HOMEWORK 4 CHAPTER 3

3.17 Wien's Displacement

$\lambda_{max} T = 2.898 \times 10^{-3}\ m \cdot K$

$\lambda_{max} = \frac{2.898 \times 10^{-3}}{T}$

T	λ_{max}	
4.2 K	0.69 mm	~ far IR
293 K	9.89 μm	~ near IR
2500 K	1.16 μm	~ near UV
9000 K	0.322 μm	~ extreme UV

3.18 In reverse

λ_{max}	T	
1.5×10^{-14} m	1.9×10^{11} K	gamma rays
1.5 nm	1.9×10^{6} K	x rays
640 nm	4530 K	red light
1 m	0.0029 K	broadcast T.V. ???
204 m	1.4×10^{-5} K	AM radio

↑ cold

think of how hot something would have to be to have these temps.

3.27 $\lambda_{max} = \frac{2.898 \times 10^{-3}\ m \cdot K}{310 K}$

$\lambda_{max} = 9.35\ \mu m$ near IR

3.33 a) γ frequency $= 1100$ kHz

b) 8 nm x rays $\longrightarrow$ photons/sec. ?

c) 4 MeV γ-rays

$P = 180\,W$

a) Energy per γ $= hf = (6.626\times10^{-34}\,J\cdot s)(1100\times10^{3}\,s^{-1})$

$= 7.3\times10^{-28}\,J$

Power in J/s and each photon is J.

$$\#\gamma = \left(\frac{1\text{ photon}}{7.3\times10^{-28}\,J}\right)\left(\frac{180\,J}{s}\right) = 2.47\times10^{29}\text{ photons/sec.}$$

b) Energy per γ $= h\frac{c}{\lambda} = \frac{(6.626\times10^{-34})(3\times10^{8})}{8\times10^{-9}}$

$= 2.48\times10^{-17}\,J$

$$\#\gamma = \left(\frac{1}{2.48\times10^{-17}}\right)\left(\frac{180}{}\right) = 7.26\times10^{18}\text{ photons/sec.}$$

c) Energy per γ $= \frac{(6.626\times10^{-34})(3\times10^{8})}{(4\text{ MeV})(1.6\times10^{-19}\,J/\text{MeV})} = 2.81\times10^{14}$ ph/s.

3-35 max λ of light (min frequency... and hence energy) which can eject photoelectrons from silver...

W.F. = ϕ = 4.64 eV ?

an incident γ must have at least ϕ for the electron to be liberated with KE = 0

$$KE = hf_{min} - \phi = 0$$

$$hf_{min} = \phi$$

$$f_{min} = \frac{\phi}{h} \quad \text{at least}$$

$$\lambda = \frac{c}{f} \qquad f = \frac{c}{\lambda}$$

$$\frac{\lambda_{max}}{c} = \frac{h}{\phi}$$

$$\lambda_{max} = \frac{hc}{\phi} = \frac{1240 \text{ eV}\cdot\text{nm}}{4.64 \text{ eV}}$$

$$\lambda_{max} = 267 \text{ nm}$$

3-39 stopping potential 1.0 V for $\lambda = 260$ nm

2.3 V for $\lambda = 207$ nm

what's h? — same material.

$$KE = eV_0 = hf - hf_0 = hf - \phi$$

$$eV_{0_1} = \frac{hc}{\lambda_1} - \phi_1$$

$$eV_{0_2} = \frac{hc}{\lambda_2} - \phi_2$$

but $\phi_1 = \phi_2$

$$eV_{01} - eV_{02} = hc\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)$$

$$h = \frac{e(V_{01} - V_{02})}{c\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)} = \frac{e(2.3 - 1.0)}{(3\times10^8)\left(\frac{1}{207} - \frac{1}{260}\right)} = 4.4\times10^{-15} \text{ eV}\cdot\text{s}$$