

17. A rectangular potential barrier is represented as

$$V = \begin{cases} 0 & \text{for } x < 0 \\ V_0 & \text{for } 0 \leq x \leq a \\ 0 & \text{for } x \geq a \end{cases}$$

Obtain the transmission coefficient through the barrier for a particle of energy $E < V_0$

18. Using the first order perturbation theory, discuss fully the effect of an electric field on the energy levels of the Hydrogen atom.
19. Evaluate the CG coefficients for $j_1 = 1/2$ and $j_2 = 1/2$.
20. Derive Klein Gordon equation for a particle moving in an electromagnetic field and apply it to Hydrogen atom.
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S.No. 7381

PN 15 PY 6

(For candidates admitted from 2015–2016 onwards)

M.Sc. DEGREE EXAMINATION, NOVEMBER 2023.

Physics

QUANTUM MECHANICS

Time : Three hours

Maximum : 100 marks

PART A — (10 × 2 = 20)

Answer ALL questions.

1. What information is obtainable from Ehrenfest's theorem?
2. Show that $(xp_x + p_x x)$ is Hermitian.
3. Define bound states.
4. Give the normalised wavefunction for Hydrogen like atom.
5. State Fermi Golden rule.
6. What is Harmonic perturbation?
7. Write the validity of Born approximation.

8. Show that $[L_x, L_y] = i\hbar L_z$
9. Why the dimension of Dirac matrices has to be even?
10. Write down the relativistic wave equations used for treating spin $\frac{1}{2}$ and spin 0 particles.

PART B — (5 × 7 = 35)

Answer ALL questions, Choosing either (a) or (b).

11. (a) Derive Time dependent Schrodinger equation for a free particle. Also give the physical significance of the wavefunction.

Or

- (b) Elaborate the importance of Heisenberg uncertainty relations. Explain any two applications of Heisenberg uncertainty relation.

12. (a) Discuss the problem of particle in a box.

Or

- (b) Obtain the ground state energy of a linear harmonic oscillator of angular frequency ω .

13. (a) Discuss the first order non degenerate stationary perturbation theory.

Or

- (b) Apply WKB approximation to tunneling problem.

14. (a) Obtain the expression for scattering amplitude in terms of Green function.

Or

- (b) Write short notes on spin angular momentum.

15. (a) Solve the Dirac equation for free particle.

Or

- (b) Write notes on spin orbit interaction.

PART C — (3 × 15 = 45)

Answer any THREE questions.

16. Discuss about

- (i) Dirac's bra-ket notation
- (ii) Schrodinger picture