Roll No. ....

JS-245

July - August 2017
M. Sc. IInd Semester Examination

PHYSICS
Paper 1 : Quantum Mechanics – II

Time 3 Hours]

[Max. Marks : Regular 85 / Private 100
[Min. Marks : Regular 28 / Private 33

Note : This question paper is meant for all Regular and Private students. Answer all five questions. All questions carry equal marks. The blind candidates will be given 40 minutes extra time.

1. Estimate the ground state energy of helium atom using first order perturbation theory.

OR

Discuss the basic idea behind variational method. Prove that for any trial function ϕ the expectation value $E[\phi]$ of the Hamiltonian of a system obeys the inequality $E_0 \le E[\phi]$ where E_o is the ground state energy.

2. Derive an expression for transition probability when a system is subjected to a time dependent perturbation.

OR

(a) What is sudden approximation ? Derive an expression for the probability of transition in this approximation. http://www.davvonline.com

(b) A particle is in the ground state of a one dimensional box with walls at $x = 0$ and $x = L$. The wall at $x = L$ is suddenly moved to $x = 2L$. Calculate the probability that the particle is found in the ground state of the new box.

[Given : Wave function of the particle in the original box is $\psi(x) = \sqrt{\dfrac{2}{L}} \sin\left(\dfrac{\pi x}{L}\right)$]

3. Define differential cross-section $\dfrac{d\sigma}{d\Omega}$. Prove that it is equal to $| f(\Omega) |^2$, where $f(\Omega)$ is the scattering amplitude.

OR

Derive an expression for the differential cross-section in Born approximation.

4. Derive the equation of continuity from Klein-Gordan equation and prove that the definition of probability density is not acceptable. Why does such a problem arise ?

OR

Prove the following for properties of components α, and β appearing in Dirac theory :

(a) They are Hermitian Operators.

(b) They are Independent of $\vec{r}, \vec{p}$ and t.

(c) They obey the anticommunication relations $\{\alpha_i, \alpha_j\} = 0$ and $\{\alpha_i, \beta\} = 0$.

(d) Their eigenvalues are ± 1.

5. Write short notes on any two of the following :

(a) What is Stark effect ? Using first order perturbation theory calculate the Stark energy shift for the ground state for hydrogen atom.

(b) Derive relationship between Einstein's A and B coefficients.

(c) Scattering cross-section for scattering of identical particles.

(d) Negative energy states in Dirac theory.

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