Lesson 3

Eclipses and TIDES

ESSENTIAL QUESTIONS

- What is a solar eclipse?
- What is a lunar eclipse?
- How do the Moon and the Sun affect Earth's oceans?

inquiry **What is this dark spot?**

1. Cosmonauts took this photo from aboard the *Mir* orbiting space station. What do you think caused the shadow on Earth?

SUBMIT SHOW ANSWERS CLEAR

Shadows—The Umbra and the Penumbra

A shadow results when one object blocks the light that another object emits or reflects. When a tree blocks light from the Sun, it casts a shadow. If you want to stand in the shadow of a tree, the tree must be in a line between you and the Sun.

If you go outside on a sunny day and look carefully at a shadow on the ground, you might notice that the edges of the shadow are not as dark as the rest of the shadow. Light from the Sun and other wide sources casts shadows with two distinct parts, as shown in **Figure 13.** *The* **umbra** *is the central, darker part of a shadow where light is totally blocked. The* **penumbra** *is the lighter part of a shadow where light is partially blocked.* If you stood within an object's penumbra, you would be able to see only part of the light source. If you stood within an object's umbra, you would not see the light source at all.

WORD ORIGIN

penumbra

from Latin *paene,* means "almost"; and *umbra,* means "shade, shadow"

2. Visual Check

Interpret Label the umbra and the penumbra of the shadow below.

SUBMIT SHOW ANSWERS CLEAR

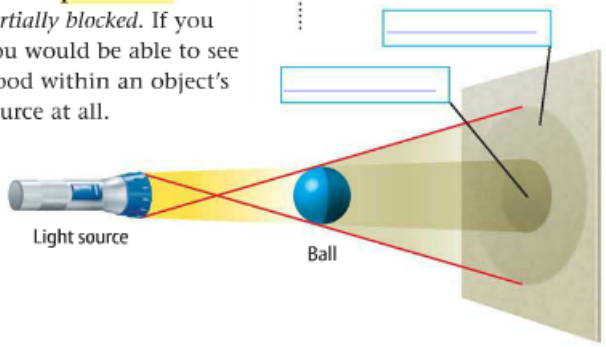


Figure 13 The shadow that a wide light source produces has two parts—the umbra and the penumbra. The light source cannot be seen from within the umbra. The light source can be partially seen from within the penumbra. ▶

Inquiry

LAB STATION

SC.8.N.1.1, SC.8.E.5.9

Try It!

MiniLab *What does the Moon's shadow look like?* at connectED.mcgraw-hill.com

Apply It!

After you complete the lab, answer these questions.

1. What type of eclipse did you model? Explain your answer.

2. Sketch your model eclipse. Label the Sun, the Moon, Earth, the umbra, and the penumbra.

SUBMIT SHOW ANSWERS CLEAR

Solar Eclipses

As the Sun shines on the Moon, the Moon casts a shadow that extends out into space. Sometimes the Moon passes between Earth and the Sun. This can only happen during the new moon phase. When Earth, the Moon, and the Sun are lined up, the Moon casts a shadow on Earth's surface, as shown in **Figure 14.** You can see the Moon's shadow in the photo at the beginning of this lesson. *When the Moon's shadow appears on Earth's surface, a* **solar eclipse** *is occurring.*

3. **NGSSS Check** **Explain** Why does a solar eclipse occur only during a new moon? SC.8.E.5.9

SUBMIT SHOW ANSWERS CLEAR

As Earth rotates, the Moon's shadow moves along Earth's surface, as shown in **Figure 14.** The type of eclipse you see depends on whether you are in the path of the umbra or the penumbra. If you are outside the umbra and penumbra, you cannot see a solar eclipse at all.

Total Solar Eclipses

You can only see a total solar eclipse from within the Moon's umbra. During a total solar eclipse, the Moon appears to cover the Sun completely, as shown in **Figure 15** on the next page. Then, the sky becomes dark enough that you can see stars. A total solar eclipse lasts no longer than about 7 minutes.

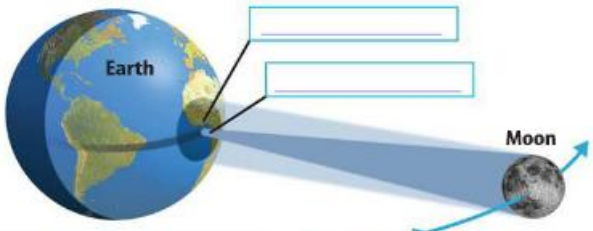
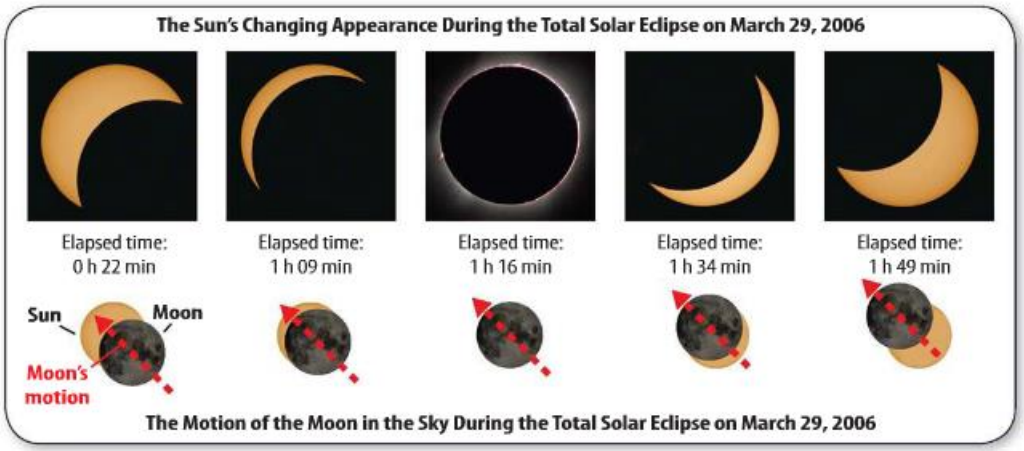


Figure 14 A solar eclipse occurs only when the Moon moves directly between Earth and the Sun. The Moon's shadow moves across Earth's surface.

4. **Visual Check** **Label** Where would a total solar eclipse be seen, and where would a partial solar eclipse be seen?

SUBMIT SHOW ANSWERS CLEAR



Partial Solar Eclipses

You can only see a total solar eclipse from within the Moon's umbra, but you can see a partial solar eclipse from within the Moon's much larger penumbra. The stages of a partial solar eclipse are similar to the stages of a total solar eclipse, except that the Moon never completely covers the Sun.

Figure 15 This sequence of photographs shows how the Sun's appearance changed during a total solar eclipse in 2006.

Click below.

Why don't solar eclipses occur every month?

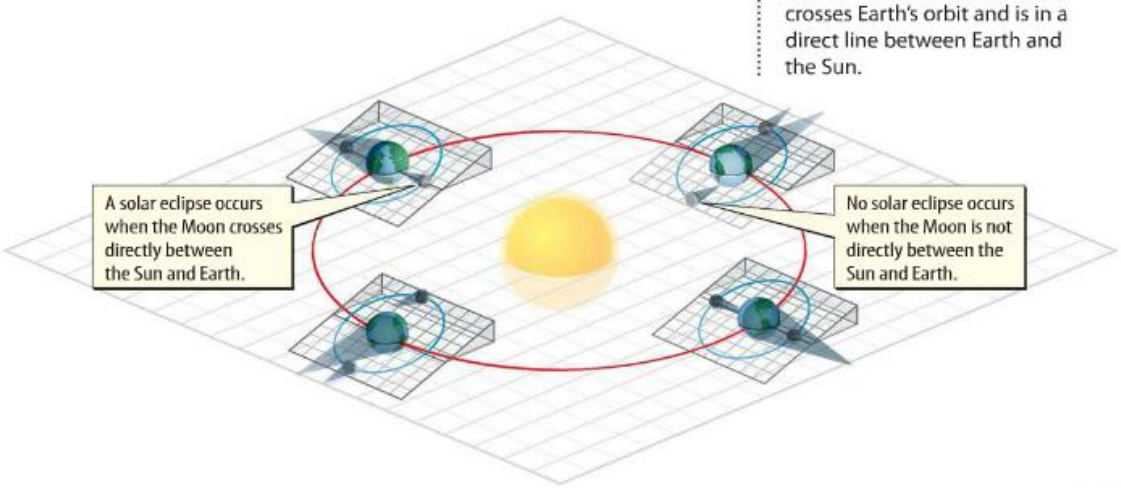
Solar eclipses only can occur during a new moon, when Earth and the Sun are on opposite sides of the Moon. However, solar eclipses do not occur during every new-moon phase. **Figure 16** shows why. The Moon's orbit is tilted slightly compared to Earth's orbit. As a result, during most new moons, Earth is either above or below the Moon's shadow. However, every so often the Moon is in a line between the Sun and Earth. Then the Moon's shadow passes over Earth and a solar eclipse occurs.

abc

Active Reading **5. Recall** Underline why a solar eclipse does not occur every month.

SUBMIT SHOW ANSWERS CLEAR

Figure 16 A solar eclipse occurs only when the Moon crosses Earth's orbit and is in a direct line between Earth and the Sun.



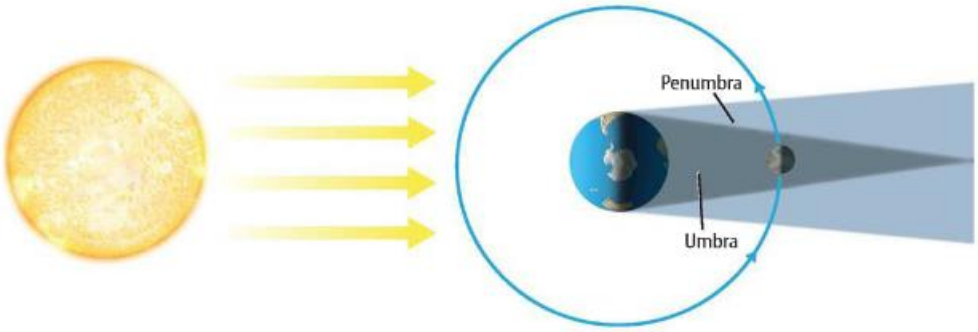


Figure 17 A lunar eclipse occurs when the Moon moves through Earth's shadow.

6. **Visual Check** **Explain** Why would more people be able to see a lunar eclipse than a solar eclipse?

Lunar Eclipses

Just like the Moon, Earth casts a shadow into space. As the Moon revolves around Earth, it sometimes moves into Earth's shadow, as shown in **Figure 17.** *A* **lunar eclipse** *occurs when the Moon moves into Earth's shadow.* Then Earth is in a line between the Sun and the Moon. This means that a lunar eclipse can occur only during the full moon phase.

Active Reading

FOLDABLES LA.8.2.2.3

Make a two-tab book from a sheet of notebook paper. Label the tabs Solar Eclipse and Lunar Eclipse. Use it to organize your notes on eclipses.

Like the Moon's shadow, Earth's shadow has an umbra and a penumbra. Different types of lunar eclipses occur depending on which part of Earth's shadow the Moon moves through. Unlike solar eclipses, you can see any lunar eclipse from any location on the side of Earth facing the Moon.

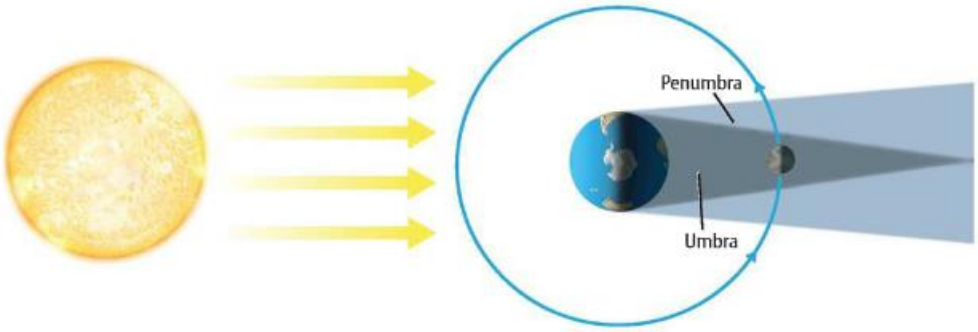
When the entire Moon moves through Earth's umbra, a total lunar eclipse occurs. **Figure 18** on the next page shows how the Moon's appearance changes during a total lunar eclipse. The Moon's appearance changes as it gradually moves into Earth's penumbra, then into Earth's umbra, back into Earth's penumbra, and then out of Earth's shadow entirely.

You can still see the Moon even when it is completely within Earth's umbra. Although Earth blocks most of the Sun's rays, Earth's atmosphere deflects some sunlight into Earth's umbra. This is also why you can often see the unlit portion of the Moon on a clear night. Astronomers often call this Earthshine. This reflected light has a reddish color and gives the Moon a reddish tint during a total lunar eclipse.

Active Reading 8. **Describe** What color does the Moon appear to be during a total lunar eclipse?

7. **NGSSS Check** **State** When can a lunar eclipse occur? SC.8.E.5.9

SUBMIT SHOW ANSWERS CLEAR



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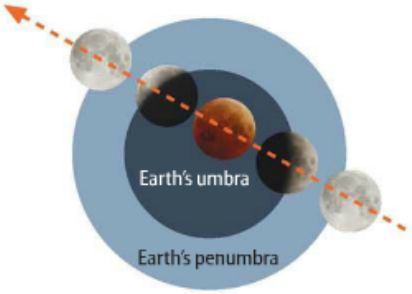


Figure 18 If the entire Moon passes through Earth's umbra, the Moon gradually darkens until a dark shadow covers it completely.

9. **Visual Check** **Contrast** How would a total lunar eclipse look different from a total solar eclipse?

SUBMIT SHOW ANSWERS CLE

Partial Lunar Eclipses

When only part of the Moon passes through Earth's umbra, a partial lunar eclipse occurs. The stages of a partial lunar eclipse are similar to those of a total lunar eclipse, shown in **Figure 18,** except the Moon is never completely covered by Earth's umbra. The part of the Moon in Earth's penumbra appears only slightly darker, while the part of the Moon in Earth's umbra appears much darker.

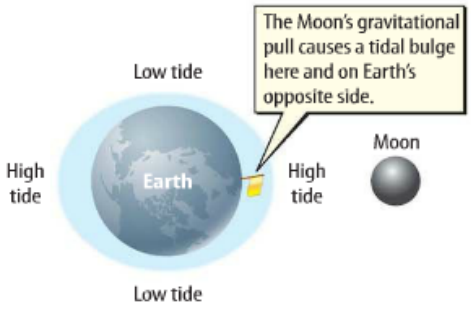
Why don't lunar eclipses occur every month?

Lunar eclipses can occur only during a full moon phase, when the Moon and the Sun are on opposite sides of Earth. However, lunar eclipses do not occur during every full moon because of the tilt of the Moon's orbit with respect to Earth's orbit. During most full moons, the Moon is slightly above or slightly below Earth's penumbra.

Tides

The positions of the Moon and the Sun also affect Earth's oceans. If you have spent time near Florida's coast, you might have seen how the ocean's height, or sea level, rises and falls twice each day. *A* **tide** *is the daily rise and fall of sea level.* Examples of tides are shown in **Figure 19.** It is primarily the Moon's gravity that causes Earth's oceans to rise and fall twice each day.

Figure 19 In the Bay of Fundy, high tides can be more than 10 m higher than low tides.



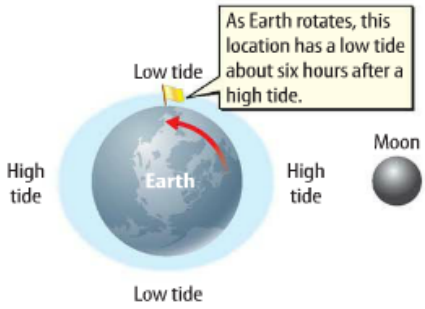


Figure 20 In this view looking down on Earth's North Pole, the flag moves into a tidal bulge as Earth rotates. A coastal area has a high tide about once every 12 hours.

The Moon's Effect on Earth's Tides

The difference in the strength of the Moon's gravity on opposite sides of Earth causes Earth's tides. The Moon's gravity is slightly stronger on the side of Earth closer to the Moon and slightly weaker on the side of Earth opposite the Moon. These differences cause tidal bulges in the oceans on opposite sides of Earth, as shown in **Figure 20**. High tides occur at the tidal bulges, and low tides occur between them.

The Sun's Effect on Earth's Tides

Because the Sun is so far away from Earth, its effect on tides is about half that of the Moon. **Figure 21** shows how the positions of the Sun and the Moon affect Earth's tides.

Spring Tides During the full moon and new moon phases, spring tides occur. This is when the Sun's and the Moon's gravitational effects combine and produce higher high tides and lower low tides.

Neap Tides A week after a spring tide, a neap tide occurs. Then the Sun, Earth, and the Moon form a right angle. When this happens, the Sun's effect on tides reduces the Moon's effect. High tides are lower and low tides are higher at neap tides.

10. NGSSS Check **Compare** Why is the Sun's effect on tides less than the Moon's effect? SC.8.E.5.9

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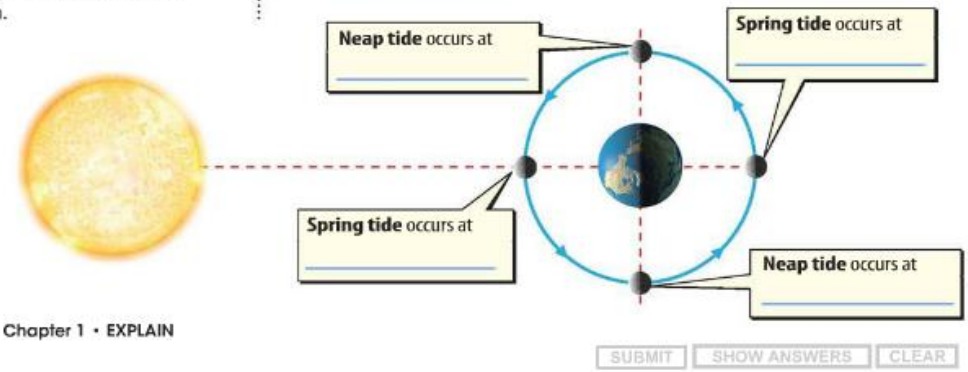
_____

Figure 21 A spring tide occurs when the Sun, Earth, and the Moon are in a line. A neap tide occurs when the Sun and the Moon form a right angle with Earth.

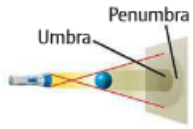
11. Visual Check **Relate** Fill in the blanks with the correct phases of the Moon.



SUBMIT SHOW ANSWERS CLEAR

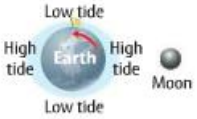
Lesson Review 3

Visual Summary



Shadows from a wide light source have two distinct parts.

The Moon's shadow produces solar eclipses. Earth's shadow produces lunar eclipses.



The positions of the Moon and the Sun in relation to Earth cause gravitational differences that produce tides.

Use Vocabulary

1. **Distinguish** between an umbra and a penumbra.

2. **Use the term** *tide* in a sentence.

Understand Key Concepts

3. **Contrast** a total lunar eclipse with a partial lunar eclipse. SC.8.E.5.9

4. Which could occur during a total solar eclipse? SC.8.E.5.9

   (A) first quarter moon
   (B) full moon
   (C) neap tide
   (D) spring tide

Interpret Graphics

5. **Conclude** What type of eclipse does the figure above illustrate? Explain your answer. SC.8.E.5.9

6. **Categorize Information** Fill in the graphic organizer below to identify two bodies that affect Earth's tides. SC.8.E.5.9

Critical Thinking

7. **Summarize** How do the Sun and the Moon affect Earth's tides?