

Earth, Moon, and Sun ▪ *Guided Reading and Study*

Phases, Eclipses, and Tides

This section explains what causes phases of the moon, what causes eclipses, and what causes the tides.

Use Target Reading Skills

Look at the Figure "Phases of the Moon" in your text. In the graphic organizer below, write a second question you have about the visuals. As you read about the moon, write the answers to both questions.

Q. Why does the moon have phases?
A.
Q.
A.

Motions of the Moon

- Circle the letter of each sentence that is true about motions of the moon.
 - The moon revolves around Earth once a year.
 - The same side of the moon always faces Earth.
 - The moon rotates slowly on its axis once every 27.3 days.
 - A "day" and a "year" on the moon are the same length.
- What causes the phases of the moon, eclipses, and tides?

Phases of the Moon

- The different shapes of the moon you see from Earth are called _____.
- How often does the moon go through an entire set of phases?

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Phases, Eclipses, and Tides *(continued)*

5. What does the phase of the moon you see depend on?

6. Complete the table to show what you see during the different phases of the moon.

Phases of the Moon	
Phase	What You See
New moon	The side of the moon facing Earth is dark.
First quarter	a.
Full moon	b.
Third quarter	c.

d. Is the near side (facing Earth) always the dark side? Use the table to explain your answer.

e. What percentage of the dark side of the moon do you see during the first and third quarters?

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Eclipses

7. When the moon's shadow hits Earth or Earth's shadow hits the moon, what occurs?

8. What are the two types of eclipses?

a. _____ b. _____

9. The darkest part of the moon's shadow is called the _____ .

10. What causes a solar eclipse?

11. The larger part of a shadow, less dark than the umbra, is called the _____ .

12. Circle the letter of each sentence that is true about solar eclipses.

- a. People in the umbra see only a partial solar eclipse.
- b. During a partial solar eclipse, part of the sun remains visible.
- c. During a total solar eclipse, the sky grows dark.
- d. People in the penumbra see a total solar eclipse.

13. What is the arrangement of Earth, the moon, and the sun during a lunar eclipse?

14. Circle the letter of each sentence that is true about lunar eclipses.

- a. People in Earth's umbra see a total lunar eclipse.
- b. A lunar eclipse always occurs at a full moon.
- c. During a lunar eclipse, Earth blocks sunlight from reaching the moon.
- d. A partial lunar eclipse occurs when the moon passes partly into the umbra of Earth's shadow.

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Phases, Eclipses, and Tides *(continued)*

Tides

15. The rise and fall of ocean water are called _____.

16. What force pulls the moon and Earth toward each other?

17. Why do tides occur?

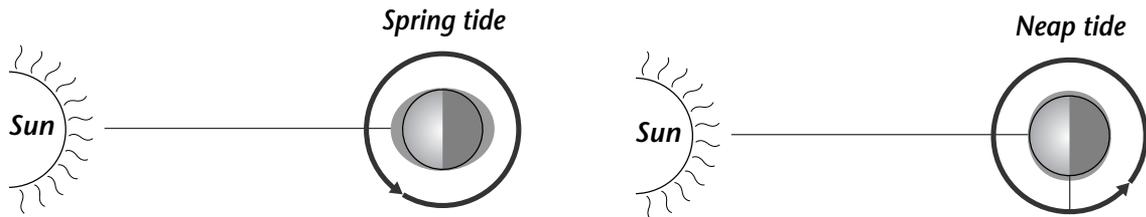
18. Circle the letter of each sentence that is true about tides.

- a. The point on Earth that is closest to the moon has a high tide.
- b. Every location on Earth has two high tides per month.
- c. A low tide occurs at the point on Earth farthest from the moon.
- d. The point on Earth farthest from the moon has a high tide.

19. What is a spring tide?

20. What is a neap tide?

21. On each of the illustrations below, draw a moon to show its position at a spring tide or at a neap tide.



22. Circle the letter of each of the phases of the moon when a spring tide occurs.

- a. new moon
- b. first quarter
- c. full moon
- d. third quarter

Earth, Moon, and Sun ▪ *Section Summary***Phases, Eclipses, and Tides****Key Concepts**

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

As the moon moves, the positions of the moon, Earth, and the sun change in relation to each other. **The changing relative positions of the moon, Earth, and the sun cause the phases of the moon, eclipses, and tides.**

The moon revolves around Earth about once every 27.3 days. It also rotates on its own axis about once every 27.3 days. The same side of the moon always faces Earth. The different shapes of the moon you see from Earth are called **phases**. **The phase of the moon you see depends on how much of the sunlit side of the moon faces Earth.**

When the moon's shadow hits Earth or Earth's shadow hits the moon, an eclipse occurs. An **eclipse** occurs when an object in space comes between the sun and a third object, and casts a shadow on that object. There are two types of eclipses: solar and lunar.

A solar eclipse occurs when the moon passes between Earth and the sun, blocking the sunlight from reaching Earth. The moon's shadow then hits Earth. So a **solar eclipse** occurs when a new moon blocks your view of the sun. The darkest part of the moon's shadow is called the **umbra**. From any part of the umbra, the moon completely blocks light from the sun. Only people in the umbra see a total solar eclipse. Another part of the shadow is less dark and larger than the umbra. It is called the **penumbra**. From within the penumbra, people see a partial eclipse because part of the sun is still visible.

A lunar eclipse occurs at a full moon when Earth is directly between the moon and the sun. **During a lunar eclipse, Earth's shadow falls on the moon.** Earth's shadow also has an umbra and a penumbra. When the moon is completely within Earth's umbra, you see a total lunar eclipse. A partial lunar eclipse happens when the moon moves partly into Earth's umbra.

Tides are the rise and fall of the ocean's water every 12.5 hours or so. The force of gravity pulls the moon and Earth toward each other. **Tides are caused mainly by differences in how much the moon pulls on different parts of Earth.** As Earth rotates, the moon's gravity pulls water toward the point on Earth's surface closest to the moon. The moon pulls least on the side of Earth farthest away. Two tides occur each day because of this difference in the pull of the moon's gravity.

Twice a month, the moon, Earth, and the sun are in a straight line. The combined forces of the gravity of the sun and moon produce an especially high tide—called a **spring tide**—and an especially low tide. Also twice a month, the pull of gravity of the sun and moon are at right angles to each other. At those times the high tide is lower than usual, and is called a **neap tide**. The low tides then are higher than usual.

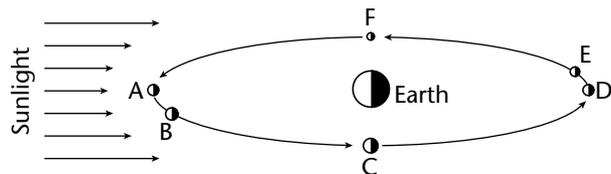
Earth, Moon, and Sun ▪ *Review and Reinforce*

Phases, Eclipses, and Tides

Understanding Main Ideas

Use the following figure to answer questions 1 and 2. Write your answers on a separate sheet of paper.

1. What phases of the moon would someone on Earth see when the moon is at positions A through F?
2. What kind of tide (spring or neap) will occur when the moon is at positions A, C, D, and F?



Building Vocabulary

From the list below, choose the term that best completes each sentence, and write it in the blank.

- | | | | | |
|-------|---------|----------|--------|-------|
| phase | gravity | penumbra | umbra | solar |
| tides | lunar | eclipse | spring | neap |

3. A(n) _____ tide occurs when the sun is at right angles to the line between Earth and the moon.
4. A(n) _____ occurs when the moon's shadow hits Earth or Earth's shadow hits the moon.
5. A person standing in the moon's _____ would see a partial solar eclipse.
6. Differences in the moon's pull on different parts of Earth cause _____.
7. A person standing in the moon's _____ would see a total solar eclipse.
8. The _____ of the moon you see depends on how much of the sunlit side of the moon faces Earth.
9. A(n) _____ tide occurs when the sun, moon, and Earth line up.
10. A(n) _____ eclipse occurs at a full moon when Earth is directly between the moon and the sun.
11. A(n) _____ eclipse occurs when the moon passes between Earth and the sun.
12. The force of _____ pulls the moon and Earth toward each other.

Earth, Moon, and Sun ▪ *Enrich*

Lunar Calendars

It is easy to see the changes in the appearance of the moon, so early peoples frequently based their calendars on the cycles of the moon. The word “month” comes from the same word as “moon.” However, the months of our solar calendar are no longer lunar months, because the Western calendar has been adjusted to become a solar calendar. Since the moon takes about 29.5 days to complete a cycle of lunar phases, 12 lunar months is about 11 days short of a solar year. In spite of this difference, many people still organize their lives by lunar calendars. Two of the world’s great religions, Judaism and Islam, keep lunar calendars.

Most Muslims recognize a 12 lunar month Islamic religious calendar for their private lives, even if they keep a different civil calendar. Originally, each lunar month began when the new moon was first sighted in the evening sky at sunset. Recently, however, many Muslims worldwide began recognizing official timekeepers in Cairo, Egypt, who announce the beginning of each month.

Unlike many other calendars, no attempt is made to keep the Islamic religious calendar synchronized with a solar calendar. So the holy month of Ramadan, a time of prayer and fasting among all Muslims, continually moves through the seasons, occurring about 11 days earlier each solar year. One year, Ramadan might be in the winter, and 16 solar years later, it would be in the summer.

The Jewish calendar has 12 or 13 lunar months. The standard year is 12 months, but an extra (or *intercalary*) month is inserted seven times during a 19-year cycle to keep the religious calendar closely aligned with the solar year. Thus, Jewish religious holidays always occur in the same season, although the exact dates vary. For example, the Jewish holiday Passover is always in spring.

Answer the following questions on a separate sheet of paper.

1. How many days are in a lunar “year” of 12 lunar months? How many days are in a solar year?
2. Not counting leap years, how many days are in 19 solar years? How many days are in 19 lunar calendar years with an extra month added in seven times? How closely does the Jewish calendar coincide with the solar calendar every 19 years?
3. Why might it be important for farmers and hunters to keep their calendar aligned with the seasons?

A “Moonth” of Phases

In this lab, you will use a model of the Earth-moon-sun system to explore how the phases of the moon occur.

Problem What causes the phases of the moon?

Materials

floor lamp with 150-watt bulb

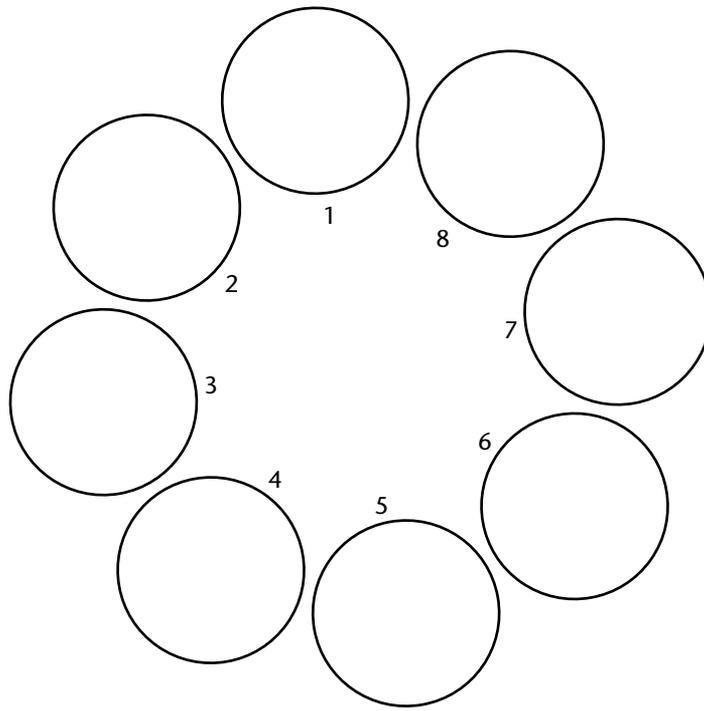
pencils

plastic foam balls

Procedure   Review the safety guidelines in Appendix A.

1. Place a lamp in the center of the room. Remove the lampshade.
2. Close the doors and shades to darken the room, and switch on the lamp.
3. Carefully stick the point of a pencil into the plastic foam ball so that the pencil can be used as a “handle.”
4. Use the Data Sheet to record your data.
5. Have your partner hold the plastic foam ball at arm’s length in front and slightly above his or her head so that the ball is between him or her and the lamp. (**CAUTION:** Do not look directly at the bulb.)
6. The ball should be about 1 to 1.5 m away from the lamp. Adjust the distance between the ball and the lamp so that the light shines brightly on the ball.
7. Stand directly behind your partner and observe what part of the ball facing you is lit by the lamp. If light is visible on the ball, draw the shape of the lighted part of the ball on the Data Sheet provided on the next page.
8. Have your partner turn 45° to the left while keeping the ball in front and at arm’s length.
9. Repeat Step 7. Be sure you are standing directly behind your partner.
10. Repeat Steps 8 and 9 six more times until your partner is facing the lamp again. See the diagram for the 8 positions.
11. Change places and repeat Steps 4–10.

Earth, Moon, and Sun ▪ Skills Lab

A “Moonth” of Phases *(continued)***Data Sheet****Analyze and Conclude**

Write your answers on a separate sheet of paper.

- 1. Making Models** In your model, what represents Earth? The sun? The moon?
- 2. Observing** Refer back to your Data Sheet. How much of the lighted part of the ball did you see when facing the lamp?
- 3. Classifying** Label your Data Sheet with the name of the phases of the moon. Which drawing represents a full moon? A new moon? Which represents a waxing crescent? A waning crescent?
- 4. Observing** How much of the lighted part of the ball did you see after each turn?
- 5. Drawing Conclusions** Whether you could see it or not, how much of the ball's surface was always lit by the lamp? Was the darkness of the new moon caused by an eclipse? Explain your answer.
- 6. Communicating** How did making a model help you understand the phases of the moon? What are some disadvantages of using models? What is another way to make a model to represent the moon's phases?

More to Explore

Design a model to show a lunar eclipse and a solar eclipse. What objects would you use for Earth, the sun, and the moon? Use the model to demonstrate why there isn't an eclipse every full moon and new moon.