



KIBABII UNIVERSITY

**UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR**

**FOURTH YEAR SECOND SEMESTER
MAIN EXAMINATIONS**

FOR THE DEGREE OF B.SC (SCIENCE)

COURSE CODE: SCH 321*/328

COURSE TITLE: COORDINATION CHEMISTRY

DURATION: 2 HOURS

DATE: 05/09/2022

TIME: 9:00AM-11:00AM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of 5 printed pages. Please Turn Over



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Question One (30 Marks)

a) Define the following terms as used in coordination compounds

- i. Ligand
- ii. Ligand donor atom [02]

b) By giving appropriate examples, differentiate between monodentate ligands and polydentate ligands. [02]

c) Complete the valence level orbital notation for the following monatomic ions. (See periodic table for Z values) [03]

- a) Ag^+ b) Co^{3+} c) Fe^{3+}

d) For each of the following complexes, determine the number of ligands and the coordination number of the central metal.

Coordination ion complex	# Ligands	Coordination #
$[\text{Mn}(\text{EDTA})]^{2-}$		
$[\text{Co}(\text{en})_2(\text{NH}_3)\text{CN}]^{2+}$		

[03]

e) Write down the molecular formulae of the following co-ordination compounds. [03]

- (i) Hexaammine iron (III) nitrate
- (ii) Ammonium tetrachlorocuprate (II)
- (iii) Sodium monochloropentacyanoferrate (III)

f) Write the IUPAC names of following compounds? [03]

- (i) $[\text{CoBr}(\text{NH}_3)_5]\text{SO}_4$
- (ii) $[\text{Fe}(\text{NH}_3)_6][\text{Cr}(\text{CN})_6]$
- (iii) $[\text{Co}(\text{SO}_4)(\text{NH}_3)_5]^+$

j) State **three** factors that affect the magnitude of Δ_o during d-splitting in complexes. [03]

k) Explain the meaning of the following terms as used to describe magnetic behaviour of inorganic materials.

- i. Paramagnetism [01]
- ii. Diamagnetism [01]
- iii. Ferromagnetism [01]
- iv. Antiferromagnetism [01]

l)

- i. How does temperature affect magnetic behavior of materials? [02]
- ii. Describe deGruy's method of determining magnetic moment of a material. [03]
- iii. State **one** advantage and **one** disadvantage of using Guoy's method to determine the magnetic moment of a system. [02]

Question two (20 Marks)

- a) Using Valence- bond theory, show that the complex ion $[\text{Fe}(\text{CN})_6]^{3-}$ is octahedral and paramagnetic. [07]
- b) Calculate the paramagnetic dipole moment for the complex, given $\mu_B = \sqrt{n(n+2)}$. [02]
- c) What are the limitations of valence-bond theory? [02]
- d) The experimental gramme susceptibility (χ_g) for $\text{K}_4[\text{MnCl}_6] \cdot 3\text{H}_2\text{O}$ is 3.38×10^{-5} cgs at room temperature. Calculate
 - i. Molar experimental susceptibility (χ_m) [03]
 - ii. Corrected molar experimental susceptibility (χ'_m) [03]
 - iii. Magnetic moment of the complex (μ) [03]
 (Use atomic masses C=12; N= 14; O=16; K=39 and Mn=55)
 (Diamagnetic correction factors: $\text{K}^+ = -14 \times 10^{-6}$ cgs; $\text{Cl}^- = -13 \times 10^{-6}$ cgs; and $\text{H}_2\text{O} = -14 \times 10^{-6}$ cgs)

Question three (20 Marks)

Determine the following for the complex ion: $[\text{Cu}(\text{en})_3]^{2+}$

- a) What type of d-electron complex is it (for example: d^0 , d^1 , d^2 , etc.)? [02]
- b) Is the ligand a strong field ligand or a weak field ligand [02]
- c) Would you expect the complex to be high spin or low spin [02]
- e) What is the hybridization of the central metal? [04]

f) Draw the valence level orbital notation for the complex; circle the electrons that come from the ligands. [04]

g) The table below shows the values of Δ_o for different metal ions with the same ligand

Complex ion	$[\text{Co}(\text{NH}_3)_6]^{3+}$	$[\text{Rh}(\text{NH}_3)_6]^{3+}$	$[\text{Ir}(\text{NH}_3)_6]^{3+}$
Δ_o in KJ	296	406	490

Explain the variation in values of Δ_o [02]

i) The crystal field splitting energy of a complex is 2.9×10^{-19} J.

- i. What wavelength of light (in nm) would be absorbed for this d-d electronic transition? [03]
- ii. To what color of light does this wave length correspond? [01]
- iii. What color would a solution of this complex appear? [01]

Question four (20 Marks)

- a) Discuss the main postulates of the Crystal field theory. [03]
- b) State and explain any FOUR factors that affect the extend of Δ splitting according to the Crystal field theory. [08]
- c) At room temperature, the observed value of $\mu_{\text{effective}}$ for $[\text{Cr}(\text{en})_3]\text{Br}_2$ is 4.75Bm .
 - i. What is the coordination number of this complex? [01]
 - ii. What is the charge on the Chromium ion? [01]
 - iii. Write the electronic configuration of the ion. [01]
 - iv. Show whether this is a high spin or a low spin complex. [04]
- d) What is 'Jahn-teller distortion'? [02]