UNIVERSITY OF EMBU

2017/2018 ACADEMIC YEAR

SECOND SEMESTER EXAMINATIONS

THIRD YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE AND BACHELOR OF EDUCATION (SCIENCE)

SCH 304: COORDINATION CHEMISTRY

DATE: APRIL 9, 2018 **TIME: 2:00-4:00PM**

INSTRUCTIONS:

Answer question ONE and any other TWO questions

QUESTION ONE (30 MARKS)

a) Explain the meaning of the following terms, giving relevant examples. (6 marks)

i) Ligand

ii) Coordination compound

iii) Chelate effect

b) Name the following complexes. (4 marks)

i) $K_3[Co(C_2O_4)_3]$

ii) $Na_3[Fe(CN)_6]$

iii) $[PtCl_4]^{2-}$

iv) $[Cr(NH_3)_3Cl_3]$

c) Write the coordination formulas for the following. (4 marks)

i)Dichlorotetraaquachromium(III)

ii)Tetrabromidocuprate(II)

iii)Carbonatopentaamminecobalt(III) chloride

iv)Potassium hexacyanoferrate(II)

d) Using examples, explain the difference between ionization isomerism and hydration isomerism (6 marks)

e) Using examples, explain what is meant by monodentate, bidentate and ambidentate ligands. (6 marks)

f) The complexes $[V(H_2O)_6]^{3+}$ and $[VF_6]^{3-}$ are both known.

i) What gives rise to the colors of these complexes? (2 marks)

ii) Which of the two complexes would you expect to absorb light of higher energy? Explain. (2 marks)

QUESTION TWO (20 MARKS)

a) $[Cr(en)_2Cl_2]^+$ exhibits two types of isomerism. Name the two types of isomerism and draw the possible structures of the different isomers of the complex. (4 marks)

b) Calculate the effective atomic number (EAN) of the central metal in each of the following compounds. (6 marks)

i) $[Fe(CN)_6]^{3-}$

ii) $[Mn(CO)_5C_2H_4]^+$

iii) $[PtCl_6]^{2-}$

c) Briefly explain the limitations of the valence bond theory. (4 marks)

d) Predict the geometric structures of the complexes $[Ni(H_2O)_6]^{2+}$ (paramagnetic) and $[Al(H_2O)_6]^{3+}$ (diamagnetic). Evaluate your answer. (6 marks)

QUESTION THREE (20 MARKS)

a) Differentiate between Orgel and Tanabe-Sugano diagrams. (6 marks)

b) List and explain the three assumptions of the crystal field theory. Compare these with what the valency bond theory says. (6 marks)

c) The molar conductivities (*in* $ohm^{-1}cm^2mol^{-1}$) for the complexes $CoCl_3.6NH_3$, $CoCl_3.5NH_3$, $CoCl_3.4NH_3$ and $CoCl_3.3NH_3$ decrease from 431 to zero, respectively. How many ions and charges are expected from each complex in solution? Explain the decrease in molar conductivity from 431 in $CoCl_3.6NH_3$ to zero in $CoCl_3.3NH_3$. (4 marks)

d) How does the splitting Δ_o in the complexes of transition elements change down the groups in the periodic table of elements if the charge on the metal ions is the same and the type of ligand and number of ligands surrounding the metal ions are the same? Explain. (4 marks)

QUESTION FOUR (20 MARKS)

a) The complex $[Co(NH_3)_6]Cl_2$ is a paramagnetic high-spin complex, while $[Co(NH_3)_6]Cl_3$ is a diamagnetic low-spin complex. Explain this difference. (4 marks)

b) Explain, using valence bond theory why $[Ni(CN)_4]^{2-}$ (square planar geometry) is diamagnetic and $[NiCl_4]^{2-}$ (tetrahedral geometry) is paramagnetic. (8 marks)

c) Explain the bonding in coordination compounds in terms of Werner's postulates. (6 marks)

d) Which complex will be more coloured either $[Co(NH_3)_6]^{3+}$ or $[Co(NH_3)_5Cl]^{2+}$. Justify your answer. (2 marks)

QUESTION FIVE (20 MARKS)

a) Discuss the nature of bonding in the following entities on the basis of valence bond theory. (12 marks)

i) $[Fe(CN)_6]^{4-}$

ii) $[FeF_6]^{3-}$

iii) $[Co(C_2O_4)]^{3-}$

b) Aqueous copper sulphate solution which is blue in colour gives a green precipitate with aqueous potassium fluoride and a bright green solution with aqueous potassium chloride. Explain these observations. (4 marks)

c) Discuss briefly two differences between crystal field theory (CFT) and ligand field theory (LFT). (4 marks)

PERIODIC TABLE

1																	18
1 H 1.008	2											13	14	15	16	17	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	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 47.88	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 65.39	31 Ga 69.72	32 Ge 72.61	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 98.91	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57* La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89** Ac (227)	104 Db (261)	105 Jl (262)	106 Rf (263)	107 Bh (262)	108 Hn (?)	109 Mt (?)									

* Lanthanides	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (147)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
** Actinides	90 Th (232)	91 Pa (231)	92 U (238)	93 Np (237)	94 Pu (239)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (252)	99 Es (252)	100 Fm (257)	101 Md (256)	102 No (259)	103 Lr (260)

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