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KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

FOURTH YEAR FIRST SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF BSC (PHYSICS) AND B.ED (SCIENCE)

COURSE CODE: SCH 412

COURSE TITLE: THE STUDY OF THE LANTHANIDE AND ACTINIDE SERIES

DURATION: 2 HOURS

DATE: TUESDAY 19TH DECEMBER 2017 **TIME:** 11.30 AM – 1.30 PM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Question one has a total of **30 marks** whereas questions two to five is each **20 Marks**
- 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.

This paper consists of 3 printed pages. Please Turn Over



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QUESTION ONE (30 MARKS)

- a) Write electronic configuration of the following elements **(4 marks)**
- Praseodymium (Pr, $z = 59$)
 - Thulium (Tm, $z = 69$)
- b)
- Explain lanthanide contraction and describe how this phenomenon influences the properties of lanthanides **(4 marks)**
 - Discuss the separation of lanthanides by ion-exchange method **(6 marks)**
- c) Compare chemical properties of lanthanides and actinides **(8 marks)**
- d) The alloy SmCo_5 forms a permanent magnet because both samarium and cobalt have unpaired electrons. With orbital diagram showing how many unpaired electrons are in Sm (given that $Z = 62$). **(8 marks)**

QUESTION TWO (20 MARKS)

- a) Explain why lanthanides and actinides do have similar physical and chemical properties **(2 marks)**
- b) Write chemical equations for the reduction of UO_3 by both hydrogen and carbon monoxide. **(4 marks)**
- c) The table below contain information of Ionization energies of the actinides in kJ/mol. Study it and answer the questions that follow.

ELEMENT	I_1	I_2	I_3	I_4
Ac	499	1170	1900	4700
Th	587	1110	1978	2780
Pa	568	1128		2991
U	584	1420	1900	3145
Np	597	1128	1997	3242
Pu	585	1128	2084	3338
Am	578	1158	2132	3493
Cm	581	1196	2026	3550
Bk	601	1186	2152	3434
Cf	608	1206	2267	3599
Es	630	1216	2334	3734
Fm	627	1225	2363	3792
Md	635	1235	2470	3840
No	642	1254	2643	3956
Lr	444	1428	2228	4910

Justify the following observations **(8 marks)**

- The 1st ionization energy values of Ac, Cm and Lr are lower than expected

- ii. Generally, 3rd ionization energy value for every element is slightly low than expected
 - iii. The 1st ionization energy value is less than 4th ionization energy for all elements
 - iv. The 4th ionization energy value of Lr slightly high than expected
- d) Explain the role of the following substances in the extraction of Lanthanides on large scale **(6 marks)**
- i. Acidic method using H₂SO₄
 - ii. Alkaline method using NaOH
 - iii. Hydrochloric acid

QUESTION THREE (20 MARKS)

- a) Explain why Sm²⁺, Eu²⁺, and Yb²⁺ ions in aqueous solution are good reducing agents but an aqueous solution of Ce⁴⁺ is a good oxidizing agent. **(4 marks)**
- b) State four commercial uses of lanthanides **(4 marks)**
- c) With aid of diagrams explain how plutonium and uranium are separated from fission products **(12 marks)**

QUESTION FOUR (20 MARKS)

With chemical equation, explain five chemical properties of lanthanides **(20 marks)**

QUESTION FIVE (20 MARKS)

- a) With chemical equations, explain four chemical properties of Actinide elements **(16 marks)**
- b) In each case, state a method applied to actinide elements on large scale **(2 marks)**
 - i. Extraction of actinide elements
 - ii. Separation of actinide elements
- c) Explain the meaning of Actinide contraction **(2 marks)**