

Five Year Integrated M.Sc. Examination, 2017

Semester - IV

Course: PH-2-4-1 (Old)

(Quantum Mechanics)

Time: Three Hours

Full Marks: 40

Questions are of value as indicated in the margin.

Answer **Question No.1** and **any three** from the rest.

1. Answer **any five** from the following: 5x2=10
 - a) The work function of sodium is 2.3 eV. What is the maximum wavelength of light that will cause photoelectrons to be emitted from sodium?
 - b) Calculate the wavelength of the first line of Balmer series of H-atom spectra. Given, $R_H = 1.097 \times 10^7 \text{ m}^{-1}$.
 - c) Find the de Broglie wavelength of a 15 keV electron. Given, $m_e = 9.109 \times 10^{-31} \text{ kg}$.
 - d) Write and briefly explain Pauli exclusion principle.
 - e) Show that one-dimensional position and momentum operators do not commute with each other.
 - f) What do you mean by bound state in quantum mechanics?
 - g) Prove that $i\hbar \frac{\partial}{\partial t}$ is a Hermitian operator.
 2.
 - a) What do you mean by black body radiation? Explain briefly. 3
 - b) Derive Planck's radiation formula. 7
 3.
 - a) Describe an experimental arrangement to verify Einstein's photoelectric equation. 3
 - b) Give an account of Bohr's theory of the spectra of hydrogen-like atoms, stating the postulates clearly. 7
 4.
 - a) Explain Compton effect and find an expression for the Compton shift. 7
 - b) A monochromatic X-ray beam, whose wavelength is $0.558 \text{ \AA}$, is scattered through 46° . Find the wavelength of the scattered beam. 3
 5. Consider a particle within a one-dimensional box of width L so that the potential energy of the particle is infinite on both sides of the box and is zero inside the box. Solve the time-dependent Schrödinger equation to obtain the normalized eigen wave functions and energy values. 10
 6.
 - a) Explain why the angular momentum operators L_x , L_y and L_z are called the generators of infinitesimal rotations about the coordinate axes. 7
 - b) Draw the ground state wave function and probability density for a one-dimensional linear harmonic oscillator. 3
-