PHYS 1512: Week 13

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Equations

$$\lambda' - \lambda = \frac{h}{mc}(1 - cos(\theta)) \quad \text{(Compton Scattering)} \tag{1}$$

$$E_i - E_f = n\frac{h}{2\pi}, n = 1, 2, 3... \quad \text{(Emitted Photon energy)} \tag{2}$$

$$L_z = m_\ell \frac{h}{2\pi} \quad \text{(Hydrogenic z - orbital angular momentum)} \tag{3}$$

$$L = \sqrt{\ell(\ell + 1)}\frac{h}{2\pi} \quad \text{(Hydrogenic total orbital angular momentum)} \tag{4}$$

$$r_n = (5.29 * 10^{-11} m)\frac{n^2}{Z}, n = 1, 2, 3... \quad \text{(Hydrogenic radius)} \tag{5}$$

$$E_n = -(13.6eV)\frac{Z^2}{n^2}, n = 1, 2, 3... \quad \text{(Hydrogenic energy levels)} \tag{6}$$

Line Spectra

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

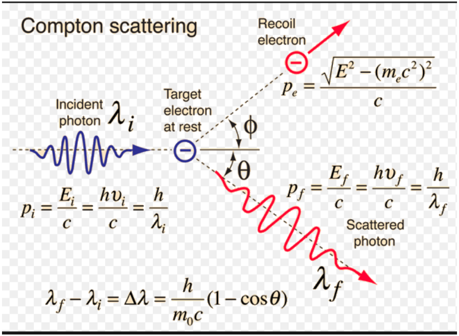
$$\begin{aligned} Lyman : n_f &= 1, \quad n_i{=}2,3,4... \\ Balmer : n_f &= 2, \quad n_i{=}3,4,5... \\ Paschen : n_f &= 3, \quad n_i = 4,5,6... \end{aligned}$$

With $R = 1.09678 * 10^7 m^{-1}$

Question #1

Straight outta Compton

In a compton scattering experiment, the incident X-rays have a wavelength of 0.2685 nm, and the scattered X-rays have a wavelength of 0.2703nm. Through what angle θ are the X-rays scattered?



Question #2

Spectral hopscotch

Find the energy (in joules) of the photon that is emitted when the electron in a hydrogen atom undergoes a transition from the n=7 energy level to produce a line in the Paschen series.

Question #3

Faster than a speeding proton

For an electron in a hydrogen atom, the z-component of the angular momentum has a maximum value $L_z = 4.22 * 10^{-34}$Js. Find the three smallest possible values (i.e. the most negative values) for the total energy (in eV) that this atom could have.

Question #4

What's really down in an atom?

In the hydrogen atom, what is the total energy (in eV) of an electron that is in an orbit that has a radius of $4.761{*}10^{-10}m$?

Question # 5

Electric potential energy in motion

The electron in a hydrogen atom is in the first excited state, when the electron acquires an additional 2.86eV of energy. What is the quantum number "n" of the state into which the electron moves?