EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCE - 2008/2009

FIRST SEMESTER (PROPER/REPEAT)

(February 2010)

PH 201 ATOMIC PHYSICS AND QUANTUM MECHANICS

me: 01 hour.

nswer ALL Questions

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ectron charge $e = 1.6 \times 10^{-19} C$

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

rmittivity in free space $\varepsilon_o = 8.85 \times 10^{-12} Fm^{-1}$

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

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

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

1. State the postulates of Bohr regarding his atomic model and hence obtain an expression for the electron energy of the n^{th} orbit. Hence show that the wavelength of an electromagnetic radiation emitted in a transition between two states of a Bohr atom is given by:

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^{\,2}} - \frac{1}{n_i^{\,2}}\right)$$

Where λ is the wavelength of the radiation, R is the Rydberg constant and n_i and n_f are integers.

Deduce the wavelength λ_α of the $H_\alpha - line$ in the Balmer series of $H-$atom and show that:

$$\frac{1}{\lambda_\alpha} = \frac{5R_H}{36},$$

where R_H is the Rydberg constant for $H-$atom.

Hence find the Rydberg constant, if the wavelength of $H_\alpha - line$ is $6563\times10^{-10}\,m$.

2. Explain briefly what do you understand by photoelectric effect and give Einstein's explanation for the photoelectric effect.

A certain metal has a threshold wavelength of $600nm$. Find the stopping potentials when the metal is irradiated with:

i. Monochromatic light of wavelength $400nm$.

ii. Light having twice the frequency and three times the intensity of wavelength $400nm$.

3. Explain what do you meant by Compton Effect?

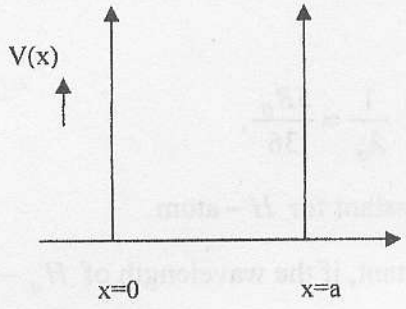
Show that the change in wavelength of a photon subject to Compton scattering by an electron is given by:

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

Where ϕ is the scattering angle of the photon and other symbols have their usual meanings.

A beam of X- rays of wavelength $0.01nm$ is incident on a carbon target. The scattered rays are detected at an angle of 60^0 to the direction of the incident beam. Find wavelength of the scattered X-rays.

4. Write down the time independent Schrödinger equation in a rectangular Cartesian ordinate system, for a particle of mass m and the energy E moving in a potential V. particle of mass m and the energy E moves inside a potential well $V(x)$ as shown in figure.



$$V(x) = 0 \text{ for } 0 \le x \le a,$$

$$V(x) \to \infty \text{ for } x < 0 \text{ and } x > a.$$

a. Write down the time independent Schrödinger equation for the motion of t particle.
b. State clearly the boundary conditions and the normalization condition for t wave function.
c. Using the above conditions, show that the wave function of the particle is giv by:

$$\Psi = \sqrt{\frac{2}{a}} Sin\left(\frac{n\pi}{a}\right)x.$$