phys 225 homework due Oct 30.

4.5 $E = hf = hc/\lambda = \dfrac{1240 \text{ eV}\cdot\text{nm}}{400\text{nm}} = 3.1 \text{ eV} - \text{max}$

$E \propto \frac{1}{\lambda}$ so for 700nm $E = E(400\text{nm})\frac{400}{700} = 1.8\text{eV} - \text{min}$

4.9 a) no. microwaves have $\lambda >$ light and light has $E < 4\text{eV}$.

b) $E = hc/\lambda \rightarrow \lambda = hc/E = 1240/4 = 310\text{nm}$

c) this is ultraviolet

4.12 photon $1.9\text{ev} \leq E = hc/\lambda$ to eject electron

a) so $\lambda \leq \dfrac{hc}{1.9\text{ev}} = \dfrac{1240}{1.9} = 650 \text{ nm}$

b) $E = hc/\lambda = 1240/500 = 2.5 \text{eV}$ is photon

$K_e = E_{photon} - \phi = 2.5 - 1.9 = 0.6 \text{eV}$

4.16 $E = mc^2 + K = 4m_pc^2 + 0$ to start

$= m_{He}c^2 + 2m_ec^2 + \underbrace{0}_{\text{mass of } \gamma\text{'s} + \nu\text{'s}} + K$ at End.

m_{He} is the mass of the ^4He nucleus

we can get masses of ATOMS in u at the end of the book

$m_p = M_{^1H} - m_e$ and $m_{He} = \underbrace{M_{^4He}}_{\text{mass of } ^4He \text{ ATOM}} - 2m_e$

so $\dfrac{K}{c^2} = 4M_{^1H} - 4m_e - M_{^4He} - 2m_e - 2m_e$

we have M for atoms in u, m_e in MeV. - will convert u to MeV eventually

$M_{^1H} = 1.00874$, $M_{^4He} = 4.0026\text{ u}$

4.16 continued

$$K/c^2 = 0.032u - 8m_e$$

$$1u = 931.5 \text{ MeV}/c^2$$

$$m_e = 0.511 \text{ MeV}/c^2$$

$K/c^2 = 30 - 4.1 = 26 \text{ MeV}/c^2$ so $K = 26$ MeV

checking the statement about the γ-rays:

95% of K goes to 5 γ's, so average γ is 4.9 MeV

$hc = 1240$ eV-nm $= 1240$ MeV-fm

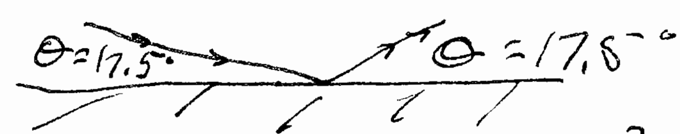
$\lambda = \frac{1240}{4.9} = 250$ fm as claimed

b.) $E \propto 1/\lambda$ so $nE_{vis} = E_\gamma$

$$n = E_\gamma / E_{vis} = \frac{1/\lambda_\gamma}{1/\lambda_{vis}} = \frac{1/250 \times 10^{-15}}{1/500 \times 10^{-9}}$$

$= 2 \times 10^6$ visable photons / gamma.

20.)



Bragg

$2d\sin\theta = n\lambda$

$n=1$, $\lambda = 0.20$ nm

a.) $d = \frac{\lambda}{2\sin\theta} = \frac{0.20}{2\sin(17.5°)} = 1/3$ nm

b.) $\frac{1}{n}\sin\theta_n = \sin\theta_1$ Since $n\lambda = 2d\sin\theta_n$ for different orders.

$\theta_1 = 17.5°$

$\theta_2 = 37.0°$

$\theta_3 = 64.4°$

$\sin\theta_4 > 1$ so no $n \geq 4$

24 $\lambda = 2d\sin\theta = (2)(.28)(\sin 20^\circ)$

$= 0.19\ \text{nm}$

$E = hc/\lambda = 1240/0.19 = 6.47\ \text{keV}$

$\therefore$ X-ray tube must have $V > 6.47\ \text{kV}$

27

For Compton (eqn. 4.24)

$1/p = 1/p_0 + \left(\frac{1}{m_e c}\right)(1-\cos\theta)$

≈ 0 if $\theta \approx 90^\circ$

so $1/pc = 1/p_0 c + 1/m_e c^2$

$= 1 + \frac{1}{0.511} = 2.96\ \text{MeV}^{-1}$

so $pc = E_{\gamma'} = 0.34\ \text{MeV}$

$K_e = 1 - 0.34 = 0.66\ \text{MeV}$ to conserve E.

29 $100\ \text{W} = 100\ \text{J/s}$ so $10^5\ \text{J}$ absorbed in 1000 s.

a.) $pc = E$ for e-m radiation

$p = E/c = \frac{10^5}{3\times10^8}\ \text{kg}\cdot\text{m/s} = \frac{1}{3}\times10^{-3}\ \text{kg}\cdot\text{m/s}$

b.) the momentum transferred to the body is that in a) and $p = m_{body} v$

since $m = 10^{-3}\ \text{kg}$, $v = 1/3\ \text{m/s}$

c.) $K_{body} = \frac{p^2}{2m} = \frac{(1/9)(10^{-6})}{2\times10^{-3}} = 5.6\times10^{-5}\ \text{J}$ nearly all the energy goes into heat.