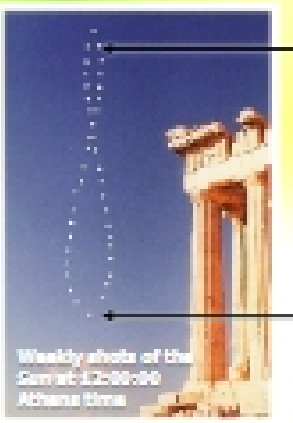
ANNOUNCEMENTS:

Coverage of Chapters 2 and 3 will be sketchy

- Skip all "Mathematical Insights".
- Read but don't focus on Ch 3.1, 3.2, 3.5
- These describe some of the grandest intellectual achievements of western civilization—and some of the ultiest!
- Kepler's three amazing laws: don't memorize them

The only way to know what material is being emphasized is to attend class and take notes.
This pertains throughout the quarter.

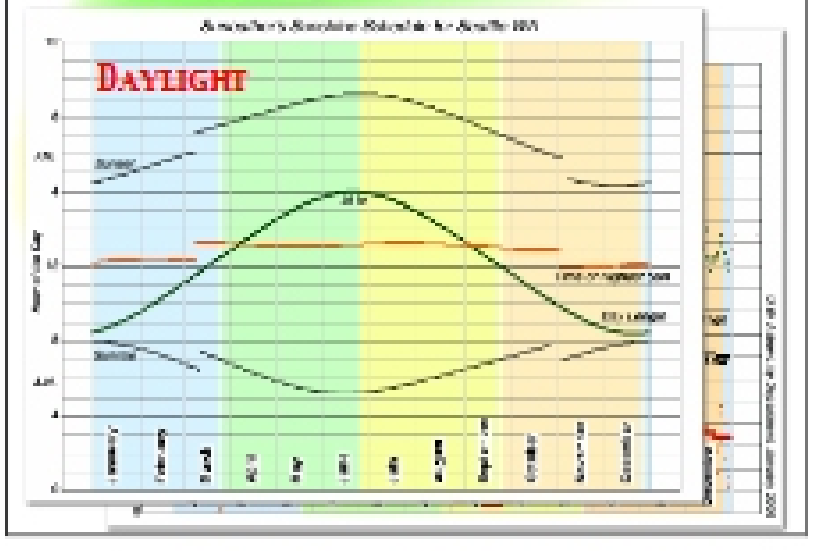
HIGHER SUN = FASTER WARMING = HIGHER TEMPERATURE



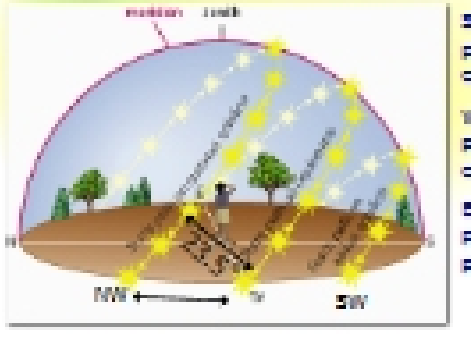
Sun's position at noon in summer: *higher altitude means more direct sunlight (and shorter shadows). Less atmosphere in the way allows more uv to reach the ground — good tanning.*

Sun's position at noon in winter: *lower altitude means less direct sunlight (and longer shadows).*

SEATTLE RESULTS



MORE FACTS: MARKING THE SEASONS



Summer solstice: Highest path, rise and set at most extreme north of due east.

Winter solstice: Lowest path, rise and set at most extreme south of due east.

Equinoxes: Sun rises precisely due east and sets precisely due west.

ONE REASONABLE & PERFECTLY WRONG EXPLANATION

Hunch:
Earth is closer to the Sun in summer and farther from the Sun in winter.

Falsified by Evidence!

Fact: When it is summer in the U.S., it is winter in Australia

Fact: The Earth is in a nearly circular orbit (±3%)

Fact: The Earth and the Sun are closest every January

EXPLAINING THE SEASONS

(IT'S ALL IN THE GEOMETRY)

The tilt of the Earth's axis is responsible for the daily duration of solar heating. The fixed angle of the tilted pole and the motion of the earth explain the seasons.

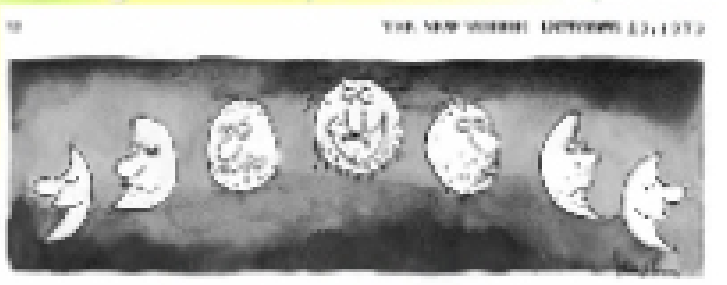
Explaining the Seasons

(it's all in the geometry)

(http://csmnhb.pearsall.com/science/geoanimations/animations/01_EarthSun_02.html)

Lunar Phases

Learning Goals: Why do we see lunar phases?

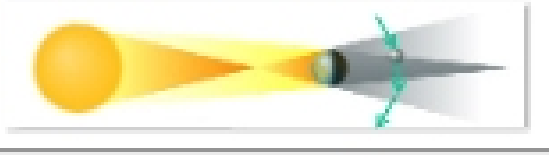


What s your hunch?

What Makes Lunar Phases? Idea 1: Earth s Shadow

Hypothesis:

Phases of the Moon are caused by the Moon sliding in and out of the Earth s shadow

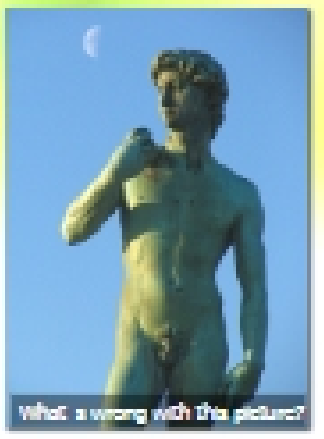


What Makes Lunar Phases? Idea 1: Earth s Shadow

Prediction:

Phases occur only when the Moon is near the Earth s shadow

What Makes Lunar Phases? Idea 1: Earth s Shadow



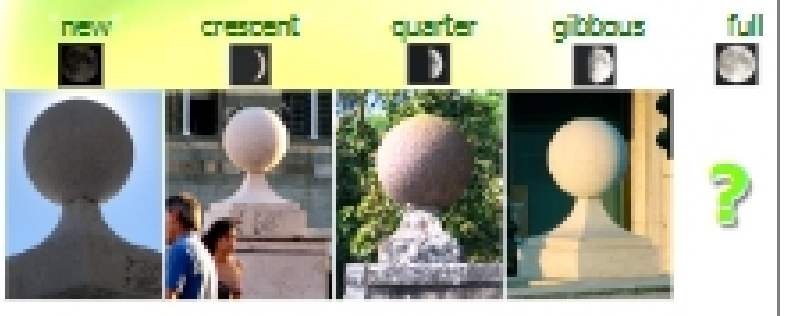
Prediction:

Phases occur only when the Moon is near the Earth s shadow

Uh-oh...

The evidence conflicts with hypothesis

What Makes Lunar Phases? Idea 2: Illumination & Geometry



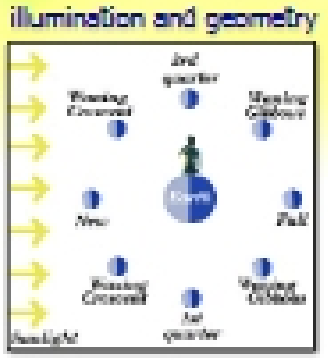
This is called learning by analogy .

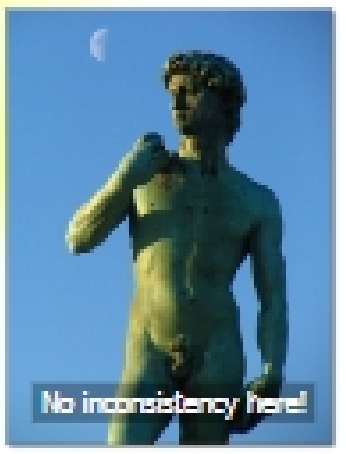
It s very powerful—and occasionally very wrong.

What Makes Lunar Phases?
Idea 2: Illumination & Geometry

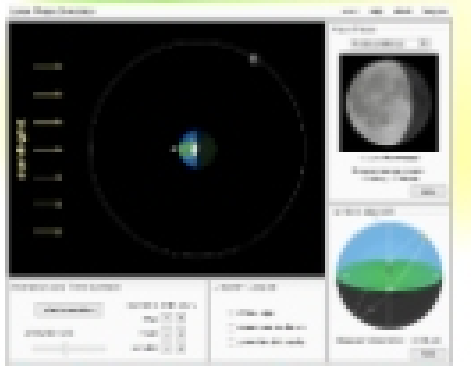
Hypothesis:

Phases are the result of illumination and geometry





What Makes Lunar Phases?
Idea 2: Illumination & Geometry



Predictions of the Model

- Full moon opposite the Sun => Moon rises when Sun sets
- New moon appears close to the Sun =>
  - They rise and set at about the same time
  - No crescent moon at midnight

(http://astro.unl.edu/naap/lps/animations/lps.swf)

These predictions have been repeatedly verified

What Makes Lunar Phases?
Idea 2: Illumination & Geometry

Know how to use the model to make predictions of lunar phase and location!

Examples:

The full moon rises at

a. noon b. sunset c. midnight d. sunrise

Just prior to a lunar eclipse, the moon must be

a. full b. gibbous c. quarter d. crescent e. new

The full moon is at its maximum sky height in

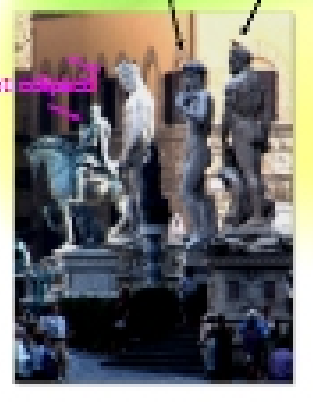
a. spring b. summer c. autumn d. winter

The moon is closest to the Earth when it is

a. full b. gibbous c. quarter d. crescent e. none

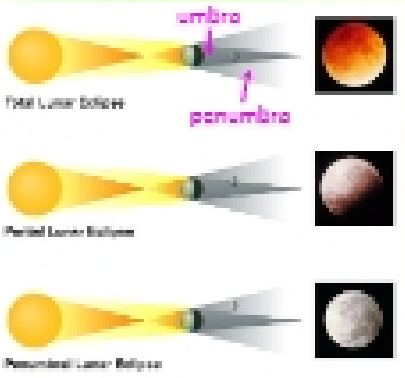
Special Events: Eclipses

Eclipse of the statues - as in eclipsed or shadowed



Movie courtesy of Greg Sellek

Lunar Eclipses



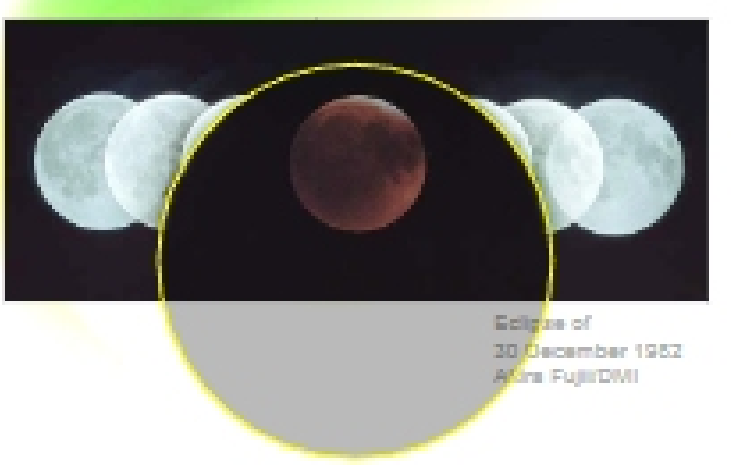
Total eclipse: when the entire moon is in the umbra

Partial eclipse: when just a part of the moon slides into the umbra

Penumbral Eclipse: the Earth only partially covers the Sun. The full moon is dimmer but still easily visible

Total lunar eclipses occur for about an hour only on nights when the Moon is full, and even then once or twice per year. Be sure to understand why!

Lunar Eclipses



Eclipse of 20 December 1952
Akira Fujii/DMI