



THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

A. M. E. C. E. A

MAIN EXAMINATION

JANUARY – APRIL 2014 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF NATURAL SCIENCE

SCHOOL FOCUSED PROGRAMME

CHEM 400: DESCRIPTIVE STUDY OF TRANSITION ELEMENTS

Date: APRIL 2014

Duration: 2 Hours

INSTRUCTIONS: Answer Question ONE and ANY OTHER TWO Questions.

- Q1. a) Write a short account on the following:
- i) The **FIVE** characteristic properties of the transition elements. **(4 marks)**
 - ii) Factors affecting the magnitude of the ligand splitting parameter, Δ **(4 marks)**
 - iii) Screening and penetration effects. **(3 marks)**
- b) KMnO_4 is purple, KTcO_4 is dark red and KReO_4 is white. Suggest the most likely explanation for the origin of colours in these compounds, and also why they vary in the manner observed.
[Mn = 25; Tc = 43; Re = 75] **(3 marks)**
- c) i) Explain what is meant by the stoichiometry of a transition metal complex. **(1 mark)**
- ii) Calculate the stoichiometry of the complex formed between iron and ethanedioate ions, from the following data. The potassium salt of the iron (III) ethanedioate complex has the following composition by mass:
K, 26.8%; Fe, 12.8%; C, 16.5%; O, 43.9%
[K = 39, Fe = 56, C = 12, O = 16]. **(3 marks)**

- iii) Suggest the geometry of the above complex and explain what type of isomerism it could show. **(3 marks)**
- iv) When aqueous potassium thiocyanate, KSCN(aq) , is added to a solution of the above complex, a red colour is observed. By contrast, when aqueous potassium hexacyanoferrate (II), no such red colour is formed. Give an explanation for this difference. **(3 marks)**
- Q2. a) Describe in detail using equations or otherwise, the extraction of Titanium from its ore. **(10 marks)**
- b) Explain why titanium is not extracted from its ore by:
- Reduction using carbon
 - Electrolysis **(2 marks)**
- c) i) State **THREE** roles of titanium as a construction material. **(3 marks)**
- ii) Why is titanium the metal of choice for hip and knee replacements? **(2 marks)**
- d) State the impact of titanium mining on the environment. **(3 marks)**
- Q3. a) i) Define the Lanthanide contraction. **(2 marks)**
- ii) What role does the Lanthanide contraction play in the chemistry of the lanthanides? **(5 marks)**
- iii) State **THREE** applications of the lanthanides. **(3 marks)**
- b) Write an account of the actinides stating:
- Their position in the periodic table. **(2 marks)**
 - Five common properties. **(5 marks)**
 - Their effect on the environment. **(3 marks)**
- Q4. Explain the following observations.
- a) The atomic radius remains fairly constant from chromium to copper, then suddenly increases in zinc. **(5 marks)**
- b) The close packed structure of the d-block elements. **(5 marks)**
- c) The transition elements exhibit very high melting points and boiling points, but for zinc there is a drastic drop. **(5 marks)**

- d) i) Manganese (II) ions shows maximum paramagnetic character. **(2 marks)**
 ii) Calculate the magnetic moment of manganese (II) ions [Mn = 25]. **(3 marks)**

Q5. Tests were carried out on two isomers of $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$. The results obtained were shown in the table below:

Test	Results	
	Isomer P	Isomer Z
1. Excess aqueous silver nitrate was added to 0.15 mole of aqueous solution of the isomer.	0.15 mole of chloride ions was precipitated	0.45 moles of chloride ions was precipitated.
2. Conductivity measurements	Two moles of conducting species	Four moles of conducting species were detected.

- a) From the above tests, write the possible molecular formular of P and Z. Give reasons for your answers. **(4 marks)**
- b) To an aqueous solution of chromium (III) sulphate was added an aqueous solution of ammonium nitrate followed by dropwise addition of aqueous ammonia until it was in excess.
- i) What was observed? **(2 marks)**
 ii) Write ionic equations to explain the observations made in b(i). **(2 marks)**
- c) Give the formula of the following compounds:
 i) Tetrachloroplatinic (II) acid.
 ii) Sulphatotetraaminecobalt (III). **(3 marks)**
- d) i) State the effective atomic number rule (EAN). **(2 marks)**
 ii) State **THREE** factors that favour formation of complexes. **(3 marks)**
- e) A green powder was dissolved in dilute hydrochloric acid to form a green solution, the resultant solution was divided into **THREE** portions.

- i) Potassium hexacyanoferrate (II) solution was added dropwise to the first portion. A brown precipitate was formed. Name the cation in the green powder. (1 mark)
- ii) Concentrated hydrochloric acid was added dropwise until in excess to the second portion.
- I) State what was observed. (1 mark)
- II) Write an equation for the reaction that took place. (1 marks)

END