Light as a wave:

$$c = \lambda * \nu$$

m/s　　　m　　　1/s

It is worth noting that 1/s is the same as Hz or s^{-1}.

*Note how the units work out. You will have m/s on both sides of the equation!

where c is the speed of light (3.00×10^8 m/s), λ is the wavelength, and ν is the frequency. The units required for all of the factors are given above.

Light as a particle:

These two equations are the same! You should be able to use the equation above and prove this to yourself!

J*s　　m/s

$$E = \frac{h * c}{\lambda}$$

J　　m

or

$$E = h * \nu$$

J　　J*s　　1/s

where c is the speed of light (3.00×10^8 m/s), h is Plank's constant (6.626×10^{-34} J*s), ν is the frequency, and λ is the wavelength.

You should also consider the units for all of the constants and variables. Note how they cancel. Energy is in Joules (J). For the first equation, the units look like this:

$$\frac{J * s * \frac{m}{s}}{m} \rightarrow \frac{J * m}{m} \rightarrow J$$

First, note that you have seconds divided by seconds, so they cancel. Then cancel the meters. This leaves plain Joules which is what is needed for energy!

NAME____________________ **(Turn in Friday, Nov.14, 2014)**

Converting between wavelength (λ) and frequency (ν):

- **Examples:**

If light has a frequency of 1.045×10^{9} s^{-1}, what is the wavelength in meters?

What is the wavelength in nm of a light wave that has a frequency of 4.53 kHz?

What is the frequency of light with a wavelength of 257 nm?

- **Problems:**

Convert the following wavelengths to frequencies:

1. **λ = 1.098x10^{-7}m**

2. **λ =3.54x10^{-3} m**

3. **λ =653 nm**

4. **λ =2.043 km**

5. **λ =5.32x10^{-7}m**

Convert the following frequencies to wavelengths:

1. **ν= 1.20×10^{16} Hz**

2. **ν= $5.42 \times 10^{14} s^{-1}$**

3. **ν= 5.43 MHz**

4. **ν=2.98 kHz, for this problem, report λ in nm**

Converting between energy and wavelength (λ) or frequency (ν):

- **Examples:**

What wavelength of light is associated with a photon with an energy of $2.75x10^{-19}$J?

What is the energy of 1.00 mole of photons with a frequency of 8.9 mHz?

If a bond has an energy of 275 kJ/mol, what is the wavelength of light that will break the bond?

- **Problems**

1. **What frequency of light is associated with a photon with an energy of $2.75x10^{-19}$J?**

2. **What wavelength (in nm) is associated with a photon with an energy of $5.26x10^{-18}$J?**

3. **What is the energy of $1.75x10^{9}$ photons of light with a frequency of $6.98x10^{15}$ Hz?**

4. **What is the frequency of light that is needed to break a bond of 275 kJ/mol?**

Mixed Problems:

1. **Ultraviolet radiation has a frequency of 6.8×10^{15} 1/s. Calculate the energy, in joules, of the photon.**

2. **Find the energy, in joules per photon, of microwave radiation with a frequency of 7.91×10^{10} Hz.**

3. **A sodium vapor lamp emits light photons with a wavelength of 5.89×10^{-7} m. What is the energy of 2.653×10^{22} of these photons?**

4. **One of the electron transitions in a hydrogen atom produces infrared light with a wavelength of 7.464×10^{-6} m. What amount of energy causes this transition?**

5. **Find the energy in kJ for an x-ray photon with a frequency of 2.4×10^{18} Hz.**

6. **A ruby laser produces red light that has a wavelength of 500 nm. Calculate its energy in joules.**

7. **What is the frequency of UV light that has an energy of 2.39×10^{-18} J?**

8. **What is the wavelength and frequency of photons with an energy of 1.4×10^{-21} J?**