Waves, Electromagnetic Spectrum and Introduction to Blackbody Radiation

Frequency/Wavelength to Energy

I'll do this one: The frequency of radiation when you get an x-ray is $3.0 \times 10^{16}$ Hz. Find the energy of the x-rays.

$$E = h\nu = 6.626 \times 10^{-34} \text{ Js} \left(3.0 \times 10^{16} \text{ Hz}\right) = 2.0 \times 10^{-15} \text{ J}$$

7) You try this one: The wavelength of red light from a traffic signal is centered at 730 nm. What is the energy of this radiation.

$$E = \frac{hc}{\lambda} = \frac{6.626 \times 10^{-34} \text{ Js} \left(2.998 \times 10^8 \text{ m/s}\right)}{730 \times 10^{-9} \text{ m}} = 2.7 \times 10^{-19} \text{ J}$$

Problem 4- Introduction to Blackbody Radiation

8) As the voltage is increased, what happens to the light bulb?

Extra Problems: We won’t do these in class, answer to be posted afterwards. They are here for extra at home practice, or if you get through the other problems faster and need something to keep yourself productively occupied.

A) The frequency of radiation from your microwave is 120 GHz. Find the wavelength of the microwaves.

$$\lambda = \frac{c}{\nu} = \frac{2.997 \times 10^8 \text{ m/s}}{120 \times 10^9 \text{ Hz}} = 2.5 \times 10^{-3} \text{ m}$$

B) The frequency of radiation from your microwave is 120 GHz. Find the energy of the microwaves.

$$E = h\nu = 6.626 \times 10^{-34} \text{ Js} \left(120 \times 10^9 \text{ Hz}\right) = 8.0 \times 10^{-23} \text{ J}$$
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Problem 10- Challenge Problem.

A) ***A lamp rated at 40 W (1W = 1J/s) emits violet light of wavelength 470 nm. How many photons of blue light can the lamp generate in 2.0s? (Note on difficulty: I know that 3 stars is much lower than a typical challenge problem, that's because this is really only a challenge problem given that we haven't really discussed these sorts of problems yet, you will definitely want to be able to do this sort of problem before the exam).

\[ E_{\text{Total}} = \text{(Number of photons)} \times \text{(Energy of each photon)} \]

\[ E = \frac{hc}{\lambda} = \frac{6.626 \times 10^{-34} \text{Js}}{470 \times 10^{-9} \text{m}} \times (2.99 \times 10^8 \text{m/s}) \]

\[ E_{\text{photon}} = 4.2 \times 10^{-19} \text{J/photon} \]

\[ \text{Number of photons} = \frac{E_{\text{Total}}}{E_{\text{photon}}} = 1.90 \times 10^{20} \text{ photons} \]

B) Synthesis*** (same reasoning on difficulty as all synthesis): Black lights emit long wave UVA rays along with a very small amount of visible light (seen as purple to our eyes). Does this mean we can develop skin and eye cancer from black lights? Why?

If in high enough doses probably, however it's still low enough energy that small amounts wear in clubs etc... wouldn't cause damage.