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Total Pages : 4

Roll No.

MSCPH-503

Quantum Mechanics

M.Sc. Physics (MSCPH)

1st Semester Examination, 2023 (June)

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 answer 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. Explain Debye's model of a solid and use it to derive expressions for the heat capacity of a solid in the limits of low and high temperature.

2. What is the wave function? Obtain the wave equation for a linear harmonic oscillator and solve it.
3. Consider a hydrogen atom which is in its ground state, the ground state wave function is given by,

$$\psi(r, \theta, \phi) = \frac{1}{\sqrt{\pi a_0^3}} e^{-r/a_0}$$

Where a_0 is the Bohr radius.

- (a) Find the most probable distance between the electron and the proton when the hydrogen atom is in its ground state.
 - (b) Find the average distance between the electron and the proton.
4. Find the eigen functions for addition of two angular momenta to give the zero total angular momentum.
 5. What do you mean by perturbation theory? Explain Time independent perturbation theory for non-degenerate case.

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. If the stopping potential of a metal when illuminated with a radiation of wavelength 480 nm is 1.2 V, find
 - (a) The work function of the metal
 - (b) The cutoff wavelength of the metal, and
 - (c) The maximum energy of the ejected electrons.
2. What is the significance of operators in quantum mechanics? Define (a) Linear operator (b) Projection operator (c) Hermitian operator (d) Unitary operator.
3. Using Schrodinger's equation, discuss and solve the problem of particle in a 3D box.
4. What do you mean by Hilbert space? How a basic set of wave functions is changed into another by unitary transformation in Hilbert space?
5. Describe W.K.B. approximation method and give an application of this method.

6. Calculate the scattering amplitude for a central potential in the first-Born approximation.
 7. Discuss the wave nature of matter and obtain an expression of de-Broglie wavelength for waves. What is the relation between energy and momentum for a particle without mass?
 8. Explain and solve the problem of hydrogen atom quantum mechanically.
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