HW # 4

4-7 $K = 0.020\ eV$

a) $p = \sqrt{2 m_{He} K}$ $m_{He}c^2 = 2(939.6 + 938.3)\ MeV = 3755.8\ MeV$

$$p = \frac{1}{c}\sqrt{2 \cdot (3755.8\ MeV)(2 \times 10^{-2}\ eV)}$$

$$= \frac{1}{c}\sqrt{1.50 \times 10^{8}}\ eV$$

$$= \frac{1}{c}\, 1.22 \times 10^{4}\ eV$$

$$\lambda = \frac{h}{p} = \frac{hc}{pc} = \frac{1.24 \times 10^{3}\ eV\ nm}{1.22 \times 10^{4}\ eV}$$

$$= 0.10\ nm$$

b) Spacing between max $\approx 8\ \mu m$ in Fig 4.12, p. 109

Use Eq. on p. 108 with

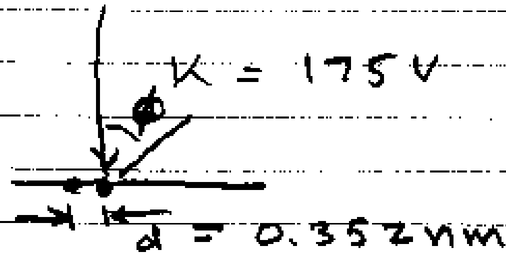
$D = .64\ m$, $d = 8\ \mu m$

$$\lambda = \frac{(8 \times 10^{-6}\ m)(8 \times 10^{-6}\ m)}{0.64\ m}$$

$$= 1 \times 10^{-10}\ m \sim 0.1\ nm$$

about same ...

4-11



what θ give maxima?

use

$$d \sin\phi = n\lambda$$

only works for $n\lambda > d$

find

$$\lambda = \frac{h}{p} = \frac{hc}{pc} = \frac{hc}{\sqrt{2m_e c^2 K}}$$

$$= \frac{1.24 \times 10^3\ \cancel{eV}\cdot nm}{\sqrt{2(5.11\times10^5\,\cancel{eV})(1.75\times10^2\,\cancel{eV})}}$$

$$= \frac{1.24 \times 10^3}{1.34 \times 10^4}\ nm$$

$$= 0.93 \times 10^{-1}\ nm$$

$$= 0.093\ nm$$

$\lambda = .093\ nm \rightarrow \quad \phi = \sin^{-1}(\lambda/d) = 15°$

$2\lambda = .185\ nm \rightarrow \quad = \sin^{-1}(2\lambda/d) = 32°$

$3\lambda = .278\ nm \rightarrow \quad = \sin^{-1}(3\lambda/d) = 52°$

$4\lambda = .370\ nm$ —

6-7 Want K for closest approach of α particle to Au nucleus of $7 \times 10^{-15}\,m$

Just use (6.22), p. 184:

$$d = 7 \times 10^{-15}\,m = \frac{\overset{z_{He}}{2} \cdot \overset{Z_{Au}}{79} \cdot (1.44\,eV\,nm)}{K} \qquad \frac{e^2}{4\pi\epsilon_0}$$

$$K = \frac{2 \cdot 79 \cdot 1.44\,eV\,\cancel{nm}}{7 \times 10^{-6}\,\cancel{nm}}$$

$$= 33 \times 10^6\,eV$$

$$= 33\,MeV$$

6-16 $n=3$ of H

v, K and U for the electron orbit

radius $r_3 = a_0 \cdot 3^2 = 9\,(0.0529\text{ nm})$

(6.31 & 6.32)

$= 0.476\text{ nm}$

• $v = \frac{n\hbar}{m r_3} = \frac{3\hbar}{m(0.476\text{ nm})}$

$\frac{v}{c} = \frac{3 \times \hbar c}{mc^2\,(0.476\text{ nm})}$

$= \frac{3}{2\pi}\,\frac{hc}{mc^2\,(0.476\text{ nm})}$

$= \frac{1}{3}(1.43)\,\frac{1.24 \times 10^3\text{ eV nm}}{(5.11 \times 10^5\text{ eV})(0.476\text{ nm})}$

$= \underbrace{\frac{1}{3}\,0.729}_{0.243} \times 10^{-2} = \frac{1}{3}\,\frac{1}{137}$

• $K = \frac{1}{8\pi\varepsilon_0}\,\frac{e^2}{r}$ (6.26)

$= \frac{1}{2}\left(\frac{e^2}{4\pi\varepsilon_0}\right)\frac{1}{9a_0}$

$= \frac{1}{2}\,(1.44\text{ eV nm})\,\frac{1}{0.476\text{ nm}}$

$= 1.51\text{ eV}$

• $U = -\frac{1}{4\pi\varepsilon_0}\,\frac{e^2}{r} = -2K = -3.02\text{ eV}$

also

$$v = \frac{n\hbar}{m r_n} = \frac{n\hbar}{m\, n^2 a_0}$$

$$= \frac{\hbar}{\cancel{m}\cdot n}\;\frac{\cancel{m}e^2}{4\pi\epsilon_0 \hbar^2}$$

$$= \frac{e^2}{4\pi\epsilon_0}\,\frac{1}{\hbar}\cdot\frac{1}{n}$$