Exam. Code : 103204
Subject Code : 1387

B.A./B.Sc. 4th Semester

PHYSICS

Paper—A

(Quantum Mechanics)

Time Allowed—Three 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 questions carry equal marks.

SECTION—A

1. Attempt **ALL** parts :

   (i) Alkali metals are most suited for photoelectric effect. Why ?

   (ii) For n = 1, find the energy of an electron in a box of length 1Å.

   (iii) What is Auger electron ?

   (iv) What is the range of r, θ and ϕ in spherical polar co-ordinates ?

(v) Name the quantum numbers n and l with their permissible values.

(vi) What is Raman Effect ?

(vii) In which region of the electromagnetic spectrum do the vibrational spectra of molecules lie ?

7×1=7

SECTION—B

2. Define phase velocity and group velocity of a wave packet. Derive a relation between group velocity and phase velocity. Prove that the particle velocity is equal to the group velocity. 7

3. (a) State de-Broglie hypothesis of matter waves. Give characteristics of de-Broglie wave. Derive an expression for de-Broglie wavelength of matter particle in terms of kinetic energy and temperature.

(b) Derive a formula expressing de-Broglie wavelength (in Angstrom units) of an electron in terms of potential difference V (in volts) through which it is accelerated. 5+2=7

SECTION—C

4. Define Hermitian operator. Prove that (i) Hermitian operator has real Eigen value, (ii) product of two Hermitian operators is Hermitian if and only if these operators commute, (iii) two Eigen functions of Hermitian operator belonging to different Eigen values are orthogonal. 7

5. (a) Give expression for expectation value of position, momentum and energy in terms of corresponding operators.

   (b) The wave function is given by :

$$\psi(x) = C \sin\left(\frac{\pi x}{L}\right) \text{ for } 0 < x < L .$$

   Calculate the expectation value of x and p for the particle associated with the wave function.

3+4=7

SECTION—D

6. Using the Schrödinger's wave equation for a particle in one dimensional rectangular potential well of finite depth, derive transcendental equation. 7

7. Solve radial part [R(r)] of Schrödinger's equation of hydrogen atom obtaining its energy values. 7

SECTION—E

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

9. (a) Describe the construction and working of Coolidge tube. How can you control (i) the intensity and (ii) the quality of X-rays ?

   (b) How is the production of characteristic X-ray spectra accounted for ? Discuss the transition for K and L series. 3+4=7