Answer on Question #58601-Physics-Quantum Mechanics

Q. A 511 kev gamma ray photon is Compton scattered form a free electron in an aluminum block. What is wavelength of incident photon? What is wavelength of scattered photon? What is energy of scattered photon?

Solution

Energy E of a photon having wavelength λ can be written as

$$E = \frac{1240\ eV \cdot nm}{\lambda}.$$

The wavelength of incident photon is

$$\lambda = \frac{1240\ eV \cdot nm}{511 \cdot 10^3\ \text{ev}} = 2.43\ pm.$$

The wavelength of scattered photon is

$$\lambda' = \lambda + \frac{h}{m_e c}(1 - \cos\theta), \qquad \frac{h}{m_e c} = 2.43\ pm,$$

where θ is a scattering angle.

$$\lambda' = 2.43\ pm + 2.43\ pm(1 - \cos\theta) = 2.43(2 - \cos\theta)\ pm$$

The energy of scattered photon is

$$E = \frac{1240\ eV \cdot nm}{\lambda'} = \frac{1240\ eV \cdot nm}{2.43(2 - \cos\theta)\ pm} = \frac{511}{(2 - \cos\theta)}\ keV.$$

Q. show that ΔE/E = hf'/moc2(1-cos ɵ)

Solution

$$\lambda' = \lambda + \frac{h}{m_e c}(1 - \cos\theta)$$

$$E' = \frac{\text{hc}}{\lambda'};\ E = \frac{\text{hc}}{\lambda}.$$

$$\frac{\Delta\text{E}}{\text{E}} = \frac{\frac{\text{hc}}{\lambda'} - \frac{\text{hc}}{\lambda}}{\frac{\text{hc}}{\lambda}} = \frac{\lambda - \lambda'}{\lambda'} = \frac{-\frac{h}{m_e c}(1 - \cos\theta)}{\frac{\text{c}}{f'}} = -\frac{hf'}{m_e c^2}(1 - \cos\theta)$$

$$\left|\frac{\Delta\text{E}}{\text{E}}\right| = \frac{hf'}{m_e c^2}(1 - \cos\theta)$$