EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCE – 2012/2013

FIRST SEMESTER (APRIL/MAY 2015)

PH 201 ATOMIC PHYSICS AND QUANTUM MECHANICS

Time: 02 hours

Answer ALL Questions

Charge of an electron $e = 1.602 \times 10^{-19} C$

Mass of an electron $m_e = 9.109 \times 10^{-31} kg$

Velocity of light $c = 3 \times 10^{8} ms^{-1}$

Planck's constant $h = 6.625 \times 10^{-34} Js$

$eV = 1.602 \times 10^{-19} J$

1. What do you meant by *Compton effect*? Show that the change in the wavelength of a photon subject to Compton scattering by an electron is given by,

$$\Delta\lambda = \frac{h}{m_0 c}(1 - Cos\theta)$$

the symbols have their usual meanings.

A beam of X-rays of wavelength $1.00A^0$ is incident on a carbon target. The scattered X-rays are detected at an angle of 90^0 to the direction of the incident beam. Find the Compton wavelength shift.

2. (a) Explain the physical significance of the four quantum numbers, which characterize the eigen states of the electron in a hydrogen atom. Write down the allowed values for each quantum numbers?

(b) Write brief description on the following coupling schemes:

(i) Russel-Saunders (or *LS*) coupling

(ii) *jj* coupling

(c) For single electron atom, write down the spectroscopic notation for the possible energy levels of an electron with l = 2. Explain with suitable diagram how the energy levels will split up when the atom is placed in a week magnetic field. Hence state which one of these magnetic levels will have the highest energy.

3. What do you mean by *Zeeman Effect*? Distinguish between normal Zeeman effect and anomalous Zeeman effect.

Explain the effect of magnetic field on energy levels of an atom in Zeeman effect on the basis of quantum theory and obtain an expression for Zeeman shift.

The Zeeman components of a 500 *nm* spectral line are 0.0116 *nm* apart when the magnetic field is 1.00 *T*. Find the ratio of e/m for the electron.

4. If the wave function for an electron in one dimensional motion is given as

$$\Psi(x,t) = e^{i(kx-\omega t)},$$

then show that $\Psi(x,t)$ satisfies the time dependent Schrödinger equation,

$$-\frac{\hbar^2}{2m}\frac{\partial^2\Psi}{\partial x^2} + V\Psi = i\hbar\frac{\partial\Psi}{\partial t}.$$

The symbols have their usual meaning.

Write down time *in*dependent Schrödinger equation for the motion of a particle havir energy $E > V_0$ and mass m in one dimensional potential barrier is shown in the figur Using the boundary conditions, show that the transmission coefficient T_{co} is given by,

$$T_{co} = \frac{4\sqrt{E(E-V_0)}}{\left[\sqrt{E}+\sqrt{E-V_0}\right]^2}$$