24.21. **Model:** Use the photon model of light.

Solve: **(a)** The wavelength is calculated as follows:

$$E_{\text{gamma}} = hf = h\left(\frac{c}{\lambda}\right) \Rightarrow \lambda = \frac{\left(6.63 \times 10^{-34} \text{ Js}\right)\left(3.0 \times 10^{8} \text{ m / s}\right)}{1.0 \times 10^{-13} \text{ J}} = 2.0 \times 10^{-12} \text{ m}$$

(b) The energy of a visible-light photon of wavelength 500 nm is

$$E_{\text{visible}} = h\left(\frac{c}{\lambda}\right) = \frac{\left(6.63 \times 10^{-34} \text{ Js}\right)\left(3.0 \times 10^{8} \text{ m / s}\right)}{500 \times 10^{-9} \text{ m}} = 3.978 \times 10^{-19} \text{ J}$$

The number of photons n such that $E_{\text{gamma}} = nE_{\text{visible}}$ is

$$n = \frac{E_{\text{gamma}}}{E_{\text{visible}}} = \frac{1.0 \times 10^{-13} \text{ J}}{3.978 \times 10^{-19} \text{ J}} = 2.51 \times 10^{5}$$