****

**NATIONAL OPEN UNIVERSITY OF NIGERIA**

**PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA**

**FACULTY OF SCIENCES**

**DEPARTMENT OF PURE AND APPLIED SCIENCE**

**APRIL/MAY, 2019 EXAMINATIONS**

**COURSE CODE: PHY 309**

**COURSE TITLE: QUANTUM MECHANICS 1**

**CREDIT UNIT 3**

**TIME ALLOWED (2½ HRS)**

**INSTRUCTION: *Answer question 1 and any other four questions***

**QUESTION 1**

a) Define the term vector space (2 marks)

b) List the properties of the inner product of a vector space . (6 marks)

c) (i) Determine if the function is even or odd (2.5 marks)

(ii) Express the function as a sum of odd and even

functions. (2.5 marks)

d) Find: (i) the change in wavelength if a proton is scattered at an angle of

after its collision with an electron initially at rest (2.5 marks)

(ii) the wavelength of the wave associated with an electron moving at .

(2.5 marks)

e) Discuss the following: Photoelectric effect (2 marks)

f) Compton effect (2 marks)

**QUESTION 2**

a Write the function *h*(*x*)  *e*2 *x* sin *x* as a sum of odd and even functions. (4 marks)

b Evaluate the following integrals

1. *aa x* 2*n*1*dx*, *n* 0,1, 2,.... (4 marks)
2. (ii) *aa**x*2*n**dx*,*n*0,1, 2,.... (4 marks)

**QUESTION 3**

a Find the maximum kinetic energy with which an electron is emitted from a metal of work function 3.2 1039 J when a radiation of energy *E* = 3.3131039 *J* falls on it, given that the work function is 3.2 1039 *J* . (5 marks)

b What value does Rayleigh-Jeans formula predict for the radiation of

frequency 6 1013 *Hz* emitted by a blackbody per unit time, per unit area at 2500 0K. Compare this value with that predicted by Planck. (4 marks)

c Discuss Compton effect (3 marks)

**QUESTION 4**

a) If the matrix is a proper orthogonal matrix, find . (4 marks)

b) Find the eigenvalues of the given matrices: (i) (4marks)

(ii) (4 marks)

**QUESTION 5**

Normalize the eigenfunction . Hence, find the probability that the particle subjected to harmonic oscillation lies in the range . (12 marks)

**QUESTION 6**

A quantum-mechanical oscillator of mass moves in one dimension such that its energy eigenstate with.

1. Find the mean position of the particle. (6 marks)
2. Find the mean momentum of the particle. (6 marks)