MAASAI MARA UNIVERSITY

REGULAR UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR
THIRD YEAR SECOND SEMESTER

SCHOOL OF SCIENCE AND INFORMATION SCIENCES
BACHELOR OF SCIENCE AND BACHELOR OF EDUCATION (SCIENCE)

COURSE CODE: CHE 318

COURSE TITLE: COORDINATION AND ORGANOMETALLIC CHEMISTRY

DATE: 20TH AUGUST 2018 TIME: 2:30 PM – 4:30 PM

INSTRUCTIONS TO CANDIDATES

Answer question ONE and any other TWO.

This paper consists of 5 printed pages. Please turn over:

SECTION A

QUESTION ONE

1)

a) Provide the names for the coordination compounds. (6 marks)

i. $[Cr(en)_2(H_2O)_2]NO_3$

ii. $[Au(CO_3)_2]^{2-}$

iii. $[Co(CO)_3(OH)(H_2O)_2]^+$

b) Provide the chemical formulas for the coordination compounds. (6 marks)

i. tetraammineplatinum(II) difluoromotetrachloroplatinate(IV)

ii. diamminediaquadithiocyanatochromium(III) bromide

iii. tris(ethylenediamine)iron(III) hexacyanocobaltate(III)

2) Define each of the following. (3 marks)

i. Ionization isomerism (and give an example)

ii. Crystal field splitting

iii. Hard acid (and give an example)

3) The complex ion $[Cu(NH_3)_6]^{2+}$ is blue in aqueous solution. The absorbance spectrum of this complex ion has a maximum absorbance at 615 nm. Calculate the crystal field splitting energy (in kJ/mol) for this ion. (4 marks)

4) Answer the question for each pair of molecules or species and briefly explain why this is the case.

i. Which of the following complexes would demonstrate the greatest magnetism? $[Ru(CN)_3(H_2O)_3]^-$ or $[Ru(Cl)_3(H_2O)_3]^-$ (3 marks)

ii. Which of the following will form the most stable adduct with Au^+? (2 marks)

F^- Cl^- Br^- I^-

iii. Which of the following is expected to have the largest Δ_0? Co^{2+} or Co^{3+}. Explain your reasoning (2 marks)

5) Briefly explain the advantages of polymerization with Ziegler-Natta catalysts over free-radical polymerization. (2 marks)

6) Explain why tetrahedral complexes of Co^{2+} are generally more stable than those of Ni^{2+}. (2 marks)

QUESTION TWO

1) Write the formula or structure as stated and indicate the overall charge. (12 marks)

a) The structure for: *cis*-dichlorobis(ethylenediamine)chromium(III)

b) The two structures for the isomers of: triaquatrichlorochromate(III) and label them

c) The formula of: μ-amido-μ-hydroxobis(tetracarbonyliron)(4+)

d) The formula of coordination isomer of:

hexaaquairon(III) hexacyanocobaltate(III)

2) Determine the ligand field stabilization energy for the following octahedral complexes and identify the complex ion that is more stable? (4 marks)

i. $[Cu(H_2O)_6]^{2+}$

ii. $[Co(CN)_6]^{3-}$

3) Briefly explain why:

i. CuI is much less soluble in water than CuF, and LiF is much less soluble than LiI. (2 marks)

ii. $H_2N(CH_2)_2NH_2$ forms a more stable complex with Zn^{2+} than $H_2N(CH_2)_5NH_2$ (2 marks)

QUESTION THREE

1) Draw the octahedral crystal field splitting diagram for metal ions in the following complex ions and in each case, indicate whether it is diamagnetic or paramagnetic: (8 marks)

iv. $[Co(CN)_6]^{3-}$

v. $[FeBr_6]^{4-}$

2) The complex $[Fe(LG)_6]^{2+}$ is known to be diamagnetic. Given that LG is a neutral monodentate ligand, is LG ligand inducing a strong field or weak field? Show your reasoning. (3 marks)

3) Identify the most likely transition metal **M**: (9 marks)

i. $K_3[\mathbf{M}(CN)_6]$, in which **M** is a first-row transition metal and the complex has three unpaired electrons

ii. $[\mathbf{M}(H_2O)_6]^{3+}$, in which **M** is a second-row transition metal and LFSE = -2.4 Δ_o

iii. tetrahedral $[\mathbf{M}Cl_4]^-$, which has five unpaired electrons and first-row transition metal **M**

QUESTION FOUR

1) Predict the number of unpaired electrons for each of the following: (8 marks)

   i. a tetrahedral d^6 ion
   ii. $[Co(H_2O)_6]^{2+}$ in octahedral field
   iii. $[Cr(H_2O)_6]^{3+}$ in octahedral field
   iv. a square-planar d^7 ion

2) Identify the first-row transition metal for the following 18-electron species: (6 marks)

   i. $[\mathbf{M}(CO)_3(PPh_3)]^-$
   ii. $H\mathbf{M}(CO)_5$
   iii. $[(\eta^5\text{-}C_5H_5)\mathbf{M}(CO)_3]_2$ (assume single **M**-**M** bond)

4) For each of the following complexes, determine the hybrid orbital type and the number of unpaired electrons. (6 marks)

   (a) $[Cr(H_2O)_6]^{2+}$

   (b) $[Co(CN)_6]^{3-}$

The Periodic Table of Elements

Metals | Metalloids | Nonmetals

Periods

Period	1A 1	2A 2	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8	9	10	1B 11	2B 12	3A 13	4A 14	5A 15	6A 16	7A 17	8A 18
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112	113	114	115	116		

Lanthanides	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
Actinides	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr