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 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, 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.

$$speed = wavelength \times frequency = \lambda f$$

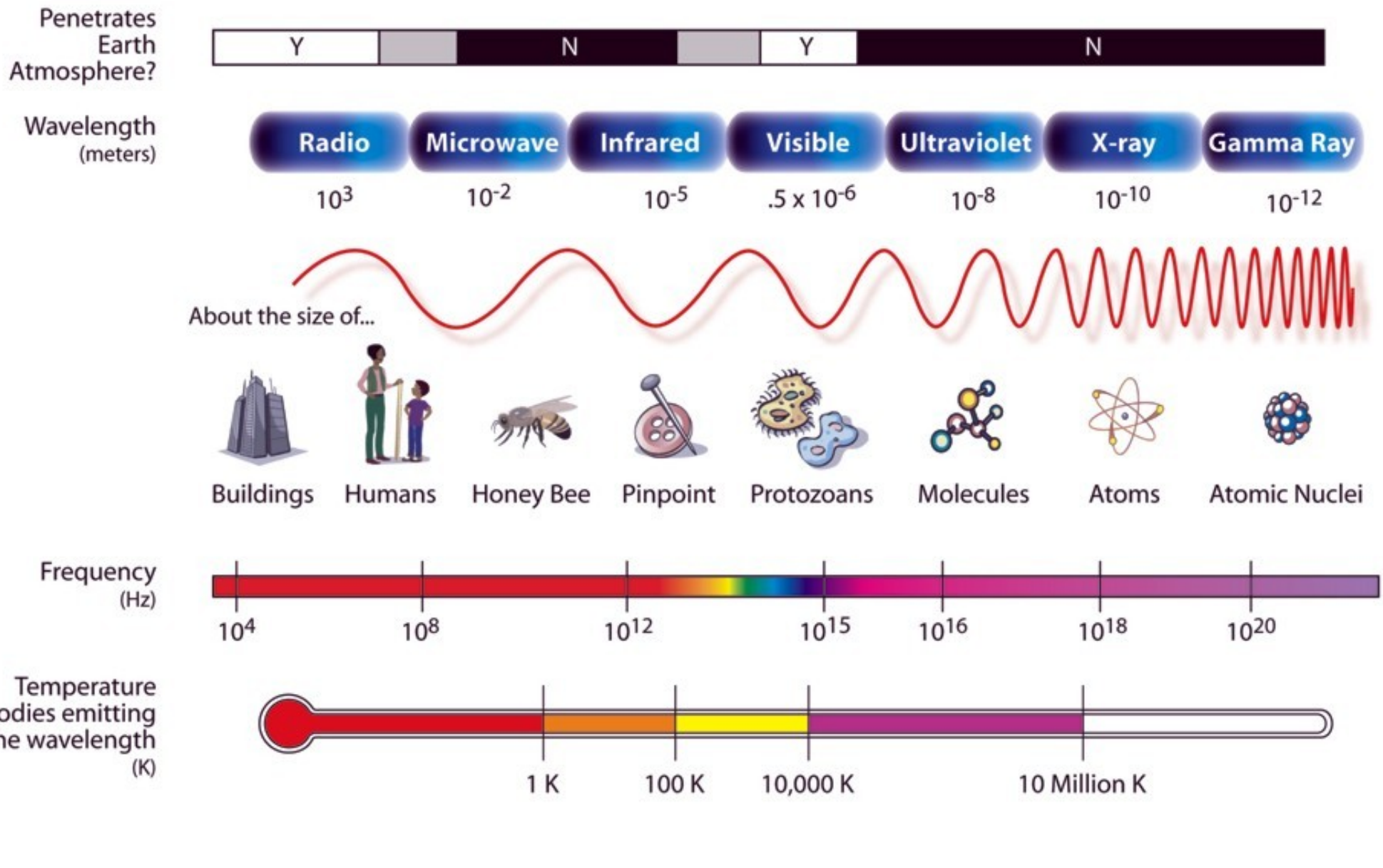
- For light the speed is always the same, c.

$$\lambda f = c$$

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



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.