Problem 1.2 Consider a beam of light with a power of 1 Watt and a wavelength of 800 nm. Calculate a) the photon energy of the photons in the beam, b) the frequency of the light wave and c) the number of photons provided by the beam in one second.

Solution The photon energy is calculated from the wavelength as:

$$E_{ph} = \frac{hc}{l} = \frac{6.626\times10^{-34}\ \text{Js}\times3\times10^{8}\ \text{m/s}}{800\times10^{-9}\ \text{m}} = 2.48 \text{ x } 10^{-19}\ \text{J}$$

or in electron Volt:

$$E_{ph} = \frac{2.48\times10^{-19}\ \text{J}}{1.602\times10^{-19}\ \text{C}} = 1.55\ \text{eV}$$

The frequency then equals:

$$n = \frac{E_{ph}}{h} = \frac{2.48\times10^{-19}\,\text{J}}{6.626\times10^{-34}\ \text{Js}} = 375\ \text{THz}$$

And the number of photons equals the ratio of the optical power and the energy per photon:

$$\#\,\text{photons} = \frac{1\,\text{Watt}}{E_{ph}} = \frac{1\,\text{Watt}}{2.48\times10^{-19}\ \text{J}} = 4 \text{ x } 10^{18}$$