Phys 232 Assignment 3 March 26, 2020

1- $d_1 = \frac{d_0}{\sqrt{2}} = \frac{4\,\text{Å}}{\sqrt{2}} = 2.8284\,\text{Å}$

$2d_1 \sin\theta_n = n\lambda \Rightarrow \sin\theta_n = \frac{n\lambda}{2d_1}$

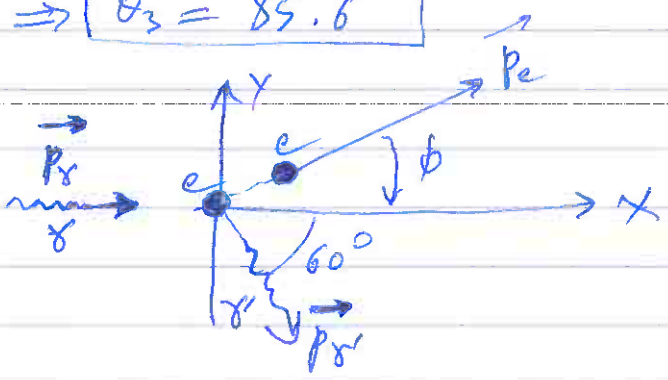
$n=1$: $\sin\theta_1 = \frac{\lambda}{2d_1} = \frac{1.88}{(2)(2.8284)} = 0.33234 \Rightarrow \boxed{\theta_1 = 19.4^\circ}$

$n=2$: $\sin\theta_2 = \frac{2\lambda}{2d_1} = 0.66468 \Rightarrow \boxed{\theta_2 = 41.7^\circ}$

$n=3$: $\sin\theta_3 = \frac{3\lambda}{2d_1} = 0.99702 \Rightarrow \boxed{\theta_3 = 85.6^\circ}$

2- (a) $\lambda_0 = \frac{c}{f} = \frac{hc}{hf} = \frac{1240\,\text{eV.nm}}{2\,\text{MeV}}$

$\boxed{\lambda_0 = 0.000620\ \text{nm}}$



(b) $\lambda' = \lambda_0 + \frac{h}{m_e c}(1 - \cos 60^\circ) = 0.000620 + 0.00243\,(1 - 0.5)$

$= 0.000620 + 0.001215 = 0.001835\ \text{nm} = \boxed{0.00184\ \text{nm}}$

(c) $E_\gamma' = hf' = \frac{hc}{\lambda'} = \frac{1240\,\text{eV.nm}}{0.00184\,\text{nm}} = 675749\,\text{eV} = \boxed{0.676\,\text{MeV}}$

(d) $K_e = 2.00 - 0.67575 = 1.32425\,\text{MeV} = \boxed{1.32\,\text{MeV}}$

(e) Conservation of momentum:

X: $p_\gamma = p_e \cos\phi + p' \cos 60^\circ \Rightarrow p_e \cos\phi = p_\gamma - p_\gamma' \cos 60^\circ \quad ...(1)$

Y: $0 = p_e \sin\phi - p_\gamma' \sin 60^\circ \Rightarrow p_e \sin\phi = p_\gamma' \sin 60^\circ \quad ...(2)$

Divide (2) by (1) $\Rightarrow \tan\phi = \frac{p_\gamma' c \sin 60^\circ}{p_\gamma c - p_\gamma' c \cos 60^\circ} = \frac{E_\gamma' \sin 60^\circ}{E_\gamma - E_\gamma' \cos 60^\circ}$

$\tan\phi = \frac{0.675749 \sin 60^\circ}{2.00 - (0.67657)\cos 60^\circ} = \frac{0.58517}{1.66215} = 0.352056$

$\boxed{\phi = 19.4^\circ}$