

CHUKA



UNIVERSITY

## UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE  
OF BACHELOR OF SCIENCE

## CHEM 417: RADIATION AND NUCLEAR CHEMISTRY

STREAMS: BSC (CHEM)

TIME: 2 HOURS

DAY/DATE: MONDAY 08/4/2019

11.30 A.M. – 1.30 P.M.

INSTRUCTIONS: Answer question ONE and any other TWO questions

## QUESTION ONE (30 MARKS)

- (a) Define the following terms [3 marks]
- Isobars
  - Isotones
  - Exoergic
  - Endoergic
  - Ionizing radiation
  - Radioactive decay

- (b) Calculate the binding energy per nucleon of  ${}^1_1\text{H} = 1.0078$  amu and  ${}^4_2\text{He} = 4.0026$  amu and

$${}^1_0\text{n} = 1.0087, {}^4_2\text{He} = 4.0026 \text{ amu} \quad [4$$

marks]

- (c) Write the symbolic equation of the following radioactive decay

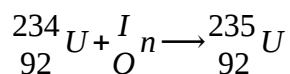
**CHEM 417**

- (i) Alpha decay [1 mark]
- (ii) Double beta decay [1.5 marks]
- (iii) Position decay [1.5 marks]
- (iv) Electron capture [1 mark]
- (d) Predict the method of decay and the decay products for the following nuclei
- (i)  ${}_{40}^{97}\text{Zr} \longrightarrow$
- (ii)  ${}_{54}^{118}\text{Xe} \longrightarrow$
- (iii)  ${}_{11}^{20}\text{Na} \longrightarrow$  [3 marks]
- (e) Explain why internal radiation sources are more dangerous than external ones [2 marks]
- (f) Briefly discuss radiation effects in cells [4 marks]
- (g) Give three measures that are recommended to keep radiation exposure to minimum [3 marks]

- (h) For the decay reaction  ${}_{92}^{238}\text{U} \longrightarrow {}_{90}^{234}\text{Th} + 4 {}_2^4\text{He}$
- Calculate the decay energy Q [3 marks]
- ${}_{92}^{238}\text{U} = 238.0508 \text{ amu}, 4 {}_2^4\text{He} = 4.0026 \text{ amu}, {}_{90}^{234}\text{Th} = 234.0436 \text{ amu}$
- (i) Give four nuclear reactions for an isotope that is off the belt of stability can use to be stable [2 marks]

**QUESTION TWO (20 MARKS)**

- (a) Calculate the binding energy of the last neutron in  ${}_{92}^{235}\text{U}$



$$\left( {}_{92}^{234}\text{U} = 234.04090 \text{ amu}, {}_0^1\text{n} = 1.00867 \text{ amu}, {}_{92}^{235}\text{U} = 235.04392 \text{ amu} \right) \quad [3 \text{ marks}]$$

## CHEM 417

- (b) Using equations give two conservation laws in radioactive decay [4 marks]
- (c) Balance the following nuclear reactions
- (i)  ${}_{94}^{239}\text{Pu} \longrightarrow {}_2^4\text{He} + A$
- (ii)  ${}_{77}^{192}\text{Ir} + B \longrightarrow {}_{76}^{92}\text{Os}$  [2 marks]
- (d) Discuss the interaction of radiation with
- (i) Metals [2 marks]
- (ii) Inorganic nonmetallic compounds [3 marks]
- (iii) Water [4 marks]
- (e) Differentiate between gamma radiation and x-rays [2 marks]

### QUESTION THREE (20 MARKS)

- (a) Draw a diagram showing the behaviour of radiation in a magnetic field [2 marks]
- (b) Differentiate between irradiation of aqueous solutions at concentrations  $\leq 0.1$  mol and aqueous solution greater than 0.1 mol/L
- (c) Briefly discuss the following dosimeters
- (i) Condenser ion chamber [2 marks]
- (ii) Chemical dosimeters [2 marks]
- (iii) Photographic emulsions [2 marks]
- (d) Give three criteria which must be fulfilled in radiation processes [3 marks]
- (e) Briefly discuss the application of radiochemistry in
- (i) Ecological studies
- (ii) Life sciences
- (iii) Physiological and metabolic studies [6 marks]

### QUESTION FOUR (20 MARKS)

- (a) Discuss the following nuclear radiation detectors
- (i) Gas filled detectors
- (ii) Proportional counters

**CHEM 417**

- (iii) Gelger-muller counters [6 marks]
- (b) Discuss the radiochemical laboratories type A, type B and C according to the International Atomic Energy Agency (IAEA) [6 marks]
- (c) Write short notes on
- (i) Single Proton Emission Tomography (SPET)
- (ii) Positron Emission Tomography (PEF)
- (d) Give two applications of radiation in industrial radiation processing [2 marks]
-