PHYSICS PAPER–C

(Quantum Physics–I)

Time Allowed : 3 Hours   Maximum Marks : 44

Note: (i)   Attempt five questions in all, selecting at least two questions each from Unit–I and Unit–II. Question No. 7 of Unit–III is compulsory.

(ii) Use of non-programmable calculator is allowed.

UNIT–I

1. (a) State and explain Ehrnefest's theorem on the motion of wave-packets.

   (b) Show that Hermitian operator has real eigen value.   6, 3

2. (a) Derive steady state (time-independent) Schrödinger's equation.

   (b) The kinetic energy of an electron is equal to the energy of a photon. Show that de-Broglie wavelength of this electron is less than the the wavelength associated with a photon.   6, 3

3. What is Compton effect ? Derive an expression for change in wavelength of scattered photon in Compton effect.   9

UNIT–II

4. (a) A particle moving with energy E along X-axis encounters a potential barrier defined by V,

   $$V = 0, \qquad \text{for } x < 0$$

   $$= V_0, \qquad \text{for } 0 < x < L$$

   $$= 0, \qquad \text{for } x > L$$

   Find expression only for reflection coefficient.

   (b) Define and illustrate degeneracy with reference to hydrogen atom wave function.   6, 3

5. (a) Discuss the probability density of electrons and shapes of hydrogen atom orbitals in ground state.

   (b) Prove that the linear momentum of a particle in infinite square well is normalized.   6, 3

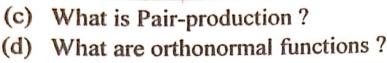6. What is harmonic oscillator ? Obtain an expression for its energy. Discuss its importance.   9

UNIT–III

(Compulsory Question)

7. Attempt any eight :   1 × 8 = 8

   (a) Why Compton effect is not observed with visible light ?

   (b) How does the K.E. of photoelectron vary with the frequency of light ?

(c) What is Pair-production ?

(d) What are orthonormal functions ?

(e) What are the conditions that a wave function must obey ?

(f) What is zero point energy of a harmonic oscillator ?

(g) Why is the principal quantum number so called ?

(h) How are spherical co-ordinates related to Cartesian coordinates ?

(i) How do the predictions of Bohr and Schrödinger treatments of hydrogen atom compare with regard to its total energy and its orbital angular momentum ?

(j) What do you understand by the meaning of expectation value of x?