

Teacher Guide: 2D Eclipse



Learning Objectives

Students will ...

- Identify the umbra and penumbra of a shadow.
- Model a partial and total solar eclipse.
- Observe the corona of the Sun during a total solar eclipse.
- Model a penumbral, partial, and total lunar eclipse.
- Describe the difference between a solar and a lunar eclipse.
- Discuss whether eclipses occur every month.



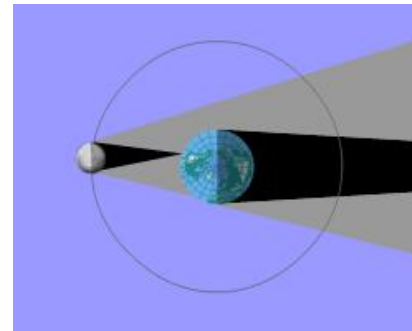
Vocabulary

corona, eclipse, lunar eclipse, penumbra, solar eclipse, umbra



Lesson Overview

On August 24, 1999, thousands of pilgrims submerged themselves in India's Ganges River, praying for the Sun to fend off the twin demons Rahu and Keta. The crowd was silent as the Sun was covered by the Moon and the sky darkened. Cheers rang out as the Sun emerged again from behind the Moon.



Eclipses of the Sun and Moon have figured prominently in legends and mythology throughout the world. The *2D Eclipse Gizmo™* allows students to model eclipses by observing the shadows of the Moon and Earth as the Moon orbits Earth. (Note: The related *Eclipse Gizmo* covers similar topics but is aimed at younger students.)

The Student Exploration sheet contains two activities:

- Activity A – Students model a partial and total solar eclipse.
- Activity B – Students model a penumbral, partial, and total lunar eclipse.



Suggested Lesson Sequence

1. Pre-Gizmo activities

Before discussing eclipses, review the phases of the Moon using the *Phases of the Moon Gizmo*. Next, show students images of solar and lunar eclipses. Ask students to compare the images of the Moon entering a lunar eclipse to the phases of the Moon. The images show a gibbous phase on the left and a lunar eclipse on the right.

(🕒 10 – 20 minutes)



2. Prior to using the Gizmo

Before students are at the computers, pass out the Student Exploration sheets and ask students to complete the Prior Knowledge Questions. (These questions ask students about shadows while they stand in front of a lamp. If you are able to, allow students to

(🕒 10 – 15 minutes)

stand up and do the activity in the classroom.) Discuss student answers as a class. Afterwards, if possible, use a projector to introduce the Gizmo and to demonstrate its basic operations, such as how to take Gizmo snapshots.

3. **Gizmo activities** (🕒 15 – 20 minutes per activity)

Assign students to computers. Students can work individually or in small groups. Have students work through the activities in the Student Exploration, using the Gizmo. Alternatively, you can use a projector and do the Exploration as a teacher-led activity.

4. **Discussion questions** (🕒 15 – 20 minutes)

As students are working or just after they are done, discuss the following questions:

- Why do the shadows of celestial objects have two parts, the umbra and the penumbra?
- How much of the Sun would you see if you were standing in the penumbra? How much of the Sun would you see if you were standing in the umbra?
- Would we see the corona or experience a total solar eclipse if the Moon were smaller or farther away?
- Why do you think it is more likely that you will be able to witness a lunar eclipse than a solar eclipse?
- How often do eclipses happen in the Gizmo? How often do they happen in real-life? Why don't eclipses happen this often in real life?

5. **Follow-up activity: Modeling eclipses** (🕒 15 – 30 minutes)

Have students model eclipses using a softball as the Moon, a flashlight as the Sun, and a human head as Earth. A student can model a solar eclipse by looking at the flashlight and then moving the softball in front of the light. The student can continue the orbit of the softball (noticing the phases of the softball) and then model a lunar eclipse by turning their back to the flashlight and moving the softball into the shadow created by his or her head. Be sure to model partial as well as total eclipses.

Next, mention that the reason we don't see an eclipse every New Moon and Full Moon is that the Moon's orbit is tilted relative to the plane of Earth's orbit. Ask students to demonstrate this with the softball and flashlight. This principle is a primary focus of the *3D Eclipse Gizmo*.



Scientific Background

An eclipse occurs when one celestial body passes into the shadow of another. Although any celestial bodies can be involved, usually the term refers to the Earth passing into the Moon's shadow (*solar eclipse*) or the Moon passing into Earth's shadow (*lunar eclipse*).

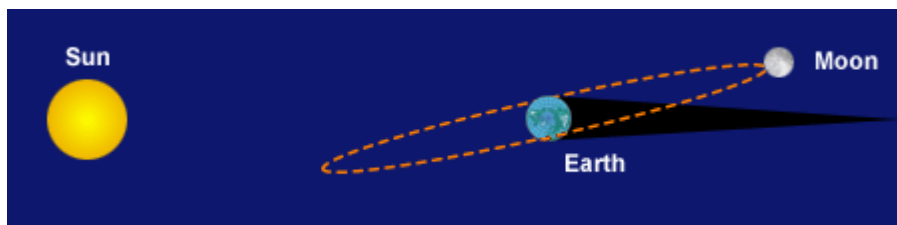
The shadows cast by celestial bodies have two parts. The *umbra* is the central, darkest part of the shadow. If an observer is standing in the umbra of the Earth or Moon, he will not be able to see any part of the Sun. The *penumbra* surrounds the umbra and is less dark. An observer standing in the penumbra will see part of the Sun. The reason these shadows have two parts is that the Sun is not a *point-source* of light, or light that emanates from a single point in space. The width of the Sun allows it to be partially covered and therefore cast a penumbral shadow.

A solar eclipse (right) occurs when the Moon's shadow crosses Earth's surface. The path of the Moon's umbra across Earth's surface is called the *path of totality*. Any observer in the path of totality will experience a total solar eclipse, in which the Sun is fully blocked by the Moon. By lucky coincidence, the apparent size of the Moon is nearly identical to the apparent size of the Sun when viewed from Earth, so the Moon can neatly block the disk of the Sun. This allows astronomers to observe the *corona*, or faint outer atmosphere of the Sun.



A lunar eclipse (left) occurs when the Moon enters Earth's shadow. First, the Moon is slightly darkened by Earth's penumbra, but this faint effect often is not noticed. Next, Earth's umbra begins to move across the Moon's surface. The shape of Earth's umbra allows an observer to distinguish the lunar eclipse from a normal phase of the Moon. At totality, when the Moon is completely in Earth's umbra, the Moon glows a faint red color because some rays of the Sun are bent around Earth by Earth's atmosphere.

As shown in the *2D Eclipse Gizmo*, you would expect a solar and a lunar eclipse every time the Moon orbits Earth, or every month. In fact, the Moon's orbit is tilted relative to the plane of Earth's orbit. The Moon's shadow usually passes above or below the Earth, and the Moon usually passes above or below Earth's shadow. Most years include about two lunar eclipses and two solar eclipses.



Selected Web Resources

NASA eclipse homepage: <http://sunearth.gsfc.nasa.gov/eclipse/eclipse.html>

Solar eclipses: <http://www.kidseclipse.com/>, <http://www.exploratorium.edu/eclipse>

Lunar eclipses: <http://www.mreclipse.com/Special/LEprimer.html>

Eclipse dates: <http://eclipse.gsfc.nasa.gov/eclipse.html>

Eclipse lesson plans: <http://www.kidseclipse.com/pages/a1b1c0d0.htm>,

http://www.eyeonthesky.org/lessonplans/11sun_eclipseclass.html

Eclipse myths and legends: http://starryskies.com/The_sky/events/lunar-2003/eclipse7.html

Related Gizmos:

Phases of the Moon: <http://www.explorellearning.com/gizmo/id?613>

Eclipse: <http://www.explorellearning.com/gizmo/id?644>

3D Eclipse: <http://www.explorellearning.com/gizmo/id?462>

Penumbra Effect: <http://www.explorellearning.com/gizmo/id?469>