



**NATIONAL OPEN UNIVERSITY OF NIGERIA**  
**PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA**  
**FACULTY OF SCIENCES**  
**DEPARTMENT OF PHYSICS**  
**2025\_2 EXAMINATIONS**

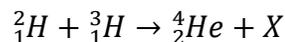
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**COURSE CODE:** PHY 456  
**COURSE TITLE:** NUCLEAR REACTOR PHYSICS  
**CREDIT UNIT:** 3  
**TIME ALLOWED:** 3 HRS  
**INSTRUCTION:** Answer question 1 and any other three questions

**CONSTANTS** (Planck's constant divide by  $2\pi$ ) =  $1.055 \times 10^{-34}$  Js  
=  $9.0 \times 10^9$  N.m<sup>2</sup>/C<sup>2</sup>  
Electron charge (e) =  $1.6 \times 10^{-19}$ C  
Electron mass =  $9.1 \times 10^{-31}$  kg  
Mass of Hydrogen = 1.007825 u  
Mass of neutron = 1.008665 u  
Boltzmann constant ( $k_B$ ) =  $1.381 \times 10^{-23}$  J/K  
Avogadro's Number ( $N_A$ ) =  $6.022 \times 10^{23}$  atoms/mole  
1 eV =  $1.6 \times 10^{-19}$  J  
1 u =  $1.66 \times 10^{-27}$  kg

**QUESTION 1**

- A. List five ways in which neutrons can interact with nuclei. (5 marks)
- B. What is a moderator? (2 marks)
- C. What is a nuclear reactor? (2 marks)
- D. What is meant by the following terms: nuclear power, nuclear energy and atomic energy? (7.5 marks)
- E. Consider the following nuclear fusion reaction that uses deuterium and tritium as fuel.



- (i). Complete the reaction equation. What is the name of the new particle released during the reaction? (2.5 mark)
- (ii). Determine the mass defect of a single reaction, given the following information.  
 ${}^2_1\text{H} = 2.0141 \text{ amu}$ ,  ${}^3_1\text{H} = 3.016049 \text{ amu}$ ,  ${}^4_2\text{H} = 4.0026 \text{ amu}$ ,  ${}_0^1\text{n} = 1.0087 \text{ amu}$  (3 marks)
- (iii). Determine the energy in joules released during a single fusion reaction. (3 marks)

**QUESTION 2**

A. What is a Cross Section in nuclear physics? (3 marks)

B. Show that macroscopic collision density  $F$  is given by (12 marks)

QUESTION 3

A. Define neutron moderation, hence list two examples of good moderators. (4.5 marks)

B. With the aid of a suitable diagram, explain two frames of reference considered for neutron thermalization. (6 marks)

C. List any 3 parts of a nuclear reactor? (4.5 marks)

QUESTION 4

A. List two types of frames of references considered for neutron moderation. (5 marks)

B. Show that fractional energy,  $\frac{E_1}{E_0} = \frac{[1+A^2+2ACos\theta]}{[1+A]^2}$  (10 marks)

QUESTION 5

A. What is meant by a reactor poison? (2 marks)

B. Calculate the power density of a typical PWR reactor such as Koeberg Unit 1 (4 marks)

C. Explain how the temperature coefficient of reactivity is largely determined by the resonances in  $^{238}\text{U}$ . (3 marks)

D. List the main component in nuclear reactor (6 marks)

QUESTION 6

A. List and discuss any four component of Nuclear Reactor (8 marks)

B. Enumerate and discuss any three type of Nuclear reactor (4.5 marks)

C. What is the medium utilization factor? (2.5 marks)