THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

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MAIN EXAMINATION

JANUARY – APRIL 2019 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF NATURAL SCIENCE (CHEMISTRY)

PART TIME PROGRAMME

CHEM 400: DESCRIPTIVE CHEMISTRY OF TRANSITION ELEMENTS

Date: APRIL 2019	**Duration: 2 Hours**
INSTRUCTIONS: Answer Question ONE and ANY OTHER TWO Questions	

Q1. a) i) Define a transition element. **(2Marks)**

ii) Whereas Cu^{+2} is a transition element, Zn^{+2} is not included among the transition elements. Explain. **(2Marks)**

b) State 3 reasons why transition metals have a strong tendency to form complex ions with different ligands. **(3Marks)**

c) i) With a few exceptions, the d-block element exhibit more than one oxidation state. Explain. **(4Marks)**

ii) Explain why the transition metals in higher oxidation states, in their compounds act as oxidizing agents. **(2Marks)**

d) i) Explain what is unique with transition metals to make them act as catalysts? **(1Mark)**

ii) Name the catalysts used in the following reactions. **(3Marks)**

i) $CH_2{=}CH_2 + H_{2(g)} \rightarrow CH_3CH_{3(s)}$

ii) $2H_2O_{2(l)} \rightarrow 2H_2O_{(l)} + O_{2(g)}$

iii) $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

e) Differentiate between absorption spectra and emission spectra. **(2Marks)**

f) Explain what you understand by each of the following **(2Marks)**
   i) Excitation
   ii) Atomic orbitals

g) Outline **three** differences between a diamagnetic material and a paramagnetic one. **(3Marks)**

h) State **three** uses of potassium permanganate ($KMnO_4$). **(3Marks)**

i) i) Name the **two** metals used in the extraction of Titanium. **(2Marks)**

ii) Lanthanides are used in control rods that are used to regulate nuclear reactors. Explain what makes them useful as control rods**.** **(1Mark)**

Q2. a) Scandium (Sc) and Zinc (Zn) are similar in some ways but different from the rest of the other transition elements. State the 3 ways they differ from the rest of the transition elements. **(6Marks)**

b) By referring to electronic configuration. Explain why:
   i) The second ionization energies of both chromium and copper are higher than those of the next element? Indicate the process that is referred to.

(3Marks)

   ii) The 3rd ionization energies of both Mn and Zn are higher than those of the next element? Indicate the process that is referred to. **(3Marks)**

c) Explain which ions between Fe^{+3} and Fe^{+2} are more stable? **(4Marks)**

d) Organo metallic compounds are often synthesized in an inert atmosphere.
   i) Name any **two** substances that provide the inert atmosphere. **(2Marks)**

   ii) Explain why they need to be prepared in an inert atmosphere? **(2Marks)**

Q3. a) State any **FOUR** properties of the transition elements and explain how each arises. **(8Marks)**

b) i) Explain what you understand by “heterogeneous catalysis”. **(2Marks)**

ii) Explain how a heterogeneous catalyst works. **(3Marks)**

c) i) Given that Manganese and iron have magnetic moments of 5.92BM and 4.9BM. Calculate the number of unpaired electrons in each of the elements. **(4 Marks)**

ii) Between Manganese and Iron, State which element is more magnetic than the other. Give a reason for your answer. **(3 Marks)**

Q4. a) Draw the shapes of the various d-orbitals, and **explain** why they are split into two groups in an octahedral field. **(7Marks)**

b) Show, diagrammatically, how the d-orbitals are split in the octahedral field.

(5Marks)

c) i) State **three** Assumptions of Crystal Field Theory. **(3Marks)**

ii) State any **Five** limitations of the Crystal Field Theory. **(5Marks)**

Q5. a) The transition elements consist of the **d-block** and **f-block** elements and both blocks of elements form complex ions. One block has a low tendency of doing so than the other. State which one and why? **(2Marks)**

b) Outline any three consequences of Lanthanide contraction. **(6Marks)**

c) Compare and contrast the Lanthanides and actinides. **(12Marks)**

THE PERIODIC TABLE

1																	18
1 **H** 1.008	2											13	14	15	16	17	2 **He** 4.0026
3 **Li** 6.94	4 **Be** 9.0122											5 **B** 10.81	6 **C** 12.011	7 **N** 14.007	8 **O** 15.999	9 **F** 18.998	10 **Ne** 20.180
11 **Na** 22.990	12 **Mg** 24.305	3	4	5	6	7	8	9	10	11	12	13 **Al** 26.982	14 **Si** 28.085	15 **P** 30.974	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.948
19 **K** 39.098	20 **Ca** 40.078	21 **Sc** 44.956	22 **Ti** 47.867	23 **V** 50.942	24 **Cr** 51.996	25 **Mn** 54.938	26 **Fe** 55.845	27 **Co** 58.933	28 **Ni** 58.693	29 **Cu** 63.546	30 **Zn** 65.38	31 **Ga** 69.723	32 **Ge** 72.630	33 **As** 74.922	34 **Se** 78.97	35 **Br** 79.904	36 **Kr** 83.798
37 **Rb** 85.468	38 **Sr** 87.62	39 **Y** 88.906	40 **Zr** 91.224	41 **Nb** 92.906	42 **Mo** 95.95	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	57-71 *	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)	89-103 #	104 **Rf** (265)	105 **Db** (268)	106 **Sg** (271)	107 **Bh** (270)	108 **Hs** (277)	109 **Mt** (276)	110 **Ds** (281)	111 **Rg** (280)	112 **Cn** (285)	113 **Nh** (286)	114 **Fl** (289)	115 **Mc** (289)	116 **Lv** (293)	117 **Ts** (294)	118 **Og** (294)

* Lanthanide series	57 **La** 138.91	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.36	63 **Eu** 151.96	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** 173.05	71 **Lu** 174.97
# Actinide series	89 **Ac** (227)	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)

END