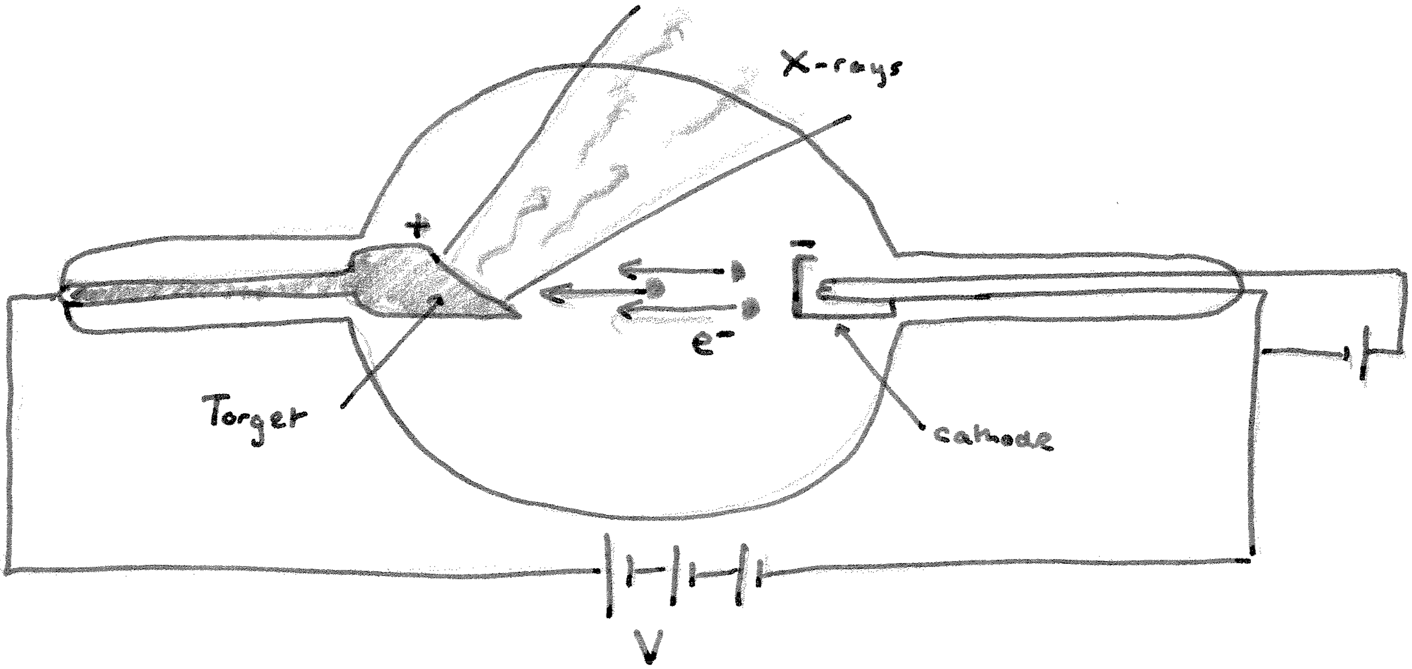
38.7 COMPTON SCATTERING + X-RAYS.



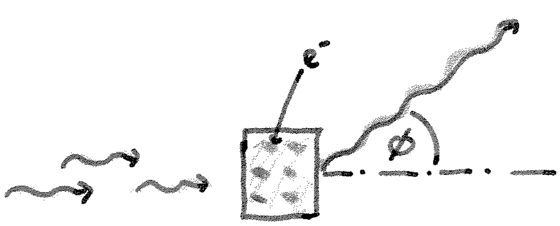
$$\boxed{eV = K_{e^-} = hf_{max} = hc/\lambda_{min}}$$

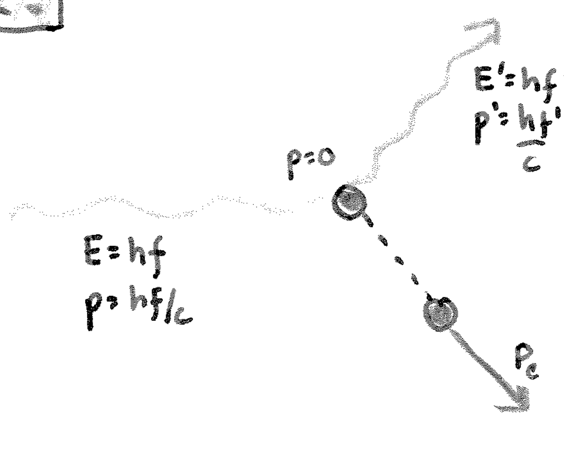
$$\lambda_{min} = \frac{hc}{eV} = \frac{6.63\times10^{-34}\,Js \times 3\times10^{8}\,m/s}{1.6\times10^{-19}\ V}$$

$$= \frac{1.24\times10^{-6}\ volt\cdot m}{V}$$

$V = 50{,}000\,V$

$$\lambda = \frac{1.24\times10^{-6}}{50{,}000} = 2.5\times10^{-11}\,m = \underline{\underline{0.25\,\text{Å}}}$$

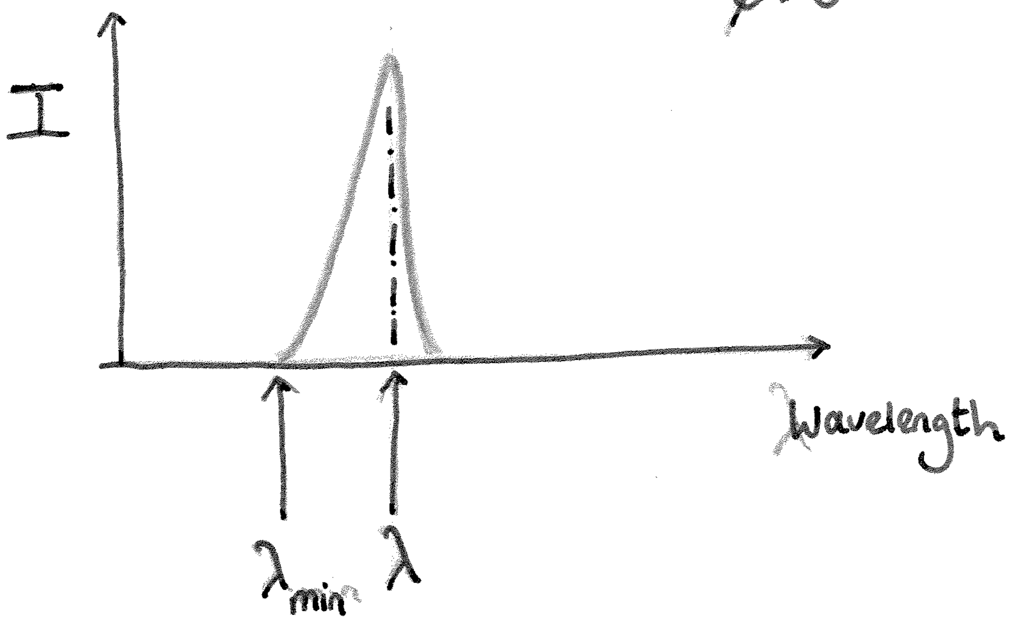




$$\boxed{\lambda' - \lambda = \frac{h}{m_e c}(1 - \cos\theta)}$$

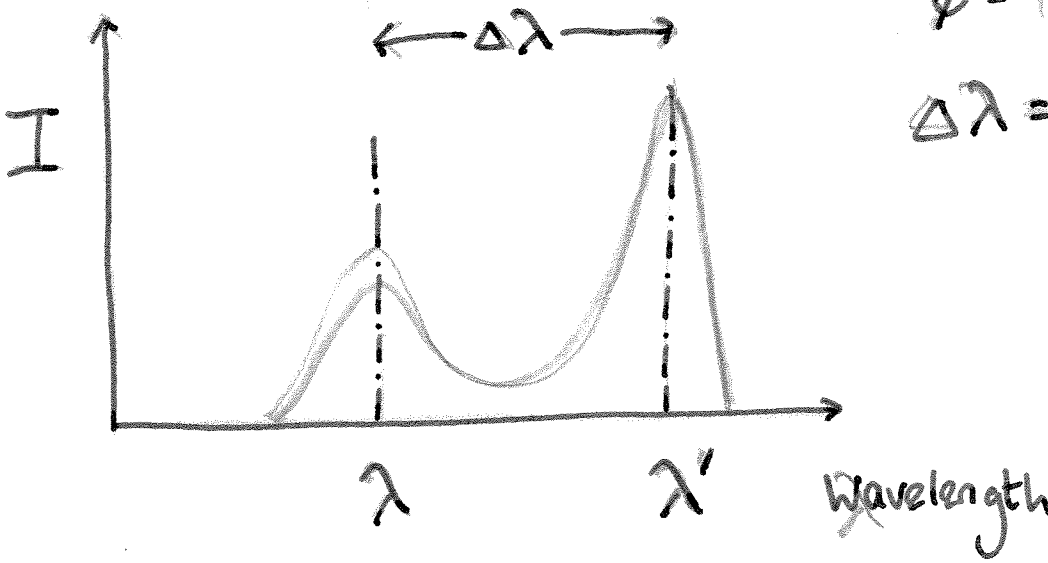
$$\frac{h}{m_e c} = 2.43\times10^{-12}\,m$$

$\phi = 0$



$\phi = 90°$

$\Delta\lambda = \frac{h}{mc}$



Proof of Compton Formula.

First note that the energy + momentum of the outgoing e^- are

$$\left.\begin{aligned} \frac{E}{c} &= mc\gamma \\ p_e &= mu\gamma \end{aligned}\right\} \quad \left(\frac{E}{c}\right)^2 - p_e^2 = m^2c^2 \tag{1}$$

$$E = mc^2 + hf' - hf$$

$$\Rightarrow \frac{E}{c} = mc + p' - p \quad \Rightarrow \left(\frac{E}{c}\right)^2 = (mc + p' - p)^2 \tag{2}$$

$$\vec{p}_e = \vec{p} - \vec{p}\,'$$

$$\Rightarrow p_e^2 = p^2 + p'^2 - 2pp'\cos\theta \quad (3)$$

$$\begin{aligned} \left(\frac{E}{c}\right)^2 - p_e^2 &= (mc + p - p')^2 - (p^2 + p'^2 - 2pp'\cos\theta) \\ &= m^2c^2 + 2mc(p - p') + 2pp'(\cos\theta - 1) \\ &= m^2c^2 \qquad (\text{by } 1) \end{aligned}$$

$$\Rightarrow mc(p - p') = pp'(1 - \cos\theta)$$

$$\Rightarrow \left(\frac{1}{p'} - \frac{1}{p}\right) = \frac{1}{mc}(1 - \cos\theta) \Rightarrow \left(\frac{h}{p'} - \frac{h}{p}\right) = \frac{h}{mc}(1 - \cos\theta)$$

$$\lambda' - \lambda = \frac{h}{mc}(1 - \cos\theta)$$