



Name: _____ Date: _____

Student Exploration: 3D Eclipse

Vocabulary: eclipse, lunar eclipse, path of totality, penumbra, solar eclipse, umbra

Prior Knowledge Questions (Do these BEFORE using the Gizmo.)

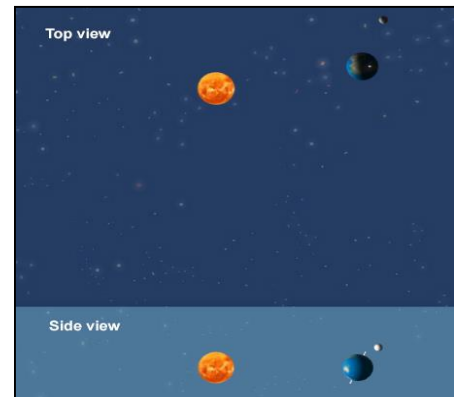
1. Have you ever seen an **eclipse**? If so, describe what you saw. _____

2. About how often do you think eclipses happen? _____

Gizmo Warm-up

If you see a two-dimensional image of the Earth, Moon, and Sun, you might predict that an eclipse occurs every time the Moon passes in front of or behind Earth, or about twice a month. However, eclipses occur much more rarely.

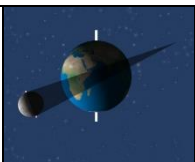
The *3D Eclipse* Gizmo shows two views of the Earth, Moon, and Sun: a top view (above) and a side view (below). The sizes of the Earth, Moon, and Sun are not to scale. (If they were, the Earth and Moon would be microscopic!)



1. Set the **Simulation speed** slider to a middle value, and click **Play** (▶). Based on the top view on the SIMULATION pane, describe the motions of the Sun, Earth, and Moon.

2. Click **Reset** (↺), and then click **Play** again. This time, focus on the side view at the bottom of the SIMULATION pane. What do you notice about the Moon's orbit?



Activity A: Solar eclipse	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • Click Reset. • Under Shadows, select Moon. • Set the Moon angle to 0.0°. 	
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Introduction: There are two parts to the Moon's shadow. The **umbra** is the central, darkest portion of the shadow. An observer standing in the umbra cannot see the Sun. The **penumbra** surrounds the umbra. An observer in the penumbra sees part of the Sun. Only the umbra is shown in the *3D Eclipse Gizmo*.

Question: What controls whether a solar eclipse will occur?

1. **Observe:** Click **Play** and then **Pause** (⏸) when the Moon is directly between the Earth and Sun. (If you go too far, you can click the **Back** button to step back.)

A. What do you notice about the Moon's shadow? _____

B. Under **Views**, select **Earth**. What do you see? _____

Any person standing in the Moon's shadow will experience a **solar eclipse**. During a *total solar eclipse*, the entire disk of the Sun is blocked by the Moon.

2. **Observe:** Set the **Simulation speed** to a lower setting and click the **Back** button until just before the Moon's shadow crosses Earth's surface. Click **Play** and observe.

A. What do you notice? _____

B. The path the Moon's umbra traces across Earth's surface is called the **path of totality**. What would you see if you were standing in the path of totality?

3. **Record:** Click **Reset**. Set the speed to a higher setting and click **Play**. Use the Gizmo to determine the dates of the first six solar eclipses of the year. Record these dates below.

Do you think solar eclipses really happen this often? Explain. _____

(Activity A continued on next page)



Activity A (continued from previous page)

4. Explore: Click **Reset**. A solar eclipse does not occur every month because the Moon's orbit is tilted 5.14° relative to Earth's orbit.

To model this, set the **Moon angle** to 5.1° . Play the simulation until January 9. Click **Pause**, reduce the speed, and click **Play**. What do you notice about the path of totality now?

5. Explore: Advance the simulation to February 8, and again play the simulation at a low speed. Does the umbra cross Earth's surface this time? _____

In this situation, a total solar eclipse will not be visible from any location on Earth's surface.

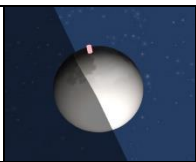
6. Record: Use the Gizmo to find the dates of the next three solar eclipses. Be sure to check carefully whether the Moon's umbra crosses Earth's surface. Record these dates below.

Do you think this frequency of solar eclipses is more realistic? Explain. _____

7. On your own: Experiment with different **Moon angle** values. How does the angle of the Moon's orbit affect the number of solar eclipses that occur in a year?

8. On your own: Return the **Moon angle** to 5.1° , and increase the **Moon distance** to 1.50. How does increasing the Earth-Moon distance affect the occurrence of total solar eclipses?



Activity B: Lunar eclipse	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • Click Reset. Under Shadows, select Earth. • Set the Moon distance to 1.00 and the Moon angle to 0.0°. 	
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Introduction: A **lunar eclipse** occurs when the Moon goes into Earth's shadow. If the Moon goes into Earth's penumbra, it is called a *penumbral lunar eclipse*. If the Moon goes into Earth's umbra, it is a *total lunar eclipse*. A *partial lunar eclipse* occurs when only part of the Moon goes into Earth's umbra. (Note: Earth's penumbra is not shown in the Gizmo.)

Question: What controls whether a lunar eclipse will occur?

1. Observe: Set the **Moon angle** to 0.0°. Click **Play**, and then click **Pause** when the Moon is in Earth's shadow. Select the **Moon** view. What do you see? _____

2. Observe: Set the speed to a lower setting and click the **Back** button until just before Earth's shadow crosses the Moon. Click **Play** and describe what you see.

3. Infer: Select the **Earth** view. Who on Earth would be able to see the lunar eclipse? Explain your answer. _____

4. Record: Click **Reset** and select the **Moon** view. Set the speed to a higher setting and click **Play**. Use the Gizmo to determine the dates of the first six lunar eclipses, and record below.

Do you think lunar eclipses really happen this often? Explain. _____

(Activity B continued on next page)

Activity B (continued from previous page)

5. **Explore:** Click **Reset**. Set the **Moon angle** to 5.1° . Play the simulation until January 24. Click **Pause**, set the speed to a low value, and click **Play**.

A. Is there a lunar eclipse this time? _____

B. Why not? (Hint: Look at the side view on the bottom of the SIMULATION pane.)

6. **Record:** Use the Gizmo to find the dates of the lunar eclipses in one year. Be sure the Moon is actually darkened by Earth's shadow for each eclipse. Label each eclipse a total eclipse (moon is completely darkened) or a partial eclipse (only part of the moon is darkened).

Do you think this frequency of lunar eclipses is more realistic? Explain. _____

7. **Think and discuss:** A person living in North America can see 15 lunar eclipses in the 2010–2020 decade. In the same time period, only two solar eclipses can be observed in North America.

Why will more lunar eclipses than solar eclipses be visible from North America in this decade? If possible, discuss your answer with your classmates and teacher.

