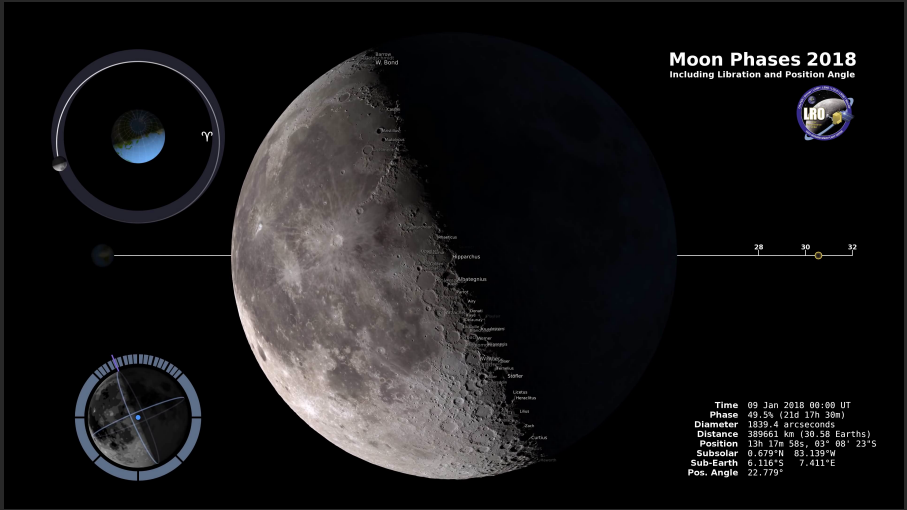
Announcements

- WebWorK due on Wednesday
- Lab tonight! Group A!
- First test a week from Friday!
  - We'll talk study plans, problems, etc end of this week.
- Polling: `rembold-class.ddns.net`

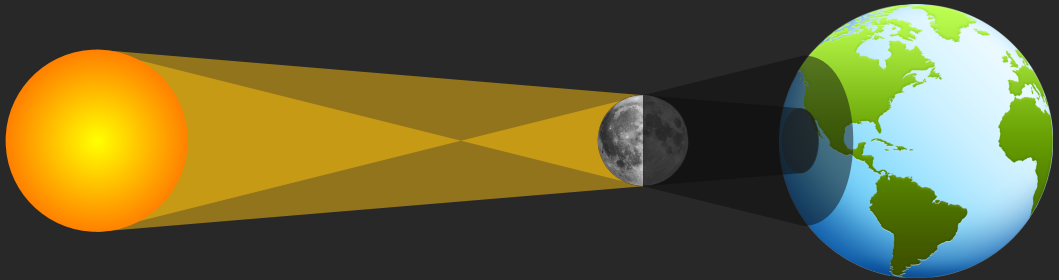
APOD!


Moon Phases 2018
Including Libration and Position Angle
LRO
Barrow
W. Bond
Xenophanes
Mouchez
Kunowsky
Hipparchus
Aristarchus
Aryabhata
Kepler
Boscovich
Wegener
Wilhelm
Bonpland
Stöfler
Longomontanus
Hevelius
Ukert
Zach
Curtius
28
30
32
Time 09 Jan 2018 00:00 UT
Phase 49.5% (21d 17h 30m)
Diameter 1839.4 arcseconds
Distance 389661 km (30.58 Earths)
Position 13h 17m 58s, 03° 08' 23"S
Subsolar 0.679°N 83.139°W
Sub-Earth 6.116°S 7.411°E
Pos. Angle 22.779°

Solar Eclipses

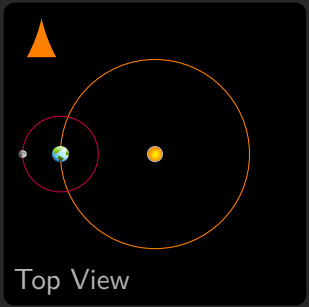
Solar Eclipses Facts

- Moon casting shadow onto the Earth
- Solar eclipses can only occur when the Moon is new!
- Solar eclipses can be partial, total, or annular
- Note that only select portions of the Earth observe the eclipsed Sun!



Why not eclipses every month?

- The Moon's orbit is tilted 5° to the ecliptic
- Results in two seasons each year when eclipses can happen



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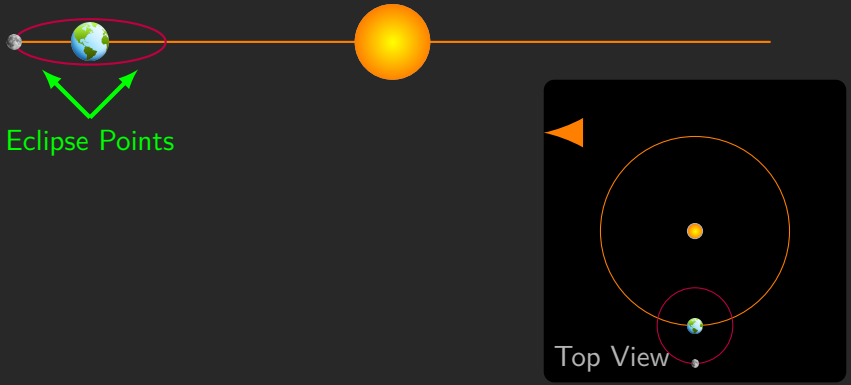

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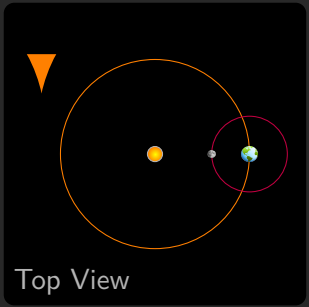

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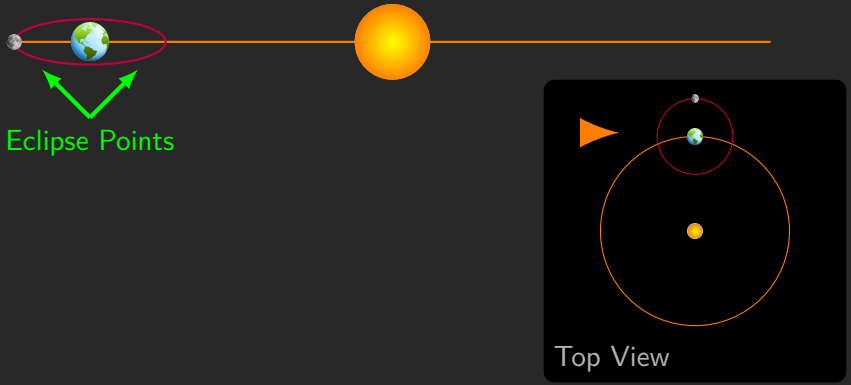

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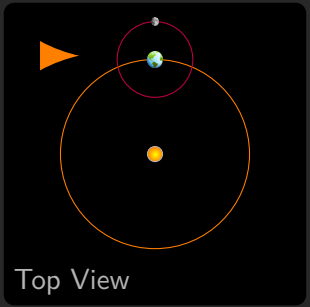
Eclipse Conditions

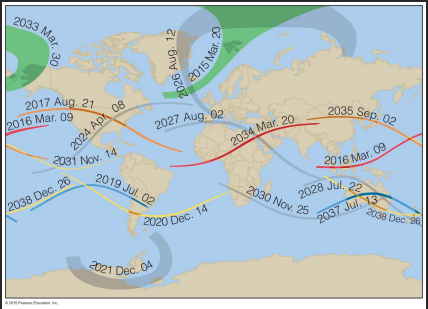
An eclipse can only occur when:

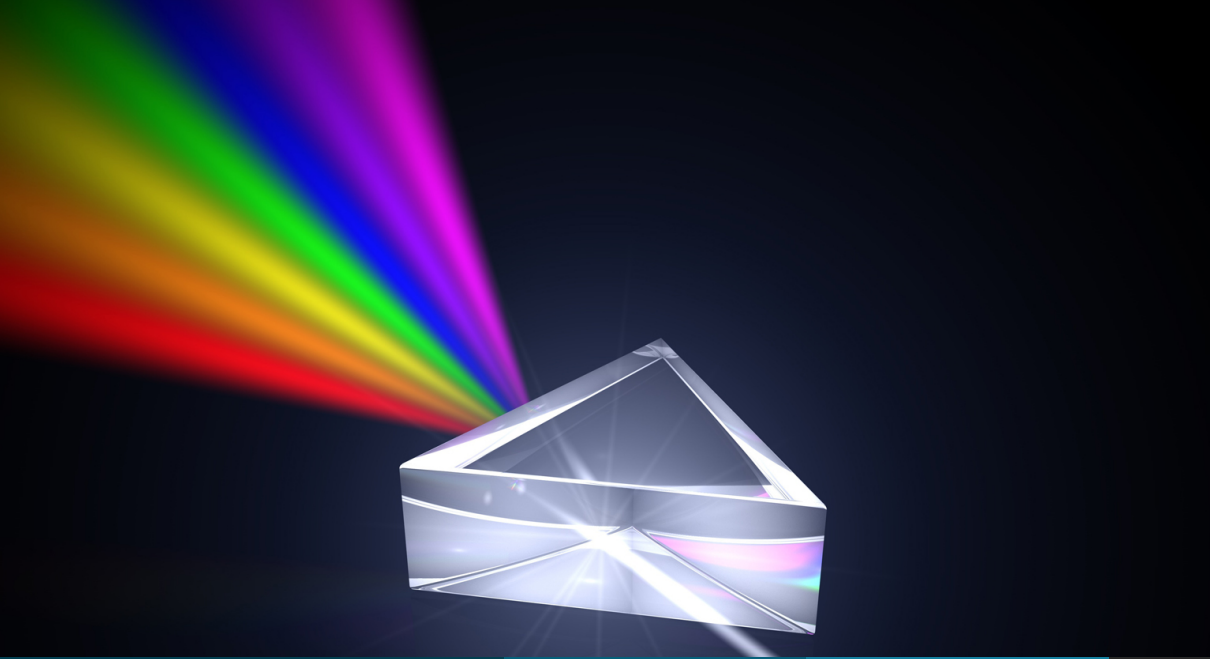
- There is a full moon (lunar eclipse) or new moon (solar eclipse)
- The Moon is at or near one of its two ecliptic crossing points



The Saros Cycle

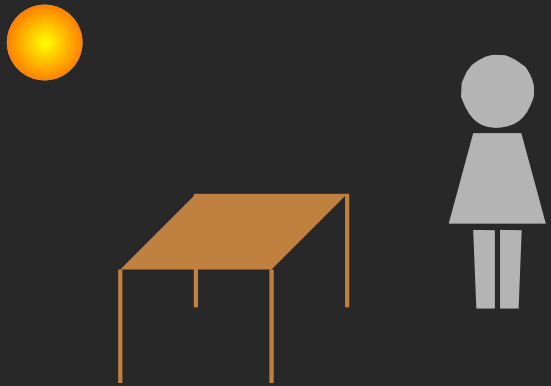
- Ecliptic crossing points slowly move around the Moon's orbit
  - Put's potential eclipse seasons about 173 days apart
- Combine with lunar cycle to get one eclipse about every 18 years, 11 days, and 8 hours.
  - Called the Saros Cycle
- Can predict *when* an eclipse will occur but not where or what type





How do we see?

- We see an object when light from that object reaches our eyes
  - Either because the object emits light itself
  - Or because the object reflects light



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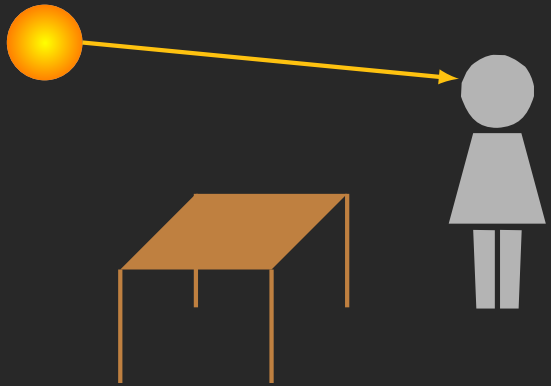

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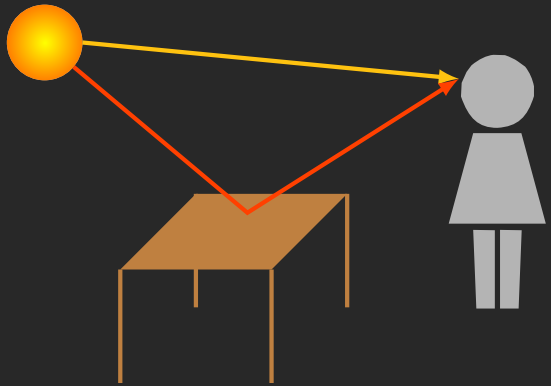
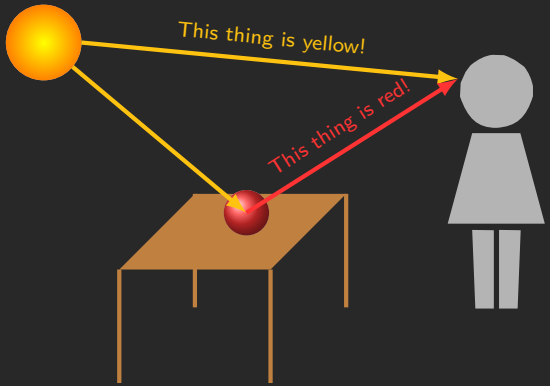


Processing Light Information

- The direction the light enters the eye gives position information
- The wavelength of the light gives color information



Tricks of Light

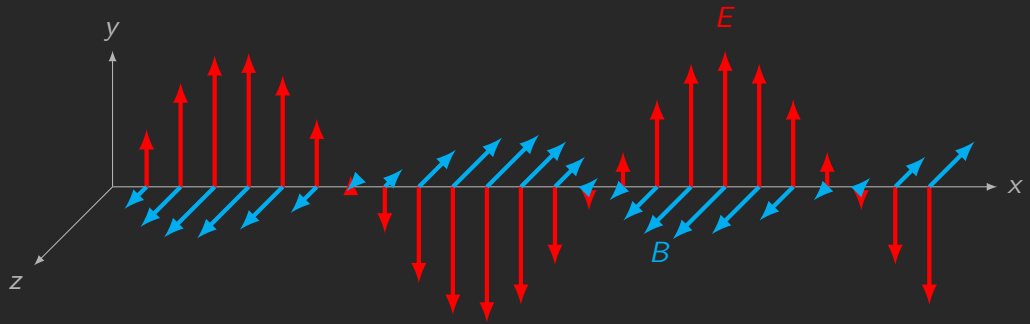
- A single image gives no distance information

Tricks of Light

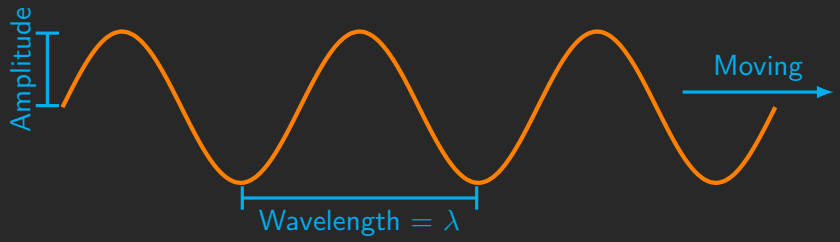
- A single image gives no distance information
- Light can bend, which confuses your brain

But how does it work?

- Light is, first and foremost, a wave
  - Similar to an ocean wave
  - Affects both electric charges and magnets "floating" atop it
  - Called an electromagnetic wave



Properties of Waves

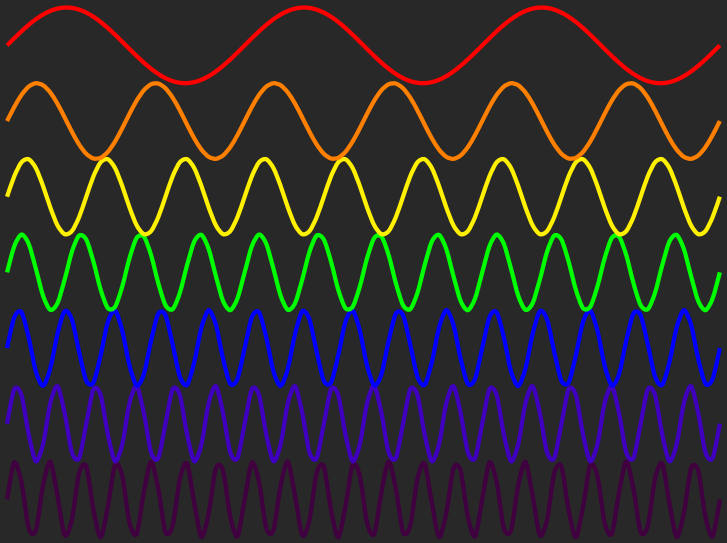


- All light waves move at speed c, the speed of light:

$$c = 3 \times 10^8 \, \mathrm{m/s}$$

- Amplitude corresponds to brightness
- Wavelength/Frequency correspond to color or portion of spectrum

The Rainbow


$\lambda = 720$nm
$\lambda = 630$nm
$\lambda = 600$nm
$\lambda = 550$nm
$\lambda = 480$nm
$\lambda = 440$nm
$\lambda = 400$nm

Wavelength and Frequency

- In a generic wave, the wavelength and frequency of a wave determine its speed
- Since light has a fixed speed, wavelength and frequency are related:

$$\lambda \times f = c$$

where

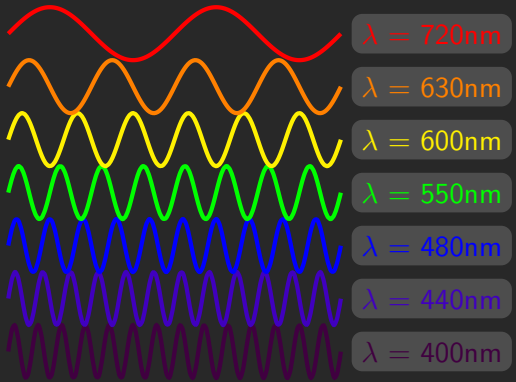
$$\begin{aligned} \lambda &= \text{ wavelength} \\ f &= \text{ frequency} \end{aligned}$$

- People flip back and forth in whether they use one or the other
- Frequencies tend to be high, so often given in THz (1×10^{12} Hz)

Understanding Check

A friend tells you they measured beam of light with a frequency of 5×10^{14} Hz. What color is it?

A. Red
B. Yellow
C. Green
D. Blue



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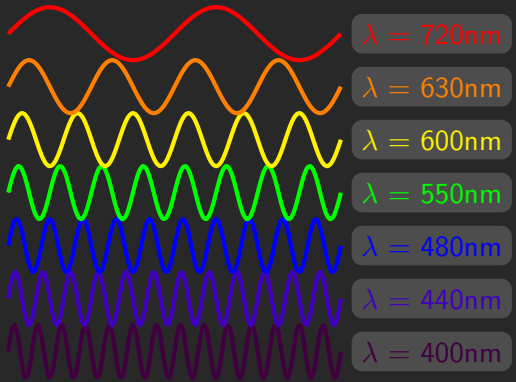

Oh the possibilities

- We have 4 main ways lightwaves will interact with objects
  - Emission: if the object is emitting visible light
  - Absorption: if the object absorbs all the light (and heats up)
  - Transmission: if the object allows light through
  - Bouncing:
    - Reflection: if the object bounces the light perfectly
    - Scattering: if the bouncing is messy and in all directions

Our Blue Sky

- Molecules in the atmosphere scatter the smaller wavelength light (Blue→Violet)
- The white light from the sun thus gets the blue bits scattered throughout the atmosphere
- The Earth reflects all manner of colors (so white) back up into the atmosphere as well, which lightens the shade of blue we see
- Why isn't the sky violet?
  - Amount of "violet" in sunlight is less
  - Our eyes are less sensitive to violet
- Sunsets redder because more blue light scattered away through thicker atmosphere

Shadings of Sky