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**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

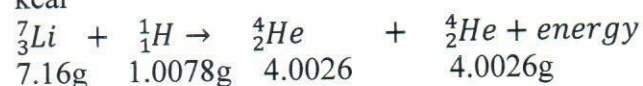
(b) Differentiate between the isotopic mass and atomic mass

(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)**

(g) (i) Define binding energy

(1 marks)ii) What is the binding energy for ${}^{11}_5\text{B}$ 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
- ii. Industrial exploration of oil leaks
- iii. Radio Carbon dating
- iv. Agriculture and give an example

(3marks)**(3marks)****(3marks)****(3 marks)**(b) The radionuclide ${}^{210}\text{Po}$ decay by alpha emission to daughter nuclide. The atomic mass of ${}^{210}\text{Po}$ is 209.982 amu and that of a daughter is 205.9745 amu and $\text{He} = 4.00260\text{amu}$

(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 (${}^3\text{H}$) decays by beta emission to (${}^3\text{He}$) 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)**

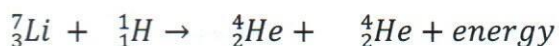
- (a) Distinguish between isotopes and isotones by giving an example for each **(4 marks)**
 (b) What is meant by bremsstrahlung radiation **(2 marks)**
 (c) An irradiated sample of gold gave the following results

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 : $t_{1/2} = 5730$ 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



- (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 ${}^4_2\text{He}$ which has a mass of 4.00260 amu. Mass of a neutron = 1.008655 amu and mass of 1 hydrogen atom = 1.007825 mass (1amu= 931.5MeV) **(3 marks)**