

A-0587

Total Pages : 4

Roll No.

MSCPH-503

M.Sc. PHYSICS (MSCPH)

(Quantum Mechanics)

1st Semester Examination, Session December 2024

Time : 2:00 Hrs.

Max. Marks : 70

Note :- This paper is of Seventy (70) marks divided into Two (02) Sections 'A' and 'B'. Attempt the questions contained in these Sections according to the detailed instructions given therein. ***Candidates should limit their answers to the questions on the given answer sheet. No additional (B) answer sheet will be issued.***

Section-A

Long Answer Type Questions 2×19=38

Note :- Section 'A' contains Five (05) Long-answer type questions of Nineteen (19) marks each. Learners are required to answer any two (02) questions only.

1. What is Photoelectric effect ? Give its experimental conclusion. Why classical theory could not explain them ? How Einstein explained it on the basis of Planck's quantum theory ?
2. What is Dirac's relativistic equation for a free particle ? Find out Dirac matrices α and β .
3. What is Fermi Golden rule ? Find its expression. How it helps in calculating intensities of spectral lines and cross sections in various processes.
4. Hydrogen atom is placed in a uniform electric field E applied along the z -direction. Find ground state energy corrected up to the second order using perturbation theory.
5. Explain the physical interpretation of wave function. What is the difference between ψ and $|\psi|^2$. Discuss how schrödinger wave equation for a free particle is established.

Section–B

Short Answer Type Questions

4×8=32

Note :– Section ‘B’ contains Eight (08) Short-answer type questions of Eight (08) marks each. Learners are required to answer any *four* (04) questions only.

1. What are Hermitian operators ? Show that the eigenvalu corresponding to Hermitian operator are always real.
2. Find the matrix representation for spin angular momentum. Show how the spin angular momenta of two electrons may be combined.
3. Determine the expectation value of position of a particle trapped in a box of width L, given :

$$\psi(x) = \sqrt{\frac{2}{L}} \sin \frac{\pi x}{2}$$

4. Show that for low-energy particles, the scattering is isotropic and the cross section is 4 times the geometrical cross section of the rigid sphere.
5. What do you mean by Hilbert space ? How a basic set of wave function is changed into another by unitary transformation in Hilbert space ?

6. Discuss the reflection of wave at potential step and show that when particle energy E is greater than the height of step V_0 , the reflection coefficient is :

$$R = \left| \frac{P_1 - P_2}{P_1 + P_2} \right|$$

where symbols have the usual meaning.

7. Discuss and describe Stern Gerlach experiment. What is importance of this experiment ?
8. Write short notes on any *three* the following :
- (a) Clebsh Gordan Coefficients
 - (b) Dirac equation and electron spin
 - (c) Quantum mechanical tunneling
 - (d) Pauli's exclusion principle
 - (e) Parity operator
