



**MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**(MMUST)**

**Main CAMPUS**

**UNIVERSITY EXAMINATIONS**

**2022/2023 ACADEMIC YEAR**

**Semester II**

**THIRD YEAR MAIN EXAMINATION**

**(BSC Chemistry)**

**FOR THE DEGREE**

**OF**

**BACHELOR OF SCIENCE IN CHEMISTRY**

**COURSE CODE: SCH 311**

**COURSE TITLE: Chemistry of Lanthanides and Actinides**

**DATE: 19/4/2023**

**TIME: 12.00 - 2.00 PM**

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**INSTRUCTIONS TO CANDIDATES**

Answer all the Questions

Find the attached periodic table

**TIME: 2 HOURS**

MMUST observes ZERO tolerance to examination cheating

### Question One (20 Marks)

1. (a) Using the provided electronic configurations of the lanthanides and actinides, **explain** why supposed and the observed electronic configurations are the same or they are different. (8 marks)

- i. Samarium (Sm) supposed is  $[\text{Xe}]_{54}4f^5 5d^1 6s^2$  and observed is  $[\text{Xe}]_{54}4f^6 6s^2$
- ii. Gadolinium (Gd) supposed is  $[\text{Xe}]_{54}4f^7 5d^1 6s^2$  and observed is  $[\text{Xe}]_{54}4f^7 5d^1 6s^2$
- iii. Ytterbium (Yb)  $[\text{Xe}]_{54}4f^{13} 5d^1 6s^2$  and observed is  $[\text{Xe}]_{54}4f^{14} 6s^2$
- iv. Actinium (Ac) supposed is  $[\text{Xe}]_{54}f^0 6d^1 7s^2$  and observed is  $[\text{Xe}]_{54}f^1 6d^0 7s^2$

(b) Why are lanthanides so poor in forming complex molecules or ions? (3 marks)

(c) State and explain the properties of lanthanides that depends on standard reduction potential values ( $E^\circ$ ) (9 Marks)

- i. Reducing properties
- ii. Electro-positive character
- iii. Liberation of  $\text{H}_2$  From water

### Question two (18 marks)

1. a. Complete the following Actinides reactions by filling in the products depicted by *a, b, c, d, e, f* and *g* as observed in the actinides. (7 Marks)

- i.  $\text{Ac}(\text{OH})_3 + 3\text{HF} + 700^\circ\text{C} \rightarrow a + b$
- ii.  $\text{Ac}_2\text{O}_3 + 6\text{NH}_4\text{Cl} + 250^\circ\text{C} \rightarrow c + 6\text{NH}_3 + d$
- iii.  $\text{Ac}_2\text{O}_3 + 2\text{AlBr}_3 + 750^\circ\text{C} \rightarrow e + f$
- iv.  $\text{Th} + 2\text{I}_2 + 400^\circ\text{C} \rightarrow g$

b. Answer the following questions regarding the properties of Lanthanides

- i. Complete the following equation by filling in the products depicted by A and B that shows this property



- ii. Explain what happens when Lanthanides are exposed to air. (2 Marks)

- iii. Complete the following equation that explains the lanthanide hydrides reaction



- iv. Complete the following reaction (2 Marks)

c. Indicate which of the following is true or false? (3 marks)

- i. Lanthanides are comparable to alkaline earth metals in reactivity.
- ii. Lanthanides tarnish upon exposure to air.
- iii. The +3 oxidation state is commonly seen among lanthanides.

**Question Three (18 Marks)**

3. Multiple Choice questions: Choose the correct answer by indicating if it is a, b, c or d

i. Which property of actinoids cannot be explained?

- a) Radioactive
- b) Oxidation
- c) Magnetic
- d) Acidic

ii. Which is the most stable oxidation state of actinoids?

- a) +2
- b) +3
- c) +4
- d) +5

iii. Actinoids are mostly attacked by which acid?

- a) Hydrochloric acid
- b) Nitric acid
- c) Sulphuric acid
- d) Boric acid

iv. Which of the actinoids is used in the treatment of cancer?

- a) Plutonium
- b) Uranium
- c) Curium
- d) Thorium

v. Which of the actinoids is used as a nuclear fuel?

- a) Actinium
- b) Thorium
- c) Uranium
- d) Californium

vi. Which isotope of plutonium is used in nuclear bombs?

- a) P-238
- b) P-239
- c) P-240
- d) P-241

vii. Choose the correct statement.

- a) Both actinoids and lanthanoids are less basic
- b) Both actinoids and lanthanoids do not show same oxidation of +3
- c) Both actinoids and lanthanoids do not exhibit magnetic and spectral properties
- d) Both actinoids and lanthanoids are electropositive

viii. The element  $Lr^{3+}$  is

- a) Paramagnetic
- b) Diamagnetic
- c) Ferrimagnetic
- d) None of these

ix.  $\text{Th}^{4+}$  ion is of

- a) yellow colour
- b) red colour
- c) colourless
- d) pink colour

x. The most important oxidation state of Thorium is

- a) +4
- b) +2
- c) +5
- d) +6

(b). Explain the following general characteristics of Actinides:

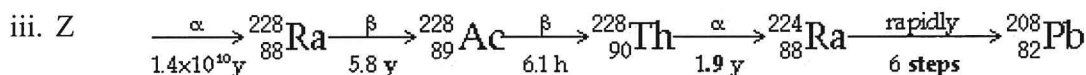
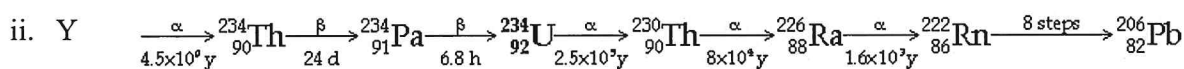
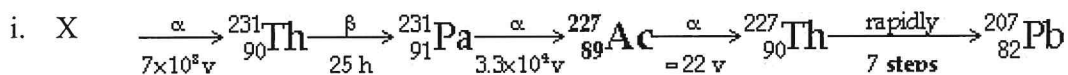
- i. Ionic radius (4 marks)
- ii. Complex formation. (4 marks)

**Question four (14 marks)**

4. a. Discuss Four Major Applications of lanthanides (4 marks)

b. Mention two major uses of any actinides. Mention the actinide or the compound of interest. (4 marks)

c. Which elements X, Y and Z are the parent elements that started the following decay series?, (6 Marks)



hydrogen 1 H 1.0079	beryllium 4 Be 9.0122	scandium 21 Sc 44.956	yttrium 39 Y 88.906	lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04	helium 2 He 4.0026									
lithium 3 Li 6.941	sodium 11 Na 22.990	potassium 19 K 39.098	rubidium 37 Rb 85.468	cesium 55 Cs 132.91	francium 87 Fr [223]	beryllium 4 Be 9.0122	calcium 20 Ca 40.078	strontium 38 Sr 87.62	barium 56 Ba 137.33	radium 88 Ra [226]	scandium 21 Sc 44.956	yttrium 39 Y 88.906	lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04	helium 2 He 4.0026
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actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]
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