UNIVERSITY EXAMINATIONS
2022/2023 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER
SPECIAL/SUPLIMENTARY EXAMINATIONS

FOR THE DEGREE OF B.Sc. (Chemistry) and BEE

COURSE CODE: SCH 322

COURSE TITLE: NUCLEAR AND RADIATION CHEMISTRY

DURATION: 2 HOURS

DATE:9/8/2023 **TIME:** 11:00-1:00PM

INSTRUCTIONS TO CANDIDATES

- Answer **all** Questions.
- 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.

QUESTION ONE (30 MARKS)

(a) Define the following terminologies **(5marks)**

i. Radioactivity
ii. Supercritical mass
iii. Isotopes
iv. Nuclide
v. Half life

(b) Differentiate between the isotopic mass and atomic mass **(2 marks)**

(c) i) Alpha(α), beta (β) and gamma (γ) rays differ from each other in nature and properties. State the three chief properties **(3marks)**

(d) State and explain two artificial sources of radioactive radiations **(4 marks)**

(k) Distinguish between nuclear fission and nuclear fusion giving one example for each **(4 marks)**

(e) The stability of a nucleus seems to depend on the neutron-to-proton ratio (n/p) in the nucleus. Explain **(3 marks)**

(f) Using Einstein equation; $E = MC^2$, determine the energy released in the following reaction in kcal **(4 marks)**

$^{7}_{3}Li + {}^{1}_{1}H \rightarrow {}^{4}_{2}He + {}^{4}_{2}He + energy$

7.16g 1.0078g 4.0026 4.0026g

(g) (i) Define binding energy **(1 marks)**

ii) What is the binding energy for $^{11}_{5}B$ nucleus if its mass defect is 0.08181 amu ?. **(4 marks)**

QUESTION TWO (20 MARKS)

(a) Discuss some of the practical application of nuclear chemistry in

i. Analytical applications and give an example **(3marks)**
ii. Industrial exploration of oil leaks **(3marks)**
iii. Radio Carbon dating **(3marks)**
iv. Agriculture and give an example **(3 marks)**

(b) The radionuclide 210Po decay by alpha emission to daughter nuclide. The atomic mass of 210Po is 209.982 amu and that of a daughter is 205.9745 amu and He = 4.00260amu

(i) Identify the daughter **(2 mark)**

(ii) Calculate the total energy release per disintegration in erg/mol. **(4 marks)**

(c) Define mass defect **(2 marks)**

QUESTION THREE (20 MARKS)

(a) State any three differences between nuclear reaction and chemical reaction **(6 marks)**

(b)i Briefly discuss scintillation counter as a method of detecting radioactive radiation **(5 marks)**

ii Uranium, Thorium, Actinium and neptunium are radioactive decay series. For each series state its commencement and termination **(4 marks)**

c) Tritium (3H) decays by beta emission to (3He) with a half- life of 12.26 years. A sample of a tritiated compound has an initial activity of 0.833Bq. Calculate the decay constant K and activity after 2.50 years. **(5 marks)**

QUESTION FOUR (20 MARKS)

(a) Distinguish between isotopes and isotones by giving an example for each **(4 marks)**
(b) What is meant by bremsstrahlung radiation **(2 marks)**
(c) An irradiated sample of gold gave the following results

Time/min	0	1	8	10	25	50	75	100
Counter/min	300	296	285	270	228	175	133	103

i). Draw the graph of counter per minute against time in minutes **(5marks)**
ii). Determine the half-life of the isotope of gold **(3 Marks)**
iii) At what time will the activity of the sample be 210c/m **(2marks)**
(e) Differentiate between the following mean life and half-life **(2 marks)**
(f)Determine the decay constant for carbon 14, if it has a half-life of 5730 years **(2 marks)**

QUESTION FIVE (20 MARKS)
(a) The activity of 1.0 g of carbon from the wood of a recently felled tree is 0.26 Bq. If the activity of 1 g of carbon isolated from the wood of an Egyptian mummy case is 0.16 Bq under the same conditions, estimate the age of the mummy case. (^{14}C: t½ =5730 yr.) **(5 marks)**
(b) Briefly describe the use of tracer in oil leak exploration **(5 marks)**
(c) Cobalt–60 decays by emission of a beta particle. Predict the atomic number, mass number, and name of the isotope formed **(3marks)**
(d) Use the following equation to answer the questions that follows

$$^{7}_{3}Li + {}^{1}_{1}H \rightarrow {}^{4}_{2}He + {}^{4}_{2}He + energy$$

(i) What type of nuclear reaction is represented by this reaction **(1 mark)**
(ii) Calculate the amount of energy released during this reaction if (Li= 7.160g, H= 1.0078g, He= 4.0026g, 1 erg = 2.39×10^{-11} kcal) in kcal **(3marks)**
(e) Calculate the binding energy per nucleon (in Mev) in He atom $^{4}_{2}He$which has a mass of 4.00260 amu. Mass of an neutron = 1.008655 amu and mass of 1 hydrogen atom = 1.007825 mass (1amu= 931.5MeV) **(3 marks)**