

Chapter 34 Problem 20 †

Given

$$h = 6.63 \times 10^{-34} \text{ J} \cdot \text{s}$$

$$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$$

Solution

a) Find the energy in electron volts for a 1.0 MHz radio photon.

The relationship between energy and frequency is

$$E = h \cdot f \tag{1}$$

$$E = (6.63 \times 10^{-34} \text{ J} \cdot \text{s}) \cdot (1.0 \times 10^6 \text{ Hz})$$

$$E = 6.63 \times 10^{-28} \text{ J}$$

Converting to electron volts gives

$$E = 6.63 \times 10^{-28} \text{ J} \left(\frac{1 \text{ eV}}{1.6 \times 10^{-19} \text{ J}} \right) = 4.14 \times 10^{-9} \text{ eV}$$

b) Find the energy in electron volts for a $5.0 \times 10^{14} \text{ Hz}$ optical photon.

Using equation (1) with the new frequency gives

$$E = (6.63 \times 10^{-34} \text{ J} \cdot \text{s}) \cdot (5.0 \times 10^{14} \text{ Hz})$$

$$E = 3.32 \times 10^{-19} \text{ J}$$

Converting to electron volts gives

$$E = 3.32 \times 10^{-19} \text{ J} \left(\frac{1 \text{ eV}}{1.6 \times 10^{-19} \text{ J}} \right) = 2.07 \text{ eV}$$

c) Find the energy in electron volts for a $3.0 \times 10^{18} \text{ Hz}$ x-ray photon.

Using equation (1) with the new frequency gives

$$E = (6.63 \times 10^{-34} \text{ J} \cdot \text{s}) \cdot (3.0 \times 10^{18} \text{ Hz})$$

$$E = 1.99 \times 10^{-15} \text{ J}$$

Converting to electron volts gives

$$E = 1.99 \times 10^{-15} \text{ J} \left(\frac{1 \text{ eV}}{1.6 \times 10^{-19} \text{ J}} \right) = 1.24 \times 10^4 \text{ eV}$$

†Problem from Essential University Physics, Wolfson