

# TODAY

## FIRST HOMEWORK DUE NEXT TIME

- SEASONS/PRECESSION RECAP
- PHASES OF THE MOON
- ECLIPSES
  - LUNAR, SOLAR
- ANCIENT ASTRONOMY

# Extra credit (2 points)

- What is the main cause of seasons on Earth?
- Be sure to include your name and section number
- You may consult your notes, but do not communicate with anyone else

# Reminder: HW due Thursday

- Must turn in before 9:30 AM Thursday
- E-mail, in PDF form, to:  
astro100-010?@astro.umd.edu  
(e.g., astro100-0103 if you are in section 0103)
- Must be typed, not scanned PDF  
**If you need help converting from Word or other programs, talk with your TA**
- Good luck!

# Summary of seasons and precession

- Marking the progression of the seasons:
  - Our **summer and winter solstices** are when the Northern Hemisphere gets its most and least direct sunlight, respectively. The **spring and fall equinoxes** are when both hemispheres get equally direct sunlight.
- Precession: the orientation of Earth's axis slowly changes with time:
  - The tilt remains about 23.5 degrees (so the season pattern is not affected), but Earth has a 26,000 year **precession** cycle that slowly and subtly changes the orientation of the Earth's axis.
  - The discovery of precession is attributed to the Ancient Greek astronomer **Hipparchus** (c. 280 BC)

# Apparent Location of Sun

From College Park, when does the Sun appear to be directly overhead (i.e., at the zenith)?

A. Noon on the equinoxes

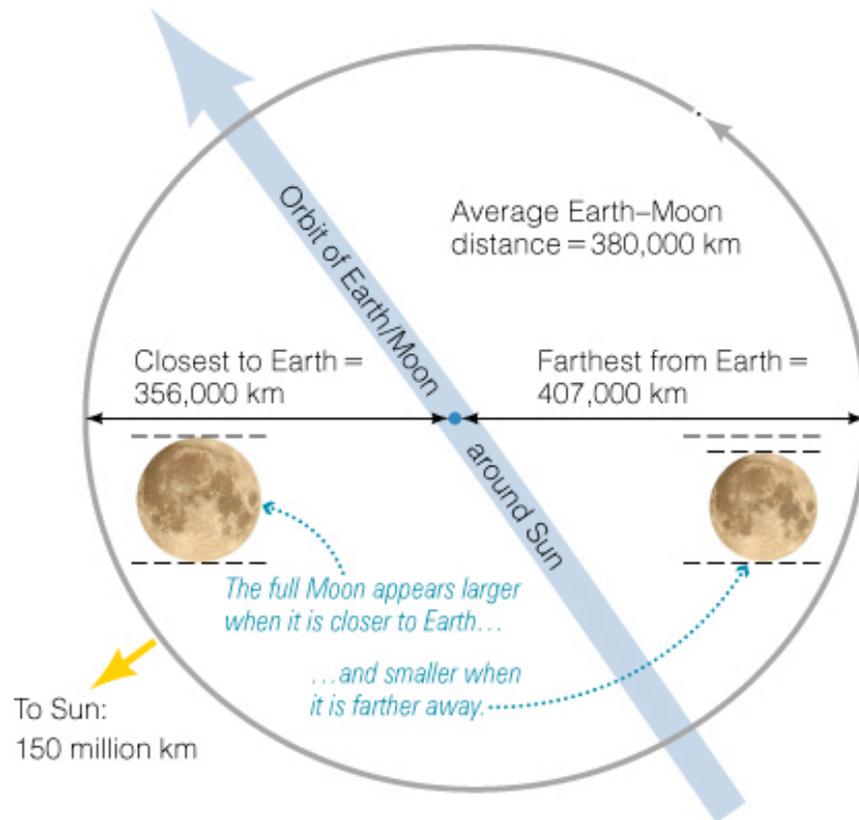
B. Never

C. Noon every day

D. Noon on the summer solstice

E. I don't know

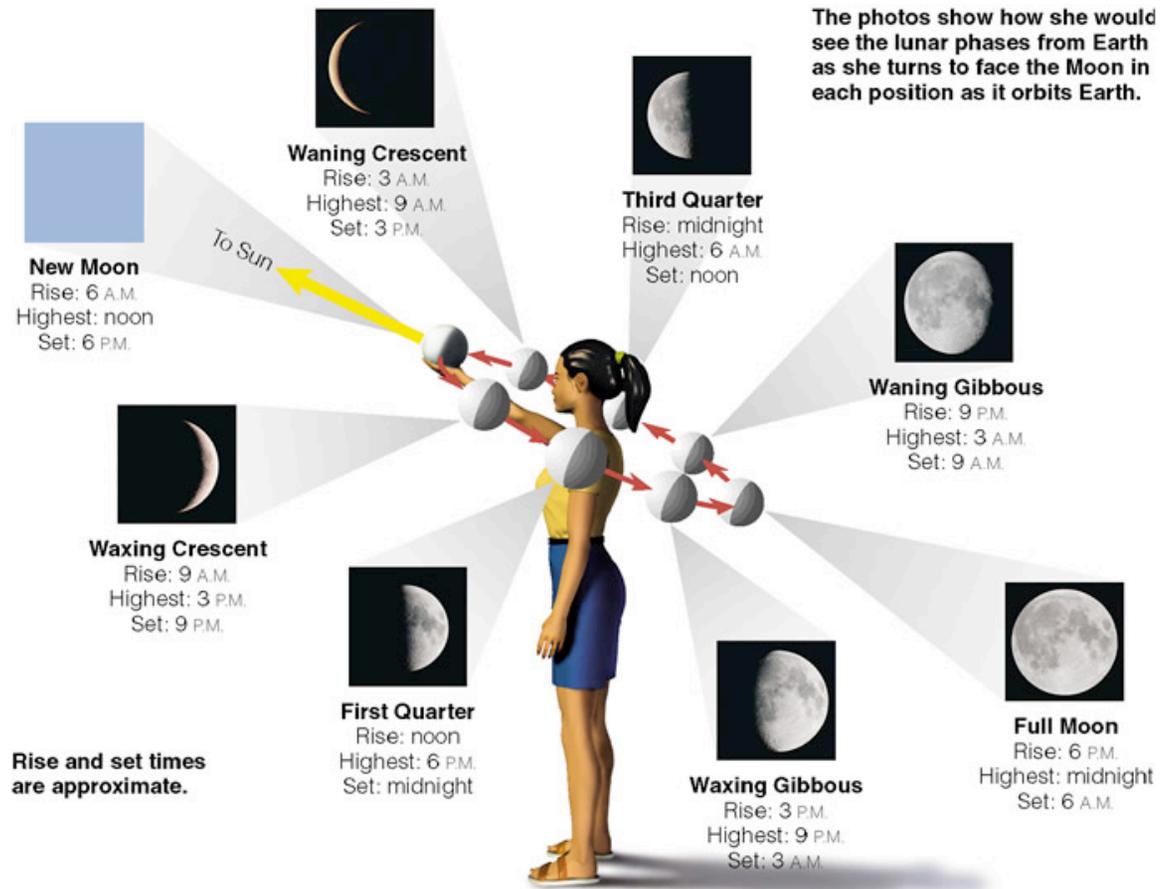
# Lunar phases



- Lunar phases are a consequence of the Moon's 27.3-day orbit around Earth.
- This is the *sidereal* period - how long it takes to complete one orbit.

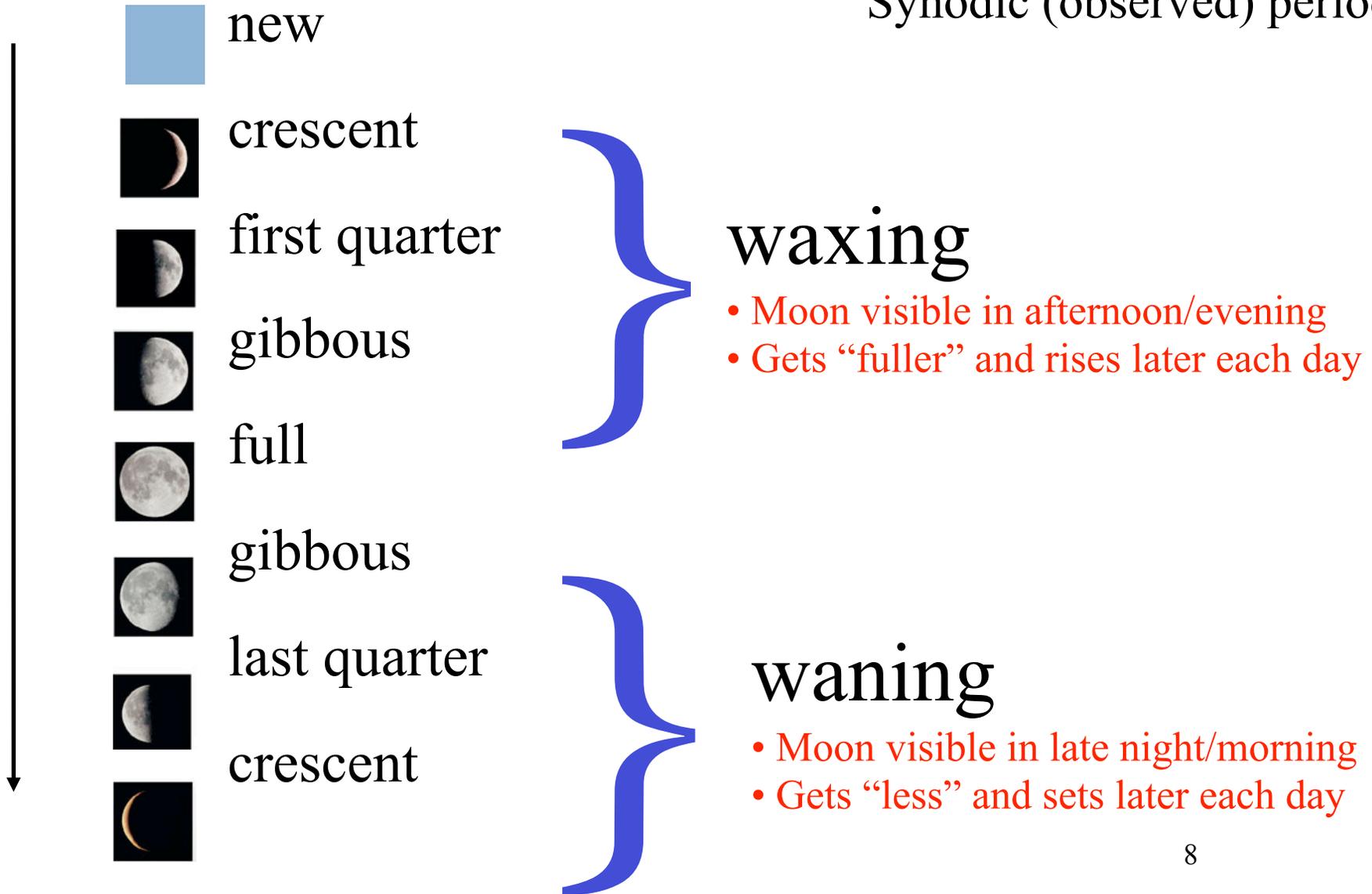
# Phases of the Moon

- Half of the Moon is illuminated by the Sun and half is dark.
- We see a changing combination of the bright and dark faces as the Moon orbits Earth.



# Phases of the Moon: 29.5-day cycle

Synodic (observed) period



# We see only one side of the Moon



Synchronous rotation:  
The Moon rotates exactly  
once with each orbit.

This is why only one side  
is visible from Earth.

This is an example of “tidal locking” in which the spin rate of a smaller moon is coupled to its orbital period around a larger planet.

# Solar Eclipse

We see a solar eclipse when the moon blocks out the Sun's light. Which of the following is the phase of the moon just prior to a solar eclipse?

A. Full

B. First quarter

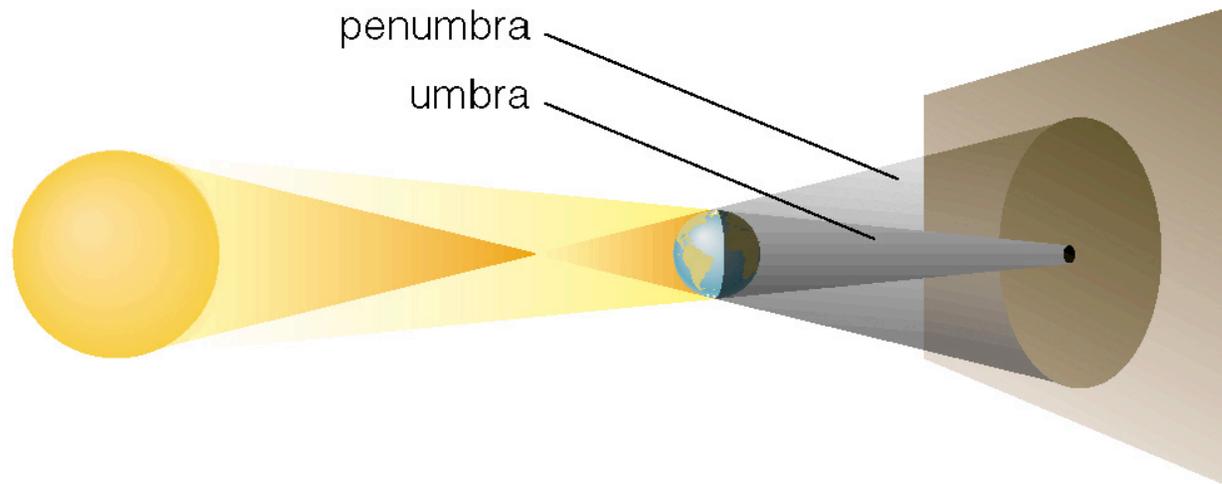
C. New

D. Third quarter

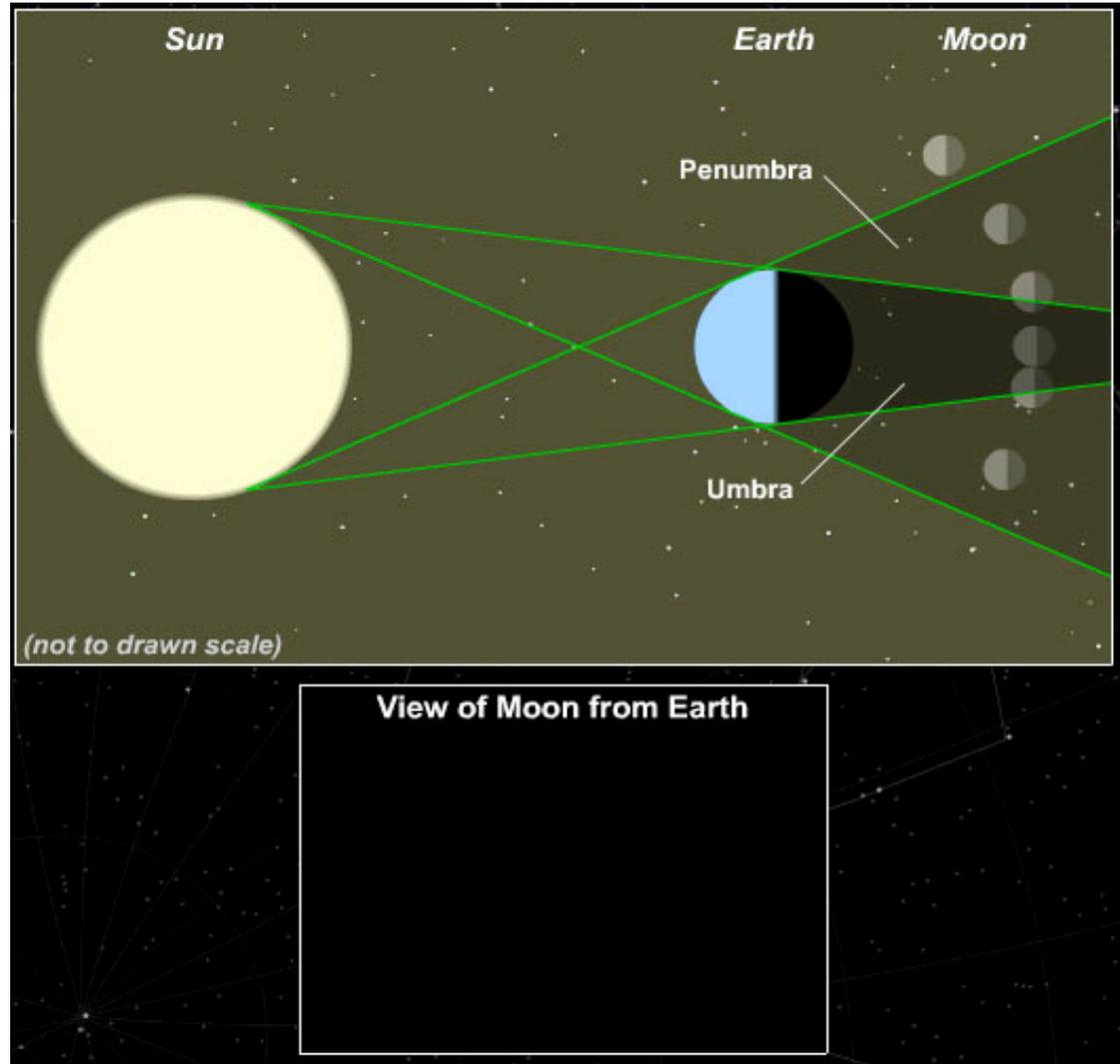
E. I don't know

# Eclipses

- The Earth and Moon cast shadows.
- When either passes through the other's shadow, we have an **eclipse**.



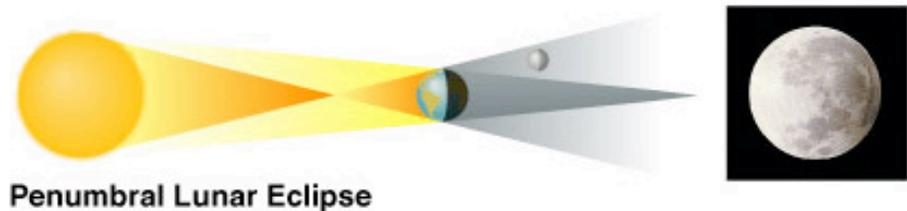
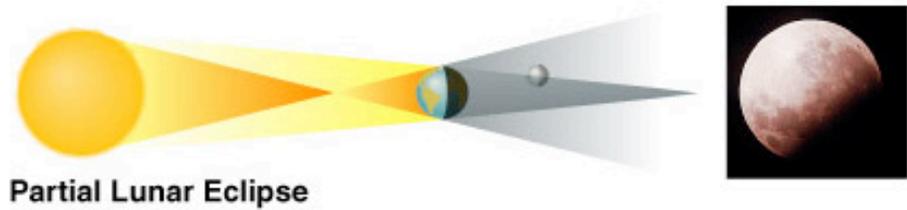
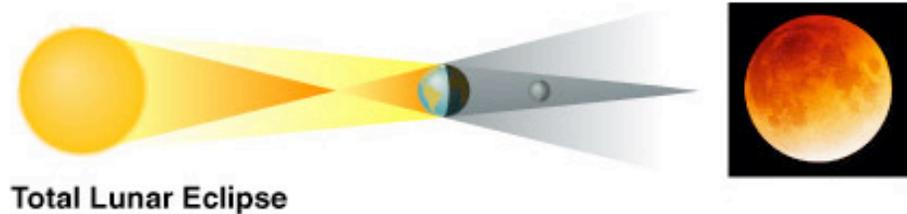
# Lunar Eclipse

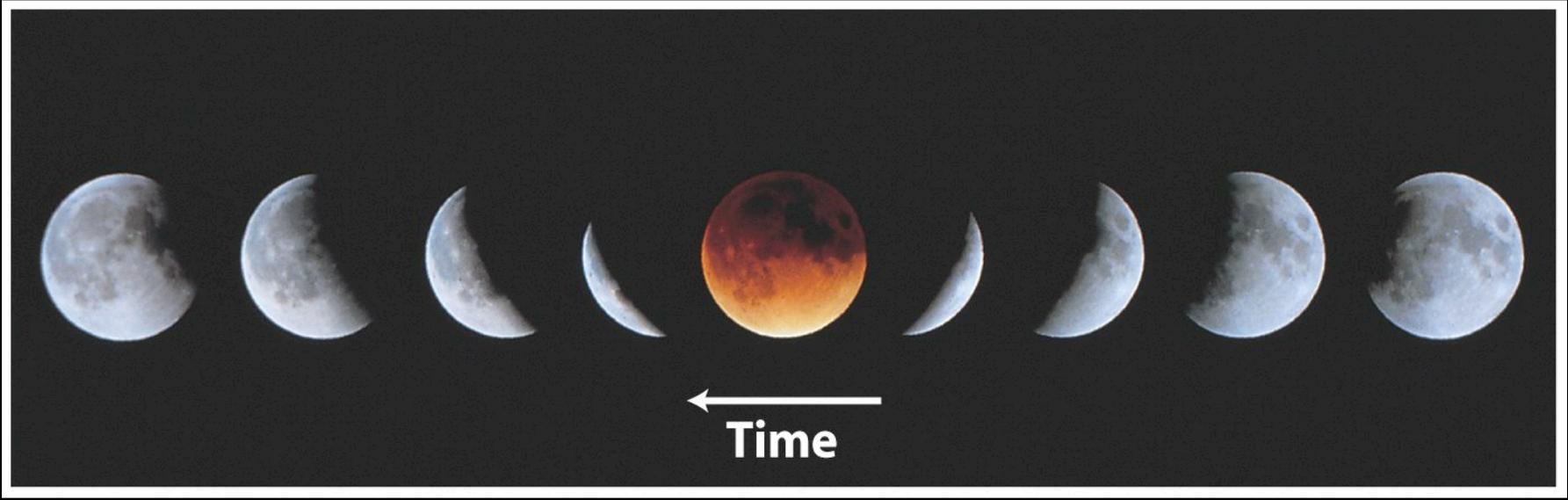


Lunar Eclipse

# When can eclipses occur?

- **Lunar eclipses** can occur only at *full moon* when the earth is between the sun and moon.
- Lunar eclipses can be **penumbral**, **partial**, or **total**.







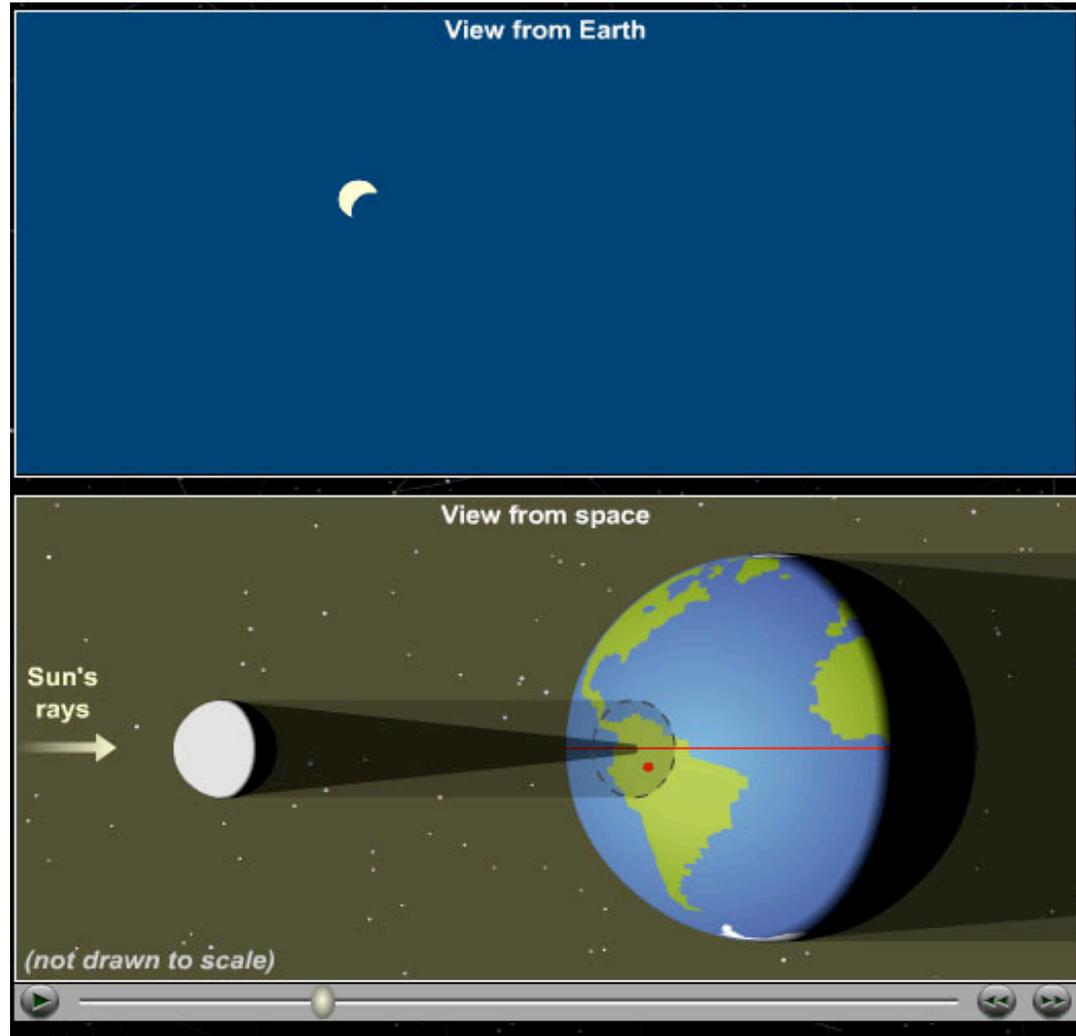
# Total Lunar Eclipse, March 3<sup>rd</sup> 2007



**Newtonhill, Aberdeenshire**

© Darren Moody  
Aberdeen Astronomical Society

# Solar Eclipse



Evolution of a Total Solar Eclipse

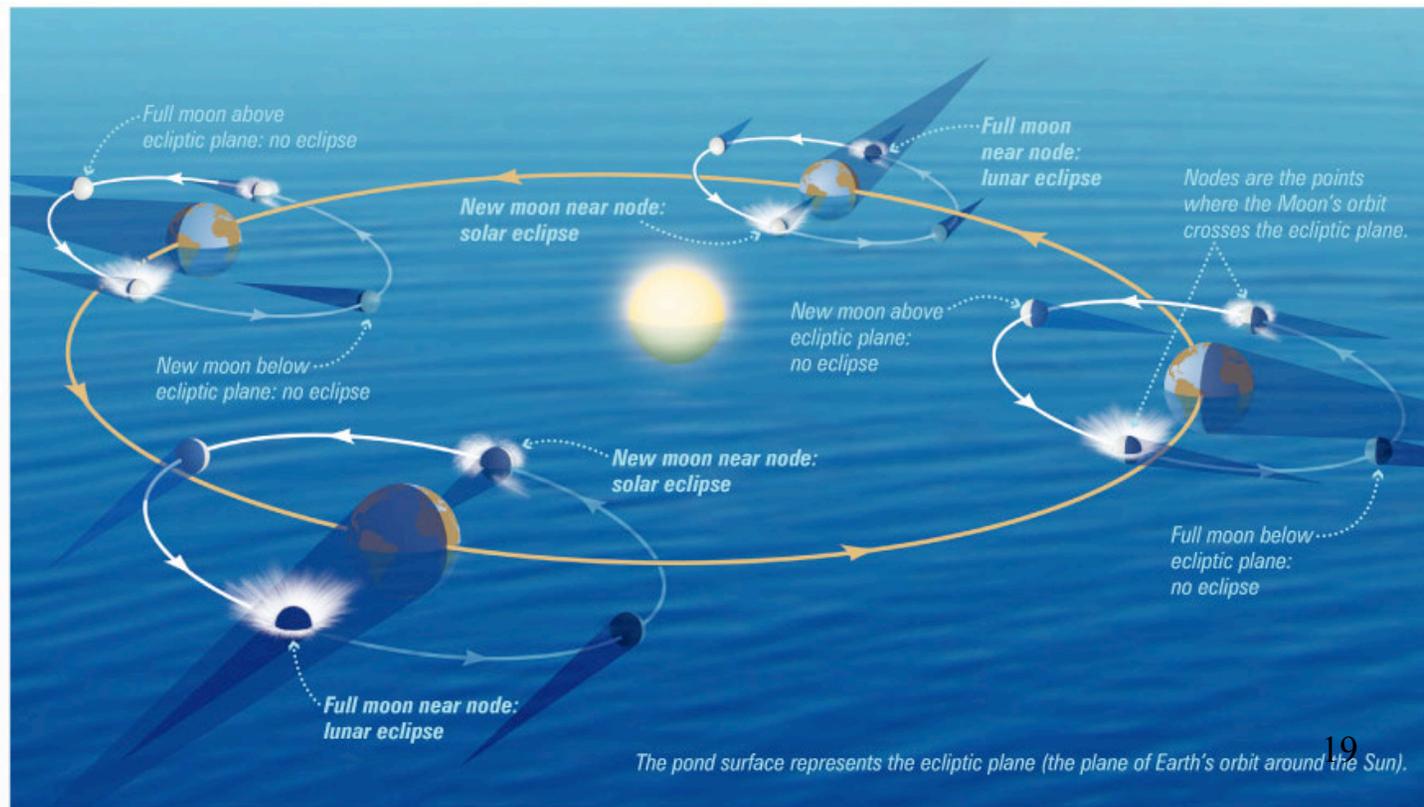
# When can eclipses occur?

- **Solar eclipses** can occur only at *new moon* when the moon is between the earth and the sun.
- Solar eclipses can be **partial**, **total**, or **annular**.
- It is a coincidence that the angular size of the sun and moon are approximately equal.



# Why don't we have an eclipse at every new and full moon?

- The Moon's orbit is tilted  $5^\circ$  to the ecliptic plane.
- So we have about two **eclipse seasons** each year, with a lunar eclipse at new moon and solar eclipse at full moon.  
**And sometimes the Moon doesn't completely cover the Sun!**



## Summary: Two conditions must be met to have an eclipse:

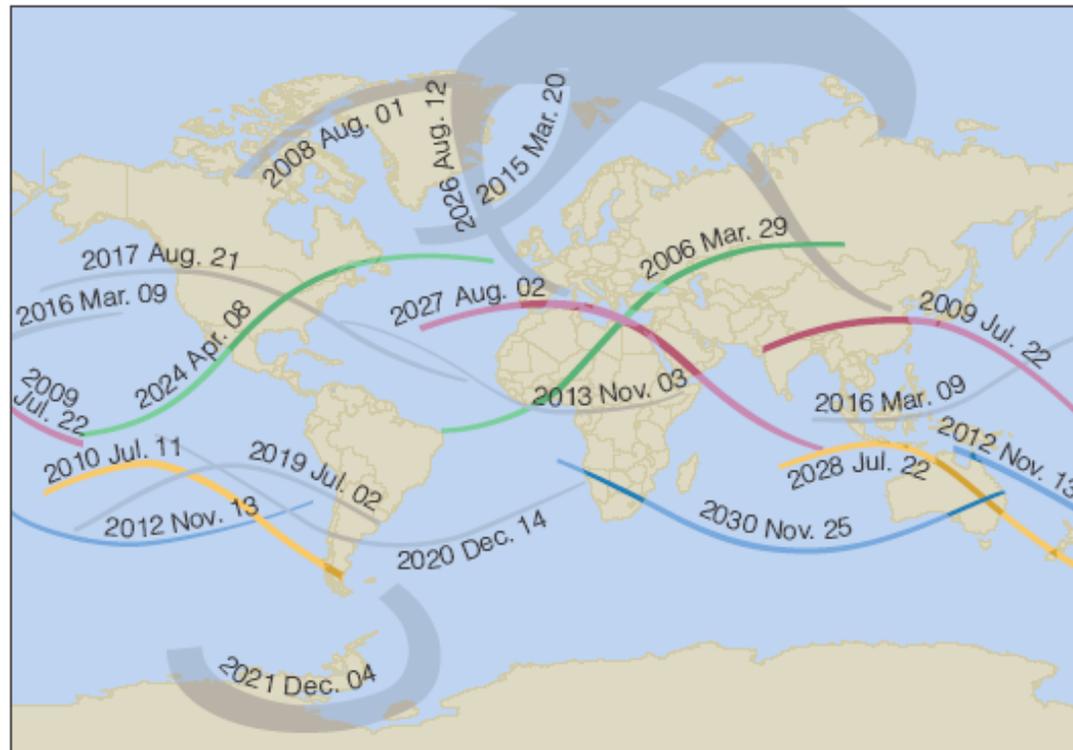
1. It must be a full moon (for a lunar eclipse) or a new moon (for a solar eclipse).

AND

2. The Moon must be at or near one of the two points in its orbit where it crosses the ecliptic plane (its nodes).

# Predicting Solar Eclipses

- Solar eclipses recur with the 18 year, 11 1/3 day **saros cycle**, but type (e.g., partial, total) and location may vary.



# What have we learned?

- Why do we see phases of the Moon?
  - Half the Moon is lit by the Sun; half is in shadow, and its appearance to us is determined by the relative positions of Sun, Moon, and Earth.
- What causes eclipses?
  - Lunar eclipse: Earth's shadow on the Moon
  - Solar eclipse: Moon's shadow on Earth
  - Tilt of Moon's orbit means eclipses occur during two periods each year

# Summary

- Phases of the moon are just the part of the Moon we see that reflects light from the Sun
- A solar eclipse occurs when we see the Moon block out the Sun's light
- A lunar eclipse occurs when the Earth's shadow falls on the moon
- Eclipses are rare: Moon's orbit is tilted!