

13. (a) Let R be the rate of photon emission (number of photons emitted per unit time) and let E be the energy of a single photon. Then, the power output of a lamp is given by $P = RE$ if all the power goes into photon production. Now, $E = hf = hc/\lambda$, where h is the Planck constant, f is the frequency of the light emitted, and λ is the wavelength. Thus $P = Rhc/\lambda$ and $R = \lambda P/hc$. The lamp emitting light with the longer wavelength (the 700 nm lamp) emits more photons per unit time. The energy of each photon is less, so it must emit photons at a greater rate.
- (b) Let R be the rate of photon production for the 700 nm lamp. Then,

$$R = \frac{\lambda P}{hc} = \frac{(700 \text{ nm})(400 \text{ J/s})}{(1.60 \times 10^{-19} \text{ J/eV})(1240 \text{ eV} \cdot \text{nm})} = 1.41 \times 10^{21} \text{ photon/s} .$$

The result $hc = 1240 \text{ eV} \cdot \text{nm}$ developed in Exercise 3 is used.