



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

COURSE CODE: PHY309
COURSE TITLE: QUANTUM MECHANICS I
CREDIT UNIT: 3
TIME ALLOWED: (3 HRS)
INSTRUCTION: *Answer question 1 and any other three questions*

- 1a.** i Explain what you understand by scattering state of a particle **4marks**
ii A particle of energy 4 eV approaches a potential step of height 2eV. Calculate the transmission and reflection coefficients. **6marks**
- 1b.** An electron and a photon each have a wavelength of 1.00 nm. Find
i. their momentum
ii. the energy of the photon, and
iii. the kinetic energy of the electron. **9marks**
- 1c.** Show that the following are vector spaces over the indicated field:
(i) The set of real numbers over the field of real numbers.
(ii) The set of complex numbers over the field of real numbers **6marks**
- 2a.** State Wien's displacement law and its limitation **5marks**
b. States four (4) limitations of Classical mechanics that lead to the introduction of quantum mechanics **4 marks**
c. Find the uncertainty in the position of an electron when the mass of an electron is 9.1×10^{-28} g and the uncertainty in velocity is equal to 2×10^{-3} cm/sec. **6marks**
- 3a.** What is the De Broglie hypothesis? and state its equation. **3marks**
b. A particle with energy 1eV encounters a potential barrier of height 2eV and width 0.5nm. What is the approximate probability of tunneling through the barrier? **7marks**
c. A beam of radiation of wavelength $\lambda = 2000 \text{ \AA}$ impinges on a metal. Calculate the kinetic energy K and the speed v of the photoelectrons **5marks**
- 4a.** Given the matrix $\begin{bmatrix} 2 & 1 \\ 5 & 1 \end{bmatrix}$, find the corresponding eigenvectors and eigenvalue **8marks**
b. For the Hermitian matrix 2a, show that the Eigen functions can be normalized and that they are orthogonal. **7marks**
- 5a.** Define Hermitian Matrices and Unitary Matrices **4marks**
b. Determine whether the vectors (5,-2,4), (2, -3, 5) and (4, 5, -7) are linearly dependent or independent. **11marks**
- 6a.** Define Photoelectric effect **3marks**
b. What is meant by a bound state? What are the necessary conditions for a particle to be in a bound state? **4 marks**
c. What key experiments revealed the inadequacies of classical mechanics? **8marks**