rank the ions $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$, $[\text{Ti}(\text{NH}_3)_6]^{3+}$, and $[\text{Ti}(\text{CN})_6]^{3-}$ in terms of Δ and of the energy of visible light absorbed (2 marks)

Question Five

- a. Assign the shape and the coordination number for each of the following complex ions (6 marks)

$[\text{CuCl}_2]^-$, $[\text{Ag}(\text{NH}_3)_2]^+$, $[\text{AuCl}_2]^-$, $[\text{Ni}(\text{CN})_4]^{2-}$, $[\text{PdCl}_4]^{2-}$, $[\text{Pt}(\text{NH}_3)_4]^{2+}$, $[\text{Cu}(\text{NH}_3)_4]^{2+}$, $[\text{Cu}(\text{CN})_4]^{3-}$, $[\text{Zn}(\text{NH}_3)_4]^{2+}$, $[\text{CdCl}_4]^{2-}$, $[\text{MnCl}_4]^{2-}$, $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$, $[\text{V}(\text{CN})_6]^{4-}$

- b. Use the crystal field theory to describe the splitting of d-orbital energies in an octahedral field of ligands and the crystal field splitting energy (use of diagram is preferred) (6 marks)

