

The Open University of Srilanka
B.Sc/B.Ed. Degree / Continuing Education Programme
Open Book Test- 2004/2005
Level 5 – Applied Mathematics
AMU 3186/AME 5186 – Quantum Mechanics



Duration : One and Half Hours

Date: 08/02/2006

Time: 4.00 p.m-5.30 p.m

Answer All Questions.

- (1) (a) Show that , in the Compton effect, the relation between the electron recoil angle ϕ and the photon scattering angle θ is

$$\tan \phi = \frac{\cot(\theta/2)}{1 + \frac{h\nu_0}{mc^2}}$$

- (b) An X ray photon of wave length 1.0 cm is incident on a stationary electron. If the photon scattering angle is 60° , find the electron recoil angle.

$$c = 3 \times 10^{10} \text{ cm/sec}$$

$$m = 9.108 \times 10^{-28} \text{ g}$$

$$h = 6.625 \times 10^{-27} \text{ erg.sec}$$

- (2) (a) Use the uncertainty relation to estimate the ground state energy of the following systems,

- (i) A harmonic oscillator of classical frequency ω .
- (ii) A particle lying on a table.

- (b) Prove that the operator equation ,

$$\hat{A}\psi(x) = \int_a^b G(x, x')(x')dx'$$

defines a linear operator.

(3) (a) Prove in the usual notation,

$$(i) \quad [\hat{A}\hat{B}, \hat{C}] = \hat{A}[\hat{B}, \hat{C}] + [\hat{A}, \hat{C}]\hat{B}$$

$$(ii) \quad \left[\hat{A}, \frac{1}{\hat{B}} \right] = - \left(\frac{1}{\hat{B}} \right) [\hat{A}, \hat{B}] \left(\frac{1}{\hat{B}} \right)$$

(b) Find the value of A , if ψ is a normalized wave function.

$$\psi = A \exp\left(\frac{i(x-x_0)}{a}\right) \exp\left(-\frac{(x-x_0)^2}{2a^2}\right),$$

Here x_0 and a are constants.