

The Sun-Earth-Moon System

Eclipses and Tides

Key Concepts

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

..... Before You Read

What do you think? Read the two statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statement or a D if you disagree. After you've read this lesson, reread the statements to see if you have changed your mind.

Before	Statement	After
	5. A solar eclipse happens when Earth moves between the Moon and the Sun.	
	6. The gravitational pull of the Moon and the Sun on Earth's oceans causes tides.	

Mark the Text

Summarize As you read, underline words or phrases that summarize the information under each heading. Then, after you finish a section, reread the underlined parts to reinforce what you just read.


..... Read to Learn

Shadows—the Umbra and the Penumbra

A shadow forms when one object blocks the light that another object emits or reflects. For example, a tree blocks light from the Sun and casts a shadow. To stand in the shadow of a tree, you must place yourself with the tree in a line between you and the Sun.

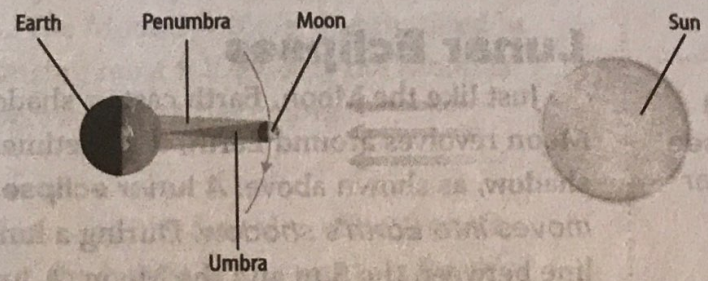
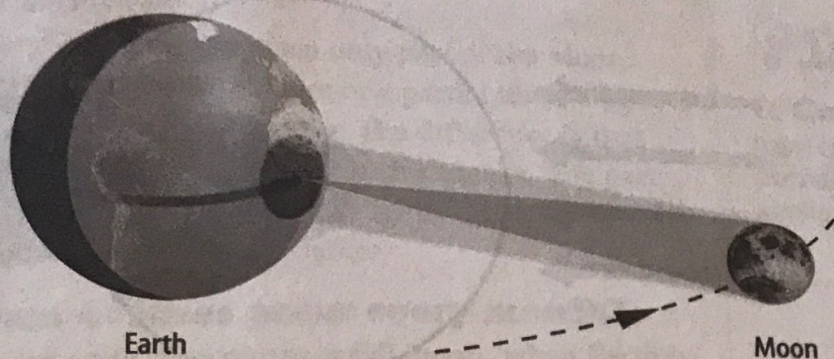
Look carefully at a shadow on the ground on a bright, sunny day. You will notice that the edges of the shadow are not as dark as the rest of the shadow. Light from the Sun and other wide light sources casts shadows with two parts. The **umbra** is the central, darker part of the shadow where light is totally blocked. The **penumbra** is the lighter part of a shadow where light is partially blocked.

Solar Eclipses

The Sun shines on the Moon. The Moon casts a shadow that extends into space. Sometimes the Moon passes between Earth and the Sun. This can happen only during the new moon phase. When Earth, the Moon, and the Sun are lined up, the Moon casts a shadow on Earth's surface. When the Moon's shadow appears on Earth's surface, a **solar eclipse** is occurring. 

Key Concept Check

1. Explain Why does a solar eclipse occur only during a new moon?



Total Solar Eclipses

The positions of Earth, the Moon, and the Sun during a solar eclipse are shown above. Look at the shadow that the Moon casts on Earth. Notice that the umbra (the darker, inner part) is much narrower than the penumbra (the lighter, outer part). 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 the eclipse at all.

You can see a total solar eclipse only if you are within the Moon's umbra. During a total solar eclipse, the Moon appears to completely cover the Sun. The sky becomes dark, and you can see stars. A total solar eclipse lasts no longer than about 7 minutes.

Partial Solar Eclipses

If you are in the Moon's penumbra, you will see a partial solar eclipse. The Moon never completely covers the Sun during a partial solar eclipse.

Why don't solar eclipses occur every month?

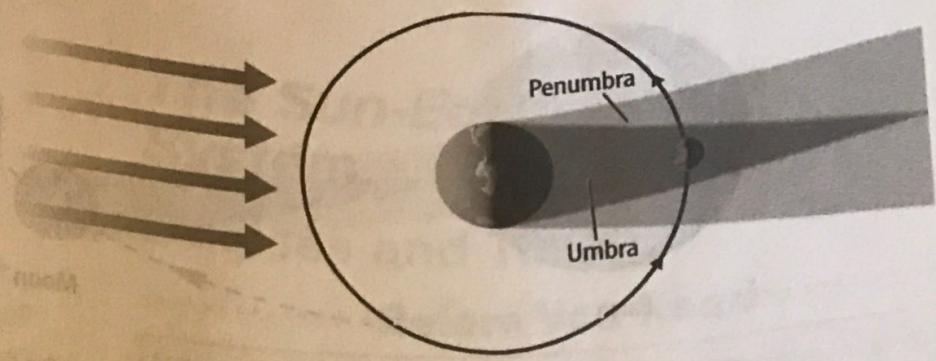
Solar eclipses occur only during the new moon phase of the lunar cycle. During a new moon, Earth and the Sun are on opposite sides of the Moon. However, solar eclipses do not occur at every new moon phase. The Moon's orbit is slightly tilted compared to Earth's orbit. During most new moons, Earth is above or below the Moon's shadow. Only when the Moon is in a line between the Sun and Earth do solar eclipses take place. ✓

Visual Check

2. Identify Why would a person in North America not see the solar eclipse shown here?

Reading Check

3. Summarize Why don't solar eclipses happen every month?



Visual Check

4. Analyze Why would more people be able to see a lunar eclipse than a solar eclipse?

Key Concept Check

5. Identify When can a lunar eclipse occur?

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 above. A **lunar eclipse** occurs when the Moon moves into Earth's shadow. During a lunar eclipse, Earth is in a line between the Sun and the Moon. A lunar eclipse can take place only during the Moon's full moon phase.

Like the Moon's shadow, Earth's shadow has an umbra and a penumbra. There are different types of lunar eclipses, depending on which part of Earth's shadow the Moon moves through. Unlike solar eclipses, all lunar eclipses can be seen from any place on Earth where it is nighttime.

Total Lunar Eclipses

When the entire Moon moves through Earth's umbra, a total lunar eclipse takes place. During a total lunar eclipse, the Moon's appearance changes slowly as it moves

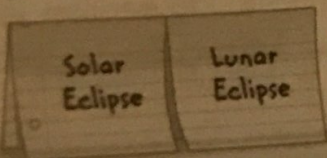
- into Earth's penumbra, then
- into Earth's umbra, then
- back into Earth's penumbra, and then
- completely out of Earth's shadow.

You can still see the Moon when it is completely in Earth's umbra. Earth blocks most of the Sun's rays. Some of the rays, however, deflect off Earth's atmosphere and into Earth's umbra. This reflected sunlight has a reddish color and gives the Moon a reddish tint during a total lunar eclipse.

The deflection of some of the Sun's rays also explains why you can see the unlit part of the Moon on a clear night. Astronomers often call this Earthshine.

FOLDABLES

Use a two-tab book to organize your notes on eclipses.



Partial Lunar Eclipses

A partial lunar eclipse happens when only part of the Moon passes through Earth's umbra. The stages of a partial lunar eclipse are similar to those of a total lunar eclipse. The difference is that the Moon is never completely covered by Earth's umbra. The part of the Moon in Earth's penumbra darkens slightly. 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, when Earth is between the Sun and the Moon. Like solar eclipses, lunar eclipses do not occur every month. The Moon's orbit is slightly tilted in relation 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. Two times each day, the height of the water in Earth's oceans, or sea level, rises and falls. *The daily rise and fall of sea level is called a tide.* Tides are caused mostly by the effect of the Moon's gravity.

The Moon's Effect on Earth's Tides

Look at the figure below. In this view, you are looking down on Earth's North Pole. The figure shows that the strength of the Moon's gravity is a little stronger on the side of Earth closer to the Moon. The strength of the Moon's gravity is slightly weaker on the side of Earth opposite the Moon. The difference in the strength of the Moon's gravity causes tidal bulges in the oceans on opposite sides of Earth. High tides occur at the tidal bulges, and low tides occur between them. Low tides occur about six hours after a high tide.

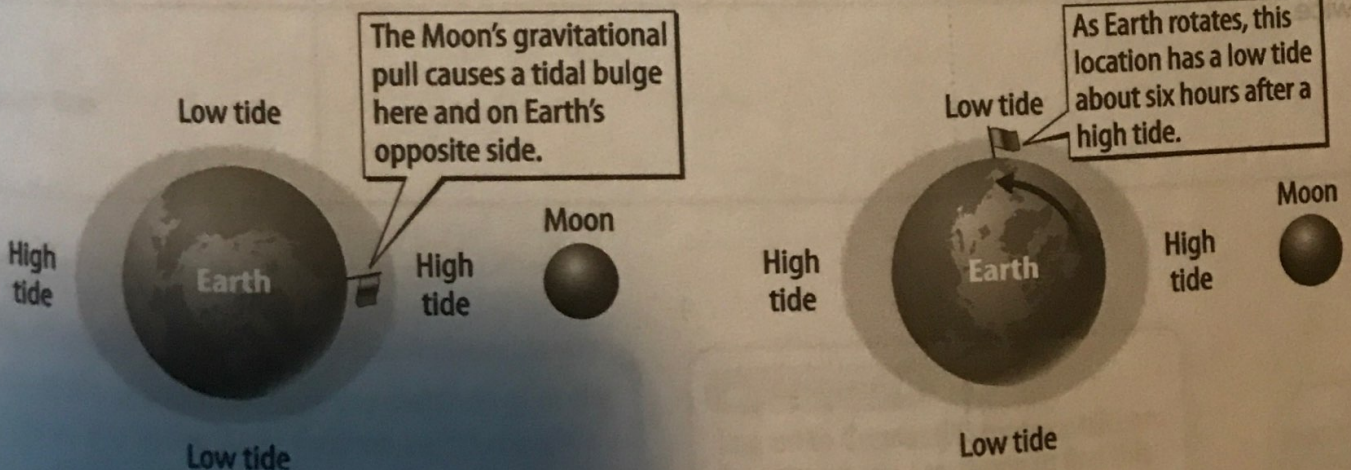
Think it Over

6. Compare How are total lunar eclipses and partial lunar eclipses similar?

Key Concept Check
8. Compare Why is the Sun's effect on tides less than the Moon's effect?

Visual Check


7. Locate Highlight the tidal bulges that represent high tides in both figures below.



The Sun's Effect on Earth's Tides

Even though the Sun is much larger than the Moon, the Sun's effect on tides is about half that of the Moon. This is because the Sun is much farther from Earth than the Moon is.

Spring Tides Spring tides do not occur only in the season of spring. Spring tides occur during the full moon and new moon phases. The Sun's and the Moon's gravitational effects combine during spring tides. As a result, high tides are higher and low tides are lower.

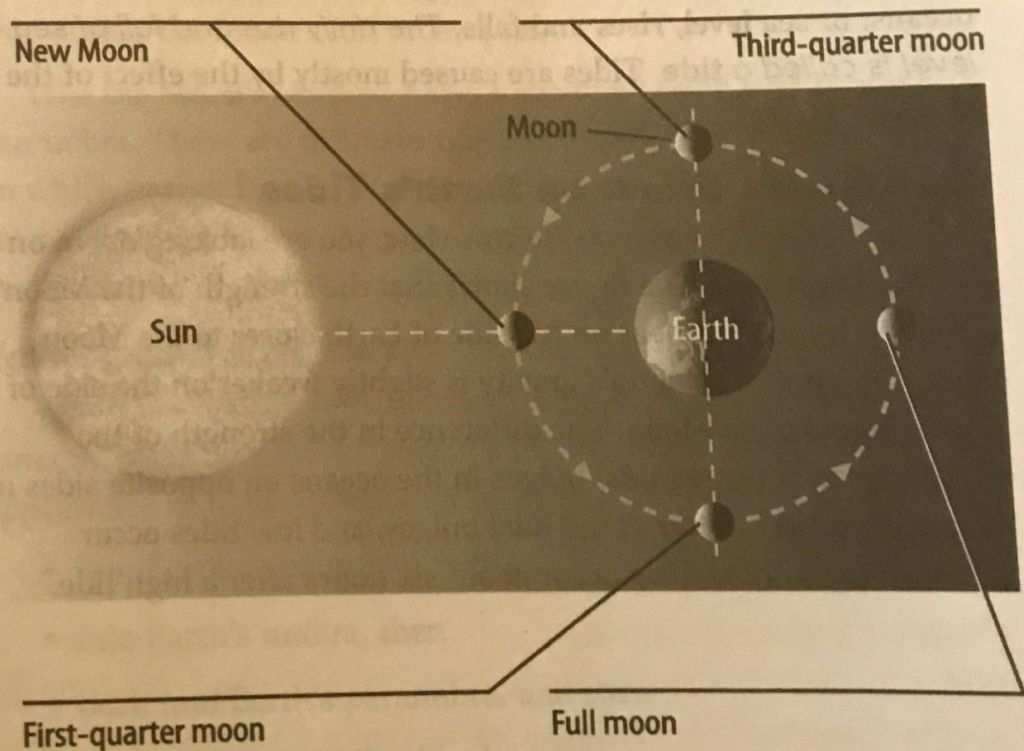
Neap Tides A neap tide occurs one week after a spring tide. The Sun, Earth, and the Moon form a right angle. The Sun's effect on tides reduces the Moon's effect. During neap tides, high tides are lower and low tides are higher. The cycle of spring tides and neap tides is shown in the figure below. 

Key Concept Check

8. Compare Why is the Sun's effect on tides less than the Moon's effect?

Visual Check

9. Label Based on the descriptions in the text, add the labels *Neap tide* and *Spring tide* to the diagram. Each label will be used twice.



After You Read

Mini Glossary

lunar eclipse: when the Moon moves into Earth's shadow

penumbra: the lighter part of a shadow where light is partially blocked

solar eclipse: when the Moon's shadow appears on Earth's surface

tide: the daily rise and fall of sea level

umbra: the central, darker part of a shadow where light is totally blocked

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that explains the difference between an umbra and a penumbra.

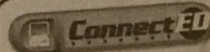
2. Draw Earth, the Sun, and the Moon to show how they are arranged during each event named in the table. For the eclipses, show the shadows that form. Label your drawings.

Event	Positions of Earth, the Sun, and the Moon
Total solar eclipse	
Total lunar eclipse	
Spring tide	
Neap tide	

What do you think

NOW?

Reread the statements at the beginning of the lesson. Fill in the After column with an A if you agree with the statement or a D if you disagree. Did you change your mind?



Log on to ConnectED.mcgraw-hill.com and access your textbook to find this lesson's resources.

END OF LESSON

Lesson 3 Eclipses and Tides

Predict three things you will learn about in Lesson 3. Look at the illustrations in the lesson to give you some clues. Write your predictions in your Science Journal.

Main Idea

Shadows—the Umbra and the Penumbra

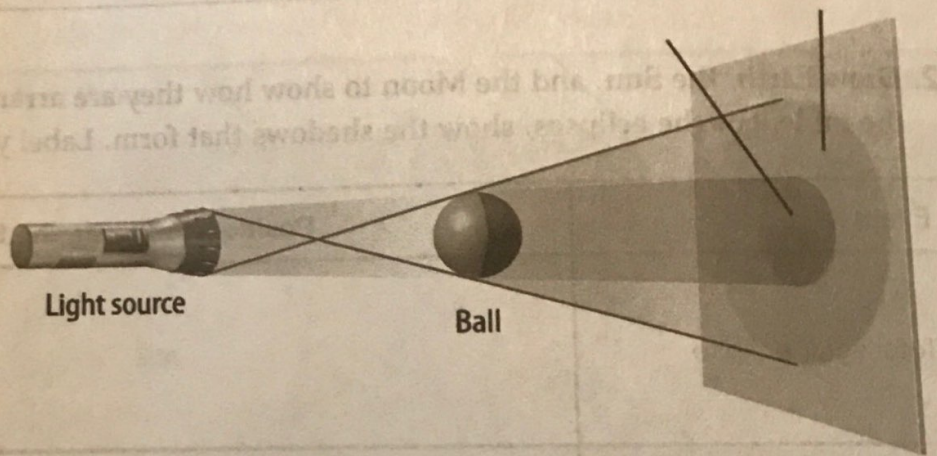
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Details

Define umbra and penumbra. Then label the umbra and the penumbra on the diagram below.

Umbra: _____

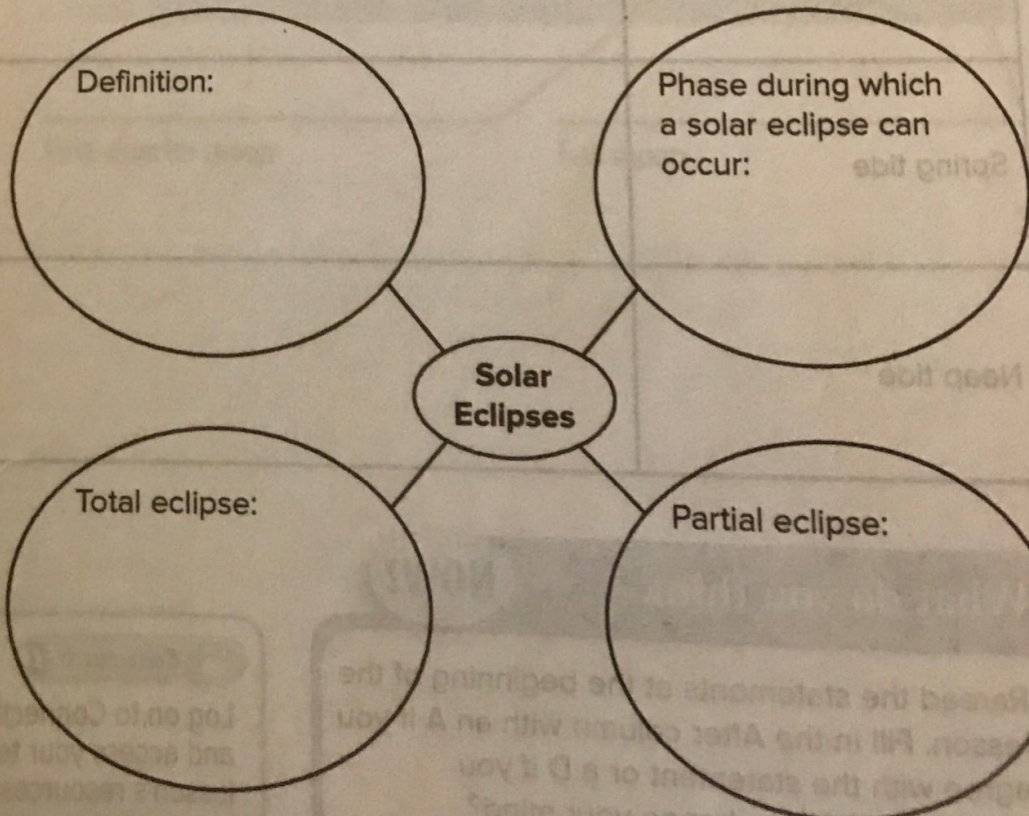
Penumbra: _____



Solar Eclipses

I found this on page _____

Compare information about solar eclipses.



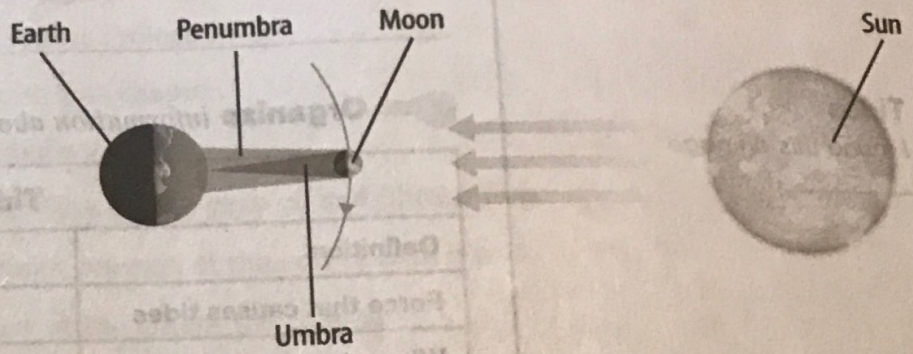
Main Idea

Details

I found this on page _____.

Label the diagram of a solar eclipse. Use these terms:

- Sun
- Moon
- penumbra
- partial solar eclipse
- Earth
- umbra
- total solar eclipse




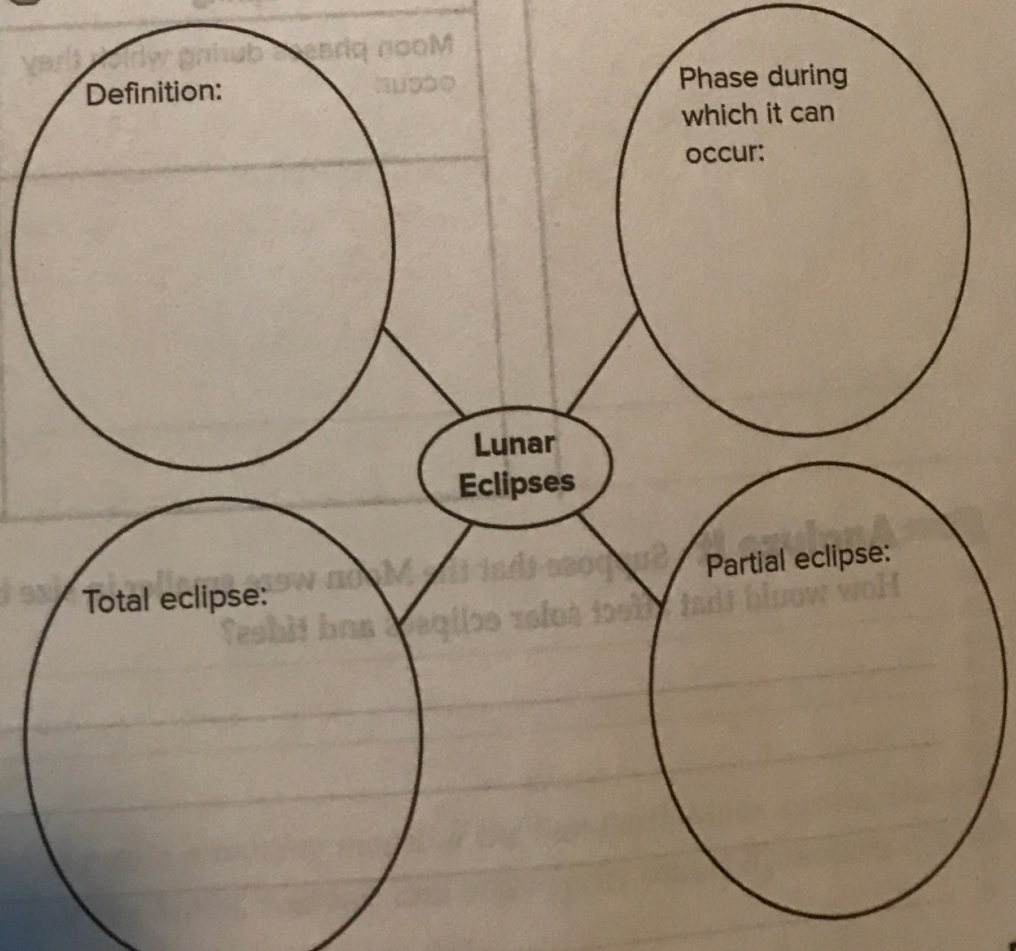
I found this on page _____.

Explain why solar eclipses do not occur every month.

Lunar Eclipses

I found this on page _____.

 Organize information about lunar eclipses.



Details

Main Idea

I found this on page _____.

Tides

I found this on page _____.

I found this on page _____.

Explain why you can still see the Moon during a total lunar eclipse.

Organize information about tides.

Tides	
Definition	
Force that causes tides	
Where low tide occurs	
Where high tide occurs	
How often high tide occurs	

Compare spring tides and neap tides. Draw the position of the Moon, the Sun, and Earth during a spring tide and a neap tide.

Types of Tides	
Spring	Neap
Moon phases during which they occur:	Moon phases during which they occur:

Analyze It Suppose that the Moon were smaller in size but greater in mass than it is now. How would that affect solar eclipses and tides?

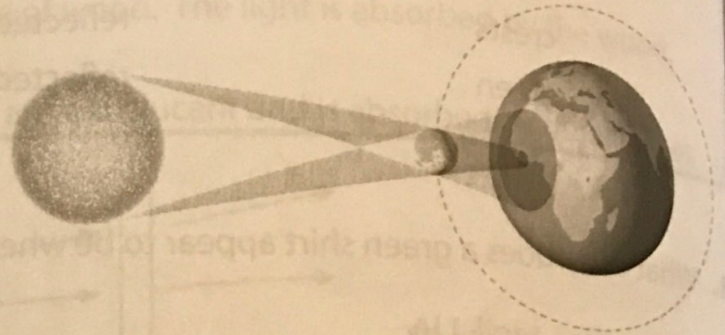
Name: _____

Date: _____

Directions: Read the text, and answer the questions.

The Sun, the Moon, and Earth

Earth orbits the sun, and the moon orbits Earth. The constant motion of Earth and the moon cause many different and amazing things. From Earth, we observe the phases of the moon, solar and lunar eclipses, and seasons. All of these things are the result of the interaction between the sun, Earth, and the moon.



You have likely witnessed the phases of the moon. Each phase is determined by how much of the moon we can see from Earth. The moon does not emit light, but it reflects it from the sun.

An eclipse happens when the sun or moon is temporarily blocked from view. Solar eclipses happen when the moon is between the sun and Earth, which blocks some of the sun's light. A lunar eclipse is when Earth is between the sun and the moon.

Earth is tilted on its axis. As Earth revolves around the sun, parts of Earth are tilted toward the sun and parts are tilted away. This causes the seasons because the part of Earth tilted toward the sun gets more intense sunlight than the parts tilted away.

1. What is a solar eclipse?

- a. When the sun changes its direction.
- b. When the moon moves between the sun and Earth.
- c. When the moon revolves around the Earth.
- d. none of the above

2. What causes Earth's seasons?

- a. lunar eclipses
- b. Earth's rotation
- c. Earth's tilt
- d. the moon

3. What determines the moon's phases?

Name: _____

Date: _____

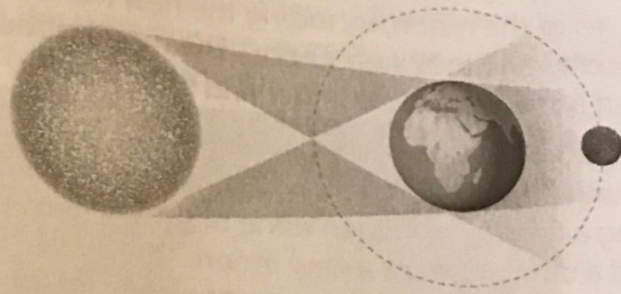
Directions: Read the text, study the diagram, and answer the questions.

There are two types of lunar eclipses.

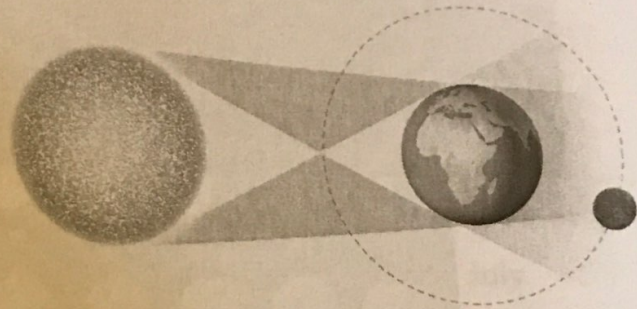
A total lunar eclipse occurs when the moon and the sun are on exact opposite sides of Earth.

A partial lunar eclipse happens when only a part of the moon enters Earth's shadow. In a partial eclipse, Earth's shadow appears very dark on the side of the moon facing Earth.

total eclipse



partial eclipse



1. What are the two types of lunar eclipses?

- a. total and partial
- b. new and waxing
- c. new and waning
- d. half and new

2. What is the position of the moon during a total lunar eclipse?

- a. on the exact opposite side of Earth
- b. next to the sun
- c. in Earth's shadow
- d. none of the above

3. Draw a possible partial lunar eclipse that is different from the diagram above.