

## FIFTH SEMESTER B.Sc. DEGREE EXAMINATION, OCTOBER 2012

(CCSS)

Physics

PH5B10/AP5B12—QUANTUM MECHANICS

Three Hours

Maximum : 30 Weightage

## Section A

Answer all questions :

- 1 If the value of Compton wavelength is  $\lambda_c$ , the maximum Compton wavelength change is \_\_\_\_\_.
- 2 De Broglie waves always travel \_\_\_\_\_ than light.
  - (a) Faster.
  - (b) Slower.
  - (c) At the same speed.
- 3 Davisson and Germer experiment confirms \_\_\_\_\_.
  - (a) Particle behaviour of electrons.
  - (b) Wave behavior of electrons.
  - (c) Charge of electrons.
- 4 According to Rayleigh-Jeans formula for black body spectrum the energy density is proportional to:
  - (a) Frequency.
  - (b) Square of frequency.
  - (c) Cube of frequency.
- 5 The temperature of an object is \_\_\_\_\_ when it glows white than when it glows red.
  - (a) Lower.
  - (b) Lower in some cases.
  - (c) Higher.
- 6 Greater the work function of a metal, the \_\_\_\_\_ the critical frequency for photoelectric emission.
  - (a) Lower.
  - (b) Lower in some cases.
  - (c) Higher.
- 7 A photon falls through a certain height in gravitational field manifest the increase energy due the fall by increase in \_\_\_\_\_.
  - (a) Kinetic energy.
  - (b) Velocity.
  - (c) Frequency.

Turn over

- 8 If a photon materialises into an electron and a positron the process is called \_\_\_\_\_.
- 9 The significance of  $\hbar$  is that it represent basic unit of \_\_\_\_\_.
- 10 In momentum representation, wave function is a function of \_\_\_\_\_.
- (a) Momentum only. (b) Momentum components and time.  
(c) Coordinates and momentum.
- 11 Fine structure in spectral lines and anomalous Zeeman effect are explained on the basis of \_\_\_\_\_.
- (a) Electron spin. (b) Electron charge.  
(c) Electron energy.
- 12 Scanning tunneling microscope is to study \_\_\_\_\_.

(12 × ¼ = 3 weight)

## Section B

II. Short answer questions. Answer *all* questions.

- 13 Why X-ray production is known as inverse of photoelectric effect ?
- 14 What is Compton effect ? Explain its significance.
- 15 Why gravitational red shift is not apparent in the case of sun ?
- 16 Explain the pair production process.
- 17 Show that Bohr's condition for stability of electronic orbit is in agreement to the de Broglie matter wave concept.
- 18 What do you mean by a well behaved wave function ?
- 19 Derive an expression for expectation value of position using the fundamental average value concept.
- 20 Show that the spacing of energy levels of Harmonic oscillator is constant.
- 21 Derive Schrodinger equation of Hydrogen atom in spherical polar coordinate.

(9 × 1 = 9 weight)

## Section C

III. Short essay or paragraph questions. Answer any *five* questions.

- 22 Show that it is impossible for pair production to conserve both energy and momentum unless some other object is involved in the process to carry away part of photon momentum.
- 23 Will photoelectron be emitted by a metal surface of work function 4.4 eV when illuminated by visible light ?
- 24 What is the effect of gravity on photons ? Derive an expression for it.
- 25 Derive time independent Schrodinger equation in one dimension.



- 28 Explain the role magnetic quantum number in space quantisation.
- 29 What voltage must be applied to an electron microscope to produce electrons of wavelength 0.05 nm ? Given : mass of electron  $9.1 \times 10^{-31}$  kg, charge of electron =  $1.6 \times 10^{-19}$  C, Planks constant  $h = 6.62 \times 10^{-34}$  J.S.
- 30 List and comment on various quantum numbers associated with an atomic electron ?

(5 × 2 = 10 weightage)

### Section D

Essay questions. Answer any two questions.

- 29 Discuss the development of quantum mechanics from the limitations of classical mechanics.
- 30 Obtain the eigen values and normalized eigen functions and probability densities of a particle confined in a one dimensional rectangular box with infinitely hard walls.
- 31 Obtain Schrodinger equation in polar coordinates for a particle moving under a spherically symmetric potential and carryout separation of variables involved in it.

(2 × 4 = 8 weightage)