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 #
$[Mn(EDTA)]^{2-}$		
$[Co(en)_2(NH_3)CN]^{2+}$		

[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) $[CoBr(NH_3)_5]SO_4$

(ii) $[Fe(NH_3)_6][Cr(CN)_6]$

(iii) $[Co(SO_4)(NH_3)_5]^{+}$

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]**

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i. How does temperature affect magnetic behavior of materials? **[02]**
ii. Describe teGuoy'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 $[Fe(CN)_6]^{3-}$ 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 $K_4[MnCl_6].3H_2O$ 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: $K^+ = -14 \times 10^{-6}$cgs; $Cl^- = -13 \times 10^{-6}$cgs; and $H_2O = -14 \times 10^{-6}$cgs)

Question three (20 Marks)

Determine the following for the complex ion: $[Cu(en)^3]^{2+}$

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	$[Co(NH_3)_6]^{3+}$	$[Rh(NH_3)_6]^{3+}$	$[Ir(NH_3)_6]^{3+}$
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 x 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 Δsplitting according to the Crystal field theory. **[08]**
c) At room temperature, the observed value of $\mu_{effective}$ for $[Cr(en)_3]Br_2$is 4.75B~~m~~.
   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]**