HW 9/27

3.36)

a) $\Delta\lambda = \frac{h}{m_e c}(1-\cos\theta)$ $\quad$ $\Delta\lambda$ is at its max when $\cos\theta = -1, \rightarrow \theta = \pi = 180°$.

$\Delta\lambda = \frac{h}{m_e c}(1-(-1)) = \frac{2\cdot(6.63\cdot10^{-34})}{(9.11\cdot10^{-31})(3\cdot10^{8})} \rightarrow \boxed{\Delta\lambda = 0.00485 \text{ nm}}$

b) $\Delta\lambda = \frac{2\cdot(6.63\cdot10^{-34})}{(1.67\cdot10^{-27})(3\cdot10^{8})} = \boxed{0.000\,00265 \text{ nm}}$

c) The electron collision is more likely to reveal the photon's particle nature. $\Delta\lambda$ for the proton was very small.

3.54) a) Momentum : $\gamma_{0.8}\, m_i(0.8c) - \frac{h}{\lambda} = \gamma_{0.6}\, m_F(0.6c)$

Energy: $\gamma_{0.8} m_i c^2 + \frac{hc}{\lambda} = \gamma_{0.6} m_F c^2$

$\gamma_{0.8} m_i c + \frac{h}{\lambda} = \gamma_{0.6}\, m_F c$

Adding these equations together:

$$\gamma_{0.8}\, m_i(0.8c) + \cancel{\frac{h}{\lambda}} + \gamma_{0.8} m_i c - \cancel{\frac{h}{\lambda}} = \gamma_{0.6}\, m_F(0.6c) + \gamma_{0.6}\, m_F c$$

$$\gamma_{0.8}\, m_i(1.8c) = \gamma_{0.6}\, m_F(1.6c)$$

$$\frac{\gamma_{0.8}(1.8\cancel{c})}{\gamma_{0.6}(1.6\cancel{c})} = \frac{m_F}{m_i}$$

$$\frac{m_F}{m_i} = \frac{\frac{5}{3}(1.8)}{\frac{5}{4}(1.6)} = \boxed{1.5}$$

b) The mass increases, so kinetic energy must decrease.

3.42) A mass / internal energy of $2m_ec^2$ disappears, so each photon must have m_ec^2 of energy.

$$m_ec^2 = (9.11\cdot10^{-31}\,kg)(3\cdot10^8\,m/s)^2 = 8.2\cdot10^{-14}\,J = \boxed{511\,keV}$$

$$E = \frac{hc}{\lambda} \rightarrow \lambda = \frac{hc}{E}$$

$$\lambda = \frac{(6.63\cdot10^{-34}\,Js)(3\cdot10^8\,m/s)}{(8.2\cdot10^{-14}\,J)} = \boxed{2.42\cdot10^{-12}\,m}$$

ep14)

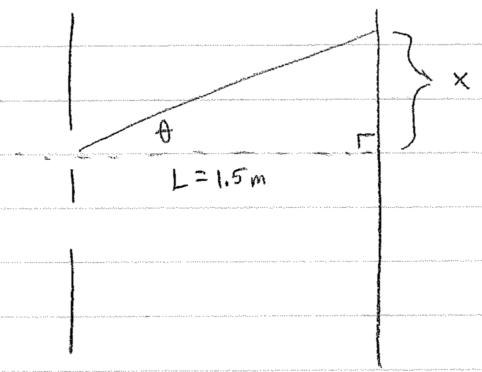
$d = 0.075\,mm$

$L = 1.5\,m$

$\lambda = 532\,nm$

$m = 3$

$d\sin\theta = m\lambda$



$$\theta = \sin^{-1}\left(\frac{m\lambda}{d}\right) = 1.22°$$

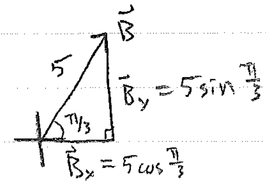
$\tan\theta = \frac{x}{L}$ $\quad x = L\tan\theta \rightarrow \boxed{x = 0.031927\,m}$

ep15) a) $\vec{A}\cdot\vec{B} = \langle 0,3\rangle \cdot \langle 5,0\rangle = 0$

b) $\vec{A}\cdot\vec{B} = \langle 0,3\rangle \cdot \langle 0,5\rangle = 0(0) + 3(5) = 15$

c) $\vec{A}\cdot\vec{B} = \langle 0,3\rangle \cdot \langle 0,-5\rangle = 0(0) + 3(-5) = -15$

d)



$$\vec{A}\cdot\vec{B} = \langle 0,3\rangle \cdot \langle 5\cos\tfrac{\pi}{3}, 5\sin\tfrac{\pi}{3}\rangle$$

$$= 0(5\cos\tfrac{\pi}{3}) + 3(5\sin\tfrac{\pi}{3}) = 15\cdot\frac{\sqrt{3}}{2} = \boxed{\frac{15\sqrt{3}}{2}}$$