Light and Electromagnetic Radiation

Light is generally used to denote the visible portion of the electromagnetic spectrum. Radio waves, microwaves, infrared radiation, ultraviolet light, x-rays and gamma rays are also part of the electromagnetic spectrum. Visible light is between infrared (far-red) and ultraviolet (beyond violet) light. I will use the term "light" to refer to any of these different types of electromagnetic radiation.

We have discussed the fact that light is a wave and a particle at the same time. Light comes in packets called quanta (singular quantum) with a specific amount of energy. We can express these mathematically.

First, some symbols:
λ is the Greek letter *lambda*. It denotes wavelength. Wavelength is the distance between one trough of a wave and the next trough, or one peak and the next peak. It is the length of a wave. It is measured in meters (m). Visible light is usually measured in nanometers (nm)

ν is the Greek letter *nu*, denotes frequency. Frequency is the amount of time between one wave and the next. It is measured in cycles per second (1/s, sec^{-1}). Cycles/s is also called Hertz (Hz)

E denotes energy. Energy is measured in electron volts (eV) and Joules (J).

c is the speed of light. It is the fastest speed there is in the universe. Nothing can go faster than the speed of light. The speed of light is approximately 299792458 m/s. This is pretty close to 300,000,000 m/s or 300,000 km/s, and we will use the approximate number. I find it annoying to write all of those zeros, so we will use scientific notation and express the speed of light as
3×10^8 m/s

h is Plank's constant = 6.63×10^{-34} J·sec

A few conversion factors:

1×10^6 μeV = 1 eV
1 eV = 1.6022×10^{-19} Joules
1 GHz = 1×10^9 Hz
Check p. 18 in your textbook for other metric prefixes.

Next a few equations

$\lambda = c / \nu$

$E = h\nu$ $\qquad$ $E = hc / \lambda$

Practice problems:

1. Growing up in the Washington D.C. area, my favorite radio station was D.C. 101 which broadcasts on a frequency of 101.1 MHz. (hint M = mega = 1×10^6 Hz)

    a. Find the wavelength

    b. Find the energy

2. Find the wavelength and energy of your favorite radio station.

3. What is the energy of light with a frequency of 4.31×10^{14}Hz?

4. A certain violet light has a wavelength of 413 nm. What is the frequency of the light? (hint Nano = nm = 1×10^{-9} meters)

5. A certain green light has a frequency of 6.26×10^{14} Hz. What is the wavelength?

6. What is the energy of light with a wavelength of 662 nm?