Apogee/Perigee
Using Geometry to:
Investigate the Moon
and It's Orbit

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Side by side images of the moon taken at apogee and perigee.

What is the apparent size of the moon's image at apogee and perigee?

Which Lunar image do you think was taken when the moon was closest to the Earth? Why?

What do you think is the shape of the Moon's orbit?

Let's use the tools of Geometry to investigate this phenomena.

Geometry: **Fact One:**   If 2 **intersecting** chords are drawn in a circle, the product of the measures of the 2 parts of one chord will equal the product of the 2 parts of the other chord. (a **chord** is a line inside a circle that connects two different points of the circumference) (a **secant** is a line that passes through a circle and forms a chord inside the circle)

Z=Diameter

$Z = Y^2/X + X$

Y

X
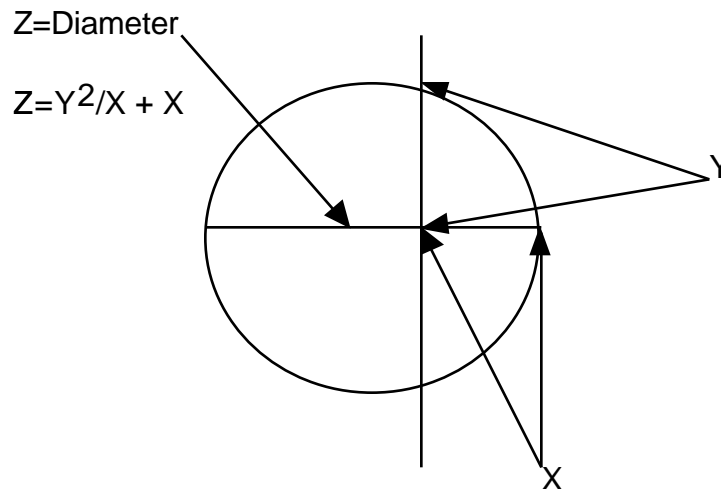
Fact Two: If you draw a perpendicular to a chord at the middle of the chord to the edge of the circle, the new line if extended across the circle pass directly through the middle of the circle and will constitute the diameter of the

Secant Line

Perpendicular

chord

circle   Diameter of Circle
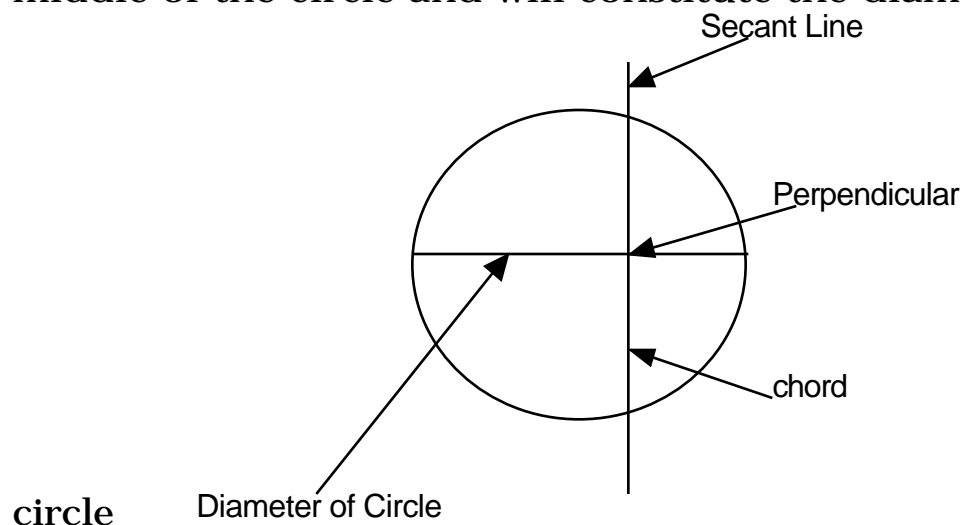
1. Open HOU-IP software.
2. Obtain image disk from you teacher
3. Open image moon-near-apogee030111.fts and image
    moon-nearperigee030124.fts
4. Flip one of the images horizontally. (Manipulation,
Add,Displayed Image. Select the other image. Save result in a
new window. OK.)

Window: The combined lunar image, center the image in the
window using the side sliding bars then :

    1. **Draw** a vertical slice (chord) on the <u>inner moon image</u>
that passes from the top edge of the image to the bottom edge.
Draw as large a slice as you can fit inside the image, keeping the
"x" coordinate with the same value as you slice from top to
bottom- keeping the entire slice visible within the inner moon
image.

    2. Using the **slice** <u>graph window</u>, hold the left mouse
button and **drag** the curser across the slice to determine the
exact length in pixels of your slice. Divide this value by 2 to
determine the middle of the slice, then locate that exact spot
using the same dragging technique you used to measure the
length of the slice. As you drag the square to the center of the
chord stop and it will remain there. **Close** the <u>graph slice</u>
window.

3. **Draw** a second slice from the center point of your chord in step #2 that is a perpendicular to this chord out to the edge of the <u>inner</u> moon image. Measure the length of this line using your slice graph.
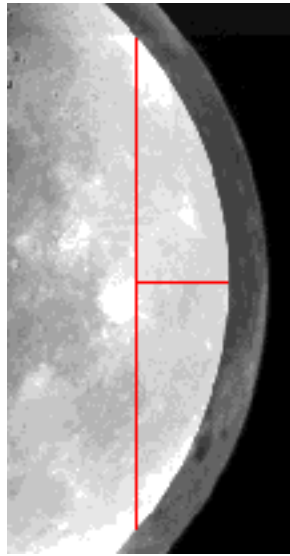
4. Using the following equation based on the Geometry of Circles, $Z = Y^2/X + X$, determine the Value of the diameter of the <u>inner</u> Moon image.

5. Repeat procedure steps 1/4 using the **outer** moon image in the <u>combined lunar image window</u>.

Now, examine the two values you calculated for the diameters of the two images that were taken at different days of the month. What do you discover? What can you conclude about the shape of the Moon's orbit around the Earth? Is it circular? Explain.

Extra Thoughts:
From your data in step 4. Can you calculate the apparent Moons % diameter size change.

Can you calculate the expected % change in apparent image diameter size using the distances to the moon found in the *Image info* under data tools.

How do the two calculated values compare? What might explain any differences. (Hint: sources of experimental error)

<u>Michigan State Science Standards</u>
   • Demonstrate an understanding of the motion of major objects in our solar system, including the rotation, orbit, and revolution of planets, moons, and asteroids.
   • All students will ask questions that help them learn about the world, design and conduct investigations using appropriate methodology and technology, and communicate finding using appropriate technology

References

http://hou.lbl.gov/~vhoette/Explorations/Apogee-
Perigee/index.html
(Vivian Hoette's Activity)

http://nssdc.gsfc.nasa.gov/planetary/factsheet/moonfact.html
(NASA fact sheet on the Moon)

http://www.astrosociety.org/education/resources/scifi.html
(moon resource guide)

http://www.nightskyobserver.com/LunarPhase/ index.html
(Lunar Phase Pro Software)

<u>Geometry</u>, Prentice Hall c.1998, Laurie Bass,Basia Rinesmith Hall, Art Johnson, Dorothy Wood

Thanks To

<u>Vivian Hoette</u>
at HOU-University of Chicago Yerkes Observatory, whom without whose help and guidance this activity would not exist: my astronomer, teacher, and friend.

<u>Miroslav Bozinovich, Mark Karaim, and Susan Weed</u>
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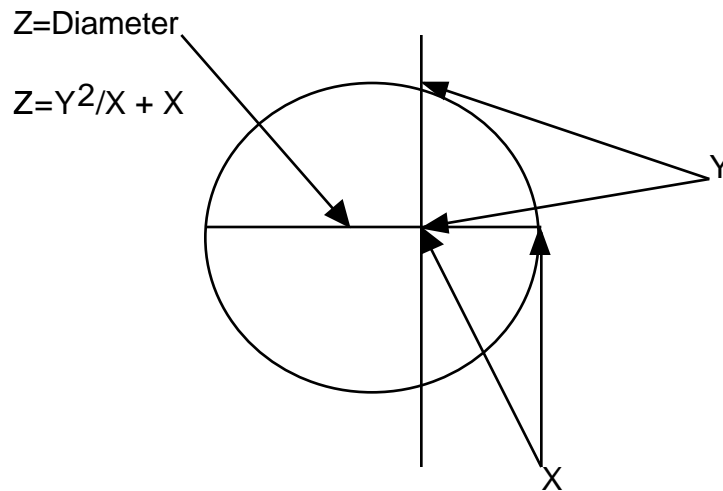
<u>My student's</u>
at Northwestern High School, whom without I wouldn't be challenged
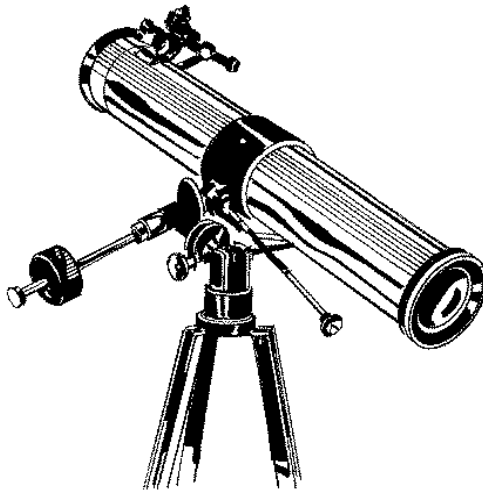
Apogee/Perigee Data Sheet

NAME:_____

Date:_____

Z=Diameter

$Z = Y^2/X + X$

Y

X

Hypothesis on which image (left or right) was taken when the moon was closest to the Earth and Lunar orbital shape

Data: Step 2- Length in Pixels of inner moon chord slice_____

Step 2- Middle of inner moon chord slice _____

Step 3- Length in Pixels of inner moon perpendicular slice_____

Step 4- Diameter of the inner moon image _____

Repeated Procedure for Outer moon image:

Step 2- Length in Pixels of outer moon chord slice_____

Step 2- Middle of outer moon chord slice _____

Step 3- Length in Pixels of outer moon perpendicular slice_____

Step 4- Diameter of the outer moon image _____

What do you conclude about the shape of the orbit of the Moon around the Earth?

Looking for the distance to the Moon found in the Image Info under data tools, what was the % change in the distance for these two images?

How close to the %distance data was your % lunar image change?