UNIVERSITY OF EMBU

2019/ 2020 ACADEMIC YEAR

SECOND SEMESTER EXAMINATIONS

FOURTH YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION, BACHELOR OF SCIENCE, BACHELOR OF SCIENCE IN ANALYTICAL CHEMISTRY, BACHELOR OF SCIENCE IN INDUSTRIAL CHEMISTRY

SCH 401: CHEMISTRY OF TRANSITION ELEMENTS

DATE: OCTOBER 15, 2020 **TIME: 8.30 – 10.30AM**

INSTRUCTIONS:

Answer Question ONE and any other TWO Questions

QUESTION ONE (30 MARKS)

a) What is a transition element ? (2 marks)

b) Explain why TiO_2 and $ZnSO_4$ are white compounds (2 marks)

c) Suggest with reasons the electronic configurations of Cr and Cu. (3 marks)

d) VCl_2 is ionic while VCl_5 is covalent. Account for this observation. (2 marks)

e) State and explain the general variation trend in the density down the group of transition metals in the periodic table (3 marks)

f) Explain why the transition metal complex containing metal ion in higher oxidation state complex is more stable than the one in the lower oxidation state. (2 marks)

g) Explain why Cr^{2+} is a powerful reducing agent while Mn^{2+} is not (3 marks)

h) $[Ni(Cl)_4]^{2-}$ is paramagnetic while $[Ni(CN)]^{2-}$ is diamagnetic.

Explain this observation. (3 marks)

i) Cu^+ ion has $3d^{10}4s^0$ configuration and colourless but Cu_2O is red and Cu_2S is black. Explain (3 marks)

j) Cu, Ag and Au are considered as transition elements while Zn, Cd and Hg are not although all the mentioned elements have complete d-orbitals. Explain. (3 marks)

k) Scandium forms no coloured ions, yet it is regarded as a transition element. Explain (2 marks)

l) Draw the structure for $[Cu(NH_3)_4(H_2O)_2]^{2+}$ complex. (2 marks)

QUESTION TWO (20 MARKS)

a) Explain why transition metals readily form complexes (3 marks)

b) Whereas both aluminum and chromium form stable compounds with chlorine namely $AlCl_3$ and $CrCl_3$ only chromium forms a stable compound with carbon monoxide namely chromium hexacarbonyl $Cr(CO)_6$ (5 marks).

c) Describe the sulphate process for the manufacture of the pigment grade TiO_2 (7 marks)

d) Discuss the existence of NbI_5 and VI_5 (5 marks).

QUESTION THREE (20 MARKS)

a) Explain how charge transfer and d-d transitions contribute to coloured compounds of transition metals. (8 marks)

b) Account for the following observations in the properties of transition metal element

i) $[Ni(NH_3)_6]^{2+}$ is blue while $[Ni(H_2O)_6]^{2+}$ is green (3 marks

ii) The highest oxidation state for the early transition metal elements, Sc, Ti, V, Cr, and Mn is the group number. On the other hand the highest oxidation state for the later elements of the same period (Fe, Co, Ni and Cu) is less than the group number. (5 marks)

c) Discuss the changes across the period of atomic radii in the first transition series. (4 marks)

QUESTION FOUR (20 MARKS)

a) Discuss the characteristics of stable compounds (4 marks)

b) What are the effects and consequences of Lanthanide contractions? (8 marks)

c) Briefly explain how pure form of Manganese can be obtained from Pyrolusite MnO_2 (5 marks)

d) Explain the differences in hardness in Chromium and zinc. (3 marks)

QUESTION FIVE (20 MARKS)

a) Explain why MnO is basic while Mn_2O_7 is strongly acidic (4 marks)

b) Outline the method for the extraction of manganese from any of the ore of your choice and give all the equations of the reactions involved. (5 marks)

c) Briefly describe four steps that may be followed during the extraction of metals from their ores . (8 marks)

d) Biologically iron is the most important transition element. Explain in three ways why this may be the case. (3 marks)

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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)