AP Phys 2 Unit 6.2 Notes - The Compton Effect

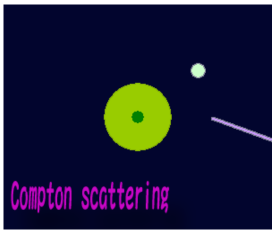
6.2 The Compton Effect

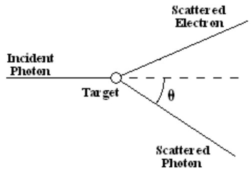
Straight Outta Compton Scattering!

The Compton Effect

Gamma and X-Rays striking materials (such as metals) undergo Compton scattering photons deflect at specific angles with an increase in wavelength, corresponding to an energy loss.

For other types of EM radiation, wavelength change is negligible.

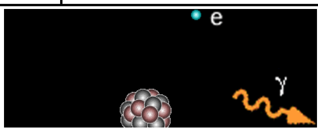




Compton Scattering Math

The photon's collision with matter also ejects an electron: some of the photon's energy is absorbed by the electron.

$\Delta\lambda = \lambda - \lambda_0$ $= \lambda_C(1-\cos\theta)$	$\Delta\lambda$ = wavelength shift (m) λ = wavelength of scattered light (m) λ_0 = wavelength of incident light (m) λ_C = Compton wavelength Constant 2.43 E -12 m θ = angle of scattered light



A Note on Scattering Angle

Scattering angle is measures how much a wavelength shifts.
0 degrees represents the minimum, and 180 degrees represents the maximum shift.

Incident Light

0° = No Shift

$$\Delta\lambda = \lambda_C(1-\cos 0^\circ)$$
$$= \lambda_C(1-1) = 0$$

180° = Double Compton Wavelength Shift

$$\Delta\lambda = \lambda_C(1-\cos 180^\circ)$$
$$= \lambda_C(1-(-1)) = 2\lambda_C$$

90° = Compton Wavelength Shift

$$\Delta\lambda = \lambda_C(1-\cos 90^\circ)$$
$$= \lambda_C(1-0) = \lambda_C$$

Examples

X-rays of wavelength 1.35 E - 10 m hit a metal foil and scatter. If the angle of the photons is 55°:

1. What is the new wavelength of scattered light?

2. By what percent did the wavelength increase?

Answers

To calculate new wavelength, use angle and initial wavelength, with Compton's constant:

$$\Delta\lambda = \lambda - \lambda_0 = \lambda_C(1-\cos\theta)$$
$$\lambda = \lambda_C(1-\cos\theta) + \lambda_0$$
$$= 2.43E-12\,m(1-\cos 55^\circ) + 1.35E-10\,m$$
$$= 1.36E-10\,m$$

The percent change is the difference in wavelength divided by the original:

$$\% = \frac{\Delta\lambda}{\lambda_0}$$
$$= \frac{1.36E-10\,m - 1.35E-10\,m}{1.35E-10\,m} \bullet 100\%$$
$$= \boxed{0.74\%}$$

Homework 6.2
Problems 6.2 in your Booklet
Due: Next Class