Wavelength, Frequency, and Energy

1. A laser will emit light with a wavelength of 650 nm. What is the frequency of this light?

$$650\ nm \times \frac{1\ m}{10^9\ nm} = 6.50 \times 10^{-7}\ m$$

$$\nu = \frac{2.998 \times 10^8\ m/s}{6.50 \times 10^{-7}\ m} = \mathbf{4.61 \times 10^{14}\ s^{-1}}$$

2. The frequency of radiant energy is 5.55 x 10^{14} Hz. In what region of the electromagnetic spectrum is this? What is the color of the light? (Hint: Calculate the wavelength)

$$\lambda = \frac{c}{\nu} = \frac{2.998 \times 10^8 \frac{m}{s}}{5.55 \times 10^{14}\ /s} = 5.40 \times 10^{-7} m = 540\ nm$$

This is in the visible region and corresponds to the color green.

3. What is the energy, in kJ, of a photon that has a wavelength of 2.46 x 10^2 m?

$$E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34}\ J \cdot s) \times (2.998 \times 10^8\ m/s)}{2.46 \times 10^2\ m} = \mathbf{8.08 \times 10^{-28}\ J}$$

4. Some sunburn occurs when exposed to light with a wavelength of 325 nm. What is the energy of 1.5 moles of these photons? How many photons are in a 1.50 mJ burst of this radiation?

325 nm = 3.25 x 10^{-7} m

$$E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34}\ J \cdot s) \times (2.998 \times 10^8\ m/s)}{3.25\ \times 10^{-7}\ m} = 6.12 \times 10^{-19}\ J/photon$$

$$1.5\ mol\ photons \times \frac{6.02 \times 10^{23}\ photons}{1\ mol\ photons} \times \frac{6.12 \times 10^{-19} J}{1\ photon} = \mathbf{5.5 \times 10^5\ J}$$

$$1.50\ mJ \times \frac{1\ J}{1000\ mJ} \times \frac{photon}{6.12 \times 10^{-19}\ J} = \mathbf{2.45 \times 10^{15}\ photons}$$

5. The work function, Φ, is 437 kJ/mol for copper. What is the threshold frequency? What wavelength does this correspond to?

$$437 \frac{kJ}{mol} \times \frac{1000\ J}{1\ kJ} \times \frac{1\ mol}{6.02 \times 10^{23}\ photons} = 7.26 \times 10^{-19} \frac{J}{photon}$$

$$E = h\nu\ \ and\ \nu = \frac{E}{h} = \frac{7.26 \times 10^{-19}\ J/photon}{6.626 \times 10^{-34}\ J \cdot s} = \mathbf{1.10 \times 10^{15}\ /s}$$

$$\lambda = \frac{2.9998 \times 10^8\ m/s}{1.10 \times 10^{15}\ /s} = 2.73 \times 10^7\ m = \mathbf{273\ nm}$$