The Motion of the Moon: Phases & Eclipses

Last class, we talked about the motion of the stars and the Sun as seen from the Earth. We'll talk about the motion the planets in the next class. Today, we'll address the motion of the Moon.

The Scale of the Earth – Moon System

We all know that the Moon orbits around the Earth, but what is the correct scale of the system. **We need a mental image.**

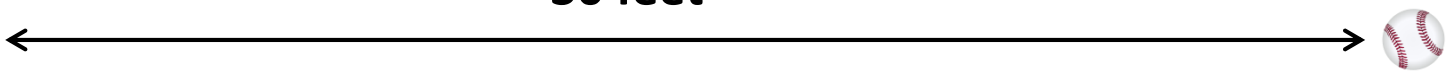
If we could fit the Earth-Moon system in this room:

the Earth would be represented by a basketball.

What's the proportionate size of the Moon, and how far away is it? (LC)

Earth

~ 30 feet



Moon

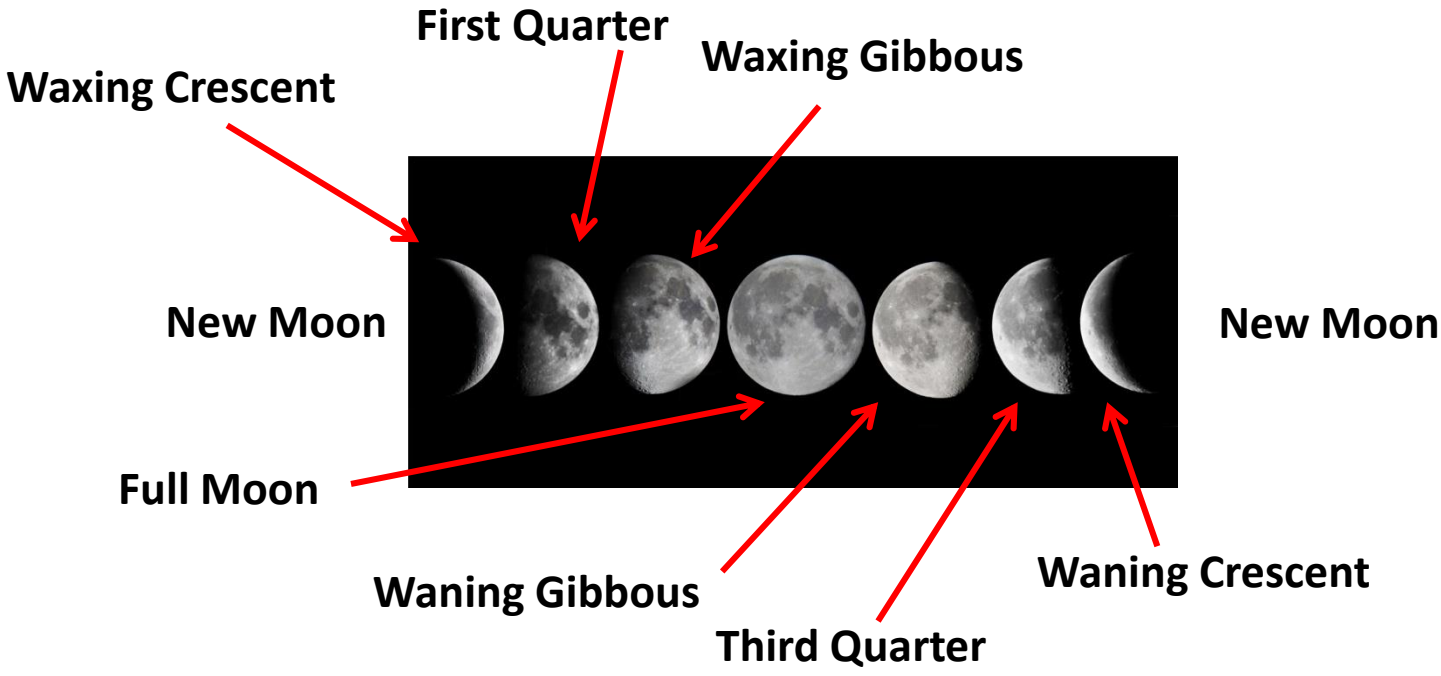
Answer: a baseball about 30 feet away.

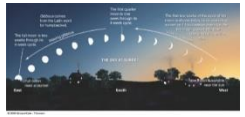
Phases of the Moon

As the Moon orbits the Earth (every ~ 29.5 days), it's appearance changes, and it's location, at a certain time of day, in the sky changes.

(**LC**: What famous movie used this music?)
(Ans: 2001, A Space Odyssey from 1968)

The various phases of the Moon are seen at these locations in the sky:





Note the changing location of the Moon in the Sky

Phases of the Moon

What's going on in this cycle of Lunar Phases? Is the Moon actually changing its shape?

No, half of the Moon is always in sunlight, but when it goes around the Earth, we see different amounts of the sunlit side.

Note, you should be able to use diagrams like this to determine Moon rise and set times for the various phases:

For Example: What are the rise and set times for the Waning Crescent?

The Waning Crescent rises at ~ 3:00am and sets at ~ 3:00pm

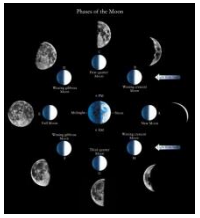
Group Exercise (LC): Discuss and work with the students around you to determine the rise and set times for the Waxing Gibbous.

Ans: The Waxing Gibbous rises at ~ 3:00pm and sets at ~ 3:00am

We'll talk about the rotation of the Moon later and why it keeps the same side facing the Earth.

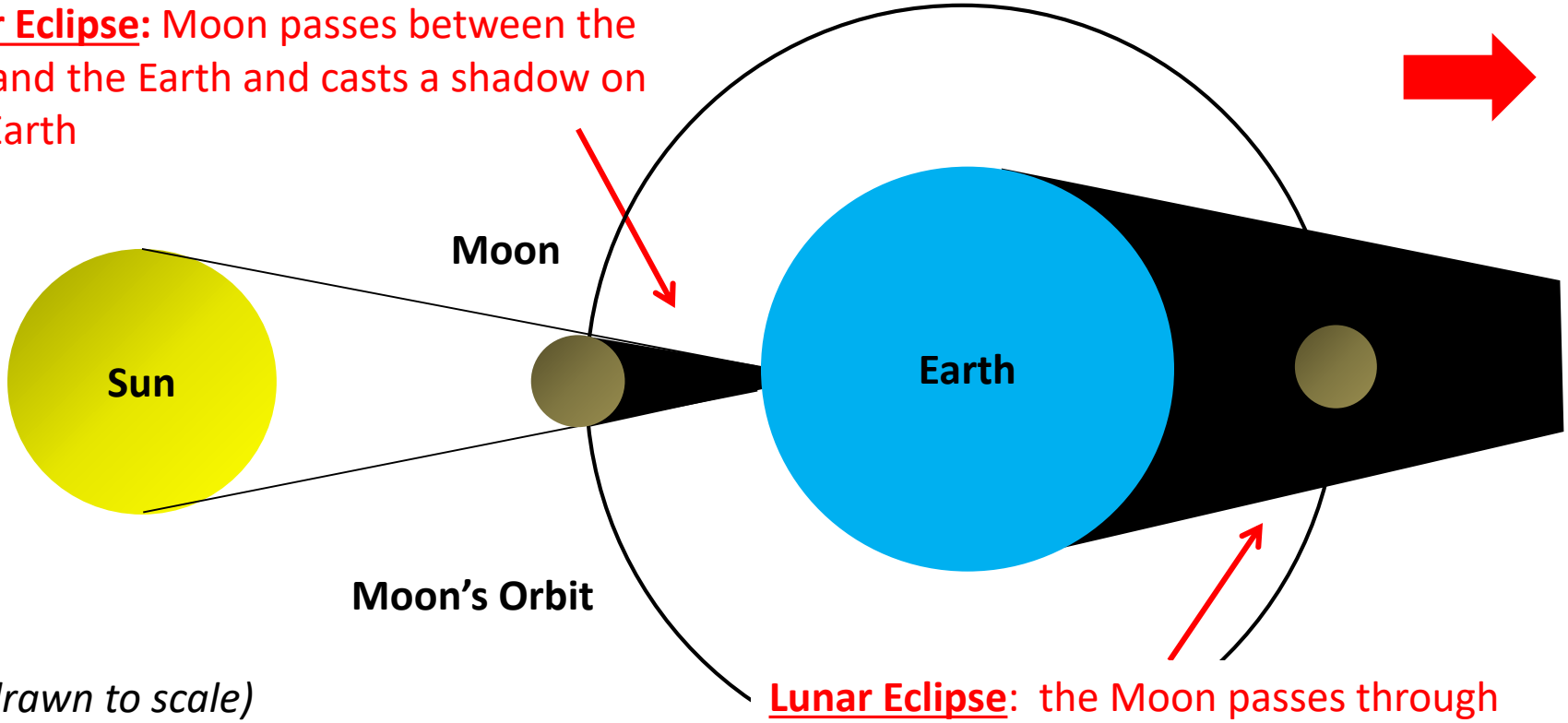
Eclipses

Diagrams like this show that sometimes the Moon can come in between the Sun and the Earth, and cast its shadow on the Earth. Likewise, the Moon can pass through the Earth's Shadow.



Two Types of Eclipses:

Solar Eclipse: Moon passes between the Sun and the Earth and casts a shadow on the Earth

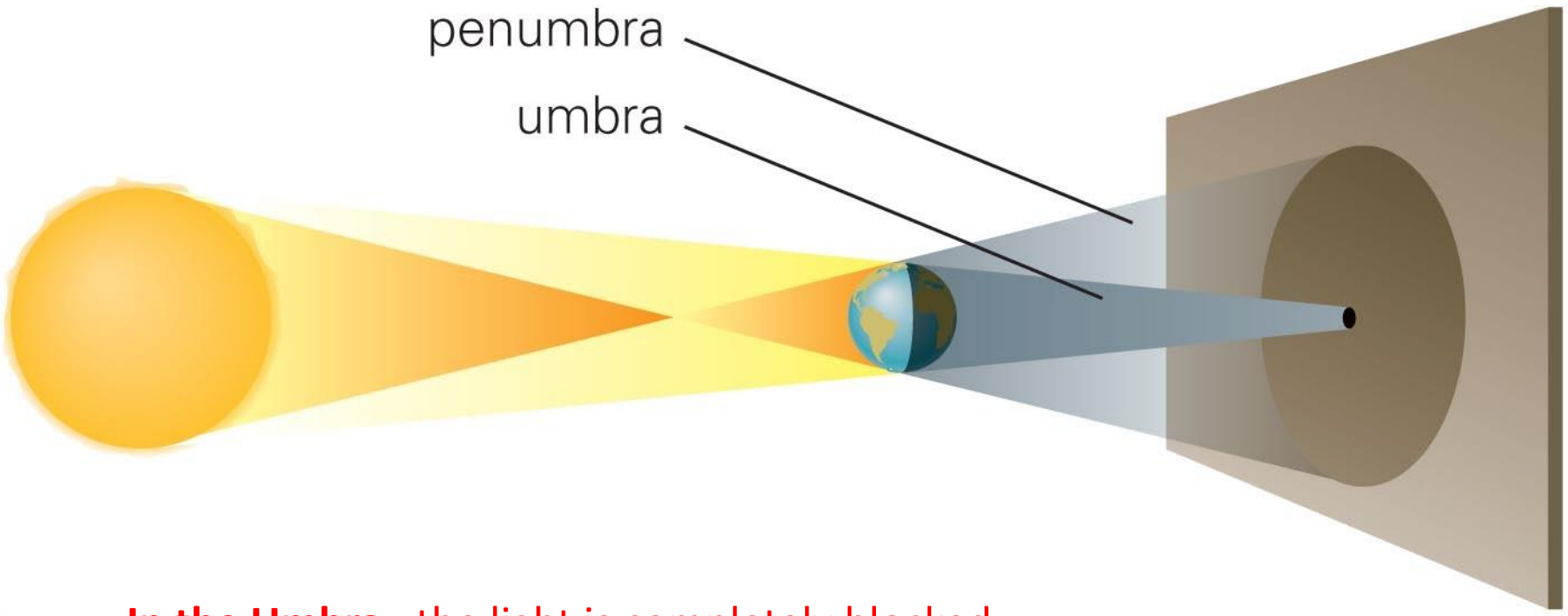


(not drawn to scale)

Lunar Eclipse: the Moon passes through the Earth's shadow.

Eclipses

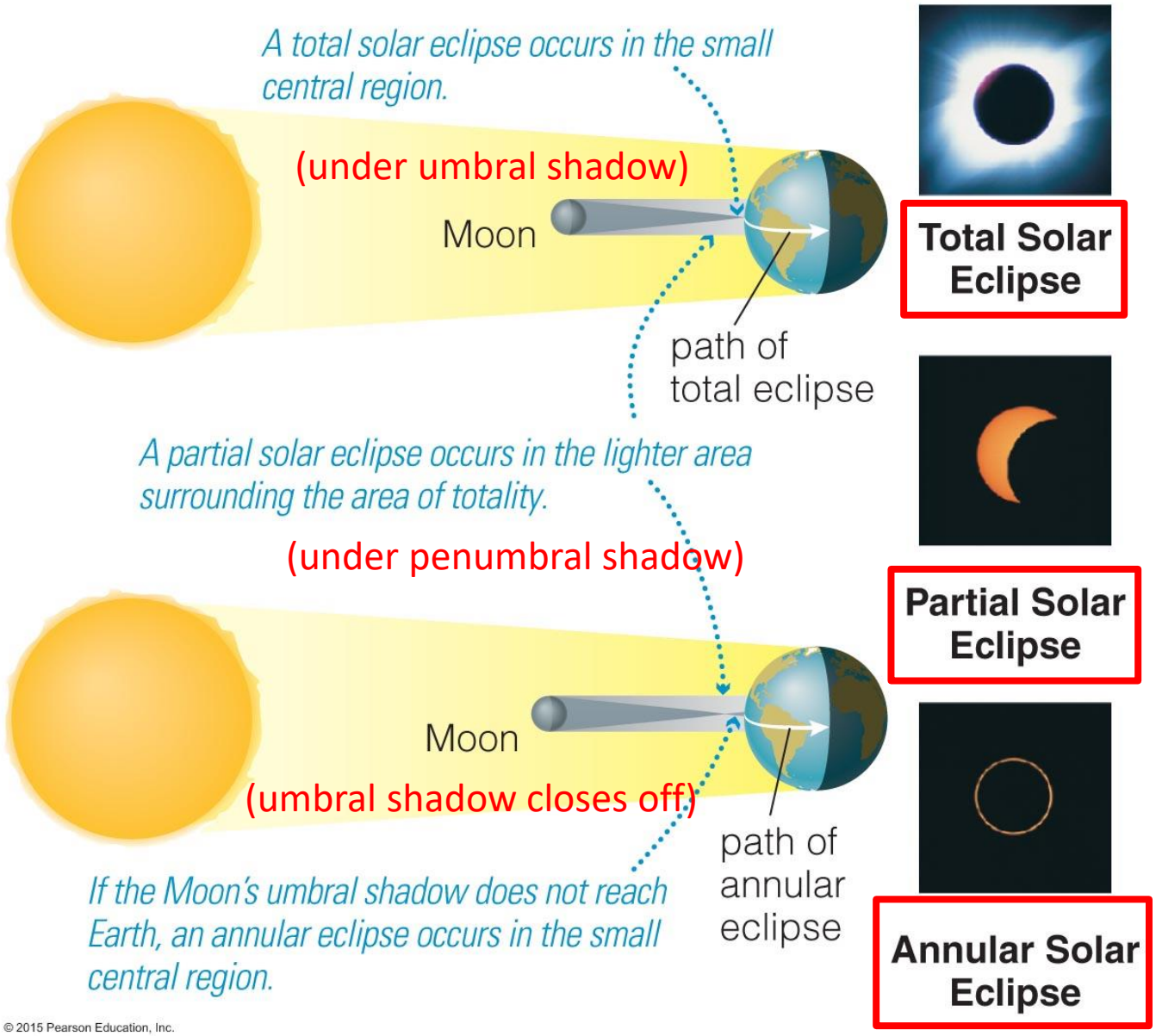
Shadow Geometry: for either type of eclipse, what is seen is determined from the shadow geometry:



In the Umbra: the light is completely blocked

In the Penumbra: the light is partially blocked

Solar Eclipses



Solar Eclipses

Some important points about Solar Eclipses:

What Phase must the Moon be in to have a Solar Eclipse? (LC)

It must be a New Moon to be between the Sun and Earth.

Who gets to see a Total Solar Eclipse and how long does one last?

(How many in here have witnessed a Total Solar Eclipse?)

Only the people in the path of the Umbra (which is typically about 100 miles wide) will see a Total Eclipse.

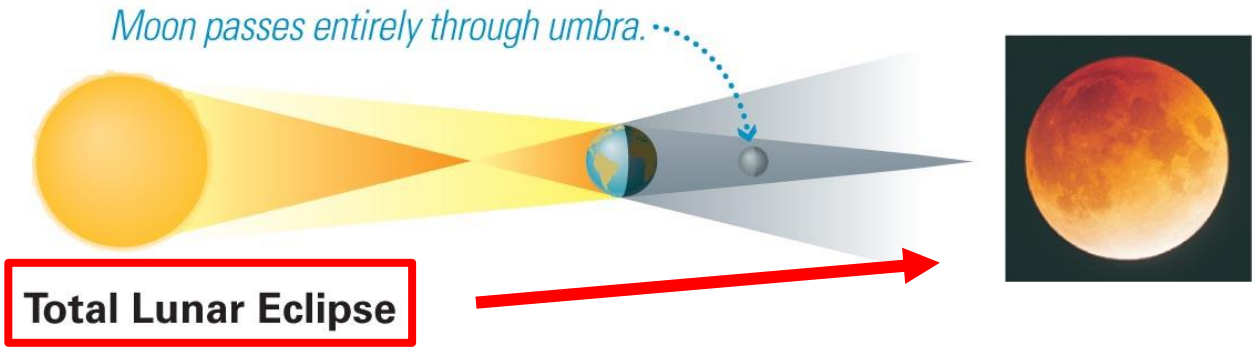
The time when the Sun is partially blocked (the time for the Penumbral shadow to pass over you) is typically 2 to 3 hours.

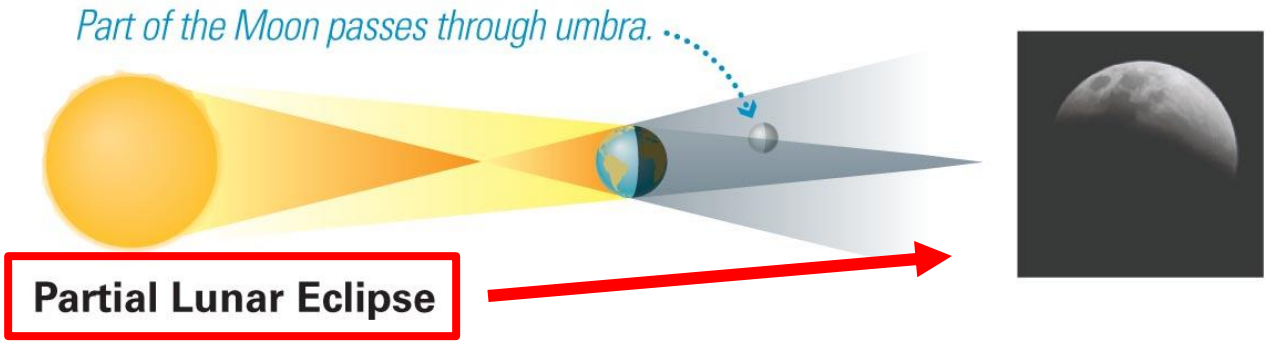
The time of Totality (time for Umbra to pass over you) is typically about 3 to 4 minutes with a maximum of about 7 minutes.

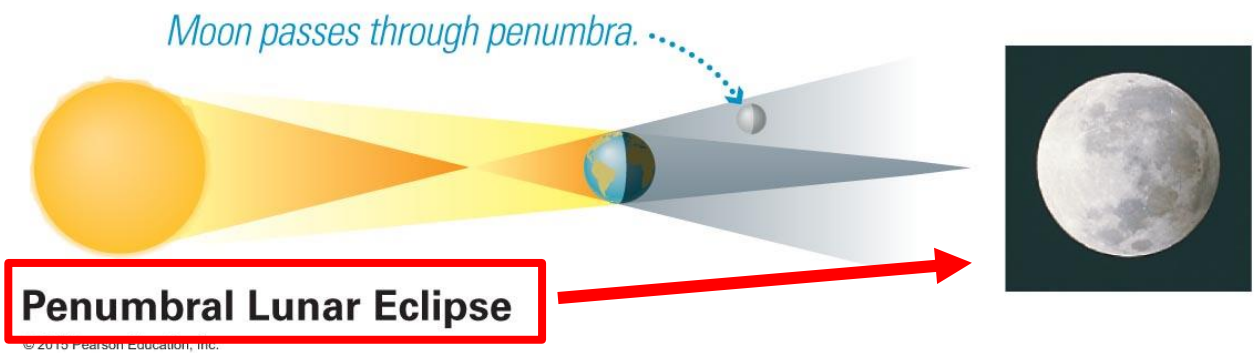
If you are under only the Penumbral Shadow, you see only a Partial Eclipse.

If you are outside the Penumbral Shadow, you don't see anything!

Lunar Eclipses: Moon Passing Through Earth's Shadow

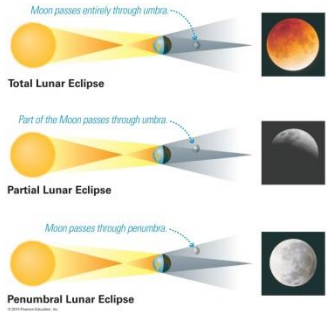






Lunar Eclipses

Some important points about Lunar Eclipses:



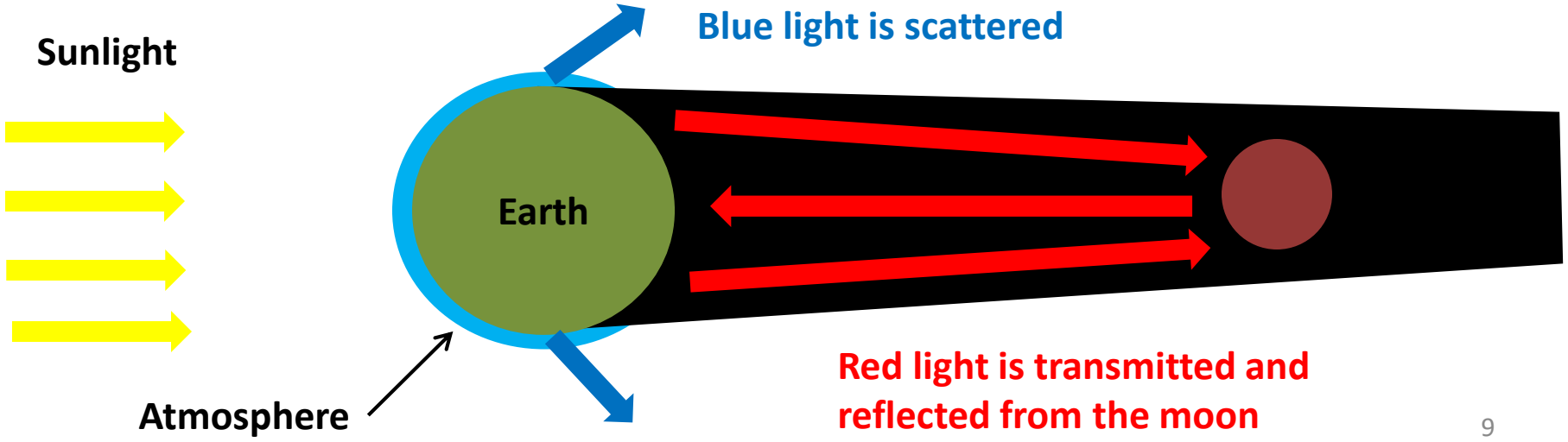
What Phase must the Moon be in to have a Lunar Eclipse? (LC)

The Moon must be in the **Full** Phase.

Who gets to see a Total Lunar Eclipse and how long does one last? (Who in here as seen one?)

Everyone on the nightside of the Earth will see the eclipse (assuming clear skies). The time of totality for a Lunar eclipse is typically between 1 to 2 hours.

Why, during totality, does the Moon sometimes have a reddish glow?

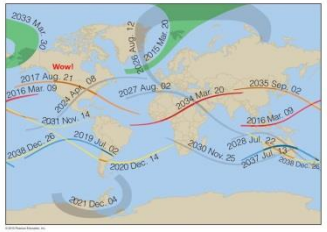


Last Things About Eclipses

Why aren't there eclipses every month?

The Moon's orbital plane is tilted about five degrees to the Earth's orbital plane, so during most of the new moons, the Moon's shadow passes above or below the Earth; and during most full moons, the Moon does not pass through the Earth's Shadow.

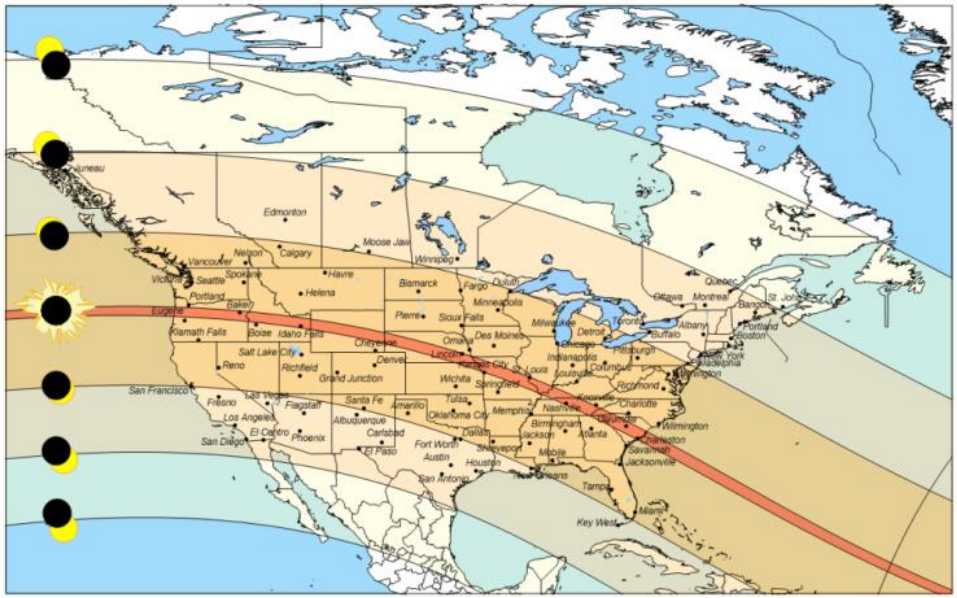
Recent and Future Total Solar Eclipses.

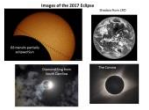


Where were you at 18:26 UT = 2:26 EDT = 1:26 CDT on August 21, 2017?

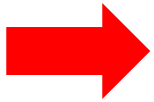
And where will you be at 19:08 UT = 15:08 EDT on April 8, 2024?

The Eclipse of August 21, 2017 (LC)





- Photos and Videos from August 21, 2017



- Annular Eclipse Oct. 14, 2023 and

- **Total Eclipse April 8, 2024**

- How spectacular is a total eclipse? (Isn't a 99% partial the same?)

- A short video that – I think - captures the raw emotion of the beauty and majesty of totality. You're seeing something special.