

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. $1 \text{ W} = 1 \text{ J/s}$
- 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 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

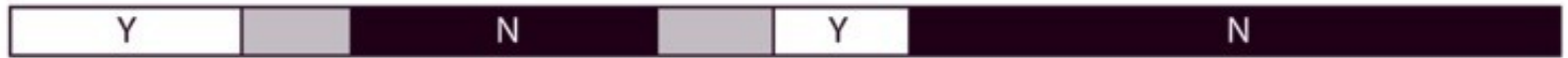
- We often care about the wave nature of light.
- Waves are characterized by wavelength, λ , frequency, f , and amplitude. We don't generally need amplitude.
- The speed of a wave is given by the product of the wavelength and the frequency.
- For light the speed is always the same, c .

Waves in What?

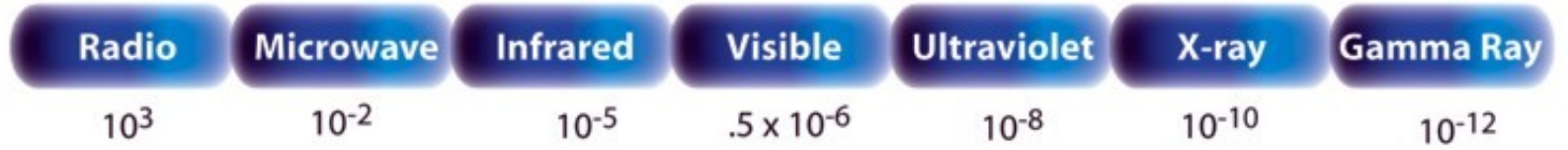
- Waves in a pond move energy, but not material. Locally the water just goes up and down as the wave propagates outward.
- Waves generally require a medium to propagate through, like the water or air.
- People proposed a “luminiferous ether” as a medium for light. Experiments showed there was no medium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

THE ELECTROMAGNETIC SPECTRUM

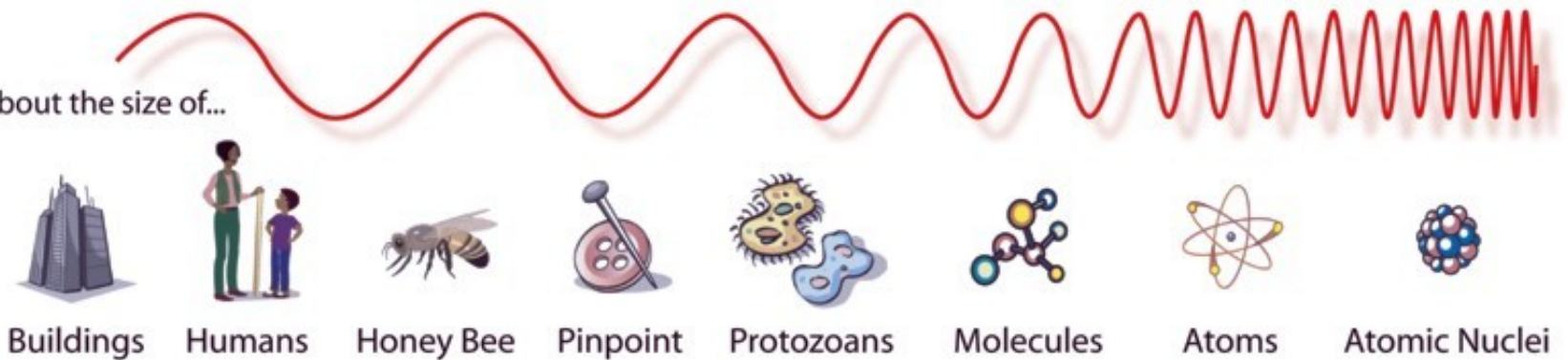
Penetrates Earth Atmosphere?



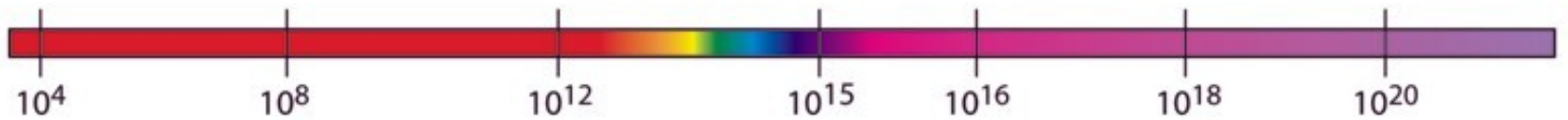
Wavelength (meters)



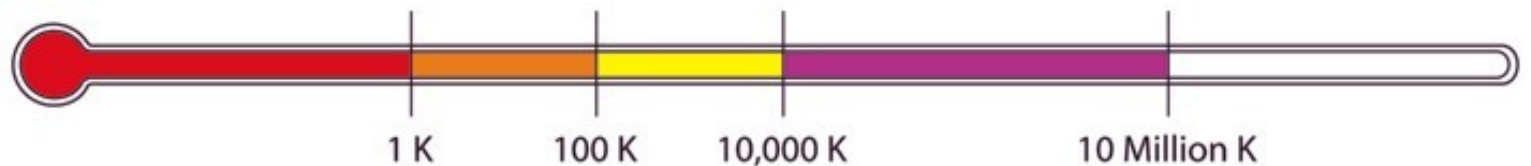
About the size of...



Frequency (Hz)



Temperature of bodies emitting the wavelength (K)



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.
- 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.

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.
- Today is Phil's birthday. Please help escort him to the fountain to uphold the proud Trinity tradition.