



MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF PURE APPLIED AND HEALTH SCIENCES

DEPARTMENT OF PHYSICAL AND BIOLOGICAL SCIENCE

UNIVERSITY ORDINARY EXAMINATION

2020/2021 ACADEMIC YEAR

**THIRD YEAR FIRST SEMESTER EXAMINATION FOR BACHELOR OF
EDUCATION SCIENCE**

UNIT CODE: ACH 309

UNIT TITLE: COORDINATION CHEMISTRY

DURATION: 2 HOURS

Instructions to candidates:

1. Answer question One and Any Other Two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

(a) Draw

(i) Trans and cis isomers of $\text{Pt}(\text{NH}_3)_2 \text{Cl}_2$ (2 marks)

(ii) Mer and Fac isomer $\left[\text{Mo} (\text{thf})_3 \text{Cl}_3 \right]$ (2 marks)

(b) Explain the meaning of the following terms

(i) Ligand (2 marks)

(ii) Coordination – compound. (2 marks)

(iii) Polydentate ligand (2 marks)

(iv) Heteroleptic complexes. (2 marks)

(c) Write the formula of the following coordination complexes.

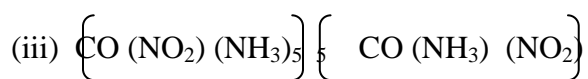
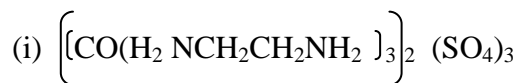
(i) Magnesium tetrahydroaluminate(III) . (2 marks)

(ii) Hex aqua- u-trishydroxido iron(III) sulphate. (2 marks)

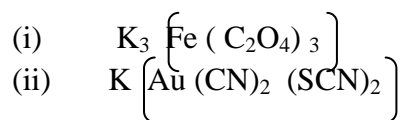
(iii) Tetrabromido cuprate (II). (2 marks)

(iv) Carbonato penta ammine Cobalt (III) Chloride (2 marks)

(d) Give the systematic name of the following complexes (6 marks)



(e) What is the coordination number of the Fe and Au atoms in. (4 marks)



SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO (20 MARKS)

(a) A pink solid has the formula $\text{CoCl}_3 \cdot 5\text{NH}_3 \cdot \text{H}_2\text{O}$. A solution of this salt is also pink and rapidly gives three moles of AgCl on titration with excess silver nitrate solution. When the pink solid is heated, it loses 1 mole of water to give a purple solid with the same ratio of NH_3 : Cl : CO . The purple solid on dissolution and titration with excess AgNO_3 , produces two moles of AgCl

- (i) Deduce the structure of the two octahedral complexes and provide IUPAC name for each one of them. (4 marks)
- (ii) Write equation for the reaction between the pink solid and excess silver nitrate. (2 marks)
- (iii) Give two possible hydrate isomer of the pink solid present in its aqueous solution. (2 marks)

(b) Draw orbital energy – level diagram for the configuration of d-electrons of the complexes

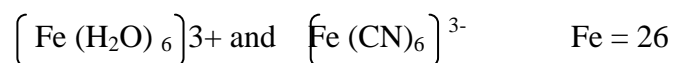


(c) Compare magnetic properties of $\left[\text{Fe} (\text{H}_2\text{O})_6 \right]^{3+}$ with those of $\left[\text{Fe} (\text{CN})_6 \right]^{3-}$

(c) Distinguish between high spin and low spin complexes. (2 marks)

QUESTION THREE (20 MARKS)

- (a) Using suitable examples, explain what is meant by monodentate, bidentate, and ambidentate ligand. (6 marks)
- (b) (i) Highlight the assumptions of Valency bond theory (VBT) (3 marks)
- (ii) Predict hybridization of the following complexes. (3 marks)



(c) Explain using valence bond theory (VBT) why $\left[\text{Ni} (\text{CN})_4 \right]^{2-}$ (square planar geometry) is diamagnetic and $\left[\text{NiCl}_4 \right]^{2-}$ tetrahedral geometry paramagnetic. (8 marks)

QUESTION FOUR (20 MARKS)

- (a) Give the basic principles of crystal field theory (CFT) pointing out clearly its merits and weakness. (10 marks)
- (b) Give the necessary conditions for occurrence of geometrical isomers in
- (i) Square planar complexes. (2 marks)
 - (ii) Octahedral complexes. (2 marks)
- (c) List **four** factors that affect stability of coordination complexes. (4 marks)
- (d) Δ_o of $\left[\text{Mn}(\text{H}_2\text{O})_6 \right]^{3+}$ is known from electron spectrum to be $21,000\text{cm}^{-1}$ the pairing energy of Mn(III) is $28,000\text{cm}^{-1}$. Predict whether the complex is high or low spin. (2 marks)