Why do Eclipses Happen?

What Is an Eclipse?

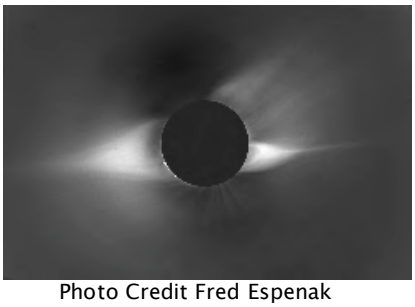
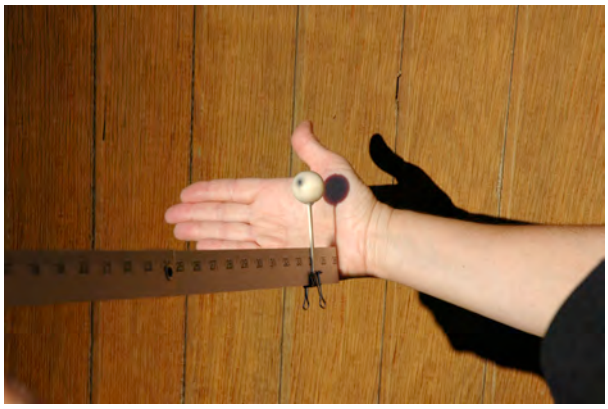


Photo Credit Fred Espenak

About the Activity

Using simple materials, participants create 3D models of the Earth, Moon and Sun and demonstrate solar and lunar eclipses.



Topics Covered

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

Participants

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

Location and Timing

Demonstrate "Why do Eclipses Happen?" outside while the Sun is out or in a classroom with one bright light. It takes about 10-15 minutes.

Materials Needed (choose one method)

- A bare light bulb or the Sun if outside

Methods 1 and 2:

- "Moon balls" for your audience members. 1"-2" dylite balls work best. *See Helpful Hints for more information.*
- Skewers or toothpicks for holding your Moon
- *(Optional)* Earth Globe four times the diameter of the Moon balls

Or Method 3- **this one is to scale**:

- 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/meter stick 30 inches (75 cm) apart

(Optional) Eclipse glasses- see Helpful Hints

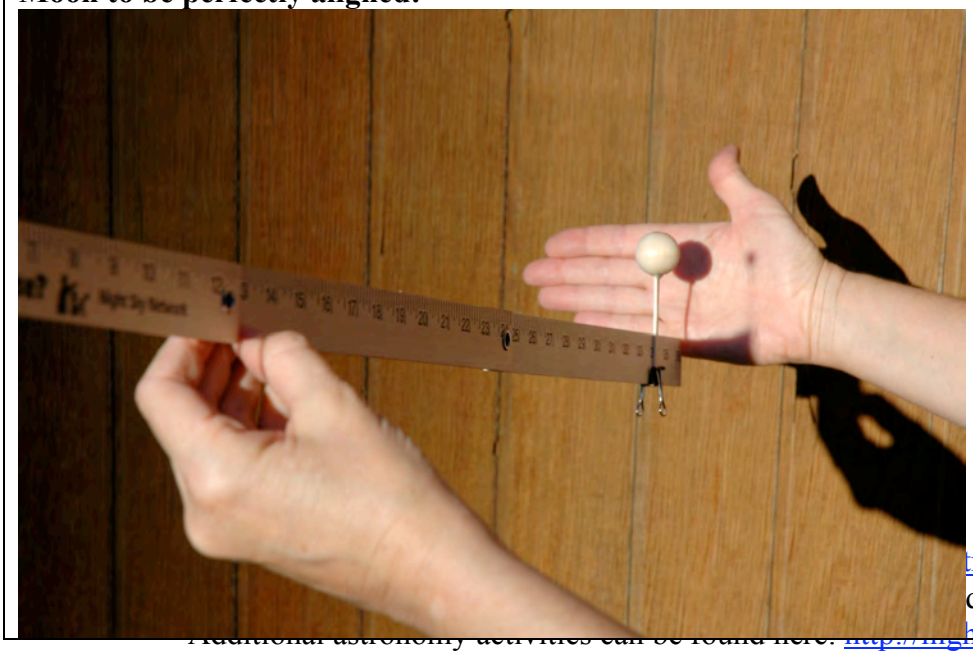
Included in This Packet	Page

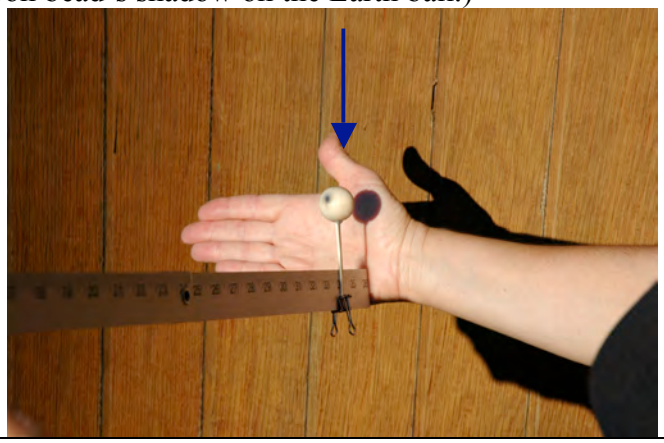
Additional astronomy activities can be found here: http://nightsky.jpl.nasa.gov

Detailed Activity Description

Why do Eclipses Happen?

Leader's Role	Participants' Role (Anticipated)
Presentation Tip: The Moon is roughly 2,000 miles (3,500 km) in diameter and the Earth is about 8,000 miles (13,000 km) in diameter. The Moon's average distance from Earth is about 240,000 miles (385,000 km). In a scale model, this makes **the Moon's distance from Earth thirty times the diameter of Earth**. So, if you have a 4-inch Earth, a 1-inch Moon would be 120 inches or ten feet away from Earth.	
To Say: So now, what's an eclipse? Let's make a lunar eclipse. That's when the Moon passes through the Earth's shadow. Where does the Moon have to be to go through the shadow of Earth? What phase is the Moon at that time? *To Do:* Choose one (or more) of the following three methods to demonstrate a **Lunar Eclipse**:	Where the shadow is. Opposite the Sun. Full Moon!
Lunar Eclipse Method 1: *To Say:* Make your Moon ball pass through your Earth-head's shadow. *To Do:* Move Moon ball into the shadow of your head	
Lunar Eclipse Method 2: Hold up the Earth globe and have someone move Moon ball into globe's shadow *(to make this to scale, calculate the distance they would need to be apart by figuring that you can fit 30 Earth diameters between the Earth and Moon.)*	

Leader's Role	Participants' Role (Anticipated)
Lunar Eclipse Method 3 (scale model): *To Do:* Clip Earth at the 4-inch (10 cm) mark on the yardstick. *To Say (Optional):* But how far apart do you suppose the Earth and Moon are? Here are smaller versions of the Earth and Moon (hold up 1" ball for Earth and 1/4" bead for Moon). And here is a yardstick. I'll clip the Earth here at the 4" mark.  Let's take some ideas of where we need to place the Moon to make this to scale.	Guesses, tries.
Here's a hint: Earth is about 8000 miles in diameter and this ball, representing Earth, is 1 inch in diameter. The Moon averages about 240,000 miles from Earth. We'd need to place this Moon-bead 30 inches (75 cm) from our Earth ball. *To Do:* Clip Moon at 34-inch (85 cm) mark. Hand Yardstick Earth-Moon model (this one is to scale) to a visitor. *To Say:* Try to move Moon-bead into Earth-bead's shadow and make a lunar eclipse. *To Do:* If the person is having difficulty, have them project the Earth's shadow onto a card or their hand. Then line up the shadows on the card. (See photo – the arrow is pointing to the Moon bead's shadow). **The point you might want to make is that it is not easy for the Sun, Earth, and Moon to be perfectly aligned!** 	More tries.

Leader's Role	Participants' Role (Anticipated)
To say: Would everyone on the night side of Earth be able to see the lunar eclipse?	Yes!
To Say: Great! Let's make a solar eclipse. That's when the Moon casts a shadow on the Earth. Where does the Moon have to be to do that? *To Do:* Choose one (or more) of the following three method to demonstrate a **Solar Eclipse:** ***Solar Eclipse Method 1:*** Choose a person to put on the eclipse glasses and have that person face the Sun. Move Moon ball so that it casts a shadow on the person's face. Have other participants watch the Moon's shadow move across the person's face. ***Solar Eclipse Method 2:*** Hold up the Earth globe and have someone move Moon ball between the Sun and the Earth globe. Have other participants watch the Moon's shadow move across the Earth globe. ***Solar Eclipse Method 3:*** Use Yardstick model: Align the Moon-bead toward the Sun and cast a shadow on the Earth-bead. Have the participants try. (The arrow in the photo is pointing to the Moon bead's shadow on the Earth ball.) 	On the side of Earth nearest the Sun.
To say: From where on Earth would the solar eclipse be visible?	Just the part where the Moon's shadow crosses.

Helpful Hints

Where to find materials

1) There are many options for "Moon Balls" but the dylite balls work by far the best. Most importantly, the balls need to be smooth and white. It is useful to be able to mount them on skewers or toothpicks.
   - 1–2" (3–5 cm) dylite/polystyrene balls: http://plasteelcorp.com/. You might also find polystyrene balls at arts and craft stores, but be sure you are using polystyrene, *NOT styrofoam*. The material is also called "dylite".
   - Ping-pong balls with hole: sporting goods – you need to poke your own small hole with a pencil. Beware, kids love to smash these.
2) Eclipse Glasses:
   - ASP: http://www.astrosociety.org click on "AstroShop"
   - Search the internet for "eclipse glasses"
   - From http://www.rainbowsymphony.com

Background Information

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

Eclipses

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

Schedule of Lunar Eclipses:

Date	Eclipse Type	Umbral Magnitude	Total Duration	Geographic Region of Eclipse Visibility
2007 Mar 03	Total	1.238	01h14m	Americas, Europe, Africa, Asia
2007 Aug 28	Total	1.481	01h31m	e Asia, Aus., Pacific, Americas
2008 Feb 21	Total	1.111	00h51m	c Pacific, Americas, Europe, Africa
2008 Aug 16	Partial	0.813	-	S. America, Europe, Africa, Asia, Aus.
2009 Feb 09	Penumbral	-0.083	-	e Europe, Asia, Aus., Pacific, w N.A.
2009 Jul 07	Penumbral	-0.909	-	Aus., Pacific, Americas
2009 Aug 06	Penumbral	-0.661	-	Americas, Europe, Africa, w Asia
2009 Dec 31	Partial	0.082	01h02m	Europe, Africa, Asia, Aus.
2010 Jun 26	Partial	0.542	02h44m	e Asia, Aus., Pacific, w Americas
2010 Dec 21	Total	1.262	03h29m	e Asia, Aus., Pacific, Americas, Europe

Umbral magnitude is the fraction of the Moon's diameter obscured by Earth's Umbra (the darkest part of Earth's shadow). For penumbral eclipses, the umbral magnitude is always less than 0. For partial eclipses, the umbral magnitude is always greater than 0 and less than 1. For total eclipses, the umbral magnitude is always greater than or equal to 1.

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

Illustration on the following page from:
http://sunearth.gsfc.nasa.gov/eclipse/SEatlas/SEatlas3/SE2001-25T-2.GIF