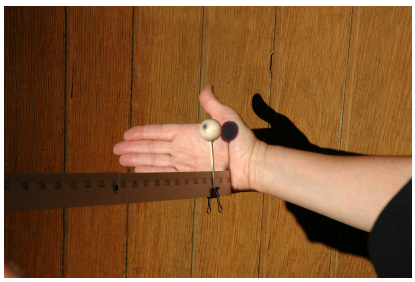
Modeling Meaningful Eclipses

Use questions to deepen eclipse understanding



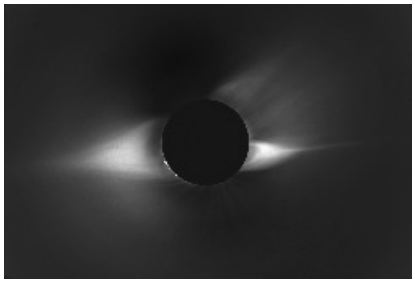


Photo Credit Fred Espenak

About the Activity

Using simple materials, participants create 3D models of the Earth, Moon and Sun and demonstrate solar and lunar eclipses. This method uses 3 steps that allow learners to engage, explore, and make meaning.

Topics Covered

- What is the difference between a solar and a lunar eclipse?
- When can you see an eclipse?

Location and Timing

Investigate Modeling Eclipses outside while the Sun is out or in a room with one bright light. Depending on level of investigation, can take between 20 - 45 minutes.

Materials Needed

The Sun or a bare light bulb if inside
An image of a solar or lunar eclipse (included or use your own)

Per group of 3-4:

- 1 Yard/Meter stick
- 1" (2.5cm) ball on a toothpick
- ¼" (7 mm) bead on a toothpick
- Binder clips to attach toothpicks to the yard stick 30 inches (75 cm) apart

(Optional) Eclipse glasses- see Helpful Hints

Participants

Use this activity with families, the general public, and school or youth groups ages 7 and up.

Note: Prior understanding of Moon phases recommended.

If your visitors are unfamiliar with the phases of the Moon, you may want to start with

- Earth-Moon scale: *Sizing up the Moon*
- And modeling lunar phases: *Why Does the Moon Have Phases?*

If visiting a classroom, be sure to ask the teacher if the students have already covered this. You may suggest that they do these 2 activities before your visit.

Modeling Meaningful Eclipses

If you don't have time for this thorough exploration, see a quick demo here: *Why Do Eclipses Happen?*

Note to Facilitator:

Do not immediately address all misconceptions!

Allow learners to work their way through misconceptions using guiding questions and these simple steps:

1) **Engage** – pique learner interest and get them personally involved
2) **Explore** – give them a chance to build understanding
3) **Make Meaning** – see how a model relates to what they observe

Detailed Activity Description

1) Engage – pique their interest

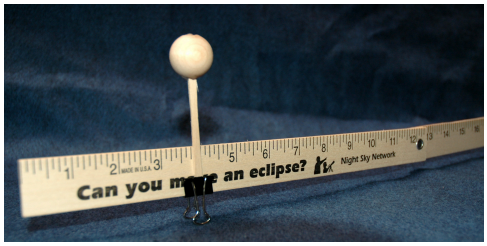
To Do: Show an image of a lunar or solar eclipse.

Engaging Questions:
"Have any of you ever seen an eclipse?"
"What did you notice?" or
"What did the Moon/Sun look like?" or
"What do you think was happening?"

Now Listen!
Allow them to elaborate on their experience and the impression it made on them. It is important at this stage to probe for their understanding of eclipses without judgment as to the correctness of their ideas. The goal is to allow learners to construct their own mental model of eclipses without providing the "answer" prematurely. It is possible many learners will convey some significant misconceptions about eclipses at this point. *It is important for you to NOT address each individual misconception.*

2) Explore – build understanding

To Do:
Hand out materials to groups of 2-3. If possible, use the actual Sun in the model. If not, have a single bright light source and no other lights in the room.



Tell them that we are going to make a model and let them know that the sizes of the 2 balls are to scale with the sizes of the Earth and Moon. Either show them where to clip the balls on the yardstick so that the actual distance is modeled (30" apart) or have them figure it out based on their previous knowledge.

The Challenge Question:

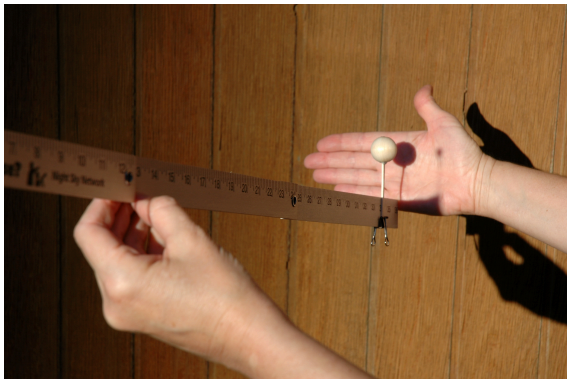
"How would you arrange the materials to recreate the earlier image of an eclipse?"

Now Listen!

Now it is the learner's turn to work with the materials. Guide them and try to give as few direct answers as possible. Instead answer their questions with leading questions that give them the joy of discovery.

Questions that encourage exploration:

"Show me where the Moon is when it is full."
"Show me where the Moon is during a lunar eclipse."
"What is the relationship between the two?"
"Where was the shadow of the Earth/Moon?"



Questions that guide learners through misconceptions:

"When you arranged it like this, what did you observe?"
"What happened when you..."
"How were you able to..."

To Do:

After all learners have had the opportunity to explore making eclipses with their models, engage them in a group discussion about the results of their modeling investigation. Give them a chance to show off what they learned.

Questions that encourage conversation:

"How were you able to make a solar eclipse with the materials?"
"How were you able to make a lunar eclipse with the materials?"
"What did you observe in your model when you made a (solar/lunar) eclipse?"

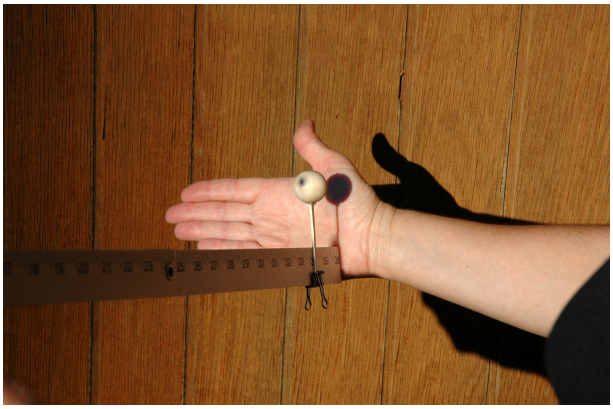
Now Listen!

Allow the learners to defend their ideas about what causes eclipses with evidence collected through their modeling investigation. Make sure you allow enough wait time after questions posed to learners to allow them the chance to respond.

3) Make Meaning – learners now apply that new understanding

To Ask:

"What time of day would you expect to see a solar/lunar eclipse?" or
"Who on Earth is able to see a solar/lunar eclipse?"



Remember to allow adequate exploration and wait time before asking specific learners to share their response(s) to the questions. Ideally, they will understand that lunar eclipses can be seen from the whole night side and solar eclipses can only be seen from parts of the dayside.

Extensions

A. Show image of annular eclipse, ask how this is different from a total eclipse. See if they can manipulate their model to explain the phenomena.
B. Extend the modeling of solar and lunar eclipses. Questions for exploration include:
   - "How often does a full/new moon occur?" and "How often do we have lunar/solar eclipses?"
   - The materials for the *Why Don't Eclipses Happen Every Month?* activity may prove useful. Remember, don't answer every question. Encourage exploration. It is more powerful for the learner to discover phenomena for themselves through their modeling activity.
C. Provide learners with several years of data on lunar phases and eclipses, and ask them to explore the data, searching for patterns and correlations between the two sets. They then could use their models to demonstrate the patterns they discover in the data.

Helpful Hints

Where to find materials

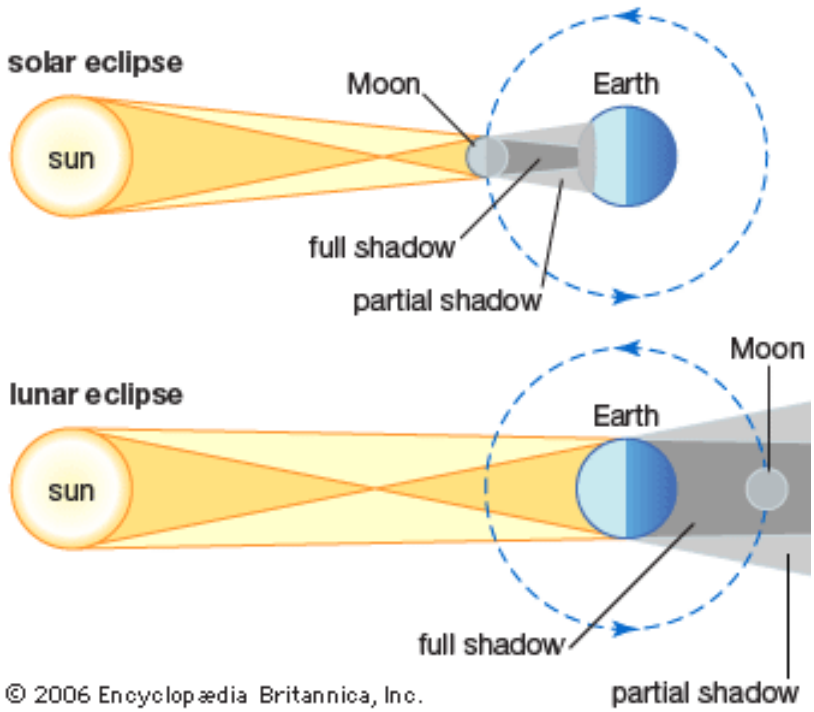
Eclipse Glasses:

- ASP: http://www.astrosociety.org click on "AstroShop"
- Search the internet for "eclipse glasses"
- From http://www.rainbowsymphony.com

Background Information

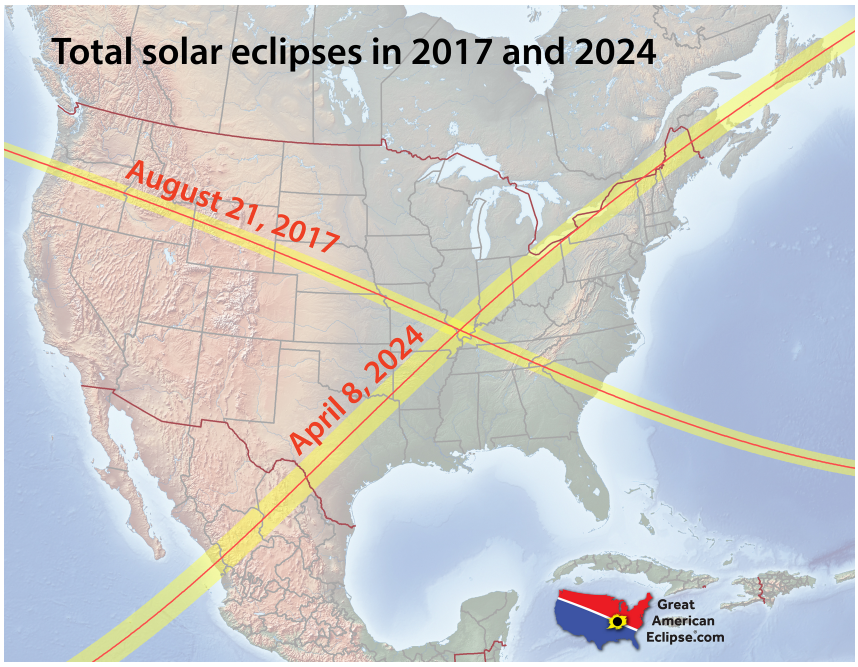
Eclipses

Everything you ever wanted to know about Solar and Lunar Eclipses:
http://sunearth.gsfc.nasa.gov/eclipse/eclipse.html



(illustration not to scale)

Upcoming Total Solar Eclipses in the USA:



Solar Eclipse **dates** around the world on the following page from:
http://eclipse.gsfc.nasa.gov/SEdecade/SEdecade2011.html

Additional astronomy activities can be found here: http://nightsky.jpl.nasa.gov

Schedule of upcoming *Lunar* Eclipses:

Date	Eclipse Type	Total Duration	Geographic Region of Eclipse Visibility
2016 Mar 23	Penumbral	-	Asia, Aus., Pacific, w Americas
2016 Sep 16	Penumbral	-	Europe, Africa, Asia, Aus., w Pacific
2017 Feb 11	Penumbral	-	Americas, Europe, Africa, Asia
2017 Aug 07	Partial	01h55m	Europe, Africa, Asia, Aus.
2018 Jan 31	Total	03h23m	Asia, Aus., Pacific, w N.America
2018 Jul 27	Total	03h55m	S.America, Europe, Africa, Asia, Aus.
2019 Jan 21	Total	03h17m	c Pacific, Americas, Europe, Africa
2019 Jul 16	Partial	02h58m	S.America, Europe, Africa, Asia, Aus.
2020 Jan 10	Penumbral	-	Europe, Africa, Asia, Aus.
2020 Jun 05	Penumbral	-	Europe, Africa, Asia, Aus.
2020 Jul 05	Penumbral	-	Americas, sw Europe, Africa
2020 Nov 30	Penumbral	-	Asia, Aus., Pacific, Americas

A **penumbral eclipse** occurs when the Moon only passes through the Earth's penumbra (the outer portion of the Earth's shadow).

Moon's Rotation

Does the Moon rotate? Why does the Moon always keep the same face to Earth? What does the other side of the Moon look like?
A discussion of these topics can be found here:
http://www-spof.gsfc.nasa.gov/stargaze/SMoon.htm

Method of Questioning Used Here

Many teachers use a similar model called the 5E's method that can be especially useful when working in classrooms. The adoption of new science standards across the country, including the Next Generation Science Standards is a fantastic opportunity for amateur astronomers to help educators in a new way. In particular for middle school teachers (grades 6-8), where the Next Generation Science Standards identifies a Performance Expectation that states:
Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.

For more information on the 5E's see NASA for Educators' EClips:
http://www.nasa.gov/audience/foreducators/nasaeclips/5eteachingmodels/