Eclipse!

Hey! You’re blocking my light!
Eclipse Terminology

- Solar vs. lunar
- Total, partial, annular
- Umbra, penumbra, eclipse (shadow) track
- Corona, diamond ring effect
- Ascending node, descending node
first type of eclipse

- Solar – the sun is eclipsed (blocked) by the moon. The moon casts the shadow onto the earth & therefore must be between the sun & earth.

- What phase does the moon have to be in for this type of eclipse to occur?
2nd type of eclipse

- Lunar – the moon is eclipsed (blocked) by the earth. The earth casts its shadow onto the moon, and therefore must be between the sun & moon.

- What phase does the moon have to be in for this type of eclipse to occur? Full
Lunar Eclipse Geometry

Sun

Earth

Moon

Penumbra

Umbra

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If the sun, earth, and moon just need to be in alignment for an eclipse to occur…

then why don’t we have 1 solar and 1 lunar eclipse every month?

The 3 bodies need to be aligned not only horizontally, but vertically too…and the moon’s orbit is tilted.
The 2 points where the moon’s orbit intersects the ecliptic are called the ascending & descending nodes.
Solar Eclipses...3 types

- Total – the entire face of the sun is blocked by the moon.
- Partial – alignment isn’t perfect, and only some of the sun’s disk is blocked.
- Annular – the moon is too far away to completely cover the face of the sun. A ring of sun surrounds the moon.
A Total Solar Eclipse
An Annular Solar Eclipse

April, 1995
Partial Solar Eclipse

The moon is slightly above or below the ecliptic.
A total solar eclipse begins Feb-26-1979.

The moon’s shadow
Just as the sun disappears... it forms the “diamond ring” effect.
When the entire sun is eclipsed, some of the prominences (storms on the sun’s surface) may become visible.
The outer layer of the sun’s atmosphere, the corona, becomes visible.
What does a solar eclipse look like from space?

1999, from Mir.
As the moon orbits around the earth in a counter-clockwise direction, the moon’s shadow slides over the earth from west to east, at about 1000 miles per hour!

The path of the shadow is called The “eclipse track.”


Lunar eclipses are less spectacular than solar eclipses, but occur much more frequently. Why?

The earth’s shadow is 4 times the diameter, and 16 times the area of the moon’s shadow.
Lunar eclipses are either partial or total, but never annular.
Lunar eclipses

- When a total lunar eclipse occurs, the moon turns a pumpkin orange to a deep blood red.
- This is because the earth’s atmosphere refracts some of the sunlight around the earth, and dust in our atmosphere scatters the blue & green wavelengths, allowing the red to continue on to the moon.
Direction of movement of the moon through the earth’s shadow.
What can eclipses tell us about our solar system?

- Ancient people knew that the moon was much closer to the earth than the sun was. How did they know this?

- Ancient people deduced that the sun was much larger than the moon, even though both appear the same size in the sky (angular diameter of $\frac{1}{2}^\circ$).
Diameter of sun = distance to sun
Diameter of moon = distance to moon

\[
\frac{X}{2000 \text{ miles}} = \frac{93,000,000}{240,000} \text{ miles}
\]

X = about 800,000 miles
Predicting Eclipses

- Solar Eclipses can only occur when the moon is in new phase and on the ecliptic (at a node).
- Generally, 2 solar eclipses occur every year (although the eclipse track may cross an un-inhabited part of the earth.)
Predicting Eclipses

- Lunar eclipses can only occur when the moon is full phase and on the ecliptic (at a node).
- Lunar eclipses occur 2 weeks before and/or 2 weeks after a solar eclipse.
Solar Eclipse:

Is the time of new moon within $+28$ hours of a node?

- **yes**
  - Is it within $+20$ hours of a node?
    - **no**
      - No eclipse
    - **yes**
      - Central

- **no**
  - Partial

Central

Is it within $+8$ days of apogee?

- **yes**
  - Annular
- **no**
  - Total
Lunar Eclipse:

Is the time of full moon within ±28 hours of a node?

- yes
  - Is it within ±20 hours of a node?
    - no: No eclipse
    - yes: Umbral
  - Penumbral
- no: No eclipse
Some potential extra credit

- Use the Distant Suns 4 program to plot the phase of the moon (as % illumination) on graph paper. You will get a sinusoidal (sine wave) type curve.

- Use the same program to determine the distance of the moon from the ecliptic. Plot this distance above/below the ecliptic on the same graph. This will also be a sine wave curve.
Some potential extra credit

- Where the 2 graphs intersect at the points of new moon (0% illumination), a solar eclipse could occur.
- Where the 2 graphs intersect at the points of full moon (100% illumination), a lunar eclipse could occur.
- Use this graphing method to predict the next 3 eclipses (of any type), for 20 points of extra credit.