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GEOG 362 Introduction to Remote Sensing and image processing
Problem Set #1, Fall 2011

1. Go to the following URL to answer the next couple questions:
http://www.lon-capa.org/~mmp/applist/Spectrum/s.htm

a.) **How does wavelength vary with frequency?** A longer wave length will have a lower frequency due to fewer waves passing a point over the same amount of time of a shorter wavelength which would have a higher frequency. This relationship is often times referred to as being an inverse one where are one value increases the other decreases.

b.) **What wavelength ranges correspond to the sizes of atomic nuclei?** Atomic nuclei are found in wavelengths from 6.711e-13m (6.7nm) up to 5.577e-12m (0.005nm) according to the slider bar provided.

c.) Put the following forms of light – ultraviolet, infrared, gamma rays, visible, radio, X-rays
In order of *increasing* frequency (lowest frequency first):
Radio, infrared, visible, ultraviolet, X-rays, Gamma rays
Put them in order of *increasing* wavelength (shortest wavelength first).
Gamma rays, X-rays, ultraviolet, visible, infrared, radio
Put them in order of *increasing* energy (lowest energy first).
Radio, infrared, visible, ultraviolet, X-rays, Gamma rays

2. Review the content on the following website and answer the following questions:
http://www.astronomynotes.com/light/s3.htm#A1.1

Convert the following wavelengths to frequency assuming an electromagnetic wave traveling through free space:

a.) 0.450 um = .45e-6m = 4.5e-7m $f = c/\lambda$ = 2.99e8 $^{m}/_{s}$ / 4.5e-7m = 6.44e14 hertz

b.) 2.5um = 2.5e-6m $f = c/\lambda$ = 2.99e8 $^{m}/_{s}$ / 2.5e-6m = 1.19e14 hertz

c.) 1 cm = .01 m $f = c/\lambda$ = 2.99e8 $^{m}/_{s}$ / .01 m = 2.99e10 hertz

2. Besides each number of wavelengths listed below, please indicate the category (e.g. Infrared or Microwave) which each wavelength belongs to.

6.5×10^{-7} m	Visible Orange/Red	0.42 μm = 4.2e-7m	Visible Blue/Purple
1×10^{-13} m	Gamma Rays	2 m	Radio Waves
1.2×10^{-5} m	Infrared/Heat Radiation	3.765 cm = 0.03765m	Microwaves/Radar

3. Supposed there are two individual photons, one's wavelength is 0.75 μm, and the other one's is 3.0μm. Please compare the amount of energy two photons have and answer which one has higher energy. (Show your steps)

We know the Frequency and wavelength relation: $f = c/\lambda$
This shows an inverse relationship between Frequency and wavelength.

We also know the following: Energy of a photon: $E = h \times f$, where h is a constant of nature called ``Planck's constant'' = 6.63×10^{-34} J·sec.
The amount of energy a photon has or produces is directly proportional to its frequency. A higher frequency (short wave length) has a higher energy level than a photon experiencing a low frequency (long wave length). This means as Frequency increases, so does the energy of a photon

With that said, a wave length of 0.75 μm is shorter than a wave length of 3.0μm. This means the shorter wavelength (0.75 μm) has the higher frequency and therefore the higher energy as well.

To Prove this here are the calculation of each photons energy

Photon 1: $f = c/\lambda$ = 2.99e8 $^{m}/_{s}$ / 7.5e-7m = 3.98e14 hertz
$E = h \times f$ =6.63×10^{-34} J·sec * 3.98e14 hertz
E = 2.63e-19 J

Photon 2: $f = c/\lambda$ = 2.99e8 $^{m}/_{s}$ / 3.0e-6m = 9.96e13 hertz
$E = h \times f$ =6.63×10^{-34} J·sec * 9.96e13 hertz
E = 6.60e-20 J

E = 2.63e-19 J > E = 6.60e-20 J
E Photon 1 > E Photon 2