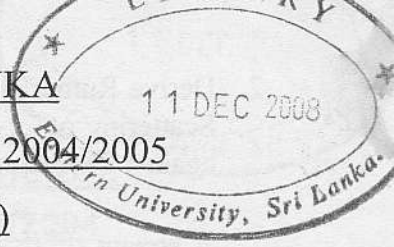


EASTERN UNIVERSITY, SRI LANKA  
SECOND EXAMINATION IN SCIENCE - 2004/2005  
SECOND SEMESTER (REPEAT)



EXTERNAL DEGREE

EXTPH-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  $\epsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^2$

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

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

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's Scattering of  $\alpha$ -particles by gold foil which supported the nuclear model of the atom against Thomson's model.

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

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

$$\Delta\lambda = \frac{h}{m_0c}(1 - \cos\theta)$$

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

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

The average period that elapses between the excitation of an atom and the time it emits radiation is  $10^{-8} \text{ sec}$ . Find the uncertainty in the energy emitted and uncertainty in the 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  $600 \text{ nm}$ . Find the stopping potential when the metal is irradiated with,

- (i) Monochromatic light of wavelength  $400 \text{ nm}$ .
- (ii) Light having twice the frequency and three times the intensity of the wavelength  $400 \text{ nm}$ .