1 Compton Scattering

Photon energy $= hc/\lambda$ Photon momentum $= h/\lambda$ $v = 2c$
we have

$$mc^2 + \frac{hc}{\lambda_0} = \frac{hc}{\lambda_1} + \sqrt{m^2c^4 + p^2c^2}$$
$$\frac{h}{\lambda_0} = \frac{h}{\lambda_1}\cos\theta + p\cos\phi$$
$$\frac{h}{\lambda_1}\sin\theta = p\sin\phi$$

From the last 2,

$$p^2 = \left(\frac{h}{\lambda_0} - \frac{h}{\lambda_1}\right)^2 + \frac{2h^2}{\lambda_0\lambda_1}(1-\cos\theta)$$

From the first,

$$p^2 = \left(\frac{h}{\lambda_0} - \frac{h}{\lambda_1}\right)^2 + 2mc\left(\frac{h}{\lambda_0} - \frac{h}{\lambda_1}\right)$$

$$\lambda_c = \frac{h}{mc}$$

c,d,e

2 Practice with delta functions

44
-2.5

3 Gaussian wave packets and Heisenberg uncertainty relation

a) $|\psi^2| = \frac{1}{\sqrt{2\pi}w_0}e^{-x^2/2w_0}$
$I = \frac{1}{\sqrt{2\pi}w_0}\int e^{-t^2}\sqrt{2}w_0 dt = 1$
b) 0, 0
c) $I = 1/\sqrt{2\pi}w_0 \int x^2 e^{-x^2/2w_0^2}dx = 1/\sqrt{2\pi}w_0 \int 2w_0^2 t^2 e^{-t^2}\sqrt{2}w_0 dt = w_0^2$
d) $\langle x^2\rangle\langle p^2\rangle = \hbar^2 k_0^2 w_0^2 = \hbar^2/4$
e) $\bar{\phi}(k) = A\int e^{-x'^2/4w_0^2}e^{-ikx'}e^{-ikx_0}dx' = e^{-ikx_0}\phi(k)$
same momentum distribution

4 Childish precision experiment