C38-34 Compton scattering

$$\lambda' - \lambda_0 = \Delta\lambda = \frac{h}{m_e c}(1-\cos\theta)$$, h - planck's constant, m_e - electron mass, θ - scattered angle

Scatter wavelength is λ', λ_0 is the incoming wave's wavelength.

$$\lambda' = \lambda_0 + \frac{h}{m_e c}(1-\cos\theta)$$

Energy of incoming photon with λ_0: $E_0 = \frac{hc}{\lambda_0}$

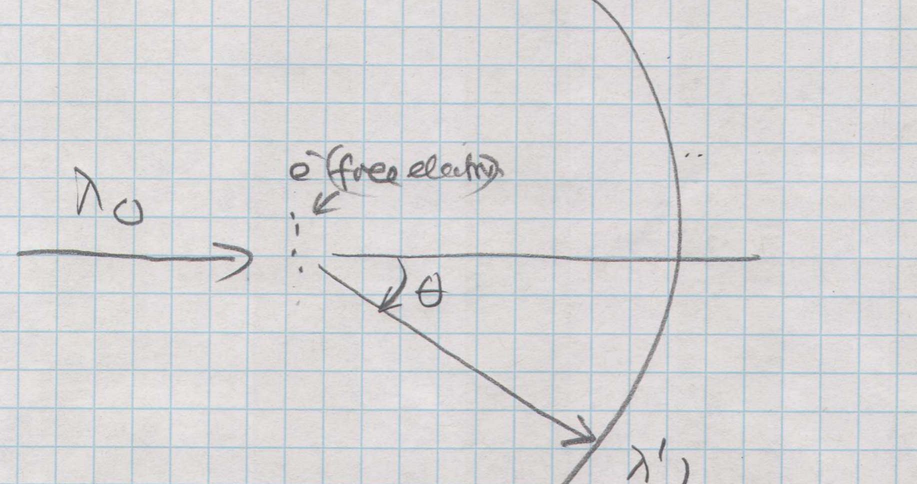
Energy of scattered photon with λ': $E' = \frac{hc}{\lambda'}$

Difference in photon energy $\Delta E = E_0 - E'$

Conservation of energy requires that the change in photon energy is taken up by the increase of kinetic energy of the scattered electron

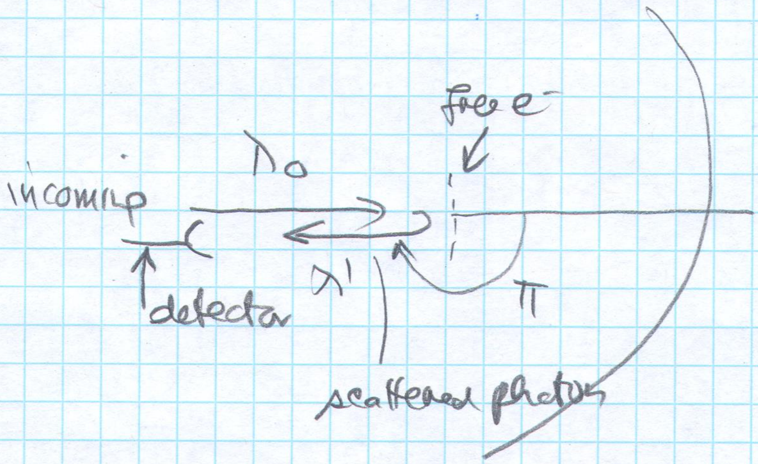
$$\Delta E = KE_e = E_0 - E' = (hc)\left(\frac{1}{\lambda_0} - \frac{1}{\lambda'}\right)$$

with $\lambda' = \lambda_0 + \frac{h}{m_e c}(1-\cos\theta)$ $\theta = 90°$



P2

e38-37



$$\lambda' - \lambda_0 = \frac{h}{m_e c}(1 - \cos\theta) \qquad \text{with } \theta = \pi$$

$$\lambda' = \lambda_0 + \frac{h}{m_e c}(1 - \cos\theta)$$

Energy of incomip photon (initial photon) $= h\nu_0 = \dfrac{hc}{\lambda_0} = E_0$

" " scattered photon " " " $= h\nu' = \dfrac{hc}{\lambda'} = E'$

$$E' = \frac{hc}{\lambda'} = \frac{hc}{\left[\lambda_0 + \frac{h}{m_e c}(1 - \cos\theta)\right]}$$

with $\theta = \pi$ (back scattered)

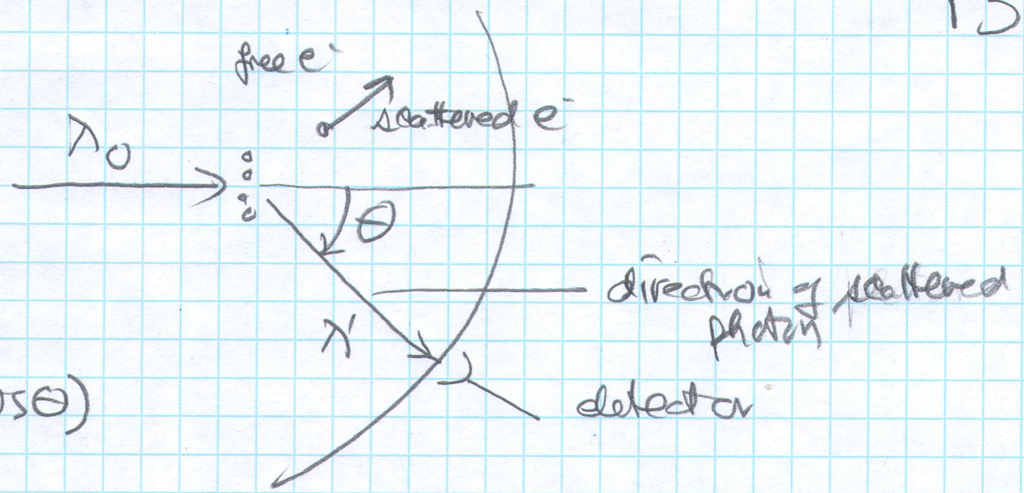
$\cos\pi = -1$

$$= \frac{hc}{\left(\frac{hc}{E_0}\right) + \frac{h}{m_e c}(2)}$$

$$= \frac{1}{\left(\frac{1}{E_0} + \frac{2}{m_e c^2}\right)} \quad //$$

$$KE \text{ of } e^- = \Delta E = E_0 - E' \quad //$$

C38-41



$\lambda_0 = 590\text{nm}.$

$$\Delta\lambda = \lambda' - \lambda_0 = \frac{h}{m_e c}(1-\cos\theta)$$

$h = 6.626\times10^{-34}$ J.s

m_e = mass of e^- = 9.109×10^{-31} kg

$c = 2.998\times10^{8}\ \text{ms}^{-1}$

$\theta = 90^\circ$ given

(a) Find $\Delta\lambda = \frac{h}{m_e c}(1-\cos 90)$ //

(b) $$\frac{\Delta\lambda}{\lambda_0} = \frac{\frac{h}{m_e c}(1-\cos 90)}{\lambda_0}$$ //

(c) E' = energy of scattered photon $= h\nu' = \frac{hc}{\lambda'}$

and $\lambda' = \lambda_0 + \Delta\lambda$. //

Calculate $\Delta\lambda$, $\frac{\Delta\lambda}{\lambda_0}$ & E' with incoming photon given in energy E_0
Since E_0 is given, find λ_0 then find λ' then use the above equations to find $\Delta\lambda$, $\frac{\Delta\lambda}{\lambda_0}$ & E'

P4

38-46 deBroglie wavelength (λ) of a Quantum particle

Find: $\lambda = \frac{h}{p}$

$$E = \frac{1}{2}mv^2 = \frac{1}{2}\frac{m^2v^2}{m} = \frac{1}{2}\frac{p^2}{m}$$

$\therefore p^2 = 2mE$ or $p = \sqrt{2mE}$ sub to deBroglie equation

$$\lambda = \frac{h}{\sqrt{2mE}}$$

(a) For electron $\lambda = \frac{h}{\sqrt{2m_e E_e}}$

$E_e = 1\,KeV = (10^3)(1.602\times10^{-19})\,J$

$m_e = 9.109\times10^{-31}\,kg$

$h = 6.626\times10^{-34}\,J.S$

Make sure the unit is correct. λ will be in meters

(c) For neutron $\lambda = \frac{h}{\sqrt{2m_n E_N}}$ $E_N = 1.KeV = (10^3)(1.602\times10^{-19})\,J$

(b) For photon $E = eV = \frac{hc}{\lambda}$ λ = photon wavelength

$\lambda = \frac{hc}{E}$ and $E = 1.KeV = (10^3)(1.6\times10^{-19})\,J$

$c = 2.99\times10^8\,ms^{-1}$

unit for λ is in meter

Ch 38 -50. $E_e = 50\text{ GeV} = \underline{50 \times 10^9 \text{ eV}}$

P5

Assume $p = \frac{E}{c}$ and since $\lambda = \frac{h}{p}$ (de Broglie)

sub $p = \frac{E}{c}$ to $\lambda = \frac{h}{p} = \frac{hc}{E}$

the corresponding electron wave length $\lambda_e = \frac{hc}{E}$ //

ratio of typical nuclei to e^- wavelength

$$\frac{R}{\lambda_e} = \frac{5 \times 10^{-15}\text{ m}}{\left(\frac{hc}{E}\right)}. \quad //$$

E in joules.
h in J.s
c in ms^{-1}

make sure the unit is correct