22P306 (Pages: 2) Name: .....

Reg.No: .....

THIRD SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2023

(CBCSS - PG)

(Regular/Supplementary/Improvement)

CC19P PHY3 C09 - QUANTUM MECHANICS - II

(Physics)

(2019 Admission onwards)

Time : 3 Hours Maximum : 30 Weightage

Section A

Answer ***all*** questions. Each question carries 1 weightage.

1. What is meant by degeneracy and lifting of degeneracy?
2. Explain briefly the principle of time independent perturbation theory.
3. Show that the variational method always gives an upper limit to the ground state energy of the system.
4. A system is subjected to a perturbation which lasts from time t=0 to $t=t_0$ and which is constant during this time. What is the transition probability?
5. Give the equation for differential scattering cross section in born approximation
6. What change occurs to an incoming spherical wave when it is subjected to a central potential?
7. What is the relevance of optical theorem in scattering?
8. Schrodinger equation fails to give the correct wave equation for relativistic particles. Why?

(8 × 1 = 8 Weightage)

Section B

Answer any ***two*** questions. Each question carries 5 weightage.

9. Discuss in detail, the degenerate perturbation theory by assuming the two-fold degeneracy. Explain how it can be generalized to higher order degeneracy.
10. Briefly explain the theory of WKB approximation. Using WKB approximation obtain the expression for transmission coefficient of a potential barrier.
11. Apply the time dependent perturbation theory to discuss the radiative transitions in atoms.
12. Starting from Dirac Hamiltonian obtain the free particle solution of Dirac Equation.

(2 × 5 = 10 Weightage)

Section C

Answer any ***four*** questions. Each question carries 3 weightage.

13. A simple harmonic oscillator is perturbed by a harmonic potential so that the result Hamiltonian is given by $H = \frac{p^2}{2m} + \frac{1}{2}m\omega^2x^2 + \lambda x^2$ Calculate the first order perturbation energy.

14. We have a Hamiltonian $H=\begin{pmatrix} 1+\propto & \propto \\ \propto & 1+\propto \end{pmatrix}$. Calculate the first order correction in energy where **α<<1.**

15. Use variational method to find the ground state energy of one dimensional harmonic oscillator using the trial wave function $\Psi = Ae^{-ax^2}$

16. A system in an unperturbed state "n" is suddenly subjected to a constant perturbation H(r). Find the transition probability from the initial state "n" to the final state "k".

17. The differential scattering cross section in a certain case is given to be $\sigma(\theta)=\alpha+\beta\cos\theta+\gamma\cos^2\theta$
    (a) What is the scattering amplitude?
    (b) Deduce the total scattering cross-section and show that it is consistent with the optical theorem.

18. Obtain the Hamiltonian form of Klein-Gordon equation.

19. Consider a Dirac particle in an electromagnetic field and obtain the Pauli equation for an electron and show that the Dirac particles (positive energy ones) are electrons.

(4 × 3 = 12 Weightage)

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