Five Year Integrated M.Sc. Examination, 2019

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) Find the wavelength and frequency of a 100 MeV photon. Given, $h = 6.62 \times 10^{-34}$ J s.
   b) A beam of X-rays is scattered by free electrons. At 45^{o} from the beam direction, the scattered X-rays have a wavelength of 0.022 Å. What is the wavelength of the X-rays in the direct beam?
   [Given, $m_e = 9.1 \times 10^{-31}$ kg.]
   c) Write and briefly explain Hisenberg's uncertainty principle.
   d) Write and briefly explain de Broglie hypothesis.
   e) Find the de Broglie wavelength of a 15 keV electron.
   f) What is the physical significance of the wave function $\Psi(x)$?
   g) What do you mean by bound state in quantum mechanics?

2. a) What do you mean by photoelectric effect?
   b) Describe an experimental arrangement to verify Einstein's photoelectric equation.
   c) What are the main features that can be observed in such an experiment which cannot be explained by classical theories? 2+4+4 = 10

3. a) Give an account of Bohr's theory of the spectra of hydrogen-like atoms, stating the postulates clearly.
   b) Write and explain Bohr's correspondence principle. 6+4 = 10

4. Explain Compton effect and find an expression for the Compton shift. 10

5. Describe the experiment of Davisson and Germer on the diffraction of electrons. How does it establish the wave nature of matter? 10

6. 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

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