KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

FOURTH YEAR FIRST SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF BSC (CHEM)

COURSE CODE: SCH 410E

COURSE TITLE: COORDINATION AND ORGANO METALLIC CHEMISTRY

DURATION: 2 HOURS

DATE: WEDNESDAY 20TH DECEMBER 2017 TIME: 3 – 5 PM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Question one has a total of **30 marks** whereas questions two to five is each **20 Marks**
- 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 **3** printed pages. Please Turn Over

QUESTION ONE (30 MARKS)

a) Define the following terms as used in coordination compounds
   i. Ligand
   ii. Ligand donor atom **(2 marks)**

b) By giving appropriate examples, differentiate between monodentate ligands and polydentate ligands. **(2 marks)**

c) Complete the valence level orbital notation for the following monatomic ions. (See periodic table for Z values) **(4 marks)**

(a) Ag^{+} (b) Co^{3+} (c) Fe^{3+} (d) Cr^{3+}

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

Coordination ion complex	# Ligands	Coordination #	Oxidation #
$[Mn(EDTA)]^{2-}$			
$[Co(en)_2(NH_3)CN]^{2+}$			

(3 marks)

e) Give the ligand name for each of the following ligands. Identify the donor atom(s) in each.

Ligand	H_2O	$C_2O_4^{2-}$	CN^-	NH_3	NO_2^-	ONO^-
Name						

(3 marks)

f) Write down the molecular formulae of the following co-ordination compounds. **(4 marks)**

(i) Hexaammine iron (III) nitrate(ii) Ammonium tetrachlorocuprate (II)

(iii) Sodium monochloropentacyanoferrate (III)(iv) Potassium hexafluorocabaltate (III)

g) Write the IUPAC names of following compounds? **(4 marks)**

(i) $[CoBr(NH_3)_5]SO_4$
(ii) $[Fe(NH_3)_6][Cr(CN)_6]$
(iii) $[Co(SO_4)(NH_3)_5]^{+}$
(iv) $[Fe(OH)(H_2O)_5]^{2+}$

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? **(3 marks)**
   ii. To what color of light does this wave length correspond? **(1 mark)**
   iii. What color would a solution of this complex appear? **(1 mark)**

j) State three factors that affect the magnitude of Δ_o during d-splitting in complexes. **(3 marks)**

QUESTION TWO (20 MARKS)

a) Using Valence- bond theory, show that the complex ion $[Fe(CN)_6]^{3-}$ is octahedral and paramagnetic. **(8 marks)**

b) Calculate the paramagnetic dipole moment for the complex, given $\mu_B = \sqrt{n(n+2)}$ **(4 marks)**

c) What are the limitations of valence-bond theory? **(4 marks)**

d) Explain the meaning of the following magnetic behavior in inorganic compounds (where possible use illustrations)

i. Para-magnetism
ii. Diamagnetism
iii. Ferromagnetism
iv. Anti ferromagnetism

(4 marks)

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.)? **(2 marks)**

b) Is the ligand a strong field ligand or a weak field ligand **(2 marks)**

c) Would you expect the complex to be high spin or low spin **(2 marks)**

e) What is the hybridization of the central metal? **(4 marks)**

f) Draw the valence level orbital notation for the complex; circle the electrons that come from the ligands. **(4 marks)**

g) Is the complex paramagnetic or diamagnetic? Calculate its magnetic dipole moment. **(4 marks)**

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 **(2 marks)**

QUESTION FOUR (20 MARKS)

a) For the complex $[CoF_6]^{3-}$:

i) Is Δ_o relatively large or small? **(2 marks)**

ii) How do the values of the splitting and the e– pairing energies compare? Ie: Δ_o (=, > or <) P **(2 marks)**

iii) Is the complex high spin or low spin? **(2 marks)**

iv) Draw crystal fields to show the valence electrons from the metal in both the isolated ion and the complex. **(6 marks)**

v) Fill in the valence level orbital notation below; circle the electrons that come from the ligands. **(2 marks)**

vi) What is the hybridization of the orbitals on the central metal ion? **(4 marks)**

vii) Based on the orbital notation in Part(v) above, would you expect the complex to be Paramagnetic or diamagnetic? **(2 marks)**