LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034
M.Sc. DEGREE EXAMINATION – PHYSICS
SECOND SEMESTER – NOVEMBER 2003
PH 2801 / PH 821 – QUANTUM MECHANICS I

29.10.2003 Max. : 100 Marks
1.00 – 4.00

SECTION – A

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

01. Calculate the Compton shift in wavelength for an electromagnetic radiation of λ = 6000 Å while the scattering angle is 30^o.

02. Find the de Broglie wavelength of an electron of energy 10 MeV.

03. Show that i $(A^+ - A)$ is a hermitian operator for any A.

04. Show that AB is hermitian only if [A,B] = 0 while A, B are hermitian.

05. Show that if any operator commutes with the parity operator, then the eigen functions of non-degenerate eigen values have definite parity.

06. If the probability densities are P_1, P_2, P_3 and P_4 for the do mains –a < x <- a/2; -a/2 < x < 0; 0 < x < a/2 ; a/2 < x <a respectively, what is $P_1 + P_2 + P_3 + P_4$?

07. Explain the basic assumptions of the perturbative technique.

08. Explain briefly WKB approximation.

09. Show that [Lx, Ly] = i η L_2.

10. Show that $e^{-\xi^2/2}$ satisfies the equation $\frac{d^2u}{d\xi^2} + (1-\xi^2)u = 0$.

SECTION – B

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

11. Explain photo electric effect using the quantum theory of radiation.

12. State and prove Ehrenfest's theorem.

13. (a) Explain the closure property.

    (b) Give the physical interpretation of eigen values and eigen functions.

14. Obtain the energy eigen values for the single harmonic oscillator.

15. Explain the removal of degeneracy in a doubly degenerate case using time independent perturbation technique.

SECTION – C

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

16. (a) Explain the variation of heat capacity with temperature for solids. (6)

    (b) Obtain an expression for the Compton shift. (6.5)

17. Explain the concept of quantum mechanical tunneling and show that the probability of barrier penetration is non-zero.

18. (a) State and prove Heisenberg's uncertainly principle. (7.5)

    (b) If [A, H] = 0, show that A becomes a constant of motion. (5)

19. (a) Express L^2 in spherical polar coordinates. (3)

    (b) Solve the eigen value equation for L^2. (9.5)

20. Explain the ground state of Hydrogen molecule by using the variational technique.

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