Hands-On Model of a Lunar Eclipse

Educational research shows that children (and many adults) have difficulty visualizing from diagrams and explanations alone, why an eclipse occurs. A very effective way to explain these concepts is through a hands-on model that allows the students to visualize the eclipse from their own point of view.

Materials

- 1 opaque white ball per student, 1" to 2" in diameter
- 1 lamp socket with plug—no shade
- 1 25-foot extension cord
- 2 clear (not frosted) light bulbs, one 40-watt, one 75-watt
- Optional: black paper, cloth, or garbage bags and tape to cover windows

Any opaque, white balls will work, including hardboiled eggs, golf balls, or white candy yogurt balls. Styrofoam does *not* work well, since it is translucent. Polystyrene balls are ideal to use for several classes because they are made of high-density foam and do not crush and crumble. Polystyrene balls may be purchased at some craft and fabric stores (especially in November and December), or ordered from a retailer—try Google: "polystyrene ball."

Before the Lesson

- Darken the room completely—cover windows with black cloth, paper, or garbage bags if necessary.
- Hang the lamp from the ceiling or clip it to a chair on top of a table, so the bulb will be in the center of the room, a little bit above eye level. Start with the 40-watt bulb.
- Experiment to see which of the bulbs is best before doing this activity with students. Push one of the moon balls onto a pencil to form a handle. Your students will be standing in a large circle to do this activity. Stand near the edge of the classroom, where your students will stand, and hold up the moon ball. Move the ball around your head, observing the "phases of the Moon." If you do not see the phases fairly clearly, try a different brightness bulb.

In Class

What is a lunar eclipse?

Imagine you are looking at a beautiful full Moon—a perfect bright circle of light against a starry night sky. All of a sudden you notice that there seems to be a shadow on one edge of the Moon! As you watch for the next half hour or so, the shadow gradually covers more and more of the Moon. A further mystery is that the shadow is not completely dark, but it glows a deep reddish orange. After an hour or two, the bright full Moon begins to appear again, and the shadow passes away as gradually as it came. You are again looking at the bright perfect disk of a full Moon. You have just witnessed an eclipse of the Moon, or lunar eclipse. Today we know that lunar eclipses occur when the Moon passes through the shadow of the Earth.

Let's use a model to find out what causes an eclipse of the Moon. Please stand up and take one of these "moons." Pretend your head is the Earth. Now I will turn on the "Sun" in the middle of the room.

Distribute Moon balls, one to each person.

Turn on the lamp at the center of the classroom, and turn off all other lights.

Hold your Moon up so it covers the Sun. That's a solar eclipse; it is not the type of eclipse Columbus saw. Now turn to your left so that you see a crescent Moon. It takes the Moon about one month (or one "Moon-th") to travel around the Earth. In that month, the shape or phase of the Moon changes slowly. (Check to be certain that the students are following you at each step. Help individuals as needed.)

Keep turning until your Moon is half full. Be sure to watch the Moon ball, not the Sun (the lamp) in the center of the room. Continue turning slowly until the Moon is almost full. (Check on students.) You have seen how the Moon changes its phase from crescent to full in almost two weeks.

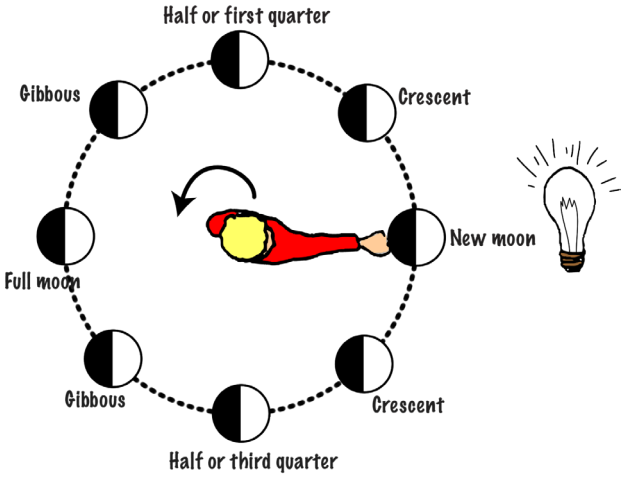
Remember that your head is the Earth. Turn your back toward the Sun so that it is nighttime over your entire face. Now, slowly move the Moon into the shadow of your head. This is a lunar eclipse. Notice that you can still see the Moon a little bit from scattered light in this room. When the real Moon moves into the shadow of the Earth, it glows dull red because some of the red light of the Sun is bent by the Earth's atmosphere into the Earth's shadow.

What phase is the Moon just before an eclipse of the Moon? [Full.] Just after an eclipse of the Moon? [Full.]

The Moon must be at full phase in order for there to be a lunar eclipse. Most of the time, the full Moon passes just above or just below the shadow of the Earth, so we do not see an eclipse. But when the Moon does pass through the shadow, we can see a lunar eclipse. Now, place the Moon back into the shadow of your head. Remember, your head is the Earth.

Where do you have to be to see the eclipse of the Moon? [On the dark side of the Earth.]

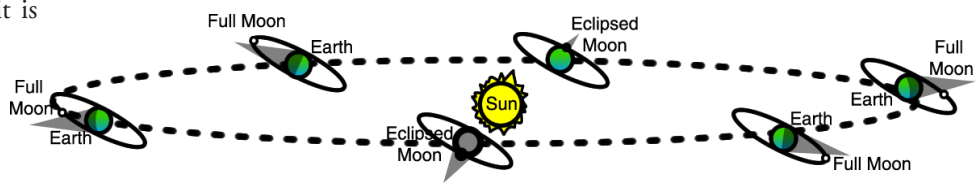
So, someone in Spain could watch the same eclipse that Columbus saw on the mystery island, as long as they could all see the Moon at the same time.



Background for Teachers—What Causes a Lunar Eclipse?

When do lunar eclipses occur?

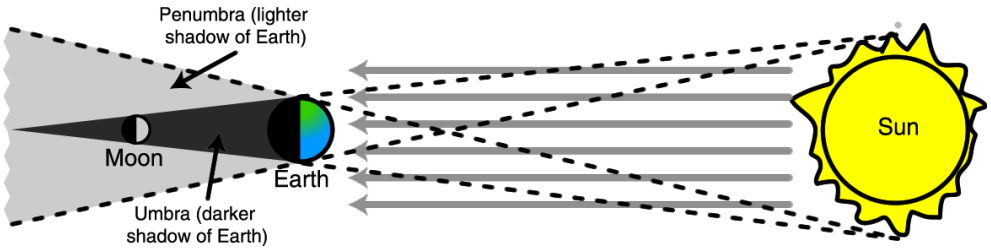
The Earth circles the Sun once per year. The plane of the Earth's orbit is called the *ecliptic*. The Sun, the Earth, and the Earth's shadow all fall within the plane of the ecliptic. The Moon circles the Earth once per month. The plane of the Moon's orbit is tilted a little bit (5°) from the plane of the ecliptic. When the Moon is on the side of the Earth away from the Sun, it passes very close to the Earth's shadow; so there is a *chance* of an eclipse every month. Because its orbit is tilted, however, the Moon usually passes just above or below the Earth's shadow. About twice per year the Moon goes right through the shadow of the Earth, creating a lunar eclipse.



Why lunar eclipses occur about two times per year: the Moon's orbit is tilted with respect to the Earth's orbit.

How frequently can you see a lunar eclipse?

On average, a lunar eclipse occurs about once in six months. Notice that the night side of the Earth faces the Moon when it is in full phase. This means that *everyone* on the night side of the planet can see a lunar eclipse when it occurs. If there were no clouds your chance of seeing a lunar eclipse would actually be a little *more* than 50% because it takes the Moon a few hours to pass completely through the Earth's shadow. So if the eclipse starts in late afternoon, you may still be able to see it come out of eclipse an hour or two after sunset.



Note

Distances and sizes in these diagrams are not to scale (by a long shot).

Why does the Moon appear reddish orange during an eclipse?

The Moon looks deep reddish orange because the Earth's atmosphere bends the red-orange part of sunlight into the shadow, just as it does at sunrise or sunset. The sky appears reddish when the Sun is below the horizon. How dark the Moon appears depends upon whether the Moon is crossing through the center of the Earth's shadow or nearer to the edge of the shadow, and how much dust or pollution is in the Earth's atmosphere.

Columbus and the lunar eclipse.

The script describes a lunar eclipse observed by Columbus at a mystery island (Jamaica). This was reported many years later by his son, Ferdinand, who was on the trip with him. During that eclipse the Moon did not pass through the center of the Earth's shadow, so it was red-orange, and fairly bright. When the Moon rose, it was almost totally eclipsed. Columbus measured the time from sunset to the end of the lunar eclipse in order to determine his longitude. It was not a particularly accurate method because Columbus lacked good clocks, and determining the precise ending of a lunar eclipse is quite difficult. But it was the best method available.