LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION - **PHYSICS**

THIRD SEMESTER – **APRIL 2013**

PH 3900 – QUANTUM MECHANICS

Date : 09/05/2013 Dept. No. Max. : 100 Marks
Time : 9:00 - 12:00

Part – A

Answer **ALL** Questions. (10x2=20)

1. List out any four failures of Classical Mechanics.
2. What is de Broglie hypothesis?
3. What are the two theorems on Hermitian operator?
4. When do we say two functions $f_1(x)$& $f_2(x)$ are orthogonal to each other?
5. Evaluate $\int_0^{2\pi} \cos(x)\,\delta(\pi - x)dx$
6. Define degeneracy? What is meant by degree of degeneracy?
7. Write down the Schrodinger wave equation for a particle of mass 'm' moving in a potential $V(x) = A\sin\left(\frac{kx}{L}\right)$
8. Write down Geiger- Nuttal law for α- decay
9. Plot the probability density of a linear harmonic oscillator in its ground state.
10. Write down the eigenvalues of $\widehat{L^2}\ and\ \hat{L}_z$ for the eigenstate $Y_{3,-2}(\theta,\varphi)$.

Part – B

Answer any **FOUR** Questions. (4x7.5=30)

11. Give an account of Planck's theory of black body radiation. Show that it reduces to Rayleigh – Jeans law and Wien's law in the appropriate limits.
12. If A and B are two vectors given by $|A> = \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \end{bmatrix}$ and $|B> = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \end{bmatrix}$, evaluate $< A|B > and\ |A >< B|$ and elaborate their difference.
13. (i) Check if the given operators are Hermitian: i) $\frac{\partial}{\partial x}$, ii) $\frac{\partial^2}{\partial x^2}$ (2+3.5)

    (ii) Evaluate the commutator $\left[\frac{d}{dx}, F(x)\right]$ (2)
14. Solve the Schroedinger wave equation and obtain the energy eigenvalues of a particle of mass 'm' in a three dimensional square well potential of side 'L'. What is the degeneracy of the state of energy $E = \frac{14h^2}{8mL^2}$?
15. Write down the eigenvalue equation of the angular momentum operator and solve it to obtain its eigenfunctions.

Part – C

Answer any **FOUR** Questions. (4x12.5=50)

16. Give a detailed account of the fundamental postulates of Quantum Mechanics.
17. Using commutator algebra, obtain Heisenberg's uncertainty relation.
18. Using the theory of particle in a potential well, show that a quantum particle has finite probability to exist in classically forbidden region.
19. Set up the Schrodinger wave equation for a linear harmonic oscillator and obtain the energy eigenfunctions. Plot the eigenfunctions and probability density distribution as a function of 'x' for the lowest two energy levels.
20. Solve the radial part of Schrodinger wave equation and obtain the energy eigenvalues and eigenfunctions for Hydrogen atom.