Chapter 36 Problem 54 †

Given $E = 400 \ mJ = 0.400 \ J$ $\lambda = 2.94 \ \mu m$ $h = 6.63 \times 10^{-34} \ J \cdot s$ $c = 3.0 \times 10^8 \ m/s$

Solution

Find the number of photons making up the laser pulse.

The energy in each photon is given by the relationship

$$E_{\gamma} = \frac{hc}{\lambda}$$

Solving for the energy per photon gives

$$E_{\gamma} = \frac{(6.63 \times 10^{-34} \ J \cdot s)(3.0 \times 10^8 \ m/s)}{2.94 \times 10^{-6} \ m} = 6.77 \times 10^{-20} \ J$$

Therefore, the number of transitions is given by

transitions =
$$\frac{E}{E_{\gamma}} = \frac{0.400 \ J}{6.77 \times 10^{-20} \ J} = 5.91 \times 10^{18} \ photons$$

The wavelength of the photons correspond to the infra-red region of the electro-magnetic spectrum.