Opening Discussion

- http://www.youtube.com/watch?v=4xXQFnlEf_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 though 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, \( \lambda \), 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)

- Radio: $10^3$
- Microwave: $10^{-2}$
- Infrared: $10^{-5}$
- Visible: $.5 \times 10^{-6}$
- Ultraviolet: $10^{-8}$
- X-ray: $10^{-10}$
- Gamma Ray: $10^{-12}$

About the size of...

- Buildings
- Humans
- Honey Bee
- Pinpoint
- Protozoans
- Molecules
- Atoms
- Atomic Nuclei

Frequency (Hz)

- $10^4$
- $10^8$
- $10^{12}$
- $10^{15}$
- $10^{16}$
- $10^{18}$
- $10^{20}$

Temperature of bodies emitting the wavelength (K)

- 1 K
- 100 K
- 10,000 K
- 10 Million 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 Plank'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.