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Total Pages : 3

238103

December, 2019

M.Sc. (Physics) I SEMESTER

Quantum Mechanics (PHL-103)

Time : 3 Hours]

[Max. Marks : 75

Instructions :

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any four questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

PART - A

1. (a) If $a = (0, 4, 0)$; $b = (i, -3i, i)$ and $c = (2, 0, 1)$; find that they are linearly independent or dependent. [CO-1] (1.5)

(b) What are Dirac Notations? [CO-1] (1.5)

(c) Find the value of $[L - L_+ + L_+ L_-]$. [CO-2] (1.5)

(d) Show that sum of two projection operators cannot be projection operator unless they commute. [CO-2] (1.5)

[CO-2] (1.5)

(e) State Pauli matrix.

(f) Define angular momentum in polar coordinate.

[CO-2] (1.5)

(g) How L-frame is different between CM-frame?

[CO-3] (1.5)

(h) What are Partial Waves in Scattering? [CO-3] (1.5)

(i) What do you mean by Zeeman effect? Can you explain Zeeman effect by perturbation theory? [CO-4] (1.5)

(j) Illustrate Harmonic Perturbations with an example.

[CO-4] (1.5)

PART - B

2. (a) Define Hilbert Space and illustrate its significance of quantum mechanics and prove that if two Hermitian operators commute, then their product is also hermitian operator. [CO-1] (10)

(b) If $\hat{X}$ and $\hat{P}_x$ are the coordinate and momentum operators. Prove that $[\hat{X}, \hat{P}_x^n] = ni\hbar\hat{P}_x^n$. [CO-1] (5)

3. (a) Explain Schrödinger Picture. Obtain the time derivative of the expectation value of an observable in it.

[CO-2] (5)

(b) Find the matrix representation for angular momentum operators J^2 and J_z. Deduce the eigen values of J^2 and j_z for $j = 1$. [CO-2] (10)

4. Explain the Born approximation and prove its validity for weak potential at high energies. [CO-3] (15)

5. (a) Explain perturbation theory for non-degenerate state with first order correction in wavefunction. [CO-4] (8)

(b) Define Fermi's Golden Rule. [CO-4] (7)

6. (a) Differentiate between differential and total scattering cross-section. Prove that $\frac{d\sigma}{d\Omega} = |f(\theta, \phi)|^2$. [CO-3] (10)

(b) Discuss Wavefunction including spin (Spinor). [CO-2] (5)

7. Write short notes on the following :

(i) Ground state He atom. [CO-4]

(ii) Postulate of Quantum Mechanics. [CO-1]

(iii) Matrix representation of $|x><y|$ [CO-1] (5×3=15)