LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034
M. Sc., DEGREE EXAMINATION – PHYSICS
THIRD SEMESTER – NOVEMBER 2003
PH 3800 / PH 920 – QUANTUM MECHANICS II

03.11.2003 Max. : 100 Marks
1.00 – 4.00

SECTION – A

Answer ALL the questions. (10 x 2 = 20)

01. If the eigen values of A are 'a', then show that $\hat{A} = \sum a \hat{P}_a$ where $\hat{P}_a$ is the projection operator.
02. Prove that $e^{-i \alpha P_x / \eta}$ is unitary when α is a real parameter.
03. Evaluate <jm | J – J + | jm>
04. Show that $e^{\frac{i}{2}(\bar{\sigma} \cdot \hat{n})\theta} = \cos\frac{\theta}{2} + i(\bar{\sigma} \cdot \hat{n}) \sin\frac{\theta}{2}$
05. What is first Born approximation?
06. State optical theorem.
07. Explain dipole approximation.
08. What are allowed and Forbidden transitions with respect to the selection rules of the dipole approximation.
09. Mention the disadvantage of Klein – Gordan equation for relativistic particles.
10. What is the significance of the negative energy state?

SECTION – B

Answer any FOUR questions. (4 x 7.5 = 30)

11. Show that $\hat{p}$ has the form $-i\eta\frac{\partial}{\partial x}$ in the Schroedinger representation.
12. Obtain the C.G. Coefficients for the coupling of two spin angular momenta ($j_1 = j_2 = ½$).
13. Arrive at an expression for the scattering amplitude using Green's functions.
14. Explain the Schroedinger picture of time evolution.
15. Obtain the explicit form for $\bar{\alpha}$ *and* β matrices in the Dirac Hamiltonian.

SECTION – C

Answer any FOUR questions. (4 x 12.5 = 50)

16. Arrive at an expression for a proper choice of basis set for commuting operators.
17. Obtain the matrix representation for J^2, Jx, Jy, Jz in the |jm> basis for j = 1 and j = 3/2.
18. Explain the partial wave analysis and derive an expression for the scattering amplitude in terms of phase shifts.

19. Derive an expression for transition probability of upward and downward transition for an atom interacting with an electromagnetic radiation.
20. Determine the eigenvalues and eigenfunctions of a free particle using Dirac's Haneiltonian.

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