PHOTOELECTRIC EFFECT

Einstein’s theory:

1. Light is made of photons (particles) of energy $E = hf$.
2. A single electron is ejected by a single photon (photon vanishes).
3. If $E < \phi$, then electron cannot be freed.
4. If $E > \phi$, then the electron is freed and has KE: $K_{\text{max}} = hf - \phi$.

Wavelength matters, but intensity does not.

Memorize two equations from last class.
COMPTON EFFECT

Momentum and Energy are conserved.

\[ \Delta \lambda = \lambda_{COMP} (1 - \cos\theta) \]

where

\[ \lambda_{COMP} = \frac{h}{m_e c} = 2.43 \times 10^{-12} \text{m} = 2.43 \text{ pm} \]

Memorize (see page 82)
CORRESPONDENCE PRINCIPLE

Previously in special relativity: in the case of low speeds, Lorentz transformations are well-modeled by Galilean transformation.

In quantum mechanics: in the case of long wavelengths, radiation is well-modeled as a continuous wave. Because in such a case $E = hf = hc/\lambda$ the photon’s energy is low, and the intensity of the radiation must be due to a lot of photons rather than a few individual ones.

Example: calculate the (Compton) scattered wavelength $\lambda_f$ in two cases. In both cases $\theta = 90^\circ$, but in the first case $\lambda_i = 0.05$ nm and in the second $\lambda_i = 500$ nm. (Give answers to 3 sig. figs. in nm.)

$$\Delta \lambda = \lambda_{COMP} (1 - \cos \theta) \text{ where}$$
$$\lambda_{COMP} = \frac{h}{m_e c} = 2.43 \times 10^{-12} \text{ m} = 2.43 \text{ pm}$$
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PAIR PRODUCTION
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WAVE-PARTICLE DUALITY

When $\lambda > D$, a wave is detected.

When $\lambda \ll D$, a particle is detected.

$\lambda \ll D$: particle
$\lambda \geq D$: wave

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Complete assignment