Chapter 3
Moon Phases and Eclipses

Guidepost

In the previous chapter we studied daily and yearly cycles of the Sun. We will now focus on the cycles of the Moon in order to answer some of the following questions:

- Why does the Moon go through phases?
- What causes a lunar eclipse?
- What causes a solar eclipse?
- How can eclipses be predicted?

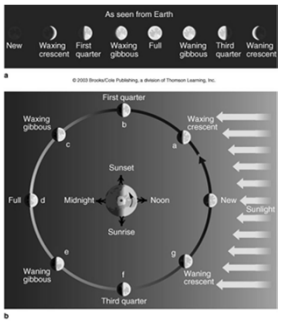
Understanding the phases of the Moon and eclipses will be an exercise in scientific imagination and will help you enjoy the marvelous sight of the Moon moving across the sky.

Outline

Cycles of the Moon
- A. The Changeable Moon
- B. Lunar Eclipses
- C. Solar Eclipses
- D. Predicting Eclipses

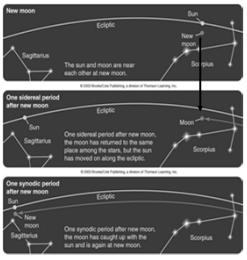
The Phases of the Moon

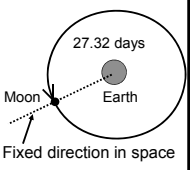
From Earth, we see different portions of the Moon's surface lit by the sun, causing the phases of the moon.



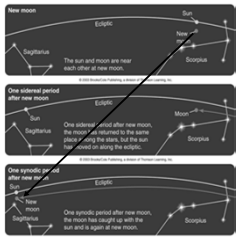
The Phases of the Moon (2)

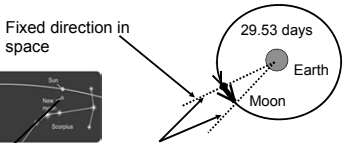
• The Moon orbits Earth in a **sidereal period** of 27.32 days.





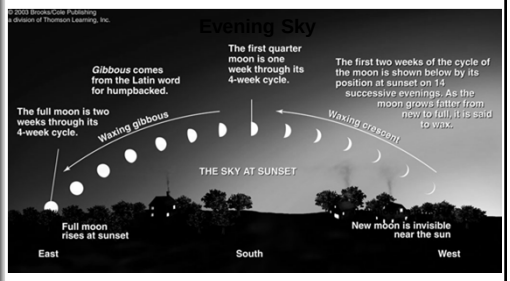
The Phases of the Moon (3)





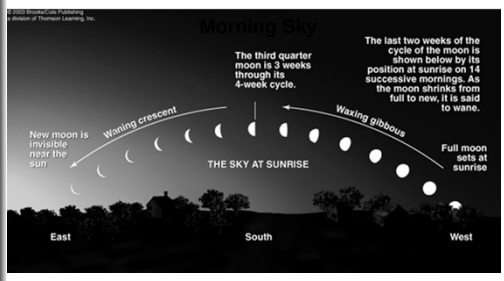
• The Moon's *synodic period* (to reach the same position relative to the sun) is 29.53 days (~ 1 month).

The Phases of the Moon (4)



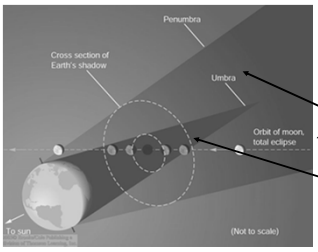
New Moon → First Quarter → Full Moon

The Phases of the Moon (5)



Full Moon → Third Quarter → New Moon

Lunar Eclipses



Earth's shadow consists of a zone of partial shadow, the **penumbra**, and a zone of full shadow, the **umbra**.

If the moon passes through Earth's full shadow (umbra), we see a lunar eclipse.

If the entire surface of the moon enters the umbra, the lunar eclipse is total.

Lunar Eclipses: 2015-2019

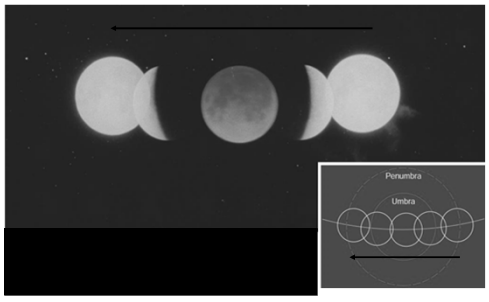
Typically, 1 or 2 lunar eclipses per year

Total and Partial Eclipses of the Moon, 2015-2019*

2015 September 28th – Total (1:12)***
2017 August 7th – Partial
2018 January 31st – Total(1:16)
2018 July 27th – Total (1:43)
2019 January 21st – Total (1:02)
2019 July 16th – Partial

*See Table 3-1 in your text for more information.

A Total Lunar Eclipse (1)

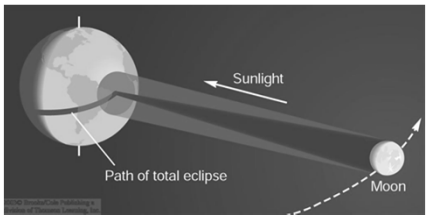


A Total Lunar Eclipse (2)

A total lunar eclipse can last up to 1 hour and 40 min.

During a total eclipse, the moon has a faint, red glow, reflecting sun light scattered in Earth's atmosphere.

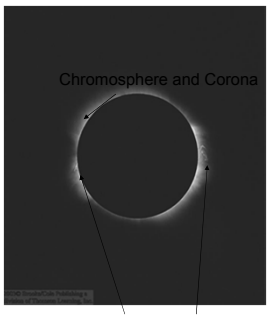
Solar Eclipses



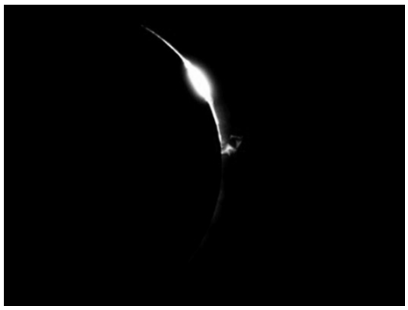
The sun appears approximately as large in the sky (same angular diameter ~ 0.5^0) as the moon.

→ When the moon passes in front of the sun, the moon can cover the sun completely, causing a total solar eclipse.

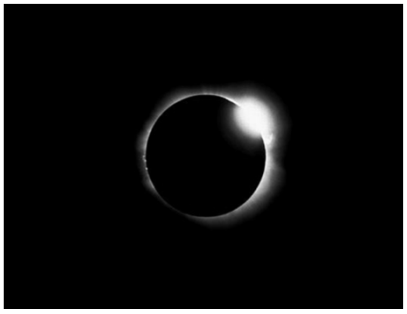
Total Solar Eclipse



Solar Atmosphere Revealed

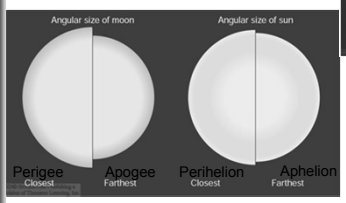


Diamond Ring Effect



Annular Solar Eclipses

When Earth is near perihelion, and the moon is near apogee, we see an annular solar eclipse.



The angular sizes of the moon and the sun vary, depending on their distance from Earth.

Solar Eclipses: 2016-2019

Approximately 1 total solar eclipse per year

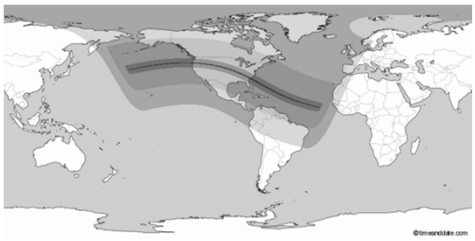
Total and Annular Eclipses of the Sun, 2016-2019*

2016 March 9th – Total, 01:58 UT
2016 September 1st – Annular, 09:08 UT
2017 February 26th – Annular, 14:55 UT
2017 August 21st – Total, 18:27 UT***
2019 July 2nd – Total, 19:24 UT
2019 December 26th – Annular, 05:19 UT

*See Table 3-2 in your text for more information.

Solar Eclipse of August 2017

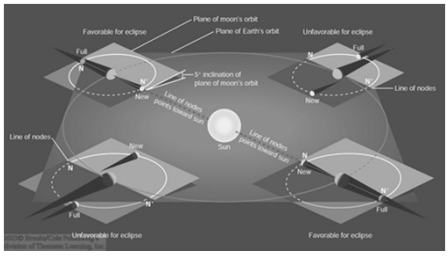
The August 2017 Eclipse will be visible here!



In Georgia: Clayton (2m34s at 2:35:45pm) , Toccoa (2m2s of totality), or Black Rock Mountain State Park (2m36s of totality). 97% in Atlanta. 91.9% in Americus!

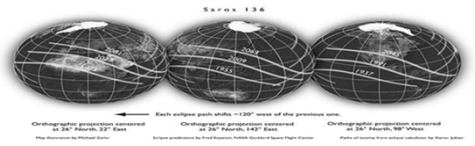
Conditions for Eclipses

Eclipses occur in a cyclic pattern.



→ **Saros cycle:** 18 years, 11 days, 8 hours

Conditions for Eclipses (2)



Eclipses will return to the same location after 3 Saros cycles, or 54 years, 23 days.

http://www.brighthub.com/science/space/articles/115032.aspx