APRIL/MAY 2018

MPH13 — QUANTUM MECHANICS – I

Time : Three hours Maximum : 75 marks

SECTION A — (5 × 6 = 30 marks)

Answer ALL the questions.

1. (a) What are stationary states? Show that the probability current density is constant with respect to time in stationary states.

Or

(b) What is a Hermitian operator? Show that any two eigenfunctions of a Hermitian operator that belongs to different eigenvalues are orthogonal.

2. (a) Write the Schrödinger equation and solve it to find the eigenvalue of a one dimensional infinite square-well potential.

Or

(b) Evaluate the most probable distance of the electron of the hydrogen atom in its $2p$ state. What is the radial probability at that distance?

3. (a) Distinguish between coordinate and momentum representations. What are the operators for coordinate and momentum representations?

Or

(b) Show that the total energy of the system is conserved if the system is invariant under translation in time.

4. (a) Apply time-independent perturbation theory for non-degenerate energy levels and obtain first order correction to the energy and wavefunction.

Or

(b) What is WKB approximation? What do you understand by classical approximation and classical turning point?

5. (a) Show that the components of angular momentum are not measurable simultaneously.

Or

(b) From Pauli's matrices, prove that, $\sigma_x^2 + \sigma_y^2 + \sigma_z^2 = 1$.

SECTION B — ($3 \times 15 = 45$ marks)

Answer any THREE questions.

6. Outline the various postulates of quantum mechanics.

7. Obtain the energy eigenvalues and eigenfunctions of a simple harmonic oscillator.

8. Explain in detail about Schrödinger picture and Heisenberg picture.

9. Apply the variation method, for obtaining the ground state of helium atom.

10. State the eigenvalue-eigenvector relations for the operators J^2 and J_z. Hence, obtain the matrices for J^2 and J_z.

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