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]

(i) Isobars

(ii) Isotones

(iii) Exoergic

(iv) Endoergic

(v) Ionizing radiation

(vi) Radioactive decay

(b) Calculate the binding energy per nucleon of $_{1}^{1}H = 1.0078$ amu and $_{2}^{4}He$

$_{0}^{1}n = 1.0087, _{2}^{4}He = 4.0026$ [4 marks]

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

(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) $^{97}_{40}Zr \longrightarrow$

(ii) $^{118}_{54}Xe \longrightarrow$

(iii) $^{20}_{11}Na \longrightarrow$ [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 $238_{\mu} \longrightarrow 234_{He} + 4\,H_e$

Calculate the decay energy Q [3 marks]

^{238}U ¿238.0508, $4\,H_e = 4.0026$ ^{234}Th=234.0436 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 ^{235}u

$$^{234}_{92}U + ^{I}_{O}n \longrightarrow ^{235}_{92}U$$

$$\left(^{234}_{92}U = 234.04090\,amu\ ^{I}_{o}n = 1.00867,\ ^{235}_{92}U = 253.04392\,amu\right)$$ [3 marks]

(b) Using equations give two conservation laws in radioactive decay [4 marks]

(c) Balance the following nuclear reactions

(i) $^{239}_{94}Pu \longrightarrow ^{4}_{2}He + A$

(ii) $^{192}_{77}Ir + B \longrightarrow ^{92}_{76}O_s$ [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 ¿0.1 mol and aqueous solution greater than 0.1 molL

(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 discus 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

(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]
