

KAMARAJ COLLEGE (Autonomous)

Accredited with A+ Grade by NAAC

(Affiliated to Manonmaniam Sundaranar University, Tirunelveli)

THOOTHUKUDI – 628 003

(6 Pages)

Reg. No:

Question Code No : 25003308

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PG Degree - End Semester Examinations, November 2025

Second Semester

M.Sc. PHYSICS

Quantum Mechanics - I

(For those who joined in July 2024 onwards)

Time : 3 Hours

Maximum : 75 Marks

PART – A (10 X 1 = 10 Marks)

Answer ALL Questions

Choose the correct answer:

1. In general, the solution of Schrodinger wave equation is
 - (a) Real
 - (b) Imaginary
 - (c) Complex
 - (d) All the above
2. What are the possible measured values of observable A called?
 - (a) Functions of A
 - (b) Eigenvalues of A

- (c) Eigenfunctions of A (d) Operators of A
3. In Schrodinger picture, the wavefunctions are time dependent and while _____ are time independent.
- (a) Operators (b) Wavefunctions
(c) Eigen values (d) Energy
4. If a system in a bound state has energy (E) and potential (V) then
- (a) $E < V$ (b) $E > V$
(c) $E = V$ (d) None of those
5. Which assumption is central to the rigid rotator model?
- (a) Distance between two mass is constant
(b) Molecule vibrates during rotation
(c) The system is relativistic
(d) Potential energy depends on orientation
6. When there is one to one correspondence between the wave function and energy, it is called
- (a) Degenerate state (b) Non degenerate state
(c) Symmetric potential (d) none
7. The splitting of energy levels of an atom by applying uniform external electric field is
- (a) Zeeman effect (b) Stark effect

- (c) Anomalous effect (d) Meissner effect
8. What is the degeneracy of the first excited state of hydrogen atom in stark effect?
- (a) One – fold (b) Two-fold
(c) Three-fold (d) Four-fold
9. Pauli spin matrices are_____ with each other.
- (a) Commute (b) Anti-commute
(c) Linear (d) None
10. The operators J_+ and J_- act as Ladder operators which respectively _____ the eigen values of angular moment operator J_z .
- (a) Lower and raise (b) Raise and lower
(c) Lower and lower (d) None

PART – B (5X5=25 Marks)

Answer ALL Questions choosing either (a) or (b).

Answer should not exceed 250 words.

11. (a) What is a wave packet? Give the physical significance of a well behaved wave function.

(OR)

- (b) Show that the eigen values of a Hermitian operators are real.

12. (a) Deduce the equation of motion using Heisenberg picture.

(OR)

- (b) Discuss the effect of time reversal in the time dependent Schrodinger equation.

13. (a) Analyze the square well potential barrier problem and its significance.

(OR)

- (b) Obtain the eigen value and eigen functions of the rigid rotator.

14. (a) Describe the first order stark effect in Hydrogen atom.

(OR)

- (b) Outline the connection formulas of WKB approximation method.

15. (a) Describe the spin angular momentum and show that how will you arrive at Pauli's spin matrices.

(OR)

- (b) State the commutation relations obeyed by the components of angular momentum and express them in vector notation.

PART – C (5 X 8 = 40 Marks)

Answer ALL Questions choosing either (a) or (b).

Answer should not exceed 600 words.

16. (a) Deduce the expression for Schrodinger time dependent wave equation for a matter wave in one dimension.

(OR)

- (b) State and prove Ehrenfest's theorem.

17. (a) Develop the equation of motion of Schrodinger picture.

(OR)

- (b) Explain the effect of parity operator on the observables r , p and L .

18. (a) Derive the Schrodinger equation and the form of wave function in the different regions of a square well potential with rigid wall.

(OR)

- (b) Illustrate the matrix theory of linear harmonic oscillator using operator method.

19. (a) Estimate the ground state energy of helium atom.

(OR)

(b) Using the first order perturbation theory, discuss the effect of an electric field in the energy level of the hydrogen atom.

20. (a) Explain in detail about Clebsch-Gordan (CG) coefficients.

(OR)

(b) Find the eigen value of J^2 and J_z .