G-2/241/21

Roll No. .....

M.Sc. II Semester Examination, 2021

PHYSICS

Paper III

(Advance Quantum Mechanics)

Time : 3 Hours] [Max. Marks : 80

Note : *All questions are compulsory. Question Paper comprises of 3 sections. Section A is objective type/multiple choice questions with no internal choice. Section B is short answer type with internal choice. Section C is long answer type with internal choice.*

SECTION A **1×8=8**

(Objective Type Questions)

Choose the correct answer :

1. When a perturbation of Cx^3 is applied in the Hamiltonian of harmonic oscillation, the shift in first order energy is :

(a) zero (b) $\frac{3}{4}c\left(\frac{\hbar\omega}{k}\right)^2$

(c) $\frac{1}{2}c\left(\frac{\hbar\omega}{k}\right)^2$ (d) $\frac{c\hbar\omega}{k}$.

2. Potential field of H atom is :

(a) $v(r) = -Are^{-r/a_0}$ (b) $v(r) = 0$

(c) $v(r) = -\frac{A}{r^2}$ (d) $v(r) = -\frac{A}{r}$.

3. Particle having spin zero are described by :

(a) The Dirac equation

(b) The Klein Gorden equation

(b) The Pauli equation

(d) The Proca equation.

4. Choose the correct option :

(a) $\alpha_x\alpha_y + \alpha_y\alpha_x = 1$ (b) $\alpha_x\alpha_y + \alpha_y\alpha_x = 0$

(c) $\alpha_y^2 = 0$ (d) $\alpha_x^2 = 0$

5. A barn is equal to the :

(a) 10^{-24} cm^2 (b) 10^{-20} cm^2

(c) 10^{-28} cm^2 (d) 10^{-30} cm^2.

6. Born approximation is valid only when :

(a) total wave function is slightly different from incident wave function

(b) total wave function is exactly equal to incident wave function

(c) always applicable

(d) none of the above.

7. The differential cross-section $\sigma(\theta, \phi)$ will be equal to :

(a) $|f(\theta,\phi)|^2$ (b) $\frac{|f(\theta,\phi)|^2}{2}$

(a) $|f(\theta, \phi)|$ (d) $f(\theta, \phi)$.

8. The antisymmetric eigen function for two identical particle is :

(a) $\psi_A = \frac{1}{\sqrt{2}}[\psi_\alpha(1)\psi_\beta(2) - \psi_\beta(1)\psi_\alpha(2)]$

(b) $\psi_A = \frac{1}{\sqrt{2}}[\psi_\beta(1)\psi_\beta(2) - \psi_\alpha(1)\psi_\alpha(2)]$

(c) $\psi_A = \frac{1}{\sqrt{2}}[\psi_\alpha(1)\psi_\alpha(2) - \psi_\beta(1)\psi_\beta(2)]$

(d) None of the above.

SECTION B **6×4=24**

(Short Answer Type Questions)

Note : *Attempt one question from each unit.*

Unit-I

1. For the Hamiltonian $H = -\frac{\hbar^2}{2m}\frac{d^2}{dx^2} = -\alpha\delta(x)$ where $\delta(x)$ is a delta function. Using Gaussian trial wave function $\psi = Ae^{-bx^2}$ find the ground state energy.

Or

What is Sommerfeld Quantization condition.

Unit-II

2. Explain Fermi's Golden rule.

Or

What is the difference between adiabatic approximation and sudden approximation.

Unit-III

3. Explain scattering amplitude and differential cross–section.

Or

What is laboratory and centre of mass frame ?

Unit-IV

4. Discuss about α and β matrices and its properties.

Or

What is symmetric and antisymmetric wave function.

SECTION C **12×4=48**

(Long Answer Type Questions)

Note : *Attempt one question from each unit.*

Unit-I

1. Derive variational method to get ground state energy of any system.

Or

Give the theory of α decay. Explain tunneling through potential barrier.

Unit-II

2. Explain time dependent perturbation theory. What is the difference between time independent and time dependent perturbation theory ?

Or

What is Einstein A and B coefficient ? How is this useful in Quantum Physics ?

Unit-III

3. Explain Born approximation method. What is its validity ? Also write its one application.

Or

Explain partial wave analysis. What is required for it and also discuss its application.

Unit-IV

4. What is physical significance of identical particles ? Discuss the exclusion principle.

Or

Give the physical significance of study of relativistic Quantum Mechanics. Derive Klein Gordan equation for free particle.

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