Homework 1

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1. Formula: $E = hf = \frac{hc}{\lambda}$ where h is Planck's Constant.

$$\begin{aligned} E &= \frac{(6.625 * 10^{-34}) * (3 * 10^{8})}{(300 * 10^{-9})} \\ &= 6.625 * 10^{-19}\text{J} = \frac{6.625 * 10^{-19}}{1.6 * 10^{-19}} = 4.14\text{eV} \end{aligned}$$

2. Formula: $E = hf$ where h is Planck's Constant.

$$\begin{aligned} E &= (6.625 * 10^{-34})(1.00 * 10^{16}) \\ &= 6.625 * 10^{-18} J \\ &= \frac{6.625 * 10^{-18}}{1.6 * 10^{-19}} = 41.406\text{eV} \end{aligned}$$

3. Formula: $E = hf = \frac{hc}{\lambda}$ where h is Planck's Constant.

$$\begin{aligned} E &= \frac{(6.625 * 10^{-34})(3 * 10^{8})}{9.4 * 10^{-6}} \\ &= 2.11 * 10^{-20}\text{J} = \frac{2.11 * 10^{-20}}{1.6 * 10^{-19}} = 0.132\text{eV} \end{aligned}$$

4. Formula: $E = hf = \frac{hc}{\lambda}$ where h is Planck's Constant.

$$\begin{aligned} 9.50 * 10^{-25} &= \frac{(6.625 * 10^{-34})(3 * 10^{8})}{\lambda} \\ \lambda &= \frac{(6.625 * 10^{-34})(3 * 10^{8})}{9.50 * 10^{-25}} \\ &= 0.209\text{m}. \end{aligned}$$

This wave is a radio wave with wavelength 0.209m.

5. Formula: $E = hf = \frac{hc}{\lambda}$ where h is Planck's Constant.

$$\begin{aligned} 0.511 * 10^6 \text{eV} &= \frac{(6.625 * 10^{-34})(3 * 10^8)}{\lambda} \\ \lambda &= \frac{(6.625 * 10^{-34})(3 * 10^8)}{(0.511 * 10^6)(1.6 * 10^{-19})} \\ &= 0.002\text{nm} \end{aligned}$$

6. Formula: $E = hf = \frac{hc}{\lambda}$ where h is Planck's Constant.

$$\begin{aligned} E &= \frac{(6.625 * 10^{-34})(3 * 10^8)}{0.072 * 10^{-9}} \\ &= 2.76 * 10^{-15}\text{J} = \frac{2.76 * 10^{-15}}{1.6 * 10^{-19}} = 17252.6\text{eV} \end{aligned}$$

7. Doppler Shift: $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$

$$\begin{aligned} \Delta\lambda &= \frac{100.0 * 10^3}{3 * 10^8} * 500 * 10^{-9} \\ &= 0.167. \end{aligned}$$

Therefore, $\lambda_{\text{observed}} = 500.167\text{nm}$

8. (a) Stefan-Boltzmann Law: $E = A\sigma T^4 : \sigma = 5.670 * 10^{-8} \frac{Joule}{m^2 k^4}$

$$\begin{aligned} \frac{E_{20000}}{E_{5000}} &= (\frac{R_{20000}}{R_{5000}})^2 * (\frac{T_{20000}}{T_{5000}})^4 \\ &= (\frac{1}{1})^2 * (\frac{20000}{5000})^4 \\ &= (1) * (4)^4 \\ &= 256 \text{ times.} \end{aligned}$$

(b) Wien's Law: $\lambda_{max} = \frac{0.0029}{T}$
20000k Star:

$$\begin{aligned} \lambda_{max} &= \frac{0.0029}{20000} \\ &= 145\text{nm} \end{aligned}$$

5000k Star:

$$\begin{aligned} \lambda_{max} &= \frac{0.0029}{5000} \\ &= 580\text{nm} \end{aligned}$$