LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – **PHYSICS**

SECOND SEMESTER – **APRIL 2016**

PH 2816 – QUANTUM MECHANICS - I

(FROM 12-BATCH)

Date: 25-04-2016 Dept. No. Max. : 100 Marks

Time: 01:00-04:00

SECTION –A

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

1. Check for the linearity of A, if $A\psi(x) = \psi(x) + x$.
2. If $[a,a^{\dagger}] = 1$ and that $H = (aa^{\dagger} + a^{\dagger}a)\frac{\hbar\omega}{2}$, then show that $[a, H] = \hbar\omega a$.
3. For a hermitian operator A, show that $U = \frac{A+iI}{A-iI}$ is unitary.
4. Show that Pauli matrices are trace *zero* and determinant *one* matrices.
5. Prove that the first order correction to the energy is the average value of the perturbation over the unperturbed states of the system.
6. Explain the general principle of the variational method.
7. Find the matrix representation of J_+ for j=1/2.
8. Write down the complete set of eigen kets for uncoupled and coupled representation of $j_1 = 1$ & $j_2 = 1$.
9. Relate scattering amplitude with differential scattering cross section.
10. State optical theorem.

SECTION –B

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

11. Derive the equations of motion in the Schroedinger picture.

12. Establish any four properties of an operator that remain invariant under unitary transformation.

13. Explain how degeneracy is lifted in a doubly degenerate state using time independent perturbation theory.

14. $|jm\rangle$ are the simultaneous eigenkets of J^2 and J_z. Show that $|jm\rangle$ are also eigenkets of $[J_y, J_-]$. Find the eigenvalues of each part of the commutator.

15. Explain the general method of partial wave analysis.

16. Assuming the wave function for an infinite one dimensional box, evaluate $\langle p^2 \rangle$.

SECTION –C

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

17. Solve graphically the eigenvalue problem of particle in a square-well potential with finite walls.

18. Obtain the eigen values of the harmonic oscillator using Heisenberg matrix method.

19. Discuss stark effect with reference to n=2 state of the hydrogen atom.

20. Obtain the C.G. coefficients for addition of angular momenta $j_1=1$ and $j_2=1/2$.

21. Derive an expression for first Born's approximation and use it to explain scattering by a screened coulomb potential.

22. With necessary theory, explain quantum mechanical tunnelling.

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