(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE (CHEMISTRY) AND BACHELOR OF INDUSTRIAL CHEMISTRY

COURSE CODE: SCH 313

COURSE TITLE: INORGANIC REACTION MECHANISMS OF COMPLEX COMPOUNDS

DATE: 21ST APRIL 2022 **TIME:** 12.00 - 2.00

INSTRUCTIONS TO CANDIDATES

Total Marks: 70

Answer all the Questions

TIME: 2 Hours

QUESTION ONE (18 Marks)

(a) Name the following complex ions/coordination complexes:

(i) $[Pt(H_2NCH_2CH_2NH_2)_2Cl_2]Cl_2$ **(2 marks)**

(ii) $[Co(H_2NCH_2CH_2NH_2)_3]_2(SO_4)_3$ **(2 marks)**

(iii) $(NH_4)_2[Ni(C_2O_4)_2(H_2O)_2]$ **(2 marks)**

(b) (i) Define *trans*-effect? **(2 marks)**

(ii) State any two applications of *trans* effect **(2 marks)**

(iii) Given that the relative order of the *trans*-directing ability of the ligands is $NO_2^- > Cl^- > NH_3$. Design a selective two step synthesis for *cis* and *trans* $[Pt(NH_3)(NO_2)Cl_2]^-$ starting with $PtCl_4^{2-}$ **(4 marks)**

(c) Draw the structures of the following compounds:

(i) *Mer*-triaquatriamminechromium(III)chloride

(ii) Λ-bis(ethylenediamine)κ-s-thiocyanido)iron(III) **(4 marks)**

QUESTION TWO (18 Marks)

(a) Explain why the stability of Co^{2+} complex is greater than for Co^{3+} complex even if the central metal ion is almost the same **(2 marks)**

(b) Explain why $[Co(NH_3)_6]^{3+}$ is an inner orbital complex whereas $[Ni(NH_3)_6]^{2+}$ is an outer orbital complex **(4 marks)**

(c) Using the Kunarkov reaction show how you will distinguish between *cisplatin* from *transplatin* geometric isomers **(4 marks)**

(d) A chelate effect is an entropy factor. Discuss in relation to $[Cd(NH_2CH_3)]^{2+}$ $\log\beta_4$= 6.6 versus $[Cd(en)_2]^{2+}$ $\log\beta_4 = 10.6$ **(5 marks)**

(e) Given the following reaction mechanism, derive its rate law equation under steady state approximation **(3 marks)**

$$ML_5X + Y \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} ML_5XY \quad \text{fast}$$

$$ML_5XY \xrightarrow{k_2} ML_5Y + X \quad \text{slow}$$

QUESTION THREE (16 Marks)

(a) State three factors that affect lability of a complex **(3 marks)**

(b) With an example define ambidentate ligands **(2 marks)**

(c) The table below shows the stability constants for each of the stages in the replacement of four of the aqua ligands in $[Cu(H_2O)_6]^{2+}$.

Ion	K_n	Value ($mol^{-1}dm^3$)
$[Cu(NH_3)(H_2O)_5]^{2+}$	K_1	1.78×10^4
$[Cu(NH_3)_2(H_2O)_4]^{2+}$	K_2	4.07×10^3
$[Cu(NH_3)_3(H_2O)_3]^{2+}$	K_3	9.55×10^2
$[Cu(NH_3)_4(H_2O)_2]^{2+}$	K_4	1.74×10^2

(i) Write the equations for the formation of each ion from the previous one with one ammonia less, and use it to write an expression for each stability constant **(4 marks)**

(ii) Write an expression for the overall stability constant for the formation of the complex ion $[Cu(NH_3)_4(H_2O)_2]^{2+}$ **(2 marks)**

(iii) Use the values in the table to calculate the overall stability constant. **(1 mark)**

(d) Briefly discuss how π-bonding theory influences substitution reaction on square planar complexes **(4 marks)**

QUESTION FOUR (18 Marks)

(a) With relevant equations where possible briefly explain the following terms:

(i) A chelate complex **(2 marks)**

(ii) Acid hydrolysis **(2 marks)**

(iii) Anation **(2 marks)**

(b) Write the formulae for the following complexes:

(i) Tetraammineaquachloridocobalt(III)chloride **(2 marks)**

(ii) Potassiumtetrahydroxidozincate(II) **(2 marks)**

(iii) Tetracarbonylnickel(0) **(2 marks)**

(c) Draw the structures the following complexes:

(i) μ-amido-μ-nitrooctaamminedicobalt(III)ion **(2 marks)**

(ii) μ-hydroxy-bis{pentaamminechromium(III)}chloride **(2 marks)**

(iii) Λ-Tris(ethylenediamine)cobalt(I)chloride **(2 marks)**

Periodic Table of the Elements 2006

1 H 1.01	2											13	14	15	16	17	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 15.99	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3	4	5	6	7	8	9	10	11	12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.41	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (270)	109 Mt (268)	110 Ds (281)	111 Rg (272)							

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)