NATIONAL OPEN UNIVERSITY OF NIGERIA
14-16 AHMADU BELLO WAY, VICTORIA ISLAND, LAGOS
SCHOOL OF SCIENCE AND TECHNOLOGY
JANUARY/FEBRUARY 2013 EXAMINATION

PHYSICS UNIT
FIRST SEMESTER 2013 EXAMINATION
COURSE CODE: PHY 402
COURSE TITLE: Nuclear Physics
CREDIT UNIT: 3
INSTTRUCTION: Answer any five questions.
TIME: 3 Hours
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) Briefly, explain the nature of nucleon forces.**5 marks**

(b) Calculate the uncertainty in the momentum of an electron confined within the nucleus and demonstrate that electrons are not constituent particles of the nucleus.**8 marks**

(c) If an electron is confined within a nucleus whose diameter is $10^{-14} m$, estimate its minimum kinetic energy.**7 marks**

2. (a) Define the terms *excess mass* and *parking fraction.***6 marks**

(b) Define the terms *nuclear binding energy* and *separation energy*.**6 marks**

(c) Calculate the binding energy of $^{126}_{52}Te$.

You may use the following data: Rest masses of proton is $1.67252 \times 10^{-27} kg$ or $1.007277\, u$, neutron is $1.67482 \times 10^{-27} kg$ or$1.008665\, u$.**8 marks**

3. (a) Mention five (5) nuclear models proposed to explain nuclear binding forces.**5 marks**

(b) Discuss the similarities between the nucleus and the liquid drop and explain what you understand by ‘’binding energy’’
7 marks

(c) Write down the Weizacker semi-empirical nuclear binding energy formula and explain each of the terms, hence calculate the atomic number of the most stable nucleus for a given mass number A.

8 marks

4. (a) Considering the reaction $A \rightarrow B \rightarrow C$ (stable), show that

$$N_B = \frac{N_0 \lambda_A}{\lambda_B - \lambda_B}\left[e^{-\lambda_A t} - e^{-\lambda_B t}\right]$$

where the symbols have their usual meaning as appropriate.**8 marks**

(b) From (a), discuss the case of ideal equilibrium and sketch,on the same set of axes,the curves of the activity versustime for the parent and the daughter nuclides A and B respectively.**6 marks**

(c) From (a), show that for the case of transient equilibrium whereby the daughter nuclide is shorter lived than the parent nuclide,

$\frac{\lambda_B N_B}{\lambda_A N_A} = \frac{T_A}{T_A - T_B}$provided the time t is large.**6 marks**

5. (a) What are radioactive series? List the four known radioactive series. **6 marks**

(b) Briefly explain Branching in radioactive decay**7 marks**

(c) Explain, with the relevant mathematical derivations, age determination using radioisotopes.

7 marks

6 (a) What is meant by the range of an α-particle?**7 marks**

(b) Briefly explain the α decay paradox.**6 marks**

(c) Explain the processes involved in a γ decay scheme of a nuclide.**7 marks**

7. (a) What do you understand by the term “specific ionization”? Write the equation relating the specific ionization and the velocity of heavy particles.**8 marks**

(b) Describe one of the ways by which energy is lost when an electron interacts with matter.**6 marks**

(c) Distinguish between Compton effect and pair production. **6 marks**