Learning Outcomes, Objectives, & Goals

- **Appreciating** science in general, and astronomy in specific.
- **Understanding** how knowledge is gained and be critical of what you see and hear.
- **Developing** a working knowledge of the scientific method and how to apply it to real world situations.
- **Critically analyzing and evaluating** information, scientific or otherwise
- Learn some simple astronomical nomenclature/terminology.
- Develop a sense of what scientists know about the overall universe, its constituents, and our location
- Explain how electromagnetic radiation is used to reveal the properties of stars and planets.
- Understand the simpler concepts about light and the different processes that cause light to be emitted or absorbed
Overarching questions

• What words mean the same as light?
• What are the types of light?
• What are different properties of waves and how are they measured/calculated?
• How do photons interact with matter?
• What are the 3 types of spectra, what are their properties, and what determines which type an object displays?
• What is the Doppler effect and how does it work? Real life and astronomical applications.

Fancy words

• Visible light = what people see
• Spectrum = all of the types of ...
• Visible spectrum = ____________
• White = roughly even mixture of visible spectrum

• Electromagnetic radiation = Light
• Electromagnetic spectrum = ____________
Pre-test: Radio waves are a form of

0 1. Light
0 2. Sound
0 3. Both light and sound

5 ways light interacts with matter
1. Gets emitted. We’ll discuss 2 ways later.
2. Gets absorbed
3. Passes through ("transmitted")
4. Reflects (shiny things)
5. Scatters in many directions (most things)

See figures 5.2 & 5.3 on pages 151-152.
Calif. Science Standards for light

- From California Science Standards, grade 3:
  - Students know the **color of light striking an object affects the way the object is seen**.
  - Students know an **object is seen when light traveling from the object enters the eye**.

- And from grade 7:
  - Students know that **for an object to be seen, light emitted by or scattered from it must be detected by the eye**.
  - Students know **light travels in straight lines** if the medium it travels through does not change.
  - Students know that **white light is a mixture of many wavelengths (colors)** …
  - Students know **light can be reflected, refracted, transmitted, and absorbed by matter**.

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Which does a movie screen do?

0 1. Scatter
0 2. Reflect
0 3. Emit
0 4. Absorb
0 5. Transmit
Which happens to light when it hits my shirt?

0  1. Scatter
0  2. Reflect

Which happens to light when it hits the Moon?

0  1. Scatter
0  2. Reflect
What color does a blue shirt ABSORB?

1. Absorb all except blue light
2. Absorb blue light

Waving

- What are some examples of waves?
- What is waving in each example? Which direction is it moving?
  - “Surface Waves in a Pond” animation [#1]
- Wave is a moving pattern carrying energy.
- Light acts like a wave. What is waving?
Wave properties

• **Wavelength** – see page 153
  – Size of wave; detecting/catching the wave
• **Frequency** – How often a wave passes by
  – units are: waves per second = Hertz (Hz)
• **Speed** = how fast one wave pattern moves (in units such as miles/hour)
  – “Anatomy of a wave” animation [#2]
• **Amplitude** = strength of wave.

Are frequency and speed the same thing?

0 1. Yes
0 2. No
Light types – memorize this page!

Seven types of light, in order (see page 155)

(Highest frequency smallest wavelength)

1. Gamma-rays
2. X-rays
3. Ultraviolet (UV) light = 10%
4. **Visible light = 45%** (ROY G BIV)
5. Infrared (IR) light = 35%
6. Microwaves
7. Radio waves

(Lowest frequency longest wavelength)

\[
\text{Speed of light} = \text{(light wavelength)} \times \text{(light frequency)}
\]

Constant number = One number goes up, the other goes down

“Visible Light Waves” animation [last]

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Test 3 (out of 6) ends here

- See title
Light in your everyday life

• Your eyes see __________ light.
• When ________ light lands on your skin, your skin gets warmer.
• When ________ light lands on your skin, you get skin damage.
• When ________ light lands on your skin, you get radiation poisoning. (two answers)
• When ________ light lands on your skin, nothing changes unless a LOT lands on you. (two answers)
• Digital cameras see visible AND infrared light. Remote controls often use IR light. Look: cell phone + remote

More light in everyday life - invisible

• What kind of light does your body mostly emit (give off)?
• Want to see it?
• Neat fact: Blacklights emit some UV. Take a look.
What is the wavelength?

0 1. 1.5 meters
0 2. 2 meters
0 3. 3 meters
0 4. 4 meters
0 5. 7 meters
0 6. 8 meters
0 7. Not enough info to answer

What is the Amplitude?

0 1. 1.5 meters
0 2. 2 meters
0 3. 3 meters
0 4. 4 meters
0 5. 7 meters
0 6. 8 meters
0 7. Not enough info to answer
What is the frequency?

1. 1.5 meters
2. 2 meters
3. 3 meters
4. 4 meters
5. 7 meters
6. 8 meters
7. Not enough info to answer

Each drawing shows what passes you by during one second. Which wave has a higher frequency?

1. Top
2. Bottom
3. Same
Each drawing shows what passes you by during one second. Which wave travels faster?

0  1. Top
0  2. Bottom
0  3. Same

Analogy – instead of waves, vehicles on 405 freeway

• New freeway: speed limit is 10 mph
• 2 special lanes: limos & motorcycles
• All traffic is bumper-to-bumper, going 10 mph
• You stand by side of road and count # of vehicles that pass you after 30 seconds
• Which vehicle type went faster?
• Which do you see more of? What wave property does this match up to?
• What else is different about the 2 vehicles? Wave property?
• Which type of wave corresponds to limos? Motorcycles?
Which travels faster

0 1. Radio waves
0 2. Visible light
0 3. X-rays
0 4. same

California Elementary School Science Standards for waves

• From California Science Standards, high school
  – Students know waves carry energy from one place to another.
  – Students know how to solve problems involving wavelength, frequency, and wave speed.
  – Students know radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately $3 \times 10^8$ m/s (186,000 miles/second).
Light acting as a particle

- We’ve been talking about light acting like a wave.
- Light also acts like a particle.
- Light particles are called ....
- The energy of a photon is related to the frequency.
  - High frequency photons have more energy than low frequency photons.