



# MASINDE MULIRO UNIVERSITY OFSCIENCE 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

#### 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  $[Xe]_{54}4f^5$  5d<sup>1</sup> 6s<sup>2</sup> and observed is  $[Xe]_{54}4f^6$  6s<sup>2</sup>
  - ii. Gadolinium (Gd) supposed is [Xe] $_{54}4f^7$  5d $^1$  6s $^2$  and observed is [Xe] $_{54}4f^7$  5d $^1$  6s $^2$
  - iii. Ytterbium (Yb) [Xe] $_{54}4f^{13}$   $5d^1$   $6s^2$  and observed is [Xe] $_{54}4f^{14}$   $6s^2$
  - iv. Actinium (Ac) supposed is  $[Xe]_{54}f^0$  6d<sup>1</sup> 7s<sup>2</sup> and observed is  $[Xe]_{54}f^1$  6d<sup>0</sup> 7s<sup>2</sup>
- (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°) (9 Marks)
  - i. Reducing properties
  - ii. Electro-positive character
  - iii. Liberation of H<sub>2</sub> 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.  $Ac(OH)_3 + 3HF + 700^{\circ}C \rightarrow a + b$
  - ii.  $Ac_2O_3 + 6NH_4C1 + 250^{\circ}C \rightarrow c + 6NH_3 + d$
  - iii.  $Ac2O_3 + 2AlBr_3 + 750^{\circ}C \rightarrow e + f$
  - iv. Th +  $2I_2 + 400$ °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

$$2Ln(s) + 6H2O(l) \rightarrow A(aq) + B(g)$$
 (2 Marks)

- ii. Explain what happens when Lanthanides are exposed to air. (2 Marks)
- iii. Complete the following equation that explains the lanthanide hydrides reaction

with water.  $CeH_2 + 2H_2O \rightarrow A + B$ 

(2 Marks)

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 Lr3+ is

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

ix. Th4+ 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)

$$i. \quad X \qquad \xrightarrow[7\times10^{8}v]{\alpha} \xrightarrow{231} Th \xrightarrow[90]{\beta} \xrightarrow{231} Pa \xrightarrow[90]{\alpha} \xrightarrow[82]{\alpha} \xrightarrow{227} Ac \xrightarrow[90]{\alpha} \xrightarrow{227} Pb \xrightarrow{rapidly} \xrightarrow{7 \text{ steps}} \xrightarrow{207} Pb$$

$$ii. \quad Y \qquad \xrightarrow{\frac{\alpha}{4.5\times10^9y}} \overset{234}{\overset{90}{}} Th \xrightarrow{\frac{\beta}{24\text{ d}}} \overset{234}{\overset{91}{}} Pa \xrightarrow{\frac{\beta}{6.8\text{ h}}} \overset{234}{\overset{92}{}} U \xrightarrow{\frac{\alpha}{2.5\times10^9y}} \overset{230}{\overset{90}{}} Th \xrightarrow{\frac{\alpha}{8\times10^9y}} \overset{226}{\overset{226}{}} Ra \xrightarrow{\frac{\alpha}{1.6\times10^9y}} \overset{222}{\overset{86}{}} Rn \xrightarrow{\frac{8\text{ steps}}{82}} \overset{206}{\overset{20}{}} Pb$$

iii. Z 
$$\xrightarrow{\alpha} {}^{228}_{88} Ra \xrightarrow{\beta} {}^{228}_{89} Ac \xrightarrow{\beta} {}^{228}_{90} Th \xrightarrow{\alpha} {}^{224}_{88} Ra \xrightarrow{rapidly} {}^{208}_{82} Pb$$

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	238.03	$\subset$	92	uranium	144.24	Z 0	60	neodymium
	[237]	Z	93	neplunium	[145]	Pm	61	promothirm
	[244]	Pu	94	plutonium	150.36	Sm	62	minemas
л	[243]	Am	95	americium	151.96		63	autonium
	[247]	Cm	96	curium	157.25	Gd	64	and dining
	[247]	BK	97	berkelium	158.93	占	65	1
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Pa 231.04

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[277]	duU uub	ununbium 112	200.59	I O	mercury 80	112,41	Cd	48	65.39	7	1 <sub>30</sub>	zinc							:			i
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