Light

9/30/2009

Opening Discussion

- http://www.youtube.com/watch?v=hdvGSgpTQ6U
- Do you have any questions about the quiz?
- Have you seen anything interesting in the news?
- What did we talk about last class?

Minute Essays

- Theories about before the big bang?
- Projectile motion?
- Differences between types of potential energy.
- Tides
  - Tidal locking of other moons.
  - Tidal bulges, tidal friction, and angular momentum transfer.
  - Breaking SL9.
  - Ocean waves, more than tides.
  - Did early humans see a bigger Moon?

More Minute Essays

- Math examples in class.
- How significant is the stuff we just covered in this class?
- Is gravity a theory?
- Why we are crashing something into the Moon? No significant damage to the Moon.
- What is my favorite genre of music?
- DPS conference: English? Topics? My presentation?
- LCROSS observing?

More Minute Essays

- Using Newtonian forms of equations for gravity.
- Is it possible there is no gravity and it is all electric or magnetic forces?
- Could there have been two moons related to ocean basins and one fell and took out the dinosaurs?
- What is the gravitational constant and how do we know it?

Centrifugal Force and Circular Orbit Velocity

- Objects want to move in a straight line. When a force causes an object to move on a curved path, we often describe it's tendency to want to go straight as a pseudo-force can centrifugal force.

$$F_c = \frac{mv^2}{r}$$

- Setting centrifugal force equal to gravitational force gives the circular orbit velocity.

$$v_{circular} = \sqrt{\frac{GM_1}{d}}$$

Energy and Power

- We have talked about energy, its forms, and the fact that light carries radiant energy.
- Many times we don't care so much about total energy as how fast energy is delivered. This is called power.
- The mks unit of power is a Watt. 1 W = 1 J/s
- You are all familiar with this unit as it is how we grade lightbulbs.
- An average human burns energy roughly at 100 W.

Interaction of Matter and Light

- There are four ways light interacts with matter:
  - Emission – matter can give off its own light.
  - Absorption – matter can absorb light that strikes it.
  - Transmission – matter can transmit light and let it pass through.
  - Reflection/scattering – matter can reflect light back or scatter it in some other direction.
- When you look around, what you are really seeing is light that has reflected off the surfaces. Color comes from some of the light being absorbed.

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.

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

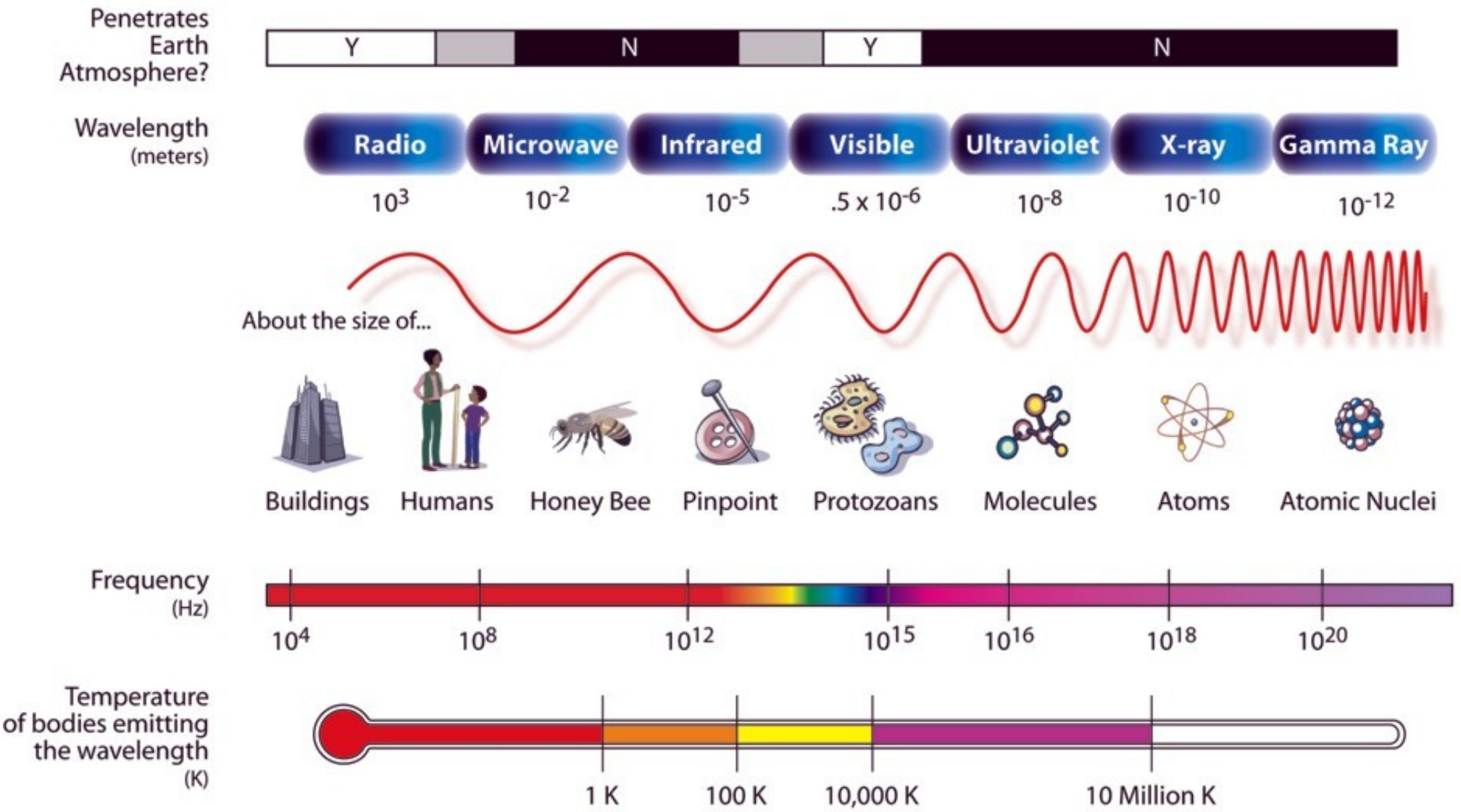
- For light the speed is always the same, c.

$$\lambda f = c$$

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



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.

Minute Essay

- Did you realize that radio waves, microwaves, and X-rays were all really just light? Are you surprised by how little of the electromagnetic spectrum you can see with your eyes?
- Note that assignment #2 has been moved so you will have next week to work on it.