EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCE - 2007/2008

FIRST SEMESTER (PROPER/REPEAT/ RE-REPEAT)

(DECEMBER 2008)

PH 201 ATOMIC PHYSICS AND QUANTUM MECHANICS

Time: 02 hours.

Answer ALL Questions

You may assume the following.

Velocity of light $c = 3\times10^{8}\,ms^{-1}$

Charge of electron $e = 1.6\times10^{-19}\,C$

Mass of electron $m_e = 9.1\times10^{-31}\,kg$

Planck constant $h = 6.62\times10^{-34}\,Js$

$\varepsilon_0 = 8.85\times10^{-12}\,Fm^{-1}$

$N_A = 6.023\times10^{23}\,atoms/mol^{-1}$

1. State the postulates of Bohr Theory. Drive an expression for wave lengths 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 wavelength of the spectral lines of this series is $0.91 \times 10^{-7}\,m$. Find,

(i) The value for R_{He} and

(ii) The longest wavelength in the series.

2. What do you mean by Photo Electric Effect?

Define the following terms in Photo Electric Effect.

(i) Threshold frequency

(ii) Stopping potential

(iii) Work function of a metal

Write down the Einstein's equation for Photo Electric Effect.

In a Photo electric experiment a light of wavelength $200nm$ falls on an aluminium surface. The work function of aluminium is $4.20eV$. Determine the following.

(i) The stopping potential

(ii) The kinetic energy of the fastest electron

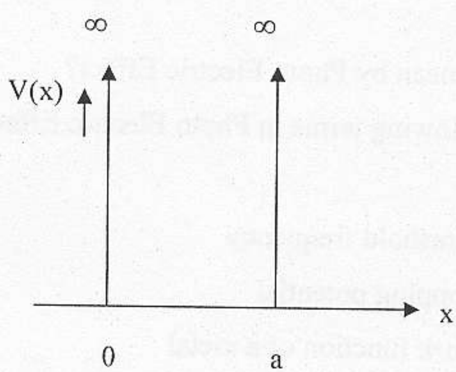
(iii) Threshold wavelength.

3. What is Compton effect?

Prove that, $\Delta\lambda = \frac{h}{m_0 c}(1 - Cos\phi)$, where the symbols have their usual meanings.

In Compton scattering the incident photons have wavelength $3 \times 10^{10}\, m$. Calculat wavelength of scattered radiation if they are viewed at an angle of 60^0 to the directi incidence.

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



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

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

(i) Write down the time independent Schrödinger equation for the m of the particle.

(ii) State clearly the boundary conditions and the normalization cond for the wave function.

(iii) Using the above conditions, show that the wave function of the par is,

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