

## Compton Scattering

**Unit:** Quantum and Particle Physics

**NGSS Standards/MA Curriculum Frameworks (2016):** N/A

**AP® Physics 2 Learning Objectives/Essential Knowledge (2024):** 15.6.A, 15.6.A.1, 15.6.A.2, 15.6.A.2.i, 15.6.A.2.ii, 15.6.A.3

**Mastery Objective(s):** (Students will be able to...)

- Describe the interaction between photons and matter using Compton scattering.

**Success Criteria:**

- Descriptions & explanations are accurate and account for observed behavior.

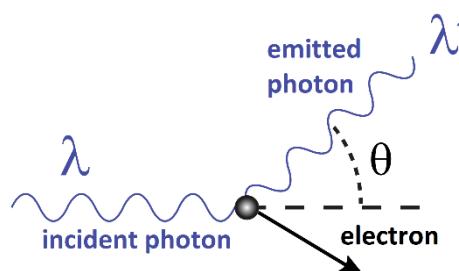
**Language Objectives:**

- Explain the important features of each model of the atom.

**Tier 2 Vocabulary:** scattering

### Notes:

In 1923, American physicist Arthur Compton performed an experiment in which a photon collided with an electron. The collision caused a transfer of momentum and energy to the electron, which therefore caused the photon to emerge with less momentum and less energy (and therefore a different frequency and wavelength).



This experiment proved that photons exhibit particle behavior and cannot be considered to be only waves.

Applying the equations:

$$E = hf \quad \text{and} \quad \lambda = \frac{h}{p} = \frac{h}{m_e c}$$

gives the following equation:

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

where:

- $\Delta\lambda$  = change in wavelength between the incident photon and the emitted photon
- $h$  = Planck's constant =  $6.63 \times 10^{-34}$  J·s
- $m_e$  = mass of an electron =  $9.11 \times 10^{-31}$  kg
- $c$  = speed of light =  $3.00 \times 10^8 \frac{\text{m}}{\text{s}}$
- $\theta$  = angle of emitted photon relative to direction of incident photon