DAA College

Dharmapuram

Department of PHYSICS

Class : I M.Sc.,(Physics)

Title of the paper : Quantum mechanics

QUESTION BANK

SHORT ANSWER TYPE QUESTIONS

UNIT I

1. Write the Schrodinger wave equation and its plane wave solution.
2. Give the physical meaning of wave function.
3. State the physical significance of time independent Schrodinger equation.
4. What do you mean by expectation value?
5. Write any two properties of Hermitian operators.
6. State Heisenberg's uncertainty relation.
7. What are called Dirac's bra and ket vectors?
8. Define Hilbert space.
9. What is Schrodinger picture?
10. Define Heisenberg picture.
11. What is interaction picture?
12. How does Schrodinger picture differs from Heisenberg picture?

UNIT II

13. Give the solution for one dimensional harmonic oscillator.
14. Why a particle trapped in a box cannot be at rest?
15. Write the admissible solution for rectangular barrier potential.
16. What is called a rigid rotator?
17. Write the solution for hydrogen atom problem.

UNIT III

18. What is meant by non degenerate state?
19. What do you mean by perturbation theory?
20. State Stark effect.
21. Define constant and harmonic perturbation.
22. Define transition probability.
23. Write a note on sudden approximation.

UNIT IV

24. What is scattering amplitude?
25. Define scattering cross section.
26. Give the significance of Born approximation.

27. Define the unit for measuring the cross sections in scattering theory.
28. Write the properties of L and L^2.
29. Write the eigen value and eigen function of L_z.

UNIT V

30. Give the Klein-Gordan equation for a free particle.
31. Write the Dirac equation for a free particle.
32. Write short notes on Dirac matrices.
33. What is meant by charge density?
34. What is called current density?
35. Define negative energy states.
36. Write the consequence of negative energy states.
37. Define spin orbit coupling.

LONG ANSWER TYPE QUESTIONS

UNIT I

38. Discuss the physical interpretation of wave function.
39. Derive the time dependent wave function.
40. Derive the time independent wave equation and explain its physical significance.
41. What is Hermitian operator? Explain its properties.
42. State and explain Heisenberg's uncertainty relation.
43. Explain Hilbert space and obtain linear vector space in Hilbert space.
44. Derive the equation of motion in Heisenberg picture.
45. Explain Schrodinger picture in detail.
46. Discuss about interaction picture.

UNIT II

47. Derive the Schrodinger wave equation for a one dimensional harmonic oscillator.
48. Solve the linear harmonic oscillator problem using operator method.
49. Solve the Schrodinger wave equation for a particle in a box.
50. Obtain the Schrodinger equation for rectangular barrier penetration problem. Solve it to obtain eigen values and eigen functions.
51. Solve the Schrodinger wave equation for a rigid rotator with free axis.
52. Solve the radial part of Schrodinger's equation for the hydrogen atom and obtain its eigen values.

UNIT III

53. Develop first order perturbation theory for a non degenerate case.
54. Outline the time independent perturbation theory.
55. Give the theory of Stark effect for the excited state of hydrogen atom.
56. Explain Stark splitting of n =2 level of the hydrogen atom in presence of an electric field using first order perturbation theory.
57. Derive the connection formula using WKB approximation.
58. What are Einstein's transition probabilities? Derive an expression for transition probability per unit time by quantum mechanical treatment.
59. State and prove Fermi Golden rule for the rate of transitions induced by constant perturbation.
60. Write a note on sudden approximation.

UNIT IV

61. Derive an expression for scattering cross section in terms of scattering amplitude.
62. Construct Green's function for a free particle.
63. Discuss the condition for validity of Born approximation.
64. Deduce an expression for scattering by screened coulomb potential.
65. Derive the commutation relation between orbital angular momentum with position.
66. Obtain the generation of eigen function of (i) L and L^2 (ii) L^2 and L_z.

UNIT V

67. Mention the application of Klein-Gordan equation for a free particle. Explain in detail.
68. Derive Dirac's relativistic equation for a free particle and find out Dirac matrices α and β.
69. Describe Zitterbewegung as a peculiar motion of electrons.
70. Discuss the theory of Born approximation. Explain in detail.
71. Write short notes on (i) negative energy states
    (ii) probability and current densities
    (iii) spin orbit interaction