

Light and Matter

10/2/2009

Opening Discussion

- http://www.youtube.com/watch?v=4xXQFnIEf_Q
- Have you seen anything interesting in the news?
- What did we talk about last class?
- Minute essay response
 - Don't feel inadequate, feel the sense of wonder in what you can learn.
 - Idea that planets move toward or away from the Sun. They don't!

What is Light?

- This question troubled science for many years.
- Newton thought light was made of particles. He was the first to show that the colors of the rainbow were a property of the light, not the material splitting it.
- Later experiments showed that light behaves as a wave.
- Einstein's Nobel prize is for experiments showing light has particle characteristics.
- Turns out it is both! Quantum Mechanics!

Wavelength and Frequency

- We often care about the wave nature of light.
- Waves are characterized by wavelength, λ , frequency, f , and amplitude. We don't generally need amplitude.
- The speed of a wave is given by the product of the wavelength and the frequency.

$$\text{speed} = \text{wavelength} \times \text{frequency} = \lambda f$$

- For light the speed is always the same, c .

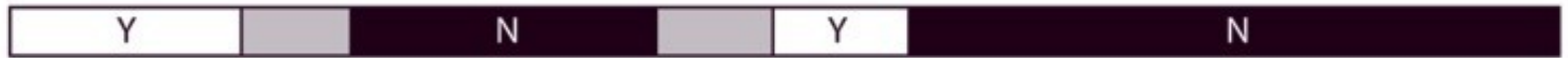
$$\lambda f = c$$

Waves in What?

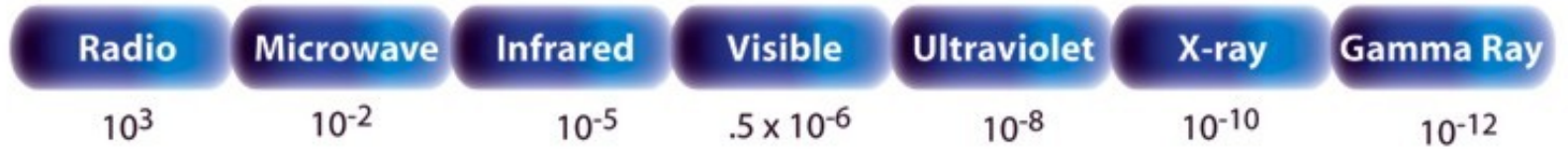
- Waves in a pond move energy, but not material. Locally the water just goes up and down as the wave propagates outward.
- Waves generally require a medium to propagate through, like the water or air.
- People proposed a “luminiferous ether” as a medium for light. Experiments showed there was no medium for light.
- Light is a self-propagating perpendicular electromagnetic wave. It requires no medium.

THE ELECTROMAGNETIC SPECTRUM

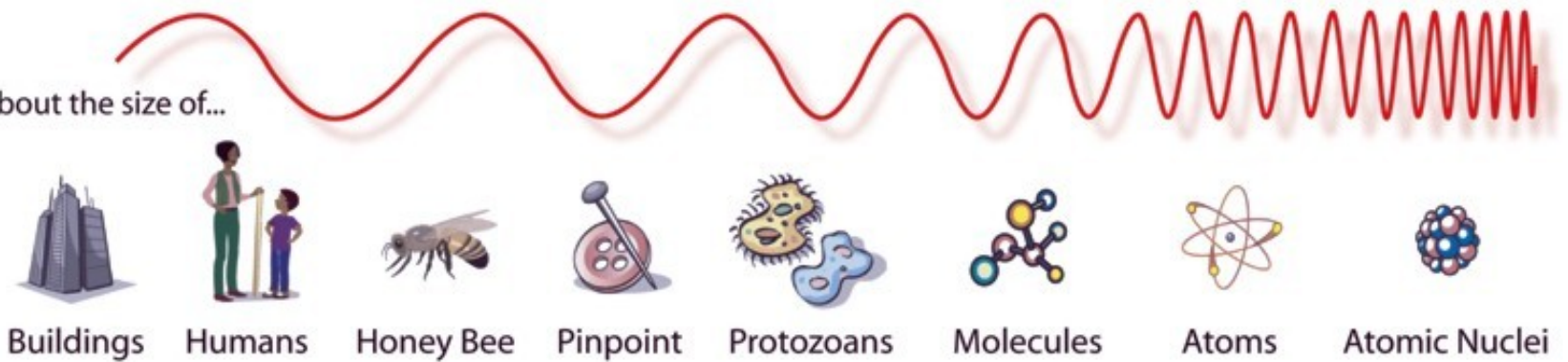
Penetrates Earth Atmosphere?



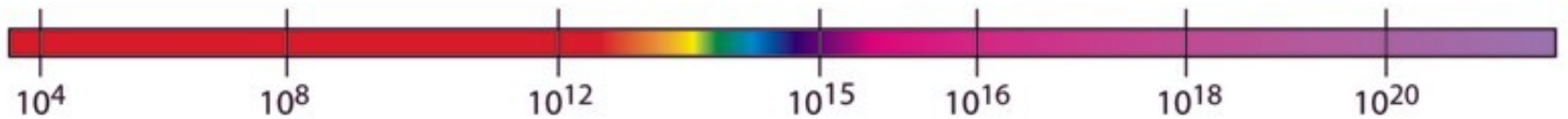
Wavelength (meters)



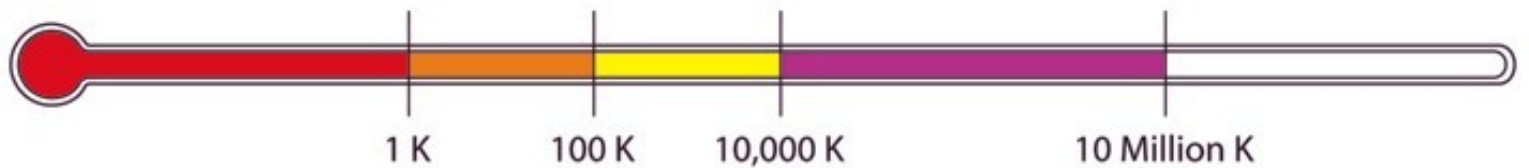
About the size of...



Frequency (Hz)



Temperature of bodies emitting the wavelength (K)



Seeing Other Parts of Spectrum

- There are reasons we only see the small part of the spectrum that we do.
 - It is the peak of our Sun's emission.
 - It is one of the few ranges that passes freely through the atmosphere.
 - It can be received nicely by things like our eyes.

Energy of Light

- Light also behaves like a collection of particles we call photons. Each photon carries a certain amount of energy depending on its wavelength/frequency.

$$E = h \times f = h \times \frac{c}{\lambda}$$

- The constant h is Planck's constant and it is equal to 6.626×10^{-34} [J*s]. Note that this is a REALLY small number. Single photons don't carry much energy.

Matter

- Matter is made out of atoms.
- Atoms have a nucleus of protons and neutrons surrounded by a cloud of electrons.
 - Protons have positive charge.
 - Electrons have negative charge.
- Number of protons determines type of element the atom is. Called the atomic number.
- Number of protons plus neutrons is the atomic mass number. Elements with same number of protons but different neutrons called isotopes.

Molecules

- Atoms can bond to one another to form molecules. Molecules can have different properties than the atoms that compose them.
- Molecules made of more than one type atom are called compounds.

Phases of Matter

- There are four main phases of matter. Which phase a material is in depends on the bond strength and the temperature and pressure.
- As temperatures rise the atoms/molecules gain kinetic energy. Eventually they break bonds and move more freely.
- Four normal phases of matter:
 - Solid – strong bonds, rigid
 - Liquid – medium bonds, changes shape, but not size.
 - Gas – weak bonds, changes shape and size.
 - Plasma – no bonds, electrons knocked off.

Minute Essay

- Any questions?
- Have a good weekend and enjoy next week. Keep your eyes on the news for press releases from DPS.
- I was told we missed Carla Miller's birthday last week. Feel free to act on that as you see fit.