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MSCPH-503

QUANTUM MECHANICS

M.Sc. Physics (MSCPH)

1st Semester Examination, 2023 (Dec.)

Time : 2 Hours] **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)

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.

(2×19=38)

1. Describe Compton effect and find out an expression for the change in wavelength. What is the physical significance of Compton effect?

2. Solve the linear harmonic oscillator problem quantum mechanically and obtain its eigen values.

3. Define any *four* of the following :

(a) Unitary Matrix.

(b) Orthogonal Matrix.

(c) Hermitian Matrix.

(d) Symmetric Matrix.

(e) Hilbert Space.

4. What do you mean by Clebsch-Gordan coefficients in connection with addition of angular momentum. Obtain Ciebsch-Gordan coefficient for addition of orbital and spin angular momentum for electron in *p*-state.

5. Give the theory of the time independent first order perturbation theory and apply it to the case of Zeeman effect.

SECTION–B

(Short Answer Type Questions)

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. (4×8=32)

1. Calculate the velocity of photoelectron if the work function of target material is 1.24 eV and the wavelength of incident light is 4.36×10^{-7}m. What retarding potential is necessary to stop the emission of these electrons?

2. Calculate the expectation value of p for the wave function

$$\varphi(x) = \sqrt{\frac{2}{L}} \sin \frac{\pi x}{L}, \quad \text{where } 0 < x < L$$

$$\varphi(x) = 0 \text{ for } |x| > L$$

3. Derive the energy eigen values and normalized wave function for a particle in 1-dimensional infinite square well potential of width L.

4. What is meant by Hermitian operator? Show that Hermitian operators have real eigen values.

5. Show that :

(a) Eigenvalues of a diagonal matrix are its diagonal elements.

(b) Eigen functions belonging to different eigenvalues are orthogonal.

6. What are Pauli spin operators? Express Pauli spin operators in the form of a 2×2 matrices.

7. Discuss the W.K.B. approximation method to explain α decay. Hence derive Geiger-Nuttel law.

8. Explain the method of partial waves to calculate the phase shifts and scattering amplitude.
