

59. (a) If t is the time interval over which the pulse is emitted, the length of the pulse is $L = ct = (3.00 \times 10^8 \text{ m/s})(1.20 \times 10^{-11} \text{ s}) = 3.60 \times 10^{-3} \text{ m}$.
- (b) If E_p is the energy of the pulse, E is the energy of a single photon in the pulse, and N is the number of photons in the pulse, then $E_p = NE$. The energy of the pulse is $E_p = (0.150 \text{ J})/(1.602 \times 10^{-19} \text{ J/eV}) = 9.36 \times 10^{17} \text{ eV}$ and the energy of a single photon is $E = (1240 \text{ eV} \cdot \text{nm})/(694.4 \text{ nm}) = 1.786 \text{ eV}$. Hence,

$$N = \frac{E_p}{E} = \frac{9.36 \times 10^{17} \text{ eV}}{1.786 \text{ eV}} = 5.24 \times 10^{17} \text{ photons} .$$