

Phases, Eclipses, and Tides

Reading Preview

Key Concepts

- What causes the phases of the moon?
- What are solar and lunar eclipses?
- What causes the tides?

Key Terms

- phases
- eclipse
- solar eclipse
- umbra
- penumbra
- lunar eclipse
- tide
- spring tide
- neap tide

Target Reading Skill

Previewing Visuals Preview Figure 11. Then write two questions about the diagram of the phases of the moon in a graphic organizer like the one below. As you read, answer your questions.

Phases of the Moon

Q. Why does the moon have phases?

A.

Q.

Lab
zone

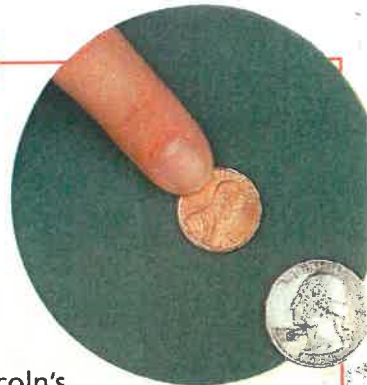
Discover Activity

How Does the Moon Move?

1. Place a quarter flat on your desk to represent Earth. Put a penny flat on your desk to represent the moon.
2. One side of the moon always faces Earth. Move the moon through one revolution around Earth, keeping Lincoln's face always looking at Earth. How many times did the penny make one complete rotation?

Think It Over

Inferring From the point of view of someone on Earth, does the moon seem to rotate? Explain your answer.



When people look up at the moon, they often see what looks like a face. Some people call this “the man in the moon.” Of course, the moon really has no face. What people are seeing is a pattern of light-colored and dark-colored areas on the moon’s surface that just happens to look like a face.

It is interesting to note that this pattern never seems to change. That is, the same side of the moon, the “near side,” always faces Earth. The “far side” of the moon always faces away from Earth, so you never see it from Earth. The reason has to do with how the moon moves in space.

Motions of the Moon

Like Earth, the moon moves through space in two ways. The moon revolves around Earth and also rotates on its own axis. It takes the moon about 27.3 days to revolve around Earth.

The moon rotates slowly on its own axis once every 27.3 days. Because the moon also revolves around Earth every 27.3 days, a “day” and a “year” on the moon are the same length. For this reason, the same side of the moon always faces Earth. As the moon revolves around Earth, the relative positions of the moon, Earth, and sun change. **The changing relative positions of the moon, Earth, and sun cause the phases of the moon, eclipses, and tides.**

The same side of the moon always faces Earth.

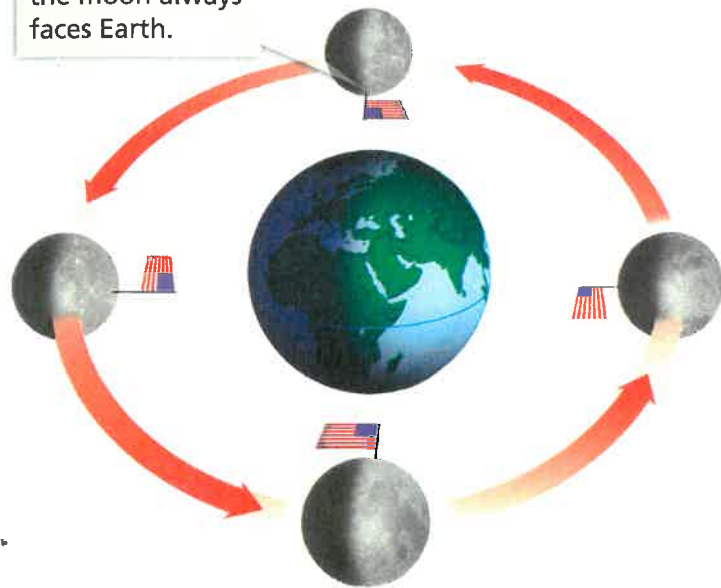


FIGURE 10

The Moon in Motion

The moon rotates on its axis and revolves around Earth in the same amount of time. As a result, the near side of the moon (shown with a flag) always faces Earth.

Interpreting Diagrams Would Earth ever appear to set below the horizon for someone standing next to the flag on the moon? Explain.

Phases of the Moon

On a clear night when the moon is full, the bright moonlight can keep you awake. But the moon does not produce the light you see. Instead, it reflects light from the sun. Imagine taking a flashlight into a dark room. If you were to shine the flashlight on a chair, you would see the chair because the light from your flashlight would bounce, or reflect, off the chair. In the same way that the chair wouldn't shine by itself, the moon doesn't give off light by itself. You can see the moon because it reflects the light of the sun.

When you see the moon in the sky, sometimes it appears round. Other times you see only a thin sliver, or crescent. The different shapes of the moon you see from Earth are called **phases**. The moon goes through its whole set of phases each time it makes a complete revolution around Earth.

Phases are caused by changes in the relative positions of the moon, Earth, and the sun. Because the sun lights the moon, half the moon is almost always in sunlight. However, since the moon revolves around Earth, you see the moon from different angles. The half of the moon that faces Earth is not always the half that is sunlit. **The phase of the moon you see depends on how much of the sunlit side of the moon faces Earth.**

The Moon Seen From Earth



1 New Moon
The sunlit side faces away from Earth.



2 Waxing Crescent
The portion of the moon you can see is waxing, or growing, into a crescent shape.



3 First Quarter
You can see half of the sunlit side of the moon.



4 Waxing Gibbous
The moon continues to wax. The visible shape of the moon is called gibbous.

View From Space

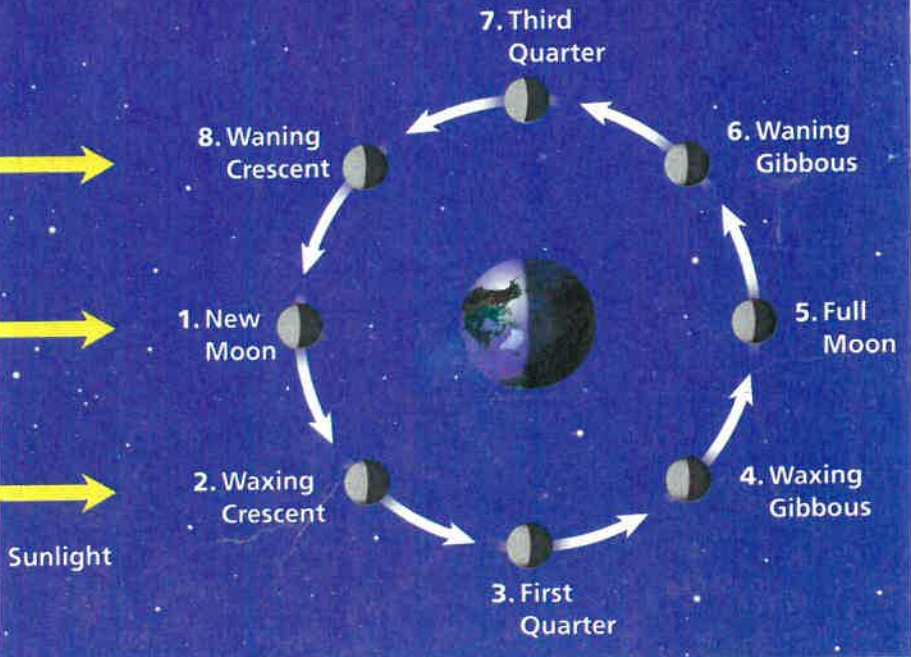


FIGURE 11

Phases of the Moon

The photos at the top of the page show how the phases of the moon appear when you look up at the moon from Earth's surface. The circular diagram at the right shows how the Earth and moon would appear to an observer in space as the moon revolves around Earth.

Interpreting Diagrams During what phases are the moon, Earth, and sun aligned in a straight line?

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5 Full Moon
The entire sunlit side faces Earth.



6 Waning Gibbous
The portion of the moon you can see wanes, or shrinks.



7 Third Quarter
You can see half of the moon's lighted side.



8 Waning Crescent
You see a crescent once again.



To understand the phases of the moon, study Figure 11. During the new moon, the side of the moon facing Earth is not lit because the sun is behind the moon. As the moon revolves around Earth, you see more and more of the lighted side of the moon every day, until the side of the moon you see is fully lit. As the moon continues in its orbit, you see less and less of the lighted side. About 29.5 days after the last new moon, the cycle is complete, and a new moon occurs again.



Reading Checkpoint

What is a new moon?

Eclipses

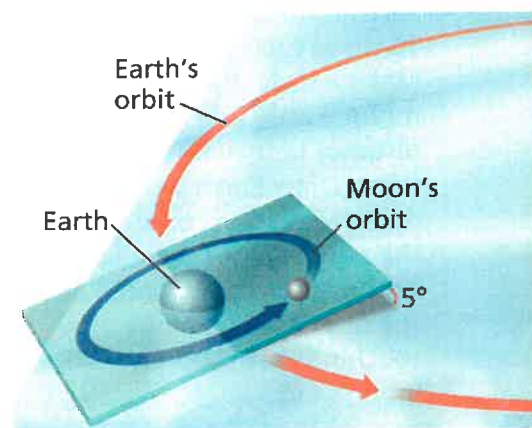
As Figure 12 shows, the moon's orbit around Earth is slightly tilted with respect to Earth's orbit around the sun. As a result, in most months the moon revolves around Earth without moving into Earth's shadow or the moon's shadow hitting Earth.

When the moon's shadow hits Earth or Earth's shadow hits the moon, an eclipse occurs. When an object in space comes between the sun and a third object, it casts a shadow on that object, causing an **eclipse** (ih KLIPS) to take place. There are two types of eclipses: solar eclipses and lunar eclipses. (The words *solar* and *lunar* come from the Latin words for "sun" and "moon.")

FIGURE 12

The Moon's Orbit

The moon's orbit is tilted about 5 degrees relative to Earth's orbit around the sun.



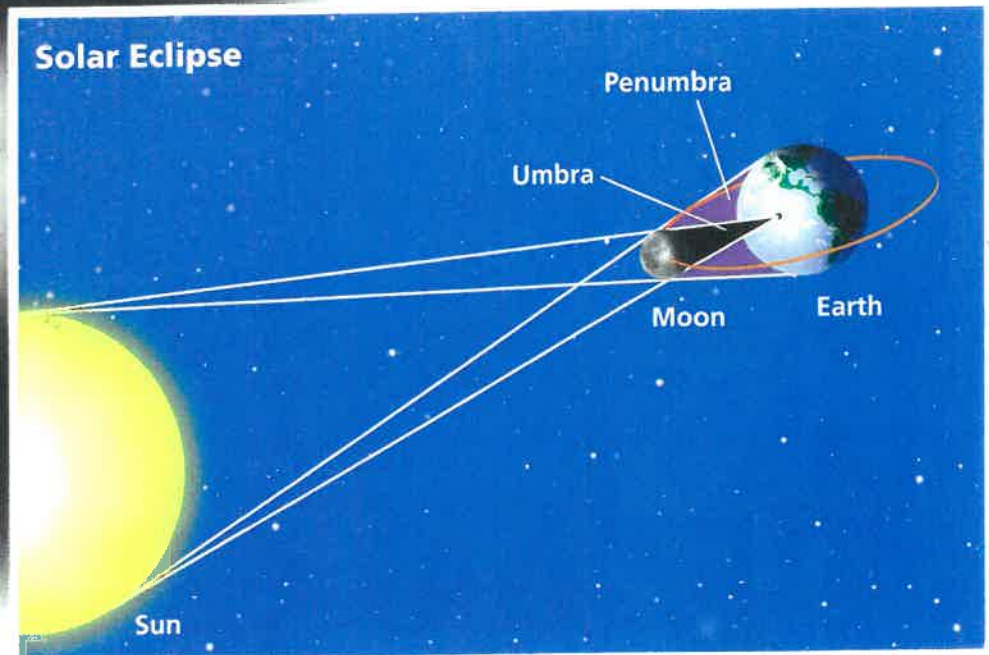


FIGURE 13

The outer layer of the sun's atmosphere, the solar corona, is visible surrounding the dark disk of the moon during a solar eclipse. During a solar eclipse, the moon blocks light from the sun, preventing sunlight from reaching parts of Earth's surface.

When Do Solar Eclipses Occur? During a new moon, the moon lies between Earth and the sun. But most months, as you have seen, the moon travels a little above or below the sun in the sky. **A solar eclipse occurs when the moon passes directly between Earth and the sun, blocking sunlight from Earth.** The moon's shadow then hits Earth, as shown in Figure 13. So a **solar eclipse** occurs when a new moon blocks your view of the sun.

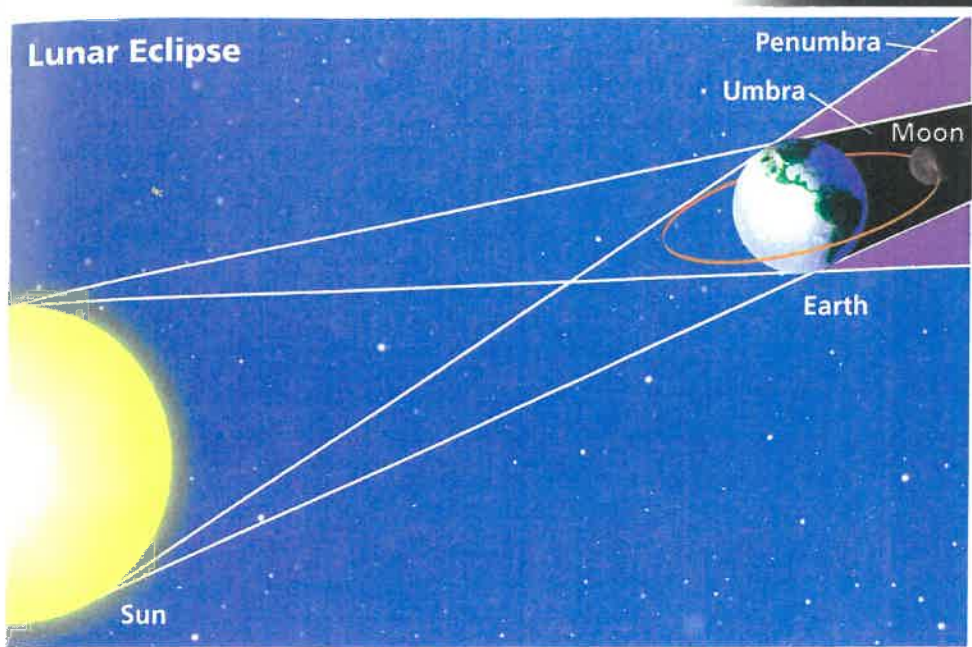
Lab zone Skills Activity

Making Models

Here is how you can draw a scale model of a solar eclipse. The moon's diameter is about one fourth Earth's diameter. The distance from Earth to the moon is about 30 times Earth's diameter. Make a scale drawing of the moon, Earth, and the distance between them. (*Hint: Draw Earth 1 cm in diameter in one corner of the paper.*) From the edges of the moon, draw and shade in a triangle just touching Earth to show the moon's umbra.

Total Solar Eclipses The very darkest part of the moon's shadow, the **umbra** (UM bruh), is cone-shaped. From any point in the umbra, light from the sun is completely blocked by the moon. The moon's umbra happens to be long enough so that the point of the cone can just reach a small part of Earth's surface. Only the people within the umbra experience a total solar eclipse. During the short period of a total solar eclipse, the sky grows as dark as night, even in the middle of a clear day. The air gets cool and the sky becomes an eerie color. You can see the stars and the solar corona, which is the faint outer atmosphere of the sun.

Partial Solar Eclipses In Figure 13, you can see that the moon casts another part of its shadow that is less dark than the umbra. This larger part of the shadow is called the **penumbra** (peh NUM bruh). In the penumbra, part of the sun is visible from Earth. During a solar eclipse, people in the penumbra see only a partial eclipse. Since an extremely bright part of the sun still remains visible, it is not safe to look directly at the sun during a partial solar eclipse (just as you wouldn't look directly at the sun during a normal day).



When Do Lunar Eclipses Occur? During most months, the moon moves near Earth's shadow but not quite into it. A **lunar eclipse** occurs at a full moon when Earth is directly between the moon and the sun. You can see a lunar eclipse in Figure 14. **During a lunar eclipse, Earth blocks sunlight from reaching the moon.** The moon is then in Earth's shadow and looks dim from Earth. Lunar eclipses occur only when there is a full moon because the moon is closest to Earth's shadow at that time.

Total Lunar Eclipses Like the moon's shadow in a solar eclipse, Earth's shadow has an umbra and a penumbra. When the moon is in Earth's umbra, you see a total lunar eclipse. You can see the edge of Earth's shadow on the moon before and after a total lunar eclipse.

Unlike a total solar eclipse, a total lunar eclipse can be seen anywhere on Earth that the moon is visible. So you are more likely to see a total lunar eclipse than a total solar eclipse.

Partial Lunar Eclipses For most lunar eclipses, Earth, the moon, and the sun are not quite in line, and only a partial lunar eclipse results. A partial lunar eclipse occurs when the moon passes partly into the umbra of Earth's shadow. The edge of the umbra appears blurry, and you can watch it pass across the moon for two or three hours.



During which phase of the moon can lunar eclipses occur?

FIGURE 14

During a lunar eclipse, Earth blocks sunlight from reaching the moon's surface. The photo of the moon above was taken during a total lunar eclipse. The moon's reddish tint occurs because Earth's atmosphere bends some sunlight toward the moon.

Interpreting Diagrams What is the difference between the umbra and the penumbra?

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High Tide



Low Tide

FIGURE 15
High and Low Tides
In some locations, such as along this beach in Australia, there can be dramatic differences between the height of high and low tides.

Tides

Have you ever built a sand castle on an ocean beach? Was it washed away by rising water? This is an example of **tides**, the rise and fall of ocean water that occurs every 12.5 hours or so. The water rises for about six hours, then falls for about six hours, in a regular cycle.

The force of gravity pulls the moon and Earth (including the water on Earth's surface) toward each other. **Tides are caused mainly by differences in how much the moon's gravity pulls on different parts of Earth.**

The Tide Cycle Look at Figure 16. The force of the moon's gravity at point A, which is closer to the moon, is stronger than the force of the moon's gravity on Earth as a whole. The water flows toward point A, and a high tide forms.

The force of the moon's gravity at point C, which is on the far side of Earth from the moon, is weaker than the force of the moon's gravity on Earth as a whole. Earth is pulled toward the moon more strongly than the water at point C, so the water is "left behind." Water flows toward point C, and a high tide occurs there too. Between points A and C, water flows away from points B and D, causing low tides.

At any one time there are two places with high tides and two places with low tides on Earth. As Earth rotates, one high tide stays on the side of Earth facing the moon. The second high tide stays on the opposite side of Earth. Each location on Earth sweeps through those two high tides and two low tides every 25 hours or so.

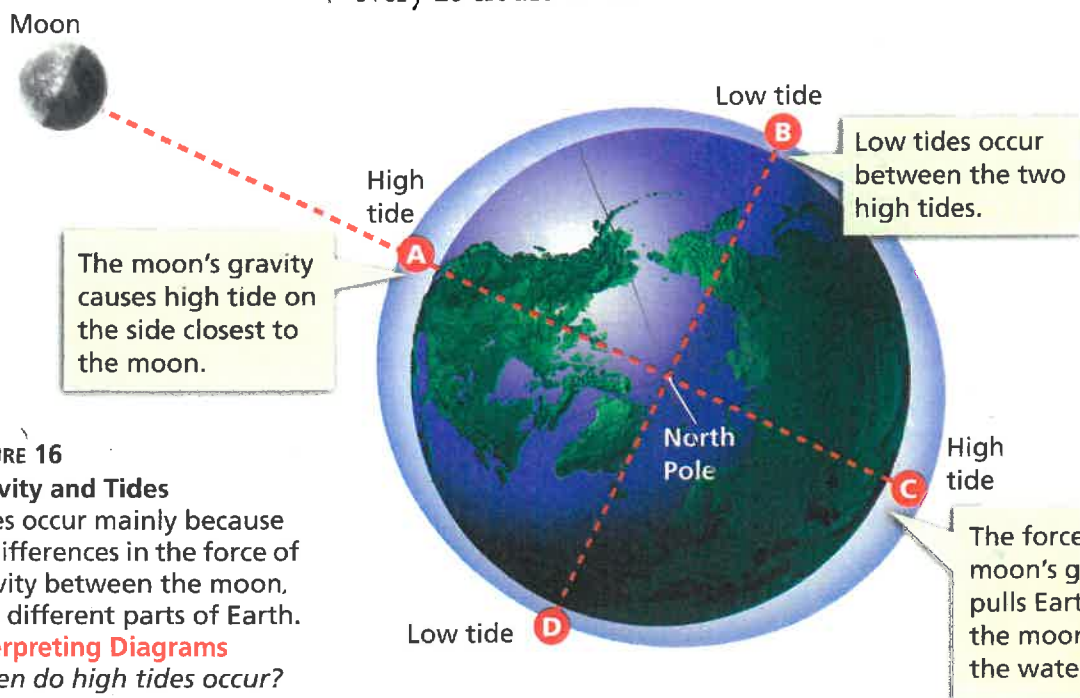


FIGURE 16
Gravity and Tides
Tides occur mainly because of differences in the force of gravity between the moon, and different parts of Earth.
Interpreting Diagrams
When do high tides occur?

Spring Tides The sun's gravity also pulls on Earth's waters. As shown in the top diagram of Figure 17, the sun, moon, and Earth are nearly in a line during a new moon. The gravity of the sun and the moon pull in the same direction. Their combined forces produce a tide with the greatest difference between consecutive low and high tides, called a **spring tide**.

At full moon, the moon and the sun are on opposite sides of Earth. Since there are high tides on both sides of Earth, a spring tide is also produced. It doesn't matter in which order the sun, Earth, and moon line up. Spring tides occur twice a month, at new moon and at full moon.

Neap Tides During the moon's first-quarter and third-quarter phases, the line between Earth and the sun is at right angles to the line between Earth and the moon. The sun's pull is at right angles to the moon's pull. This arrangement produces a **neap tide**, a tide with the least difference between consecutive low and high tides. Neap tides occur twice a month.



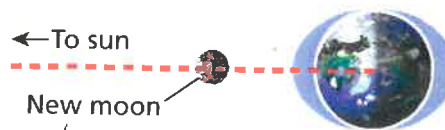
What is a neap tide?

FIGURE 17

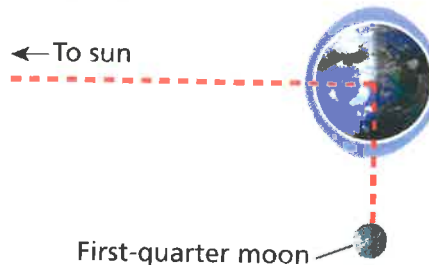
Spring and Neap Tides

When Earth, the sun, and the moon are in a straight line (top), a spring tide occurs. When the moon is at a right angle to the sun (bottom), a neap tide occurs.

Spring Tide



Neap Tide



Section **3** Assessment

Target Reading Skill Previewing Visuals Refer to your questions and answers about Figure 11 to help you answer Question 1 below.

Reviewing Key Concepts

1. a. **Explaining** What causes the moon to shine?
 b. **Relating Cause and Effect** Why does the moon appear to change shape during the course of a month?
 c. **Interpreting Diagrams** Use Figure 11 to explain why you can't see the moon at the time of a new moon.
2. a. **Explaining** What is an eclipse?
 b. **Comparing and Contrasting** How is a solar eclipse different from a lunar eclipse?
 c. **Relating Cause and Effect** Why isn't there a solar eclipse and a lunar eclipse each month?
3. a. **Summarizing** What causes the tides?
 b. **Explaining** Explain why most coastal regions have two high tides and two low tides each day.
 c. **Comparing and Contrasting** Compare the size of high and low tides in a spring tide and a neap tide. What causes the difference?



At-Home Activity

Tracking the Tides Use a daily newspaper or the Internet to track the height of high and low tides at a location of your choice for at least two weeks. Make a graph of your data, with the date as the x-axis and tide height as the y-axis. Also find the dates of the new moon and full moon and add them to your graph. Show your completed graph to a relative and explain what the graph shows.