ANNOUNCEMENTS:

Please register your clicker on Blackboard (Under “Tools” : Turning Point Registration)

Graded clicker questions will start next class

Clicker Test

• What class are you in?
  • A) Freshman
  • B) Sophomore
  • C) Junior
  • D) Senior
  • E) Other

THE COSMIC CALENDAR

If the history of the entire universe was condensed into a single year, the earliest humans (hominids) would have appeared about:

A. September 1
B. December 1
C. December 30
D. 9 p.m. December 31 (3 hours before year-end)
E. 11:59:30 p.m. December 31 (30 seconds before year-end)
Light: The Cosmic Messenger

For nearly all astronomical objects, light brings us our only information.

Need to understand what light is and how it interacts with matter.

Light is a form of ENERGY

White light is made up of many different colors.

Wave-Particle Duality of Light

Light can behave like a wave.

Light can also behave like a particle.

“...”
Light as a WAVE
Anatomy of a Wave

- Speed of light is the SAME for all wavelengths
- The shorter the wavelength, the more cycles pass per second
- How to remember equation?

Light as a PARTICLE

- Light can also be thought of as a particle → “photon” (NOT proton!)

A photon is a mass-less particle of electromagnetic radiation energy

Wave-particle duality seen in other particles (e.g., electrons) as well

Photon Energy Depends on Frequency/Wavelength

Quantum mechanics:

\[ E' = h \times f \]

Higher frequencies \( \Rightarrow \) more energy
Shorter wavelengths \( \Rightarrow \) more energy
(UV, X-Rays more dangerous!)

\[ E \propto f \]
\[ E \propto 1/\lambda \]

The Electromagnetic Spectrum
**Clicker Question**

**What is LIGHT?**

A. Light is a wave, like sound only much faster.
B. Light is like little particles. Each one is a photon.
C. Light is the absence of dark.
D. A kind of energy we *model* with some of the properties of waves and some properties of particles.
E. Light is the sensation you feel when hit by energy, visible or invisible.

**Clicker Question**

**When compared to RED light \( (\lambda = 700 \text{ nm}) \), Blue light \( (\lambda = 400 \text{ nm}) \) is:**

A. Longer wavelength
B. Lower Frequency
C. Higher energy photons
D. Faster photons
E. None of the above
Four Ways in Which Light can Interact with Matter

1. **Emission** – matter releases energy as light
2. **Absorption** – matter takes energy from light
3. **Transmission** – matter allows light to pass through it
4. **Reflection** – matter repels light in another direction
Why is a rose red?

A. The rose emits red light.
B. The rose absorbs red light.
C. The rose transmits red light.
D. The rose reflects red light.

Humans emit in the Infrared

SO FAR:

NEXT:

LIGHT

MATTER and the Interaction of Light With Matter
Light as Information Bearer through its interaction with matter

We can separate light into its different wavelengths (spectrum).

By studying the spectrum of an object, we can learn its:

•
•
•