H-2-41-22 Roll No. .....

II Semester Examination, 2022

M.Sc.

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**

(Multiple Choice Questions)

Choose the correct answer :

1. The variation method is used primarily for the estimation of :

(a) Excited state

(b) Ground state

(c) Bound state

(d) Stationary state

P.T.O.

2. The validity condition for *WKB* approximation is given by :

(a) $\frac{1}{K^2}\left|\frac{dK}{d\lambda}\right| << 0$ (b) $\frac{1}{K}\left|\frac{dK}{d\lambda}\right| << K$

(c) $\frac{1}{K}\left|\frac{dK}{dX}\right| << K$ (d) $\frac{1}{K^2}\left|\frac{dK}{dX}\right| << 0$

3. In series classical theory of radiation :

(a) Matter treated classically, radiation treated quantum mechanically.

(b) Both matter and radiation are treated quantum mechanically.

(c) Both matter and radiation treated classically.

(d) Matter treated quantum mechanically, radiation treated classically.

4. If both initial and final states are S states, the transition will be of type :

(a) Forbidden

(b) Electric-dipole

(c) Allowed

(d) None of these

5. The following statement is true in scattering experiment :

(a) Total scattering cross section σ is same in centre of mass frame

(b) Differential cross section $\frac{d\sigma}{d\Omega}$ is same in laboratory frame

(c) Both (a) and (b) options are wrong

(d) (a) and (b) both options are right

6. The formula depending optical theorem is :

(a) $\sigma = \frac{4\pi}{R} a^2$ (b) $\sigma = \frac{4\pi}{R} f(\theta)$

(c) $\sigma = \frac{4\pi}{R} f(0)$ (d) None of these

7. Electrons are always represented by :

(a) Symmetric wave function

(b) Antisymmetric wave function

(c) Both are true

(d) None are true

8. For α and β matrices which of the following relation is correct :

(a) $\alpha_x^2 = \alpha_y^2 = \alpha_z^2 = \beta^2 = 1$

(b) $\alpha_x^2 = \alpha_y^2 = \alpha_z^2 = 1 \neq \beta^2$

(c) $\alpha_x^2 = \alpha_y^2 = \alpha_z^2 \neq 1, \beta^2 = 1$

(d) $\alpha_x^2 = \alpha_y^2 = \alpha_z^2 = \beta^2 \neq 1$

Section 'B' 6 × 4 = 24

(Short Answer Type Questions)

Note : *Attempt one question from each unit.*

Unit–I

1. Discuss ground state energy of one dimensional Harmonic oscillator.

Or

Write note on probability penetration through potential barrier.

Unit–II

2. Discuss transition probabilities of induced emission.

Or

Explain Einstein's *A* and *B* coefficients.

Unit–III

3. Discuss first Born approximation.

Or

Discuss optical theorem.

Unit–IV

4. Explain spin angular momentum.

Or

Discuss Klein-Gordon equation for free particle.

Section 'C' **12 × 4 = 48**

(Long Answer Type Questions)

Note : *Attempt one question from each unit.*

Unit–I

1. Discuss variational method and Explain ground state of Helium atom.

Or

Discuss *WKB* approximation method. Give its application to the problem of alpha decay.

Unit–II

2. Discuss time dependent perturbation theory and show that transition probability per unit time is $\frac{2\pi}{\hbar}|\mu'(mn)|^2\,\rho(m)$, where symbols have their usual meaning.

Or

Derive Fermi-Golden rule for constant perturbation act for a short interval of time and apply to it find the transition rate of an a particle.

Unit–III

3. Define the scattering cross section. Describe the method of partial waves for scattering.

Or

Deduce an expression for the scattering cross section by a square well potential. Explain the significance of phase shift term.

Unit–IV

4. What are symmetric and anti-symmetric wave functions ? Show that do they lead to the paulis principle.

Or

Discuss Dirac equation for free particle and explain α and β matrices.

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