Exam. Code : 103204
Subject Code : 1354

B.A./B.Sc. Semester—IV

PHYSICS (Quantum Mechanics)

Paper–A

Time Allowed—3 Hours] [Maximum Marks—35

Note :— The candidates are required to attempt **one** question each from Sections B, C, D and E. Section A consisting of **seven** short answer type questions is compulsory. All question carry equal marks.

SECTION–A

1. Attempt **all** parts :
   (i) The work function of aluminum is 4.2 eV. If two photons each of energy 2.5 eV strike an electron of aluminum will the emission of electron be possible ? Explain.
   (ii) How do matter waves differ from electromagnetic waves ?
   (iii) What does quantum number n (for a particle in a box problem) determine ?
   (iv) Define Hermitian operator.
   (v) What is Raman Effect ?
   (vi) In which region of the electromagnetic spectrum do the rotational spectra of molecules lie ?
   (vii) What is the range of r, θ and ϕ in spherical polar co-ordinates ? 7×1=7

SECTION–B

2. What is Compton Effect ? Derive an expression for Compton shift. Derive a relation between angle of scattering of photon and angle of recoil of electron in Compton Effect. 7

3. (a) By using uncertainty principle calculate the binding energy of an electron in hydrogen atom.
   (b) By using uncertainty principle calculate the minimum energy of a simple harmonic oscillator. 4+3

SECTION–C

4. State and prove Ehrenfest's theorem. 7

5. What do you understand by orthogonal wave functions ? Prove the orthogonality of energy Eigen functions for one dimensional case. 7

SECTION–D

6. A particle of mass m and energy $E < V_0$ travelling along x-axis has a potential barrier defined by : $V(x) = 0$ for $x < 0$, $V(x) = V_0$ for $0 \leq x \leq a$ and $V(x) = 0$ for $x > a$. Derive the expression for transmission coefficient of the particle. 7

7. (a) Solve $\Theta(\theta)$ equation for hydrogen atom.
   (b) Define degeneracy. Show that hydrogen has n^2 fold degeneracy for the nth state. 4+3

SECTION–E

8. Obtain an expression for energies of various vibrational levels of diatomic molecules and frequency of vibrational spectra. State clearly the selection rules. Show that in vibrational spectra the energy levels are equally spaced. 7

9. (a) Draw graphs of relative intensity of continuous spectra versus wavelengths of X-rays at different values of accelerating potential (V) of X-ray tube. Show that λ_{min} is inversely proportional to V.
   (b) Explain the production of characteristic X-ray spectra. Discuss the transitions of K and L series. 3+4