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**UNIVERSITY EXAMINATIONS
2023/2024 ACADEMIC YEAR**

**FOURTH YEAR FIRST SEMESTER
MAIN EXAMINATIONS**

FOR THE DEGREE OF BACHELOR OF CHEMISTRY

COURSE CODE: SCH 415

COURSE TITLE: THE STUDY OF LANTHANIDES AND ACTINIDE
SERIES

DURATION: 2 HOURS

DATE: 8/12/2023

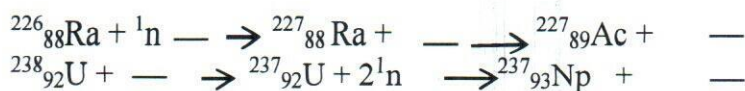
TIME: 9:00-11:00AM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

Question 1 (Compulsory) 30 Marks

- (a) Comment on the stability of the various oxidation states of lanthanides [2 mks]
- (b) State four ligands that form complexes with Lanthanide elements [2 mks]
- (c) State and explain the trend of the following across the lanthanide series
- (i) Basicity [3 mks]
- (ii) Malleability [3 mks]
- (d) (i) What is responsible for nuclear criticality in actinides? [1 mk]
(ii) What is the consequence of nuclear criticality [1 mk]
(iii) State the factors that affect nuclear criticality [2 mks]
- (e) State any four properties of actinides [4 mks]
- (f) State any two uses of actinides [2 mks]
- (a) Describe how the following techniques are applied to separate lanthanide
- (i) Fractional thermal decomposition of oxy salts [2 mks]
(ii) Paper Chromatography [2 mks]
(iii) Complex formation [2 mks]
- (b) Use radiation particles to balance the following nuclear reactions [4 mks]

**Question 2 (20MKS)**

- (a) What is a metallic bond? Explain the nature of the metallic bond based on free electron theory, valence bond theory and molecular orbital theory. [10 mks]
- (b) Give the structures of $\text{Ni}(\text{CO})_4$, $\text{Mn}_2(\text{CO})_{10}$, $\text{Fe}_2(\text{CO})_9$ and $\text{Co}_2(\text{CO})_8$. [4 mks]
- (c) Explain why AuBrR_2 complexes are dimeric but $\text{AuBr}(\text{CN})$ complexes are tetrameric. [6 mks]

Question 3 (20 Marks)

- (a) Explain the structure, preparation and bonding in ferrocene. [6 mks]
- (b) What is 18 – electron rule? [2 mks]
- (c) Explain how molecular orbital theory explains the bonding and structure of metal carbonyls. [6 mks]

(d) State the magnetic property and hybridization of $\text{Ni}(\text{CO})_4$ [6 mks]

Question 4 (20Marks)

- (a) Metal – Ligand multiple bonding is a feature of the heavy metals. Give examples of the types of ligand and the characteristics of the metals involved [6 mks]
- (b) Why are the oxo ligands 'cis' in the Molybdenum complex $\text{MoO}_2(\text{Ph}_3\text{PO})_2\text{Cl}_2$ but 'trans' for the uranium complex $\text{UO}_2(\text{Ph}_3\text{PO})_2\text{Cl}_2$? Explain why U-O bond lengths are about the same length as the Mo-O bond lengths [8 mks]
- (c) Explain why AuBrR_2 complexes are dimeric but $\text{AuBr}_2(\text{CN})$ complexes are tetrameric (6)

Question 5 (20 Marks)

- (a) Using atleast four examples, discuss the extent to which the lanthanides are chemically similar to s block elements [4 mks]
- (b) (i) What is responsible for the colour of lanthanides? [1 mk]
(ii) What are the features of lanthanides that are colourless [1 mk]
(iii) Give examples of lanthanides colours and compare the colour with the properties that provide the colour [2 mks]
- (c) Write the electronic configurations of the following ions [3 mks]
(i) Ce^{3+}
(ii) Am^{3+}
(iii) Hence determine which series they belong to.
- (d) Highlight four similarities between lanthanides and actinides [4 mks]
- (e) Justify the position of Scandium and Lanthanides in the periodic table [2 mks]
- (f) State two similarities between Scandium and Lanthanides in the periodic table [4 mks]
- (g) Many lanthanide compounds are paramagnetic. Explain why only those of Gd^{3+} have magnetic moments that are predicted by the spin only formula [3 mks]