19002084

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Reg. No.....

Name.....

M.Sc. DEGREE (C.S.S.) EXAMINATION, NOVEMBER 2019

Third Semester

Faculty of Science

Branch II—Physics–A–Pure Physics

PH 3C 09—QUANTUM MECHANICS—II

(2012—2018 Admissions)

Time : Three Hours Maximum Weight : 30

Part A

Answer any **six** *questions.*
Weight 1 *each.*

1. Explain Fermi's golden rule of time dependent perturbation theory.
2. Explain what dipole approximation is.
3. Spontaneous emission far exceeds stimulated emission in the visible region whereas the reverse is true in the microwave region. Why ?
4. Define scattering length. How is it related to zero-energy cross section ?
5. What is the relevance of Green's function in the scattering problem ?
6. Discuss the interpretational problem connected with Klein-Gordon equation.
7. What are partial waves ?
8. The dimension of Dirac matrices have to be even. Why ?
9. What is Lamb shift ?
10. What are creation, annihilation and number operators ? Why are they called so ?

(6 × 1 = 6)

Part B

Answer any **four** *questions.*
Weight 2 *each.*

11. Obtain the selection rule for electric dipole transitions of a linear harmonic oscillator.
12. Find the B coefficient for emission from the $2p \rightarrow 1s$ state of the hydrogen atom. Hence evaluate the probability per unit time for spontaneous emission from $2p$ state to $1s$ state of the hydrogen atom.

Turn over

13. Given $\frac{d\sigma}{d\Omega} = a + b\cos^2\theta$, where a and b are constants and θ goes from 0 to π. Obtain the total cross section.

14. Evaluate the scattering amplitude in the Born approximation for scattering by the Yukawa potential $V(r)\frac{V_0 \exp(-ar)}{r}$ where V_0 and r are constants.

15. Show that the Dirac matrices a_x, a_y, a_z and β are unimodular and they anticommute mutually.

16. Derive Weyl's equation from Dirac equation. What is your inference on parity ?

$(4 \times 2 = 8)$

Part C

Answer **all** *questions.*
Weight 4 *each.*

17. (a) For a system of fermions, define the number operator N_k and show that its Eigen values are zero and one.

Or

(b) Apply time dependent perturbation theory to dipole transition.

18. (a) Outline the first order time dependent perturbation theory and derive the Fermi golden rule for the transition rate from a given state to a final state in the continuum.

Or

(b) Discuss about Bom approximation.

19. (a) Describe the method of partial waves in calculating the scattering amplitude for the case of spherically symmetric potential and obtain an expression for the total scattering cross-section.

Or

(b) Explain the free particle solution of Dirac's relativistic equation and show the existence of negative energy states.

20. (a) Set up Klein-Gordon equation and discuss the difficulties associated with it with regard to negative probability. Show that such difficulties do not arise with Dirac equation.

Or

(b) Describe the method of quantizing Schrodinger wave field and show that the field contains particles with all possible energies.

$(4 \times 4 = 16)$