EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCE - 2004/2005

SECOND SEMESTER (REPEAT)

EXTERNAL DEGREE

EXT PH-201 ATOMIC PHYSICS AND QUANTUM MECHANICS

Time: 2 hours.

Answer ALL Questions

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

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

Planck's constant $h = 6.63 \times 10^{-34} Js$

Permittivity in free space $\varepsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^2$

$1eV = 1.602 \times 10^{-19} J$

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

The symbols have their usual meanings.

1. State the postulates of Bohr Theory. Deduce the wavelength of the spectral lines in the Balmer line series for the single ionized Helium atom as,

$$\frac{1}{\lambda} = R_{He}\left(\frac{1}{4} - \frac{1}{n^2}\right)$$

Where R_{He} is the Rydberg constant for single ionized Helium.

If the shortest wave length of the spectral lines series is $0.91 \times 10^{-7} m$, find:

(i) A value for R_{He}

(ii) The longest wavelength in the series.

2. Derive Rutherford's Scattering formula and state the important features of Rutherford Scattering of α – particles by gold foil which supported the nuclear model of the ato against Thomson's model.

A stream of α – particles is bombardered on a mercury nucleus $(Z = 80)$ with velocit $1.0 \times 10^{-7} ms^{-1}$. If an α – particle is approaching the nucleus in head-on directio calculate the distance of closest approach. The mass of α – particle is $6.4 \times 10^{-27} kg$.

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

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

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

4. (a) Briefly explain the Heisenberg's uncertainty principle and give the mathematic expression for uncertainty in the energy.

The average period that elapses between the excitation of an atom and the time it emit radiation is 10^{-8} sec. Find the uncertainty in the energy emitted and uncertainty in th frequency of the light emitted.

(b) Explain briefly the photo electric effect and give Einstein's explanation for the same

A certain metal has a threshold wavelength of $600nm$. Find the stopping potential whe the metal is irradiated with,

(i) Monochromatic light of wavelength $400nm$.
(ii) Light having twice the frequency and three times the intensity of th wavelength $400nm$.