

Moon Stats.

- Distance from the Earth to the Moon:
 - 238,855 miles (average)
 - 225,700 miles (perigee)
 - 252,000 miles (apogee)
- ...and growing!!!

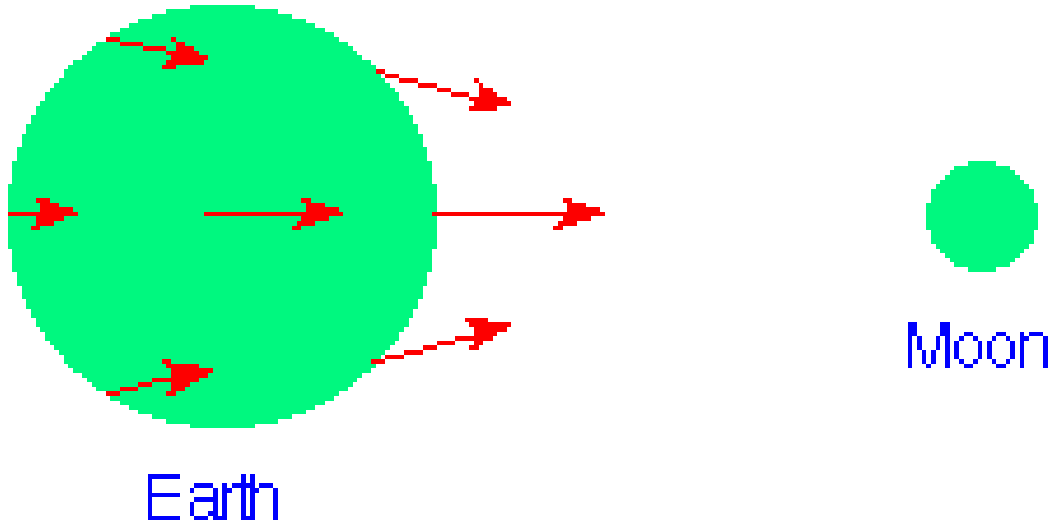
How do we know?????

Some Proof that Astronauts landed on the Moon

Mirror on the moon left by Buzz Aldrin and Neil Armstrong.

- 2ft wide panel with 100 mirrors

Tides

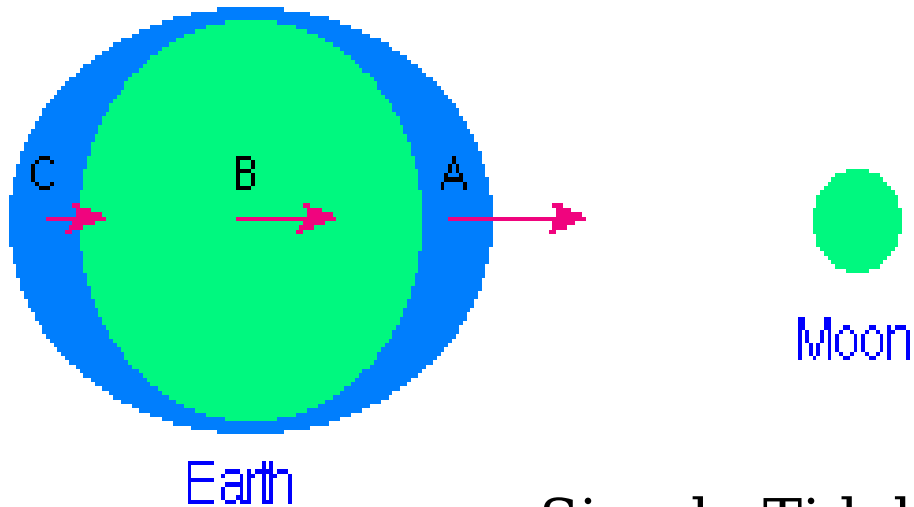


Small gravitational attraction of the Moon on the Earth.

Water is easily deformed by attraction because it is fluid.

Differential Forces cause portions of the Earth that are closer to experience larger attractions.

Tides



Simple Tidal Model:

(A) water is closer to Moon so experiences larger gravitational force than (B).

(C) water will also bulge because of the Earth attraction toward the moon and away from the water.

Each day two high tides occur and two low tides.

Tides

Spring tides occur when the Sun and the Moon are aligned. This causes very high and very low tides.

Neap tides occur during quarter phases which causes weak tides.

Informally referred to as a Double Planet.

Moon Stats.

- Surface Gravity:
 - $1/6^{\text{th}}$ Earth Surface Gravity
 - What a great weight loss program!!! Well sorta....

Fifth Largest Moon in the Solar System.

Atmosphere

No atmosphere.

Why??

Moon's gravity is too small to keep molecules near it.

Light and particles from the Sun sweep any that exist away.

Moon Surface

Regolith:

Powdery soil as a result of meteoric bombardment.

Highlands:

Light areas in high elevation like mountains but not formed by plate tectonics.

Mare or Maria:

Dark areas in altitude lower than Highlands.

- Vast pools of ancient solidified lava.

Ice in craters???!?

Moon Surface

Craters:

The remains of collisions between an asteroid, comet, or meteorite and the Moon.

Sizes are anywhere from tiny holes
less than an inch to gaping holes
150 miles long

Two Types:

Simple Crater

Complex Crater

Moon Surface

Have bowl shaped depressions, mostly smooth walls.

Diameter less than 9 miles

Moon Surface

Have single or multiple peaks in the center of crater.

Diameter ranges from 12 - 110 miles.

Formation of the Moon

The Fission Theory:

Moon was once a part of the Earth and somehow separated from Earth early in the history of the Solar System.

Formation of the Moon

The Capture Theory:

The Moon was originally formed elsewhere in the Solar System and was captured by Earth's gravitational field.

Formation of the Moon

The Condensation Theory:

The Moon and the Earth condensed individually from nebula gases where upon the Moon just happened to form in the orbit of Earth.

Formation of the Moon

The Giant Impactor Theory:

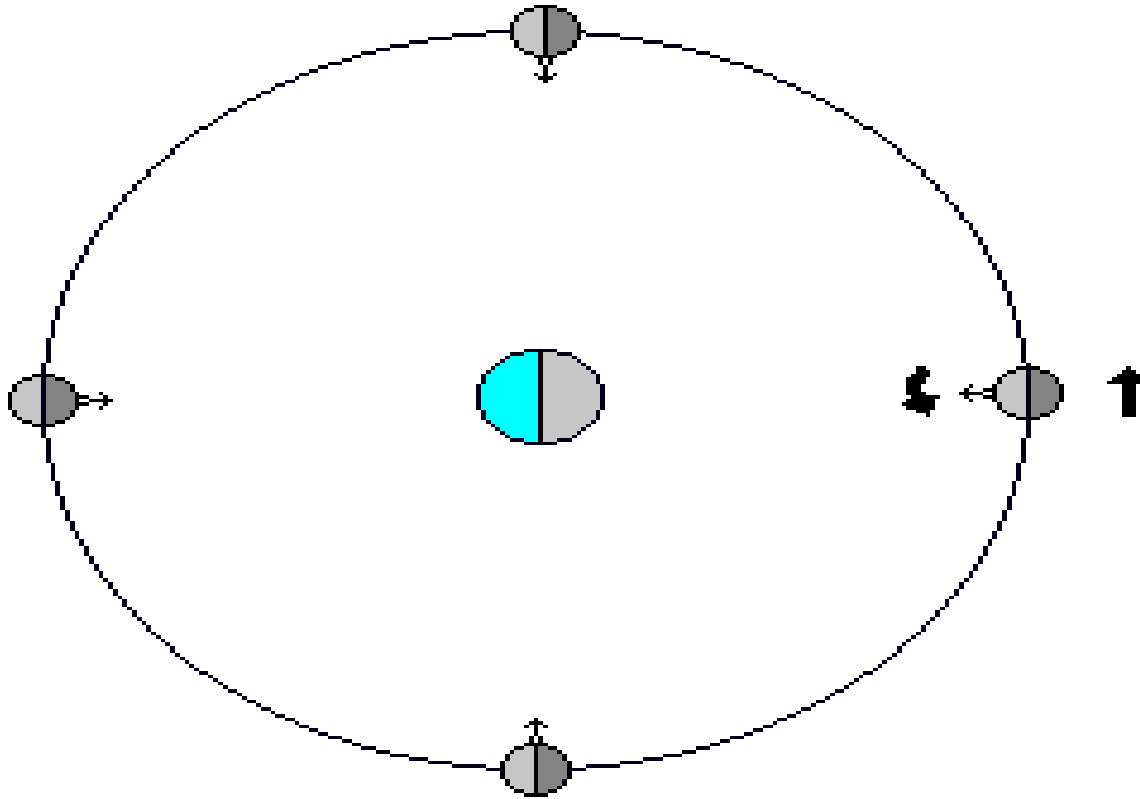
A protoplanet the size of Mars struck the Earth ejecting large volumes of heated material from both objects.

This ejected material formed a disk that orbited Earth and eventually stuck together to form the Moon.

Most widely accepted theory.

Moon Motion

- Orbit around Earth tilted by 5 degrees.



- Two types of orbital periods around Earth:
 - Sidereal Month (amount of time it takes the Moon to return to the same position in the sky with respect to the stars.)
27.321 days
 - Synodic Month (new moon- new moon)
29 days 12 hours 44 min 2.8 sec.

Moon Motion

- Rotational Axis tilted by 1.5 degrees.
- Rotation Period (synchronous rotation):
 - 29 days 12 hours 44 min 2.8 sec.

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Four Major Phases:

New Moon

First Quarter

Full Moon

Last Quarter

Between each major phase is an intermediate transition phase of “waxing” (growing) or “waning” (diminishin

Day 0: New Moon

Rise and Sets with Sun. Moon is between the Sun and Earth (conjunction) or at “syzygy”.

Day 1 – 6: Waxing Crescent

The moon is gradually becoming visible. Light will grow or “wax” from right to left. Rises between Sunrise and midday.

Moon Phases

Day 7.4: First Quarter

Moon is located $\frac{1}{4}^{\text{th}}$ around Earth or at “quadrature”. Now appears $\frac{1}{2}$ during the day and $\frac{1}{2}$ during the night. Rises Noon , midpoint is at sunset, and sets at midnight.

Day 8 – 13: Waxing Gibbous

Moon is moving toward far side of orbit away from sun.

Moon Phases

Day 14.8: Full Moon

Moon is now on farside (opposition) of the Earth directly opposite the Sun or at “syzygy”.

Rise at Sunset in the East, mid-point is at midnight, and sets Sunrise following day.

Day 15-21: Waning Gibbous

Moon is now traveling toward the Sun in its orbit. Can be seen from night to predawn.

Moon Phases

Day 22.1: Last Quarter

Appears $\frac{1}{2}$ during the night and $\frac{1}{2}$ during the day. The moon is now $\frac{3}{4}$ the way in its orbit around Earth or at “quadrature”.

Moon rises at midnight, is at mid-point at sunrise, and sets at Noon.

Day 23 – 28: Waning Crescent

Now beginning to move toward the trailing edge of orbit.

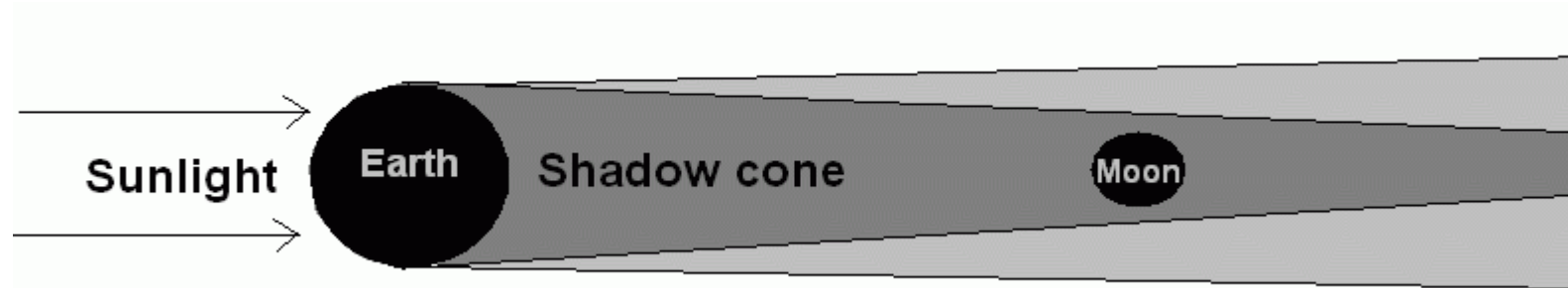
Day 29 : Back to the New Moon.
The cycle starts again!

Moon Rise and Moon Set

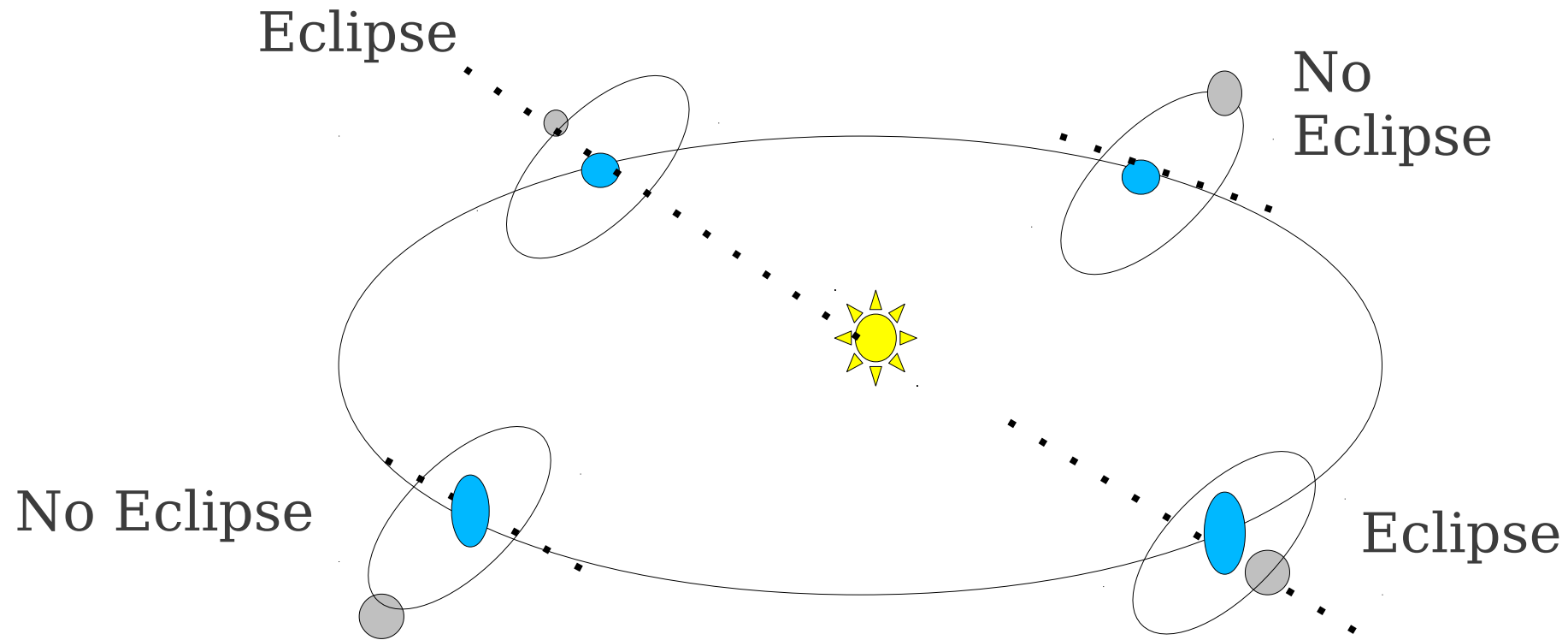
Phase	Rise	Mid	Set
New	Sunrise	Noon	Sunset
1 st Qtr.	Noon	Sunset	Midnight
Full	Sunset	Midnight	Sunrise
Last Qtr.	Midnight	Sunrise	Noon

Lunar Eclipses

- Occur when the Sun, Earth, and Moon line up exactly during the Full moon (opposition).
- The Earth Occults the Sunlight which puts the moon in a shadow.
- Everyone on the night side will see some type of lunar eclipse.



Why then do we not observe a lunar eclipse every full moon???



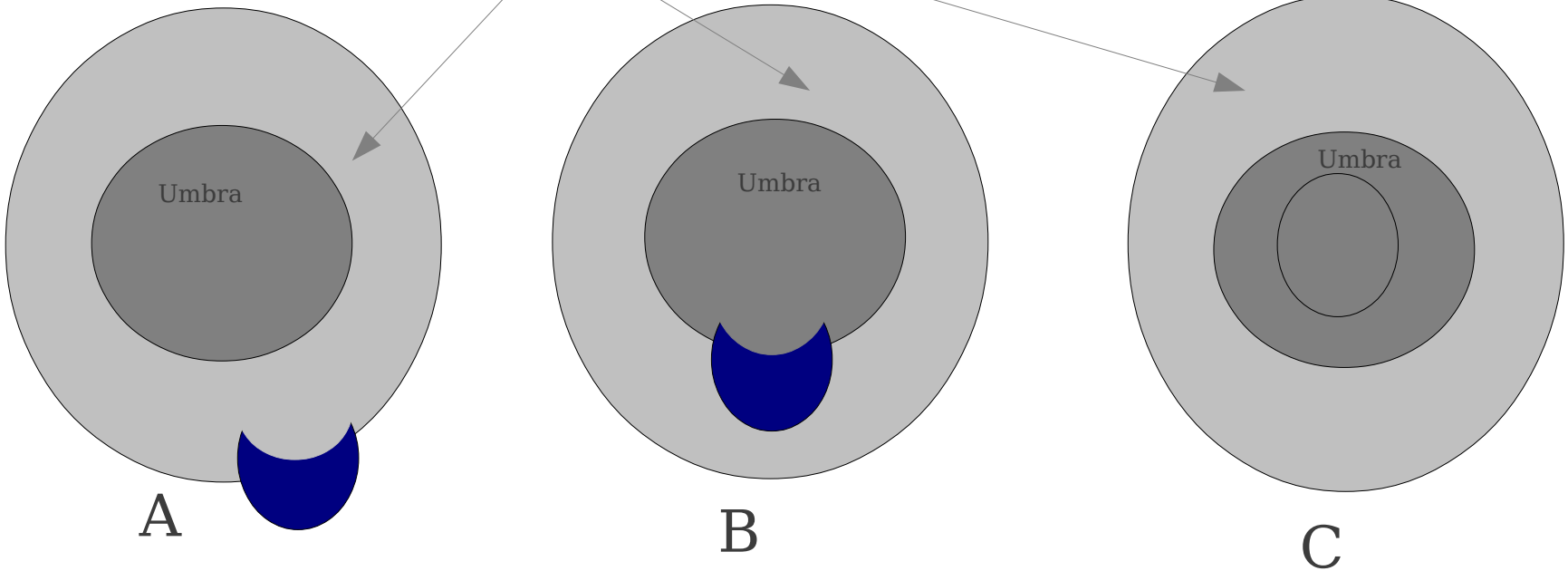
- Lunar Eclipses do not occur every Full Moon due to the 5 degree tilt in the Moons orbit around the Earth.
- Moon is either above or below the plane of the Earth at most of the time due to this tilt.
- Shadow of the Earth stays at the plane of the ecliptic. Moon must be in the plane of the shadow for an eclipse to occur.

Lunar Eclipses

Penumbra: Portion of shadow that results from the source of illumination being only partially blocked.

Umbra: Darkest part of the shadow. Source of light completely blocked.

Earth's Shadows



- depending on the shadow the Moon happens to travel through at its node determines the type of eclipse

- A) Penumbral Eclipse:
Passes through the penumbra only. Subtle and difficult to observe.
- B) Partial Eclipse:
A portion of the moon passes through the umbra.
- C) Total Eclipse:
Moon passes fully through the umbra.

Next Total Lunar Eclipse: April 15, 2014

<http://eclipse.gsfc.nasa.gov/LEplot/LEplot2001/LE2014Apr15T.pdf>

<http://eclipse.gsfc.nasa.gov/LEdecade/LEdecade2011.html>

Solar Eclipses

- Moon moves directly in front of the Sun and obscures it totally or partially.
- Can only occur during a New Moon in the same plane as the Earth.
- The apparent size of the Moon and the Sun are approximately the same size over the average orbit.
- Occurs 2 weeks before or after a Lunar Eclipse.

Solar Eclipses

Partial Solar Eclipse: Penumbra of the Moon's shadow passes over a region of the Earth.

Total Solar Eclipse: Umbra of the Moon's shadow passes over a region of the Earth.

Annular Eclipse: a region on the Earth's surface is in line with the umbra but the distances are such that the tip of the Umbra does not reach the Earth's surface.

Earthshine

- Dimly (blueish or reddish) lit portion of moon during crescent phases.
- Occurs due to a double reflection of sunlight.

Earthshine

Light from the Sun is reflected off of the Earth (point A) onto the Moon (point B). Some of this light is then reflected off of the Moon back towards the Earth (point C).

Part of the Moon is illuminated by the Sun and the rest of the Moon dimly illuminated by this doubly reflected light