2010 – 2011
B.Sc. (HONS.) (PART – III) EXAMINATION
(PHYSICS)
QUANTUM MECHANICS
(PH – 313)

Maximum Marks : 40 Duration : Three Hours

Note: Answer all questions. Use of Calculator is allowed.
Planck's constant $h = 6.63 \times 10^{-34}$ J-sec,
Mass of electron $m_e = 9.1 \times 10^{-31}$ kg.

1. Answer any Six of the following:

(i) The work function of a metal is 4×10^{-19} J. Find the threshold frequency for photoelectric effect. [2]

(ii) Find the de Broglie wavelength for an electron of kinetic energy 10 eV. [2]

(iii) An X-ray of wavelength 0.5 Angstrom undergoes a 60^0 Compton scattering. Find the wavelength of scattered photon. [2]

(iv) The radius of an atomic nucleus is around 5 Fermi. Use the uncertainty principle to place a lower limit on the energy of an electron if it is to be inside the nucleus (one Fermi = 10^{-15} meters). [2]

(v) The wave function of a particle in one dimensional box of length L is given by [2]

$$\psi_n(x) = \sqrt{\frac{2}{L}} \sin\left(\frac{n\pi}{L}x\right).$$

Find the expectation value of x.

(vi) Evaluate $[\hat{p}_x, x]$ [2]

(vii) What is the spacing between two consecutive energy levels of a particle in a one dimensional potential box? [2]

(viii) What do you understand by zero point energy of a particle in a harmonic oscillator potential? [2]

(ix) The ground state wave function of an electron in hydrogen atom is given by [2]

$$\psi_{nlm} = \psi_{100} = \left(\frac{1}{\pi a_0^3}\right)^{\frac{1}{2}} e^{-\frac{r}{a_0}},$$

where a_0 is the Bohr radius, find the expectation value of the potential energy $\left(-\frac{e^2}{r}\right)$ in the above state.

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nction of a particle. [4]

on coefficient of a particle incident on a [7]
ergy E of a particle is less than the barrier

Three Hours

rödinger equation for the hydrogen atom and obtain [7]
l as the energy eigenfunctions.

periment and its importance. [5]

OR

spin angular momentum operators S^2 and S_z for a spin – ½ particle [5]
uli matrices. Obtain the eigenfunctions of S_z operator.

[2]

quantum mechanical treatment of collisions and obtain the selection [5]
n scattering amplitude and differential scattering cross section.

OR

Obtain the correction to energy and wave function in first order perturbation theory. [5]

$S = \pm \frac{1}{2} \times \frac{1}{2}$