NATIONAL OPEN UNIVERSITY OF NIGERIA
14-16 AHMADU BELLO WAY, VICTORIA ISLAND LAGOS
SCHOOL OF SCIENCE AND TECHNOLOGY
MARCH/APRIL 2015 EXAMINATION

COURSE CODE: **PHY 402**
COURSE TITLE: **Nuclear Physics**
TIME: **3 Hours**

INSTRUCTION: Answer question 1 and any other four questions.
PHYSICAL CONSTANTS:

Speed of light $c = 2.9979 ms^{-1}$; mass of electro $m_e = 0.9110 \times 10^{-31} kg$; Electronic charge $e = 1.6022 \times 10^{-19} C$; Avogadro's number $N_A = 6.0221 \times 10^{26} kmol^{-1}$; Boltzmann constant $k = 1.3806 \times 10^{-23} J K^{-1}$; Plank's constant $h = 6.6257 \times 10^{-34} Js$; $\mu_0 = 4\pi \times 10^{-7} Henry/m$.

1. (a)(i) List **FOUR** models of the nucleus **4 marks**
(ii) Write down the Weizacker's semi-empirical formula for nuclear binding energy and explain each of the terms **4 marks**
(b)(i) Using Weizacker's semi-empirical formula, calculate the atomic number of the most stable nucleus for a given odd mass number A.
6 marks

2. (a)(i) Define the terms Excess mass and Packing fraction. **4 marks**
(ii) Distinguish between binding energy and separation energy **4 marks**
(b)(i) Calculate the uncertainty in the momentum of an electron confined within the nucleus and demonstrate that electrons are not constituent particles of the nucleus. **4 marks**
(ii) In tabular form compare the properties of the nucleus with those of the liquid drop **3 marks**

3. (a)(i) Write down the simple relationship among the nuclear radius R, the radius of the nucleon r_0, and the number of nucleon number A.
4 marks
(ii) Determine the radius of $^{16}_{8}O$ Take $r_o = 1.4$ fm **2 marks**
(b) (i) What are **isotones**? **2 mark**
(ii) A nucleus with mass number A = 235 splits into two nuclei whose mass numbers are in the ratio of 2:1. Find the radii of the nuclei.
6 marks

4. (a) (i) What are radioactive series? **2 marks**

(ii) Mention four radioisotopes that are useful for geological age dating **4 marks**

(b)(i) Write down the general equation of the decay of a radioisotope X, yielding another radioisotope Y, alpha particle α, gamma radiation γ, and energy Q.

2 marks

(ii) A carbon specimen found in a cave contained $\frac{1}{8}$ as much $^{14}_{6}C$ as an equal amount of carbon in living matter. Calculate the approximate age of the specimen. The half-life period of $^{14}_{6}C$ is 5568 years. **6 marks**

5. (a) Obtain a formula for calculating the *half-life* of a radioactive substance. **6 marks**
of a radioactive substance

(b) (i) Define the mean-life of a radioactive element. **4 marks**

(ii) Show that the mean life $\overline{T}=\frac{1}{\lambda}$ where λ is the decay constant. **4 marks**

6 (a) (i) Show that $^{236}_{94}Pu$ is unstable against α-decay. **4 marks**

(The masses of Pu, Uranium and alpha-particles are respectively $236.046071\,u$, $232.037168\,u$ and $4.002603\,u$ in atomic mass units, u).

(ii) List the conditions necessary for an α-decay to occur. **4 marks**

(b) (i) What is meant by the range of an α-particle? **3 marks**

(ii) Write down the general equation representing $\beta^{+¿¿}$ decay of a nuclide **3 marks**

7. (a) (i)What do you understand by the term “specific ionization”? **4 marks**

(ii) Write the equation relating the specific ionization and the velocity of heavy particles.

4 marks

(b) (i) Describe one of the ways by which energy is lost when an electron interact with matter.

4 marks

(ii)What is nuclear isomerism? **2 marks**