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OFFICE OF THE DEPUTY PRINCIPAL
ACADEMICS, STUDENT AFFAIRS AND RESEARCH

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

FOURTH YEAR FIRST SEMESTER REGULAR EXAMINATION

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE

COURSE CODE: CHE 410

COURSE TITLE: TRANSITION METAL CHEMISTRY

DATE: 27TH JANUARY, 2022 **TIME: 0900 – 1200 HRS**

INSTRUCTION TO CANDIDATES

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REGULAR – MAIN EXAM

CHE 410: TRANSITION METAL CHEMISTRY

STREAM: BED (Scie) **DURATION: 3 Hours**

INSTRUCTIONS TO CANDIDATES

i. *Answer **ALL** questions.*
ii. *Diagrams may be used whenever they serve to illustrate the answer.*
iii. *Do not write on the question paper.*

Question One

a. State the origin of the color of transition-metal complexes (2 marks).

b. Chloride ions form the tetrahedral complex ion $[AlCl_4]^-$ but fluoride ions form the octahedral complex ion $[AlF_6]^{3-}$. Suggest a reason for this difference. (1 mark)

c. Iron (II) forms a complex in hemoglobin. For each of the two octahedral complex ions $[Fe(H_2O)_6]^{2+}$ and $[Fe(CN)_6]^{4}$, draw an energy diagram showing orbital splitting, predict the number of unpaired electrons, and identify the ion as low spin or high spin (5 marks).

d. What are the systematic names of;

i. $Na_3[AlF_6]$? (1 marks)
ii. $[Co(en)_2Cl_2]NO_3$? (1 marks)

e. What is the formula of;

i. tetraamminebromochloroplatinum(IV) chloride? (1 marks)

ii. hexaamminecobalt(III) tetrachloroferrate(III)? (1 marks)

Question Two

a. Discuss the following with respect to trends in the properties of transition metals

i. Atomic size (1 marks)

ii. Electronegativity (1 marks)

iii. Ionization energy (1 marks)

iv. Density (1 marks)

b. Using appropriate examples, discuss the classification of ligands (3 marks)

c. Describe the ligand field theory (5 marks)

Question Three

Explain the following types of isomerism in coordination compounds.

i. Constitutional isomers (2 marks)
ii. Stereoisomers (2 marks)
iii. Coordination isomers (2 marks)
iv. Linkage isomers (2 marks)
v. Geometric isomers (2 marks)
vi. Optical isomers (2 marks)

Question Four

a. Explain the following terms;
   i. transition elements (1 marks)
   ii coordination compounds (1 marks)
b. Explain why the alloy $SmCo_5$ forms a permanent magnet (2 marks)
c. Write electron configurations for the following: Zr, Mo^{3+}, V^{+}, V^{2+}, V^{3+}, V^{4+}, (6 marks)
d. Rank the ions $[Ti(H_2O)_6]^{3+}$, $[Ti(NH_3)_6]^{3+}$, and $[Ti(CN)_6]^{3-}$ in terms of Δ and of the energy of visible light absorbed (2 marks)

Question Five

a. Assign the shape and the coordination number for each of the following complex ions (6 marks)

$[CuCl_2]^-$, $[Ag(NH_3)_2]^+$, $[AuCl_2]^-$, $[Ni(CN)_4]^{2-}$, $[PdCl_4]^{2-}$, $[Pt(NH_3)_4]^{2+}$, $[Cu(NH_3)_4]^{2+}$, $[Cu(CN)_4]^{3-}$, $[Zn(NH_3)_4]^{2+}$, $[CdCl_4]^{2-}$. $[MnCl_4]^{2-}$, $[Ti(H_2O)_6]^{3+}$, $[V(CN)_6]^{4-}$

b. Use the crystal field theory to describe the splitting of d-orbital energies in an octahedral field of ligands and the crystal field splitting energy (use of diagram is preffered) (6 marks)

Question Six

a. Use appropriate diagrams to describe hybrid orbitals and bonding in the;
   i. octahedral $[Cr(NH_3)_6]^{3+}$ (2 marks)
   ii. square planar $[Ni(CN)_4]^{2-}$ (2 marks)

b. What is the donor atom in each of the following ligands (6 marks)

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