B.Sc. Third Year (CBCS Pattern) Semester-VI

USDSEPHT16 - Physics Paper-III - Quantum Mechanics

P. Pages : 2 **GUG/S/25/13368**

Time : Three Hours * 1 7 3 3 * Max. Marks : 50

Notes : 1. All questions are compulsory.
2. Draw neat and well labelled diagrams wherever necessary.

Either:

1. A) i) Derive an expression for a free particle wave function. **4**

ii) Derive the normalization condition for a one-dimensional wave function. **6**

OR

B) a) Write and explain the time-independent Schrodinger equation. **2½**

b) Define and derive the expression for probability current in one dimension. **2½**

c) What are stationary states? What is their significance? **2½**

d) Derive the expression for expectation value of position. **2½**

Either:

2. A) i) Explain the significance of the zero-point energy in the quantum simple harmonic oscillator. Why does it exist? **5**

ii) A particle of mass (m) is confined in an infinitely deep square well of width (L). **5**
(a) Write down the normalized wave functions for the particle.
(b) Calculate the expectation value of the position for the ground statex.

OR

B) a) Explain the physical significance of the continuity of the wave function. **2½**

b) What are energy eigenfunctions? How are they related to the energy levels? **2½**

c) Sketch the wave function for the ground state and the first excited state of a particle in a finite square well potential. **2½**

d) Describe the conditions under which discrete energy levels arise when a particle is confined by a potential. **2½**

Either:

3. A) i) Derive the time-independent Schrödinger equation for hydrogen atom in spherical polar coordinates. **8**

ii) For 1=2, find all possible values of m. **2**

OR

B) a) Write down the general form of the radial and angular wave functions. **2½**

b) Derive the form of the angular part of the Schrödinger equation in spherical coordinates. **2½**

c) State the significance of quantum numbers n, l, m in atomic orbitals. **2½**

d) Calculate the magnitude of orbital angular momentum for 1 = 3. **2½**

Either:

4. A) i) Derive the expression for the Larmor frequency and discuss its physical interpretation in terms of the precession of the electron's magnetic moment. **6**

ii) Describe how the Lande (g)-factor accounts for the anomalous Zeeman effect. What is its value for a state with only orbital angular momentum ((s = 0))? **4**

OR

B) a) How does the magnetic field interact with the magnetic moment of an electron? **2½**

b) What selection rules govern the transitions between Zeeman sublevels? **2½**

c) Write a simple expression for the spin magnetic moment in terms of the spin angular momentum. **2½**

d) An electron has an orbital angular momentum quantum number (1=2). What are the possible orientations of its orbital angular momentum vector in space? **2½**

5. Attempt **any ten** questions from the following.(Each Carry 1 Mark)

a) Define normalization of a wave function. **1**

b) What is a stationary state? **1**

c) Write the time-dependent Schrodinger equation. **1**

d) What is a bound state in quantum mechanics? **1**

e) What is a square well potential? **1**

f) What is the ground state energy of a quantum SHO (qualitatively)? **1**

g) Define orbital angular momentum quantum number(1). **1**

h) Write the values of l for the p-subshell. **1**

i) What are the three quantum numbers used in hydrogen-like atoms? **1**

j) What is electron spin? **1**

k) What is the Zeeman effect? **1**

l) What is electron angular momentum? **1**

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