

A surreal landscape featuring a large, glowing blue planet in the upper right sky, a bright sun on the horizon, and dark, jagged mountains in the foreground. The sky transitions from a deep blue at the top to a warm orange and yellow near the sun. The foreground shows dark, rocky terrain with a deep canyon.

Earth, Sun and Moon Systems

A Note About Shadows

- When you hold a light source FAR from an object, the object only blocks a little light, so its shadow is SMALL and SHARP.
- When you move the light source CLOSE to the object, the object blocks a lot of light and its shadow is BIG



Our Best Pal, The Moon!

- Probably formed when a large object hit Earth and broke off a piece.
- The moon is about $\frac{1}{4}$ the size of Earth
- It takes about 27.3 days to orbit Earth
- About 386,000 km from Earth





Phases of the Moon

- The Moon itself does not emit any light; We see the Moon because it reflects sunlight back toward us.
- As the Moon circles the Earth, the amount of the lit side we see



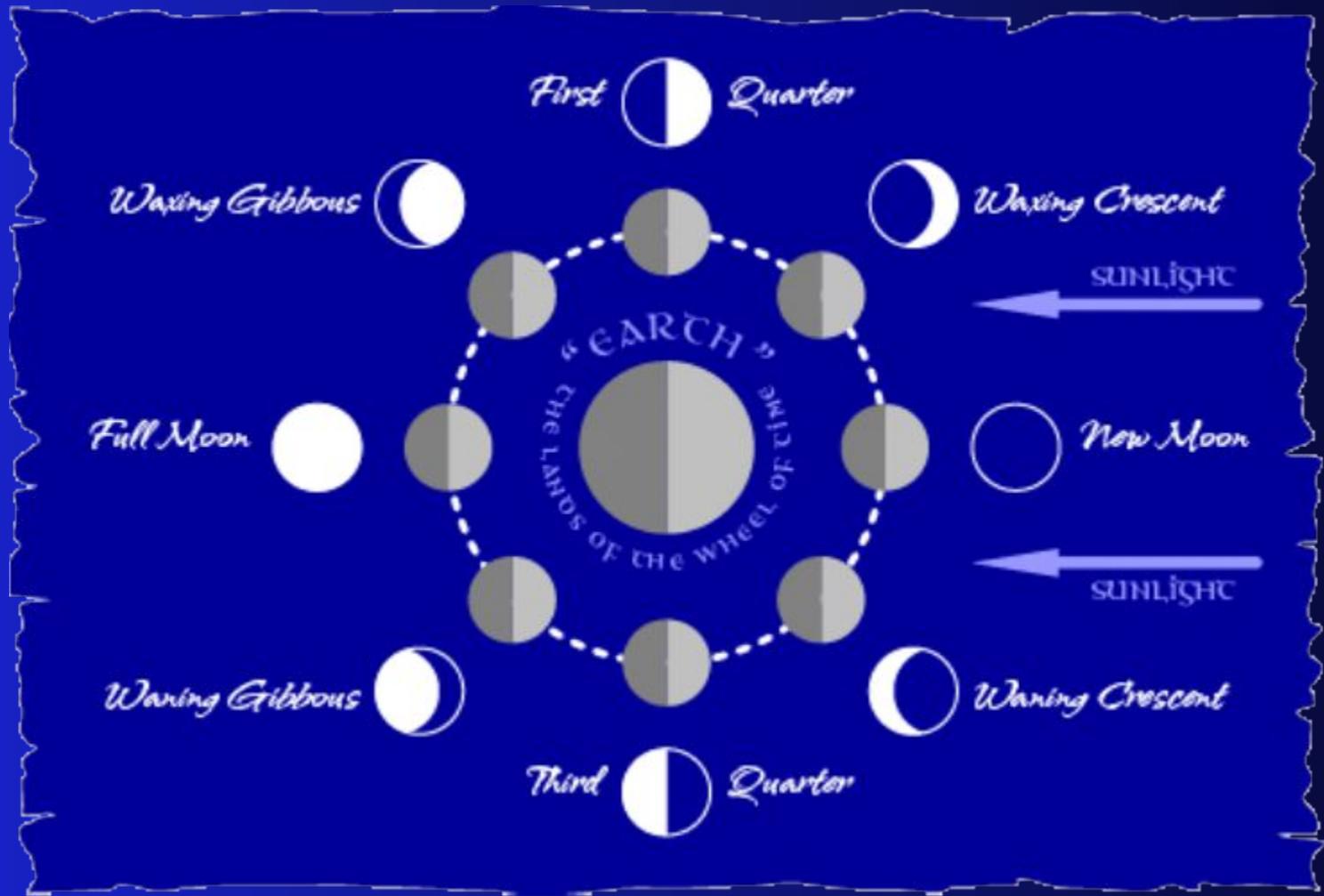
creates the daily
Yes, phases of the Moon
illustrated using delicious
Oreo cookies!

Important Moon Phase Terms



- **Waxing**: Changing from **new** moon to **full** moon (~2 weeks). As we see **more** of the moon we call the phases **“waxing.”**
- **Waning**: Changing from **full** moon back to **new** moon (~2 weeks). As we see **less** of the moon we call the phases **“waning.”**
- Crescent = see **less than** half the moon
- Gibbous = see **more than** half the moon
- At the **1st** and **3rd** Quarters, we see exactly **half** of the moon

Phases of the Moon



Phases of the Moon



new moon



new crescent



first quarter



waxing gibbous



full moon



waning gibbous



last quarter



old crescent

Dark Side of the Moon?

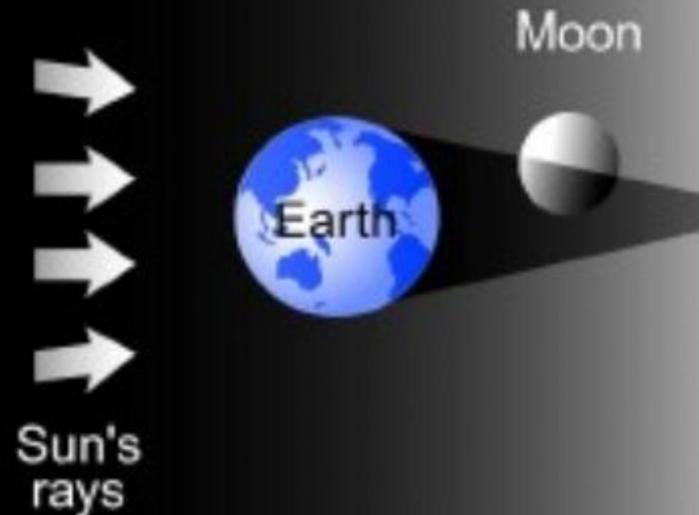
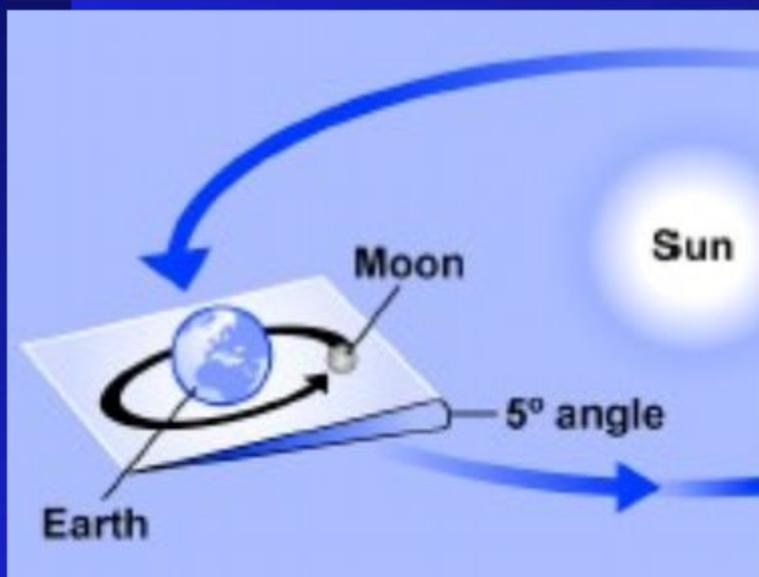
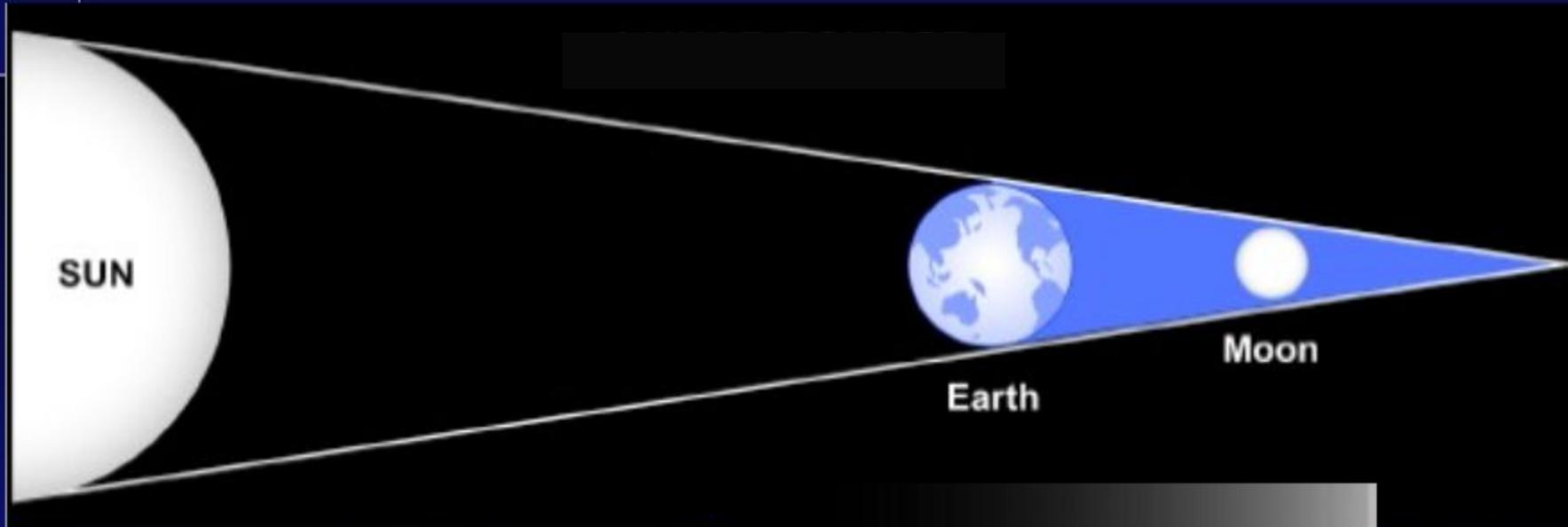
- Why does the moon have a dark side?
Why does the illuminated side always look the same (the moon revolves, after all!)
- **Physics Connection!** It's "synchronous rotation." The time it takes the moon to rotate once on its axis is the same as the time it takes it to revolve around the Earth.
- This is caused by the Earth's "tidal force" or differential (uneven) gravitational force on the Moon.

The Lunar Eclipse!

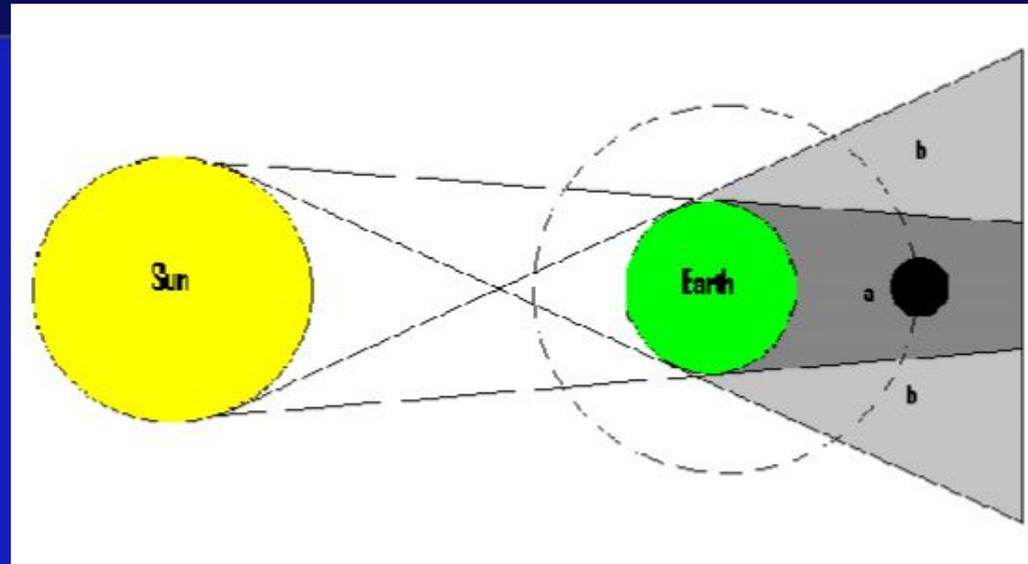
- A lunar eclipse happens during a full moon when the Moon passes through the Earth's shadow.



Lunar Eclipses



Some Basic Terms



a. Umbra:

- darker , central region of the Earth's shadow

b. Penumbra-

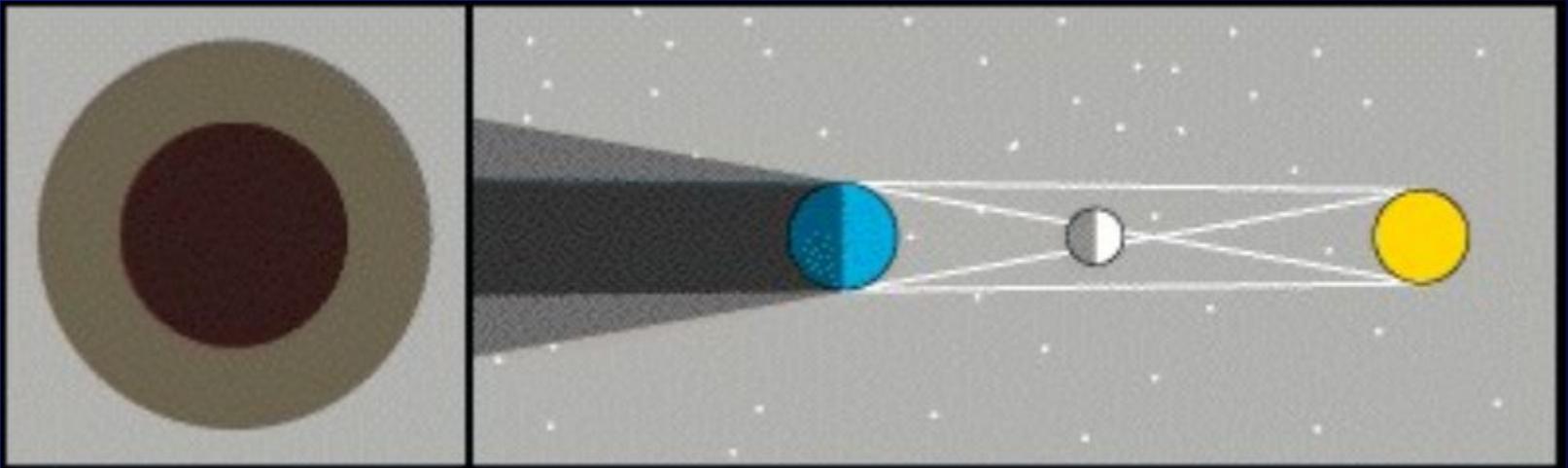
fainter , outer region of the Earth's shadow

Partial vs. Total Lunar Eclipse



- **TOTAL** Lunar Eclipse: You see a total lunar eclipse when the Moon is in the **darker** **central** region of the Earth's shadow (**umbra**).
- **PARTIAL** Lunar Eclipse: You see a partial lunar eclipse the Moon is in the **fainter** **outer** region of the Earth's shadow (**penumbra**).

Model of a Lunar Eclipse



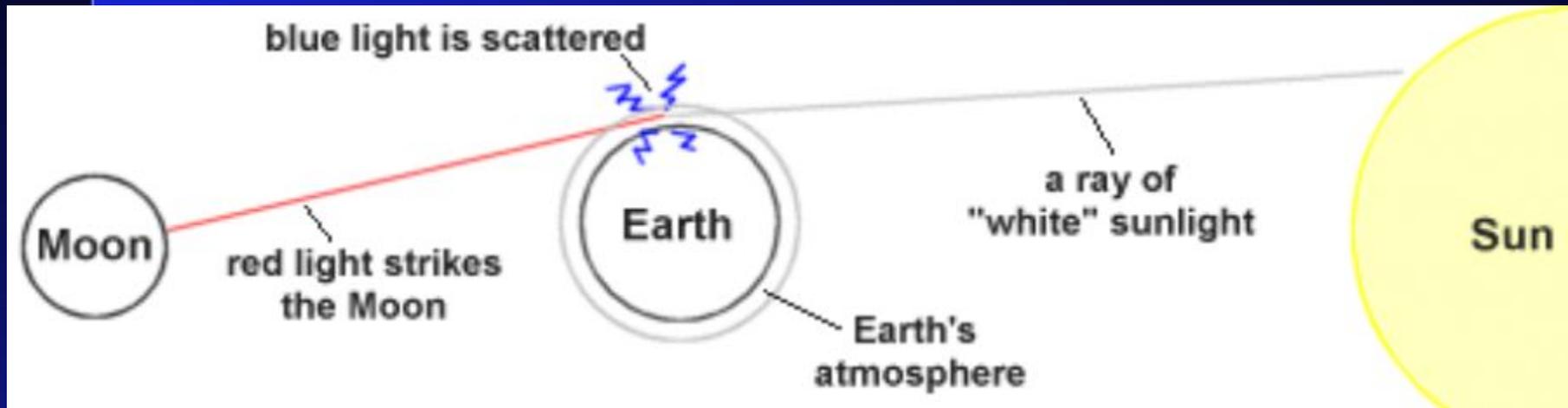
www.salagram.net/eclipses-page.htm

Other Notes – Lunar Eclipses

- Only happen when the moon is in “full moon position”
 - Can last for several hours
 - Happen slightly more often than solar eclipses
- (3-4 times per year)
- The moon never fully disappears, but instead



Why the Moon looks “red”

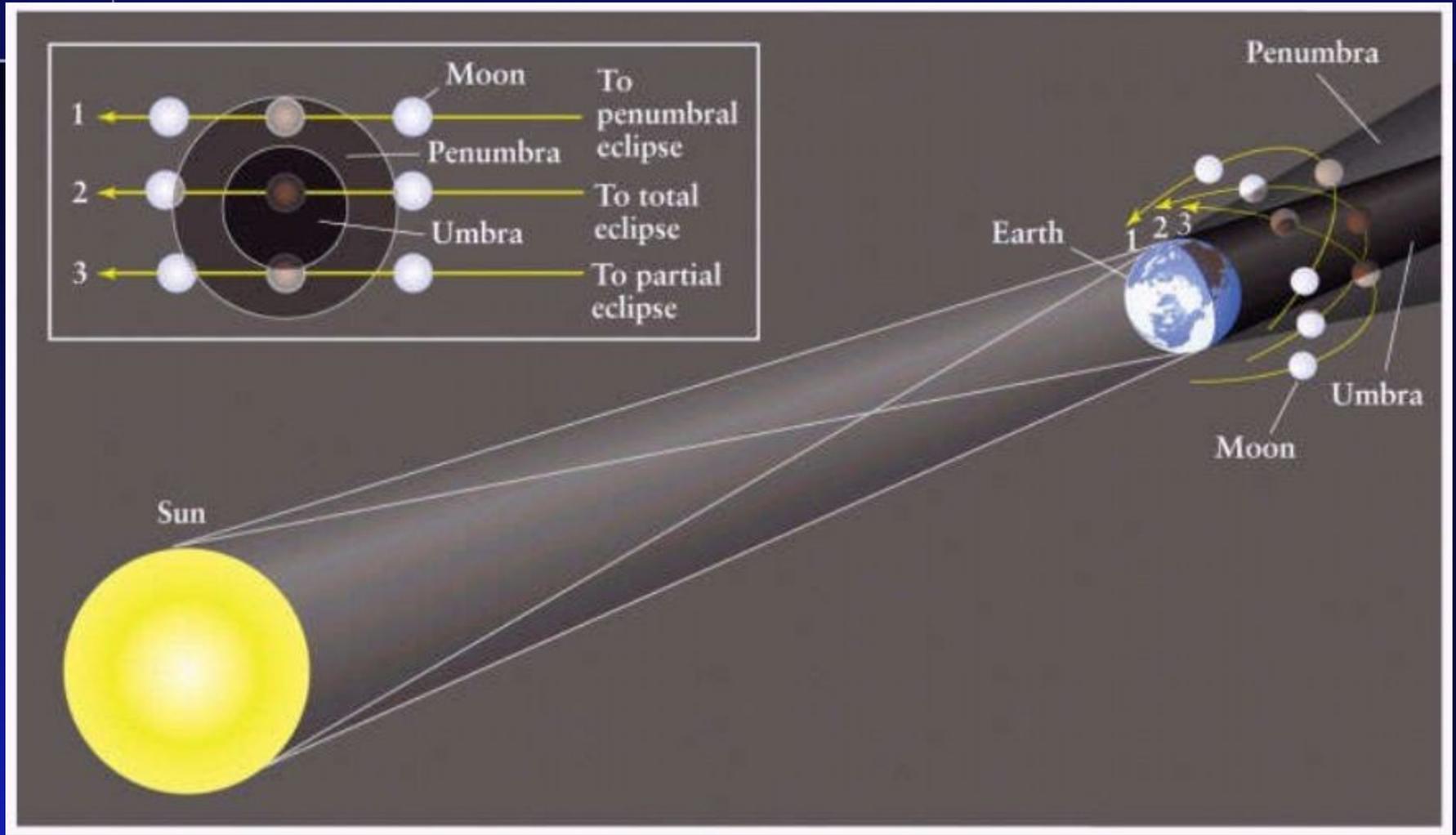


Lunar Eclipses

- Tend to occur more frequently, last longer
 - ▶ Earth's shadow is bigger than the Moon's
- Light gets refracted through Earth's atmosphere
 - ▶ Moon never gets fully dark - turns orange-red color.



Close up of a Lunar Eclipse



It's All About Your View

November 8 - 9, 2003

Nov. 8, 22:15 UT
Eclipse begins



Francis Reddy

<http://celestialdelights.info>

Eclipse View From The Moon

2003 11 09 01:44:05 UTC

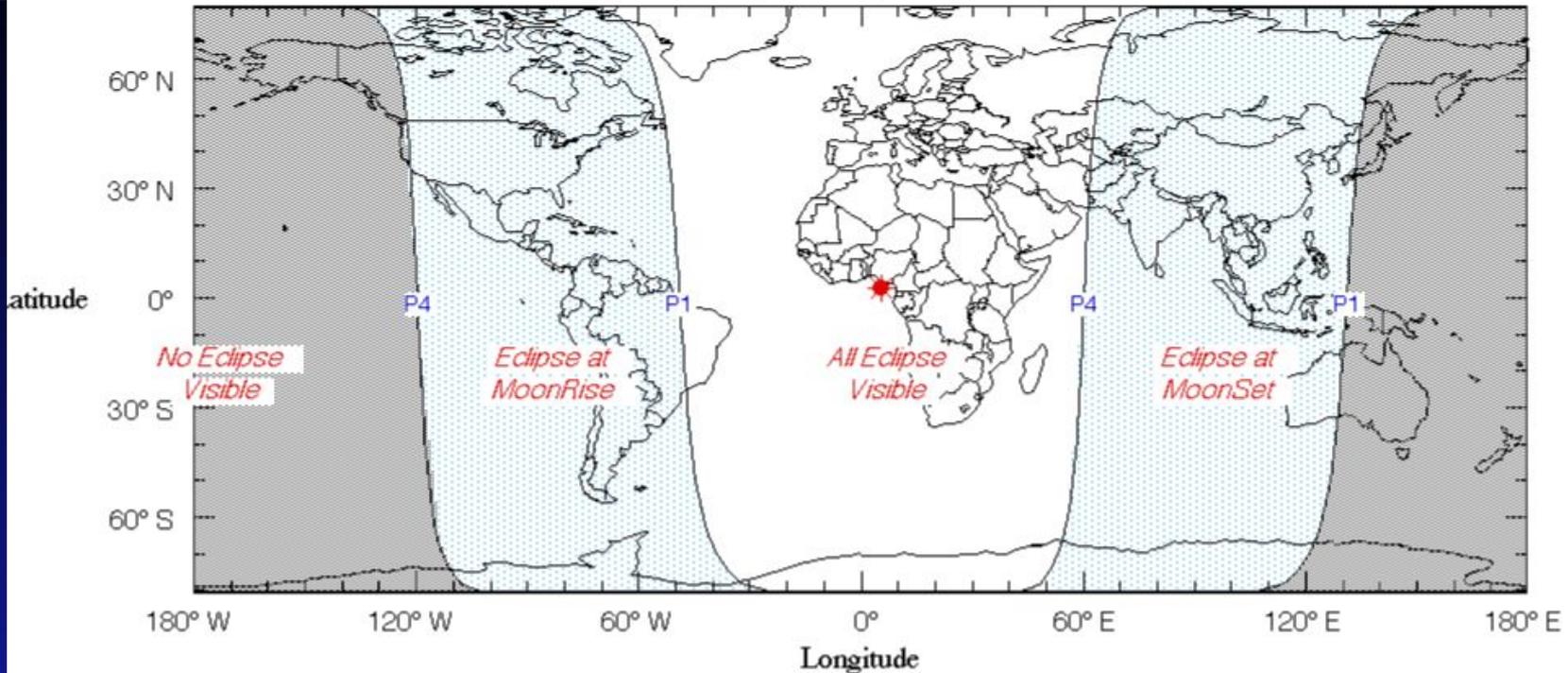
Real time



This would be your perspective if you were standing on the Moon. You would be experiencing a **solar** eclipse of the Earth.

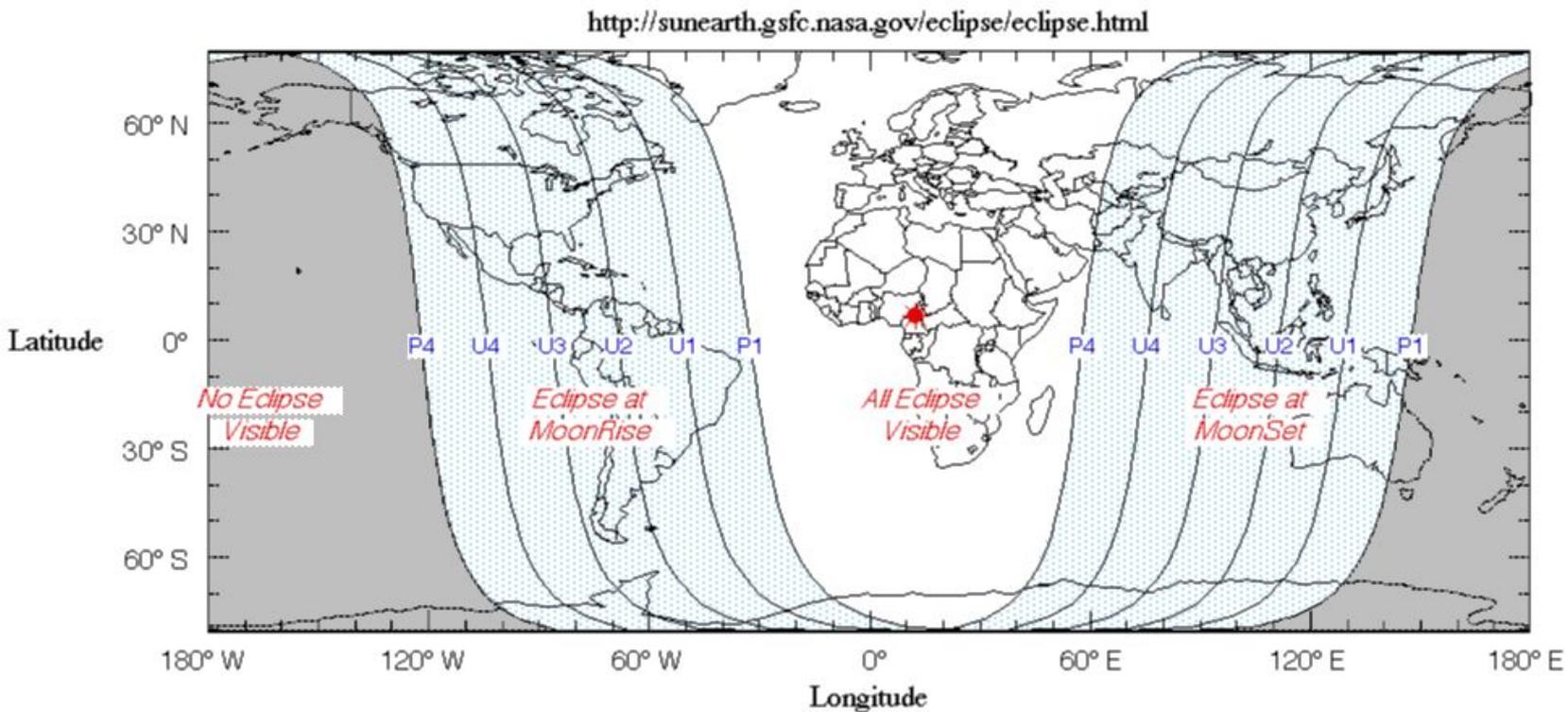
When can we see a lunar eclipse?

<http://sunearth.gsfc.nasa.gov/eclipse/eclipse.html>



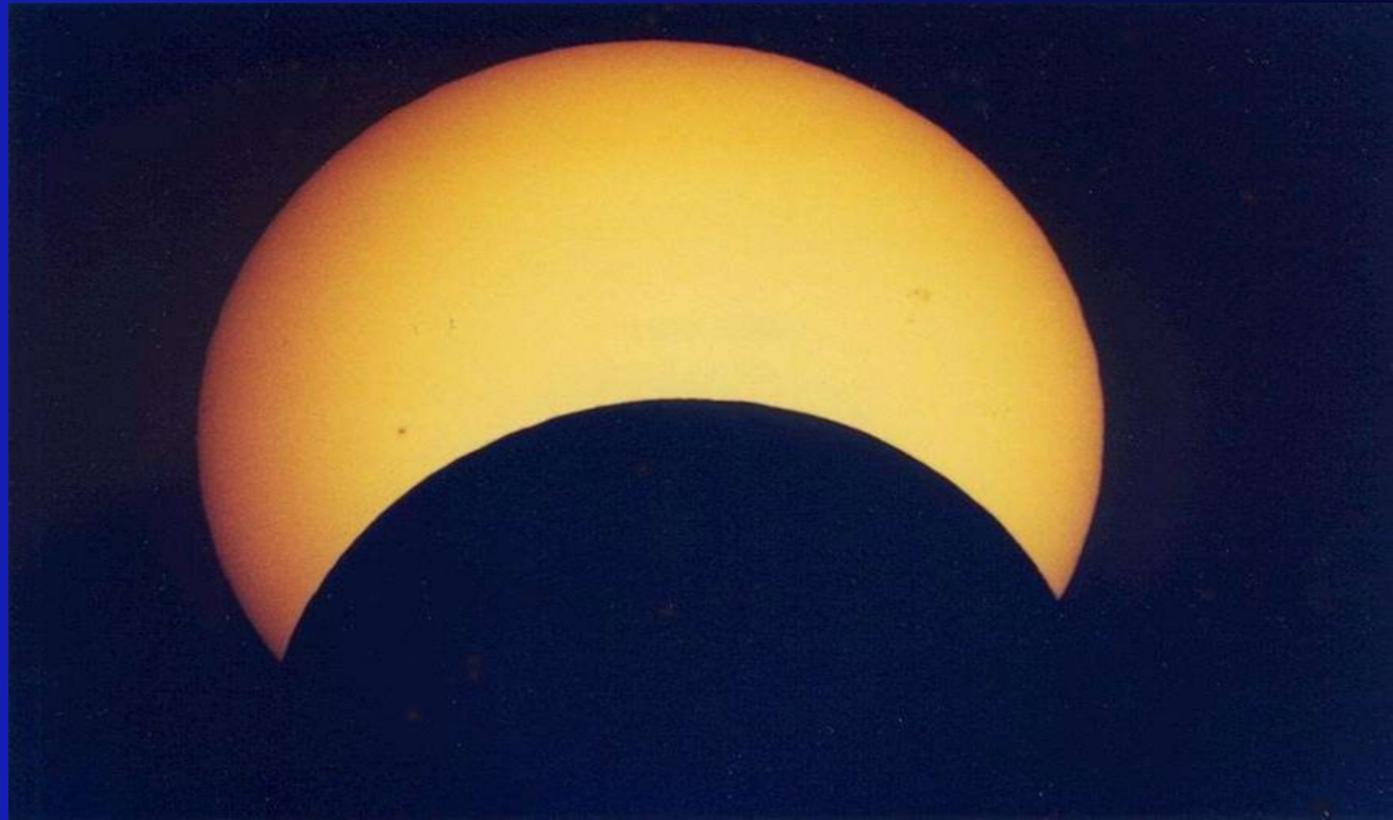
When can we see a lunar eclipse?

Next total lunar eclipse seen from
North America = April 15, 2014

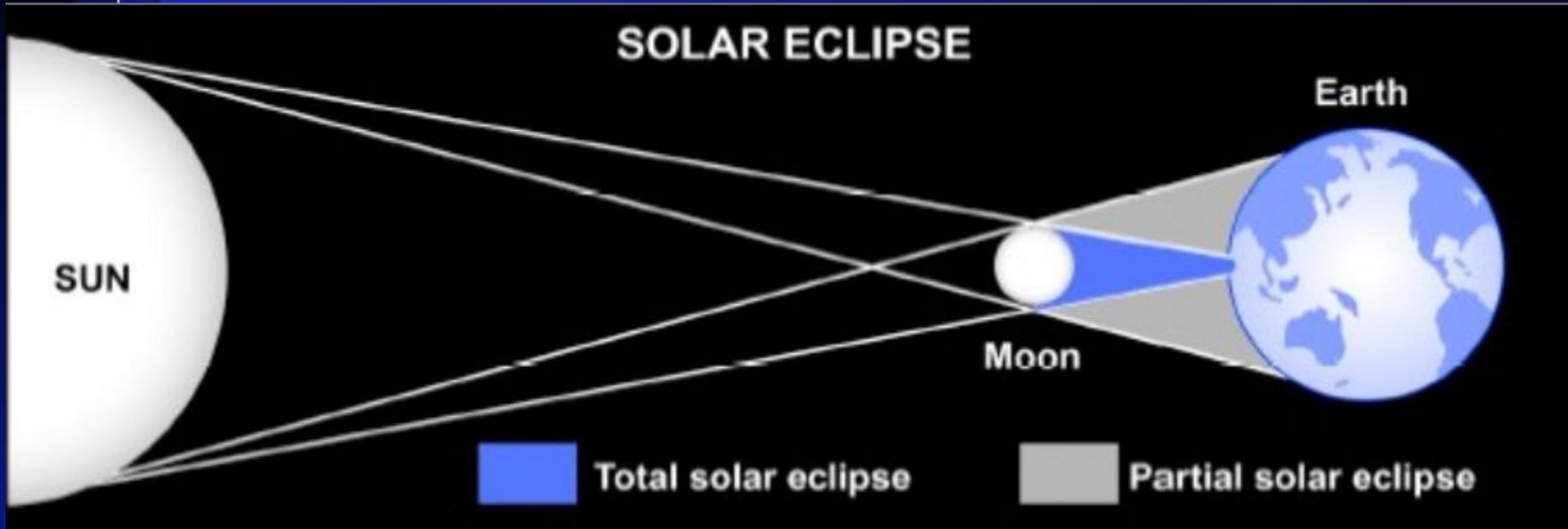


The Solar Eclipse!

- A solar eclipse happens during a NEW MOON when the Moon lies directly between the Earth and Sun.

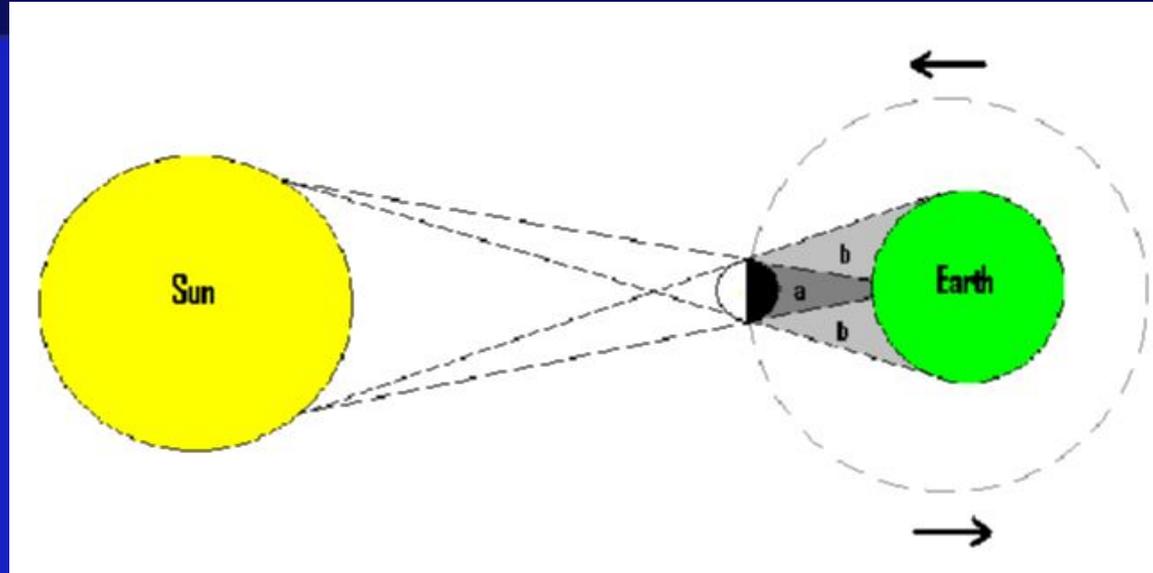


Solar Eclipse



The last full solar eclipse in North America will be in August, 2017.

Solar Eclipse



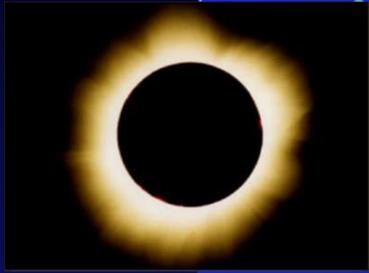
a. Umbra:

-dark, central region of the moon's shadow from where you can see a total eclipse

b. Penumbra-

-fainter, outer region of the moon's shadow from where you can see a partial eclipse

Partial vs. Total Solar Eclipse



TOTAL Solar Eclipse: You see a total solar eclipse when you are located where the Moon's **darkest shadow** falls on Earth (**umbra**).



- **PARTIAL** Solar Eclipse: You see a partial solar eclipse when you are located where the Moon's **lighter shadow** falls on Earth (**penumbra**).

Other Notes on Solar Eclipses...

- Only happen when the moon is in "new moon position"
- Only lasts a few minutes (totality)
 - Happens 2-3 times per year

Other Notes, cont...

Solar Eclipses

- Moon's orbit is elliptical
 - ▶ **Total eclipses** occur when Moon is close enough to cover the sun's disk.
 - ▶ **Annular eclipses** occur when Moon is too far away.
 - ▶ **Partial eclipses** occur when the Earth misses the umbra



Total Solar Eclipse



Annular Solar Eclipse

Annular Eclipses



Annular Solar Eclipses:

- The Moon's distance from Earth **increases** during the year, and when it is **farthest** away (at its **apogee**) it looks **smaller**.
- If an eclipse happens at this point, the moon looks too small to **cover** the sun, so you see an "**annular** eclipse" or **ring** around the otherwise darkened sun.

Perigee



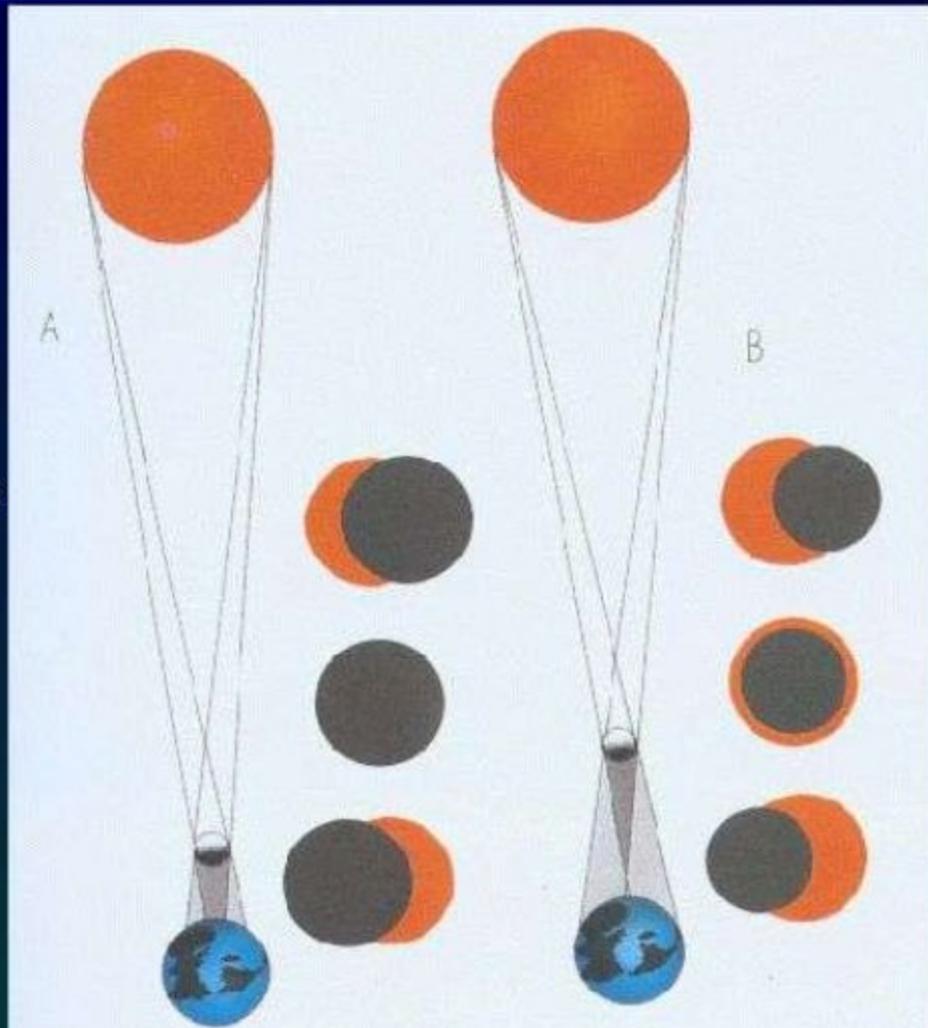
221,500 miles



Apogee

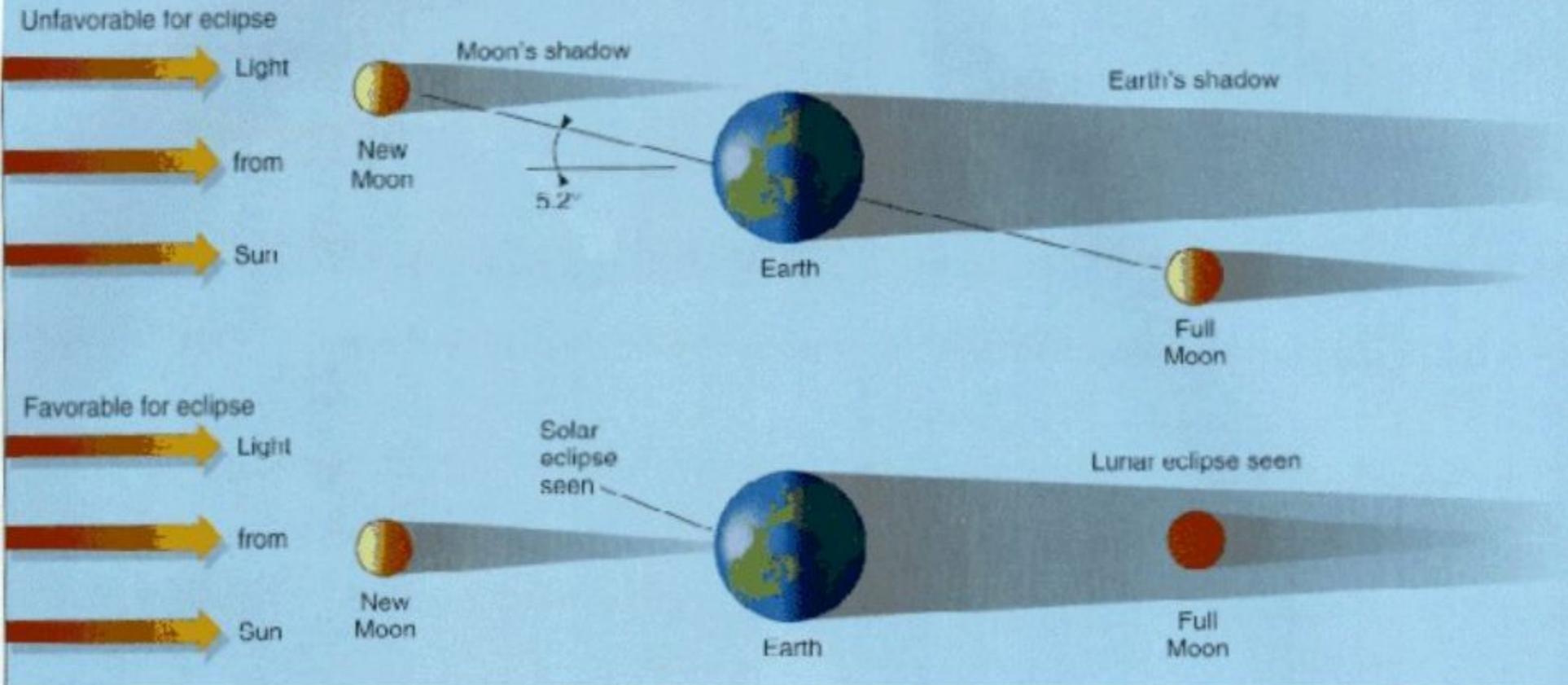
252,700 miles

Total
Solar
Eclipse



Annular
Solar
Eclipse

Why don't eclipses happen every month?



Why don't eclipses happen every month?

- The moon's orbit around the Earth is tilted at 5 degrees compared to the Earth's orbit around the sun.
- Therefore, the moon, Sun and Earth are not perfectly lined up every new or full moon to create an eclipse.



Tides

- The moon also affects the tides in our oceans as it revolves around the earth.
- The gravitational pull between the Earth and the moon and the Earth and the sun, create a **bulge** of water every day.
- When the gravitational forces of the **moon and sun** combine to **pull in the same direction** we get our biggest tides (spring tides)...
- ...and we get our **lowest tides** (neap tides) when these forces pull in **different directions**.

