Last Time

- Earth Rotates on its axis once per day, causing:
  - Daily ("Diurnal") Motions of stars, Sun, everything in the sky.

- Earth orbits the sun once per year, causing:
  - Sun's motions on the celestial sphere ("slips" from W to E). Path is called the ecliptic (constellations the sun moves through the zodiac).
  - Earth's rotation axis is tipped 23.5°: Seasons (not the distance to the sun!) Solstices/equinoxes.
The Earth isn’t a perfect sphere, but “bulges” slightly at the equator.

Pull of Moon and Sun on the “inner tube” of the Earth causes it’s direction of spin to “precess” slowly, taking 26,000 years to return.
Precession of the Earth

The Earth isn’t a perfect sphere, but “bulges” slightly at the equator.

Pull of Moon and Sun on the “inner tube” of the Earth causes it’s direction of spin to “precess” slowly, taking 26,000 years to return.
Civil Time is based on the Sun’s position, but Earth orbits a little bit each day, so must rotate a little bit more than one full turn to get the Sun back up high: stars rise and set a bit earlier every day.

The moon: orbits the Earth every 27 1/2 days.

Phases of the moon: pattern of waxing and waning over 29.5 days. Moon must go a little further since the Earth has orbited ~1/12th the way around the Sun during that time.
Some Tips

The Earth-Moon-Sun system is vital for understanding: Rising and setting, the motion of the Sun along its Ecliptic path, earlier rise of stars night by night, phases of the moon, what stars/constellations are visible from the earth’s surface throughout the year, The Seasons, solar and lunar eclipses...

If you are having trouble with this:

- Draw a picture!
- Do your reading before class.
- Use and understand the interactive Figures on MA
- Come see me and we’ll go through it!
Our Companion, The Moon
Why do we see phases of the Moon?

- One half of the moon is always illuminated by the Sun
- Phases are a result of the Moon’s position relative to the Sun as it orbits the Earth
What causes moon phases?

A) Moon passes into the shadow of the earth.

B) Relative orientation of Sun, Moon, and Earth determines the phase.

C) Moon is made of cheese, and the north wind eats it day by day.
What causes moon phases?

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C) Moon is made of cheese, and the north wind eats it day by day.
In-class Demo

- Your Head is the Earth
- The styrofoam Ball is the moon
- This light is the sun
In-class Demo

- Your Head is the Earth
- The styrofoam Ball is the moon
- This light is the sun
But…. Doesn’t the Moon block out the Sun?
But.... Doesn’t the Moon block out the sun?
But.... Doesn’t the Moon block out the sun?
Rotations of Moon

- We Always see the same side
- Moon rotates about once per month

Non-rotating moon

Rotating moon
The “Dark Side of the Moon”

- Is not actually Dark!

- Better called the “back side of the moon” or “Far side of the moon”

- Has “night” and “day” just like the front side.
About what time is it at the marked position?

A) 6AM
B) 9AM
C) 6PM
D) Midnight
About what time is it at the marked position?

A) 6AM
B) 9AM
C) 6PM
D) Midnight
Which phase of the Moon rises at 9am?

A) Waning gibbous
B) Third quarter
C) First quarter
D) Waxing crescent
E) None of the above
Which phase of the Moon rises at 9am?

A) WanING GIBBOUS
B) Third quarter
C) First quarter
D) WanING CRESCENT
E) None of the above
Which phase of the Moon rises at 9am?

A) **Waning gibbous**
B) **Third quarter**
C) **First quarter**
D) **Waxing crescent**
E) **None of the above**
Which phase of the Moon rises at 9am?

A) **Waning gibbous**

B) **Third quarter**

C) **First quarter**

D) **Waxing crescent**

E) None of the above
Is the Moon up in the daytime?

Yes!

Spends half of it’s time up during the day.

Smkymtnmnman/Flickr
Comment from photographer: “Taken at 10:41am this morning. Wish it had been full.”

What’s wrong with this statement?
You look up at a 1\textsuperscript{st} Quarter moon and see that the crater where you built your retirement home is on the terminator (the dividing line between light and dark). What time of day is it there?

A) Sunrise
B) Noon
C) Sunset
D) Midnight
You look up at a 1st Quarter moon and see that the crater where you built your retirement home is on the terminator (the dividing line between light and dark). What time of day is it there?

A) Sunrise
B) Noon
C) Sunset
D) Midnight
A tough One!

You look up at a 1st Quarter moon and see that the crater where you built your retirement home is on the terminator (the dividing line between light and dark). What time of day is it there?

A) Sunrise  
B) Noon  
C) Sunset  
D) Midnight
Motion of the Moon

- Daily motion of the moon is set by earth’s rotation (just like everything else!).

- Moon “slips” fast, rising about 53m later every day: moves fast enough to “see” compared to bright nearby stars.

- Each hour, it “slips” 1/2°, it’s own diameter.
**Rotation of Moon**

- **Always see same side**

- **Moon rotates about once per month**

![Diagram of Moon Rotation](image)

**Non-rotating moon**

**Rotating moon**
Moon’s apparent size

- Distance varies somewhat throughout orbit around the Earth.

- “Very large moon” is an illusion.
Eclipses
Solar & Lunar Eclipses
Earth and Moon Shadows

A. Umbra

B. (and C) Penumbra

D. Umbral Extension
What Causes Eclipses?

- The Earth and the Moon cast shadows.

- Whenever one passes into the shadow of the other, an **eclipse** occurs.
Lunar eclipses can only occur at full moon.

Lunar eclipses can be either penumbral, partial, or total.
**When Can an Eclipse Occur?**

- **Solar Eclipses** can only occur at new moon.

- **Solar eclipses** can be partial, total, or annular.

- Coincidence that the angular size of the Sun and Moon are the same!
Moon's Orbit around Earth: Tipped about 5° from Earth's orbit around the Sun.
Shadow of the moon on the Earth’s Surface from the International Space Station
When the Moon appears to completely cover the Sun (a solar eclipse), the Moon must be at which phase?

A) full
B) new
C) first quarter
D) last quarter
When the Moon appears to completely cover the Sun (a solar eclipse), the Moon must be at which phase?

A) Full
B) New
C) First Quarter
D) Last Quarter
Participation Question

Take out a piece of paper, write your name and Rocket ID, and the answer(s) to this question:

**Solar eclipses occur when the __________ blocks the light of the __________, as seen from Earth.**

Don’t forget to turn it in at the end of class for your participation credit!!!
Lunar Eclipse

Thursday, September 2, 2010
Lunar Eclipse

- **Moon is “reddened” by total lunar eclipse since light passes through Earth’s atmosphere (just like the reddened sun at sunset!).**
**Eclipse Seasons**

- **Twice each year, when sun is near lunar crossing**

- **Eclipses occur in sets**
  - “two’s” or “three’s”
  - Alternate lunar, solar (separated by 2 weeks)

- **Frequency of eclipses: solar same as lunar**
  - Lunar visible from half of Earth
  - Solar only dramatic if total
  - Total Solar only visible from small region
Reminders/Todo

- **Need Red/Blue Cards, Syllabus, Schedule, blue observing handout, etc? See me after class.**

- **Mid-Term Exam #1 in One Week: Sep 9th, in class**

- **Homework #1 Due Tomorrow (Fri) Night at 11:45pm!!! Find it at masteringastronomy.com**

- **Turn in Participation Credit Answers: Remember Name/Rocket ID**

- **Return styrofoam balls in bag down here**