LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

B.Sc. DEGREE EXAMINATION – **PHYSICS**

FIFTH SEMESTER – **APRIL 2023**

UPH 5501 – QUANTUM MECHANICS

Date: 29-04-2023   Dept. No.   Max. : 100 Marks
Time: 01:00 PM - 04:00 PM

Part A

Answer all the questions   (10 X 2 = 20 marks)

1. Find the de Broglie wavelength associated with an electron subjected to a potential difference of 1.25 kV.
2. List out the inadequacies of classical mechanics
3. What is meant by orthonormal functions?
4. Define linear vector space?
5. What is quantum mechanical tunneling?
6. What is meant by zero point energy of a linear harmonic oscillator?
7. Write down the eigenvalues of operators L^2 and L_z for the eigen function $Y_{3,-3}(\theta, \varphi)$.
8. What are spherical harmonics?
9. What is the ground state energy of a 3D cubical box of side L.
10. What is the degeneracy of a 3D harmonic oscillator in n = 2 state?

Part B

Answer any four questions   (4 X 7.5 = 30 marks)
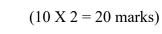
11. What is Compton effect? Derive an expression for the change in the wave length of a photon scattered by a stationary electron
12. What are Hermitian operators? State and prove the two theorems on Hermitian operators.
13. State and explain the fundamental postulates of quantum mechanics.
14. Set up the Schrodinger equation for a rigid rotator by reducing it to a single body problem and solve it to obtain the energy eigenvalues.
15. With necessary diagram, describe Stern-Gerlach experiment and give its importance in quantum mechanics.
16. Derive the equation of continuity in quantum mechanics.

Part – C

Answer any four questions   (4 X 12.5 = 50 marks)

17. i) With a neat diagram, describe how Davisson and Germer's experiment proves the wave nature of moving electrons. (7.5)
    ii) In detail discuss Einstein's explanation of photoelectric effect. (5)
18. State and prove Ehrenfest's theorems.
19. Obtain energy eigenvalues and eigen functions of a linear harmonic oscillator.
20. Discuss tunnel effect in a square potential barrier problem and derive the expression for the transmission coefficient.
21. Obtain the matrix representations of operators L_+, L_-, L_x, L_y for $l = 1$ using the eigenkets of L^2.
22. Write the radial part of Schrodinger wave equation for hydrogen atom and solve it to obtain the energy eigenvalues.

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