

17-1 What causes day and night?

Objective Explain the causes of day and night.

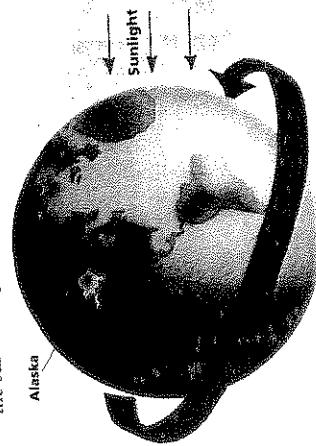
Terms

- ▶ **axis** (AK-sis): imaginary line through the center of a planet on which the planet rotates
- ▶ **revolution** (reh-vuh-LOO-shun): movement of a planet in its orbit
- ▶ **rotation** (roh-TAY-shun): spinning of a planet on its axis

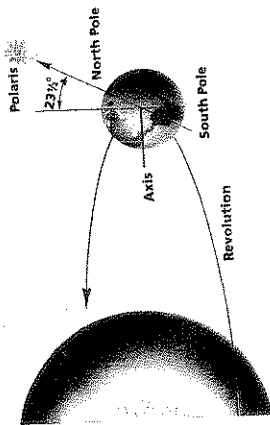
Earth's Movements Although you cannot feel it, the earth is always moving. The earth moves in an orbit around the sun. This movement is called **revolution** (reh-vuh-LOO-shun). The earth also spins on its axis (AK-sis). An axis is an imaginary line around which something spins. The earth's axis runs from the North Pole to the South Pole. The spinning of the earth on its axis is called **rotation** (roh-TAY-shun).

Identify: What are two motions of the earth?

Day and Night The earth's rotation causes day and night. The sun shines on only one side of the earth at a time. The side of the earth that faces the sun has daylight. The side that faces away from the sun has night.



Explain: What causes day and night?



Length of Day and Night You may have noticed that during the year, the number of daylight hours changes. During the summer, there are more hours of daylight than of darkness. During the winter, there are more hours of darkness than of daylight. Why do the number of daylight hours change throughout the year? The number of daylight hours changes because the earth's axis is tilted.

The earth's axis is tilted at an angle of $23 \frac{1}{2}^\circ$. As a result, the North Pole of the earth points toward Polaris. Polaris also is called the North Star. The axis always points in the same direction as the earth moves in its orbit. If the earth's axis were not tilted, all parts of the earth would always have 12 hours of daylight and 12 hours of night.

State: Why are the number of hours of daylight and darkness not the same all year?

Sunrise and Sunset When viewed from the North Pole, the earth rotates on its axis from west to east. This rotation makes the sun appear to rise, or come up, in the east and set, or go down, in the west. As the earth rotates, the sun seems to move across the sky from east to west.

Refute: In which direction does the earth rotate?

Name _____ Class _____ Date _____

17-1 What causes day and night?

Lesson Review

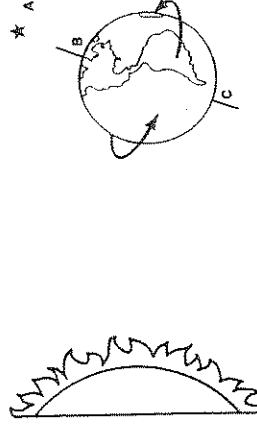
Complete the following. Write your answer in the space provided.

1. The earth moves in an _____ around the sun.
2. The movement of the earth around the sun is called _____.
3. The imaginary line through the center of the earth on which the earth spins is its _____.
4. The spinning motion of the earth is called _____.
5. Day and night are caused by the earth's _____.
6. The earth's axis is tilted at an angle of _____.
7. The earth rotates on its axis from _____.
8. The North Pole of the earth points toward _____.

Skill Challenge

Skills: identifying, applying concepts, modeling

Use the diagram to complete the following.



1. Two names for the object shown at A are _____ and _____.
2. The line that runs from points B to C is called an _____.
3. The location on the earth at point B is the _____.
4. The location on the earth at point C is the _____.
5. Shade the side of the earth that is having night.

17-2 What causes the seasons?

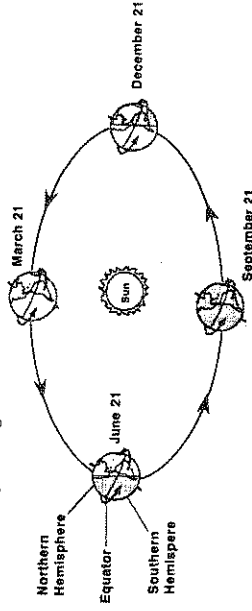
Lesson Review

Write true if the statement is true. If the statement is false, change the underlined term to make the statement true.

- The earth is closest to the sun in July. _____
- The earth is farthest from the sun in July. _____
- The Northern Hemisphere is closest to the sun in the summer. _____
- The seasons are caused by the tilt of the earth's axis. _____
- During the summer, the earth receives slanted rays from the sun. _____
- Direct rays produce more heat than slanted rays. _____
- The seasons in the Northern Hemisphere and the Southern Hemisphere are the same. _____
- During July, the Southern Hemisphere has winter. _____

Skill Challenge

Skills: Interpreting, applying concepts
Use the diagram to answer the following.

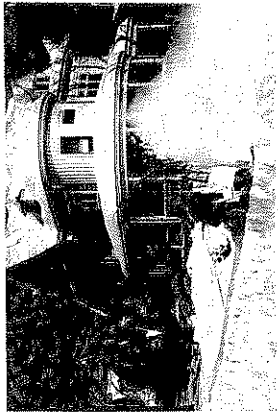


- In which direction does the earth revolve around the sun? _____
- What season is the Northern Hemisphere having on December 21? _____
 - What season is the Southern Hemisphere having? _____
- What season is the Northern Hemisphere having on March 21? _____
 - What season is the Southern Hemisphere having? _____
- Does the Northern Hemisphere receive direct or slanted rays from the sun on June 21? _____
- Does the Northern Hemisphere have more daylight hours on December 21 or June 21? _____

R-170

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17-2 What causes the seasons?



slanted. Slanted rays spread out the heat. There also are fewer daylight hours. The combination of fewer daylight hours and slanted rays cause the earth to get less heat. Temperatures drop. Lower temperatures cause winter.

Describe: What causes the change of season?

Opposite Seasons The Northern and Southern Hemispheres have opposite seasons. Look at the diagram of the earth's seasons. Notice that when the Northern Hemisphere gets slanted rays, it has winter. At the same time, the Southern Hemisphere gets direct rays and has summer. When summer comes to the Northern Hemisphere, it is winter in the Southern Hemisphere.

Name: If it is summer in the Northern Hemisphere, what season is it in the Southern Hemisphere?

Objective Explain how the tilt of the earth's axis causes the change of season.

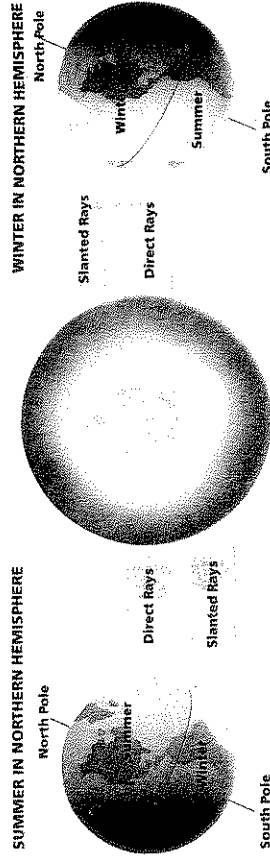
Near and Far During the year, there are differences in the distance between the earth and the sun. These differences have nothing to do with the change in seasons. The earth is closest to the sun in January. The Northern Hemisphere has winter. In July, the earth is farthest from the sun. Yet, this is when the Northern Hemisphere has summer. The seasons do not depend on the distance of the earth from the sun.

Name: During which season is the Northern Hemisphere closest to the sun?

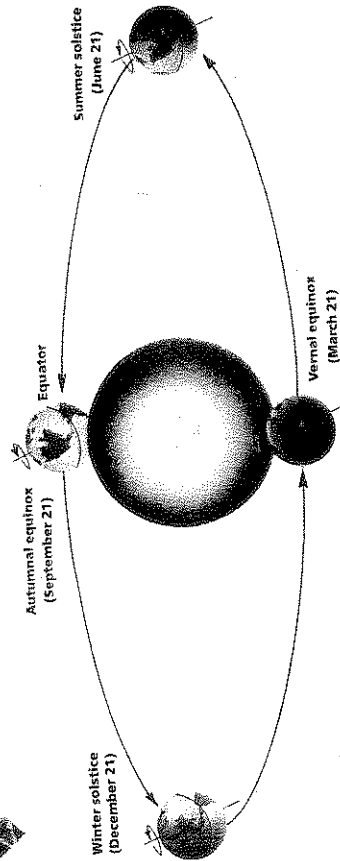
Earth's Tilt and Seasons As you know, the earth's axis is tilted. The seasons are caused by the tilt of the earth's axis. The earth's axis is tilted toward the sun for part of the year. Its axis is tilted away from the sun for the other part of the year.

The angle of the sun's rays and the number of daylight hours cause the differences in seasons. When the Northern Hemisphere is tilted toward the sun, it receives direct rays. Direct rays heat best. The Northern Hemisphere also has more hours of daylight during this time. The combination of more daylight hours and direct rays cause the earth to get more heat. The higher temperatures cause summer.

At the same time, the Southern Hemisphere is tilted away from the sun. The sun's rays are



17-3 When do the solstices and equinoxes occur?



Objective ▶ Define solstice and equinox.

TechTerms

- ▶ **equinox** (EE-kwuh-nahks): "equal night"; day on which the sun shines directly on the equator
- ▶ **solstice** (SAHL-stis): "sun stop"; day on which the North Pole points toward or away from the sun

Solstices and Equinoxes Have you ever heard the words "solstice" (SAHL-stis) and "equinox" (EE-kwuh-nahks)? If you have, you know that a solstice or an equinox is a day that marks the beginning of a season. "Solstice" means "sun stop." The word "equinox" means "equal night."

Define: What does the word "equinox" mean?

Summer Solstice In the Northern Hemisphere, the first day of summer is June 21. On this day, the North Pole points directly toward the sun. The sun seems to follow its highest path across the sky. This day is the summer solstice. On this day, the North Pole has 24 hours of daylight. At the same time, the South Pole points away from the sun. The South Pole has 24 hours of darkness.

Winter begins on this date in the Southern Hemisphere.

Identify: What day marks the first day of winter in the Southern Hemisphere?

Winter Solstice The first day of winter in the Northern Hemisphere is December 21. This day is called the winter solstice. On the winter solstice, the North Pole points away from the sun. The sun seems to follow its lowest path across the sky. On this day, the South Pole has 24 hours of daylight.

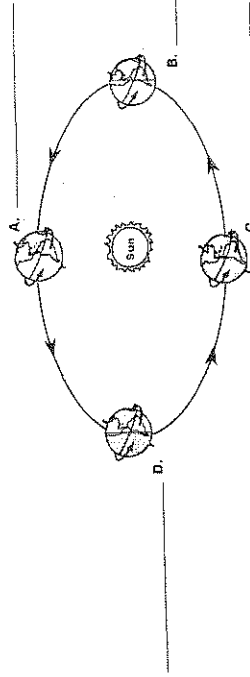
Interpret: On which day of the year does the North Pole have 24 hours of darkness?

Equinoxes On two days of the year, the sun shines directly on the equator. These days are the equinoxes. The spring, or vernal, equinox occurs on March 21. This is the first day of spring. The fall, or autumnal (aw-TUM-nul), equinox occurs on September 21. The autumnal equinox marks the first day of autumn. During an equinox, all places on the earth have 12 hours of darkness and 12 hours of daylight.

Name: On which days of the year does the North Pole have 12 hours of daylight and 12 hours of night?

Skill Challenge

Skills: *interpreting, applying concepts*
Use the diagram to complete the following.



1. The diagram shows the position of the earth in its orbit at the beginning of each season. Write the date for each position of the earth in the spaces provided.
 - _____ at point A?
 - _____ at point B?
 - _____ at point C?
 - _____ at point D?
2. What season begins when the earth is at point A?
3. What season begins when the earth is at point B?
4. At which point is the earth when the summer solstice occurs?
5. At which point is the earth when the autumnal equinox occurs?

17-4 What are time zones?

Objectives ▶ Recognize the importance of standard time zones. ▶ Identify four time zones in the United States.

TECH TERMS

- ▶ **international date line:** the boundary formed where the first and twenty-fourth time zone meet
- ▶ **solar noon:** time when the sun is highest in the sky

Solar Time The sun can be used to tell time. Using the sun to measure time is called solar time. When the sun is highest in the sky, the time is **solar noon**. Because the earth rotates, different places have solar noon at different times. For example, when it is solar noon in Philadelphia, it is 4 minutes later in New York and 17 minutes later in Boston.

Hypothesize: State a problem that is likely to arise using solar time.

Time zones In 1883, the earth was divided into 24 time zones, each 15° of longitude wide. All

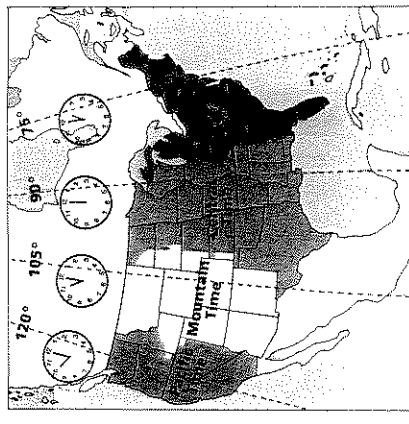


Figure 1

places within a time zone have the same time. This time is called standard time.

The United States has four time zones. These time zones are Eastern Standard Time, Central Standard Time, Mountain Standard Time, and Pacific Standard Time. All of the states in the United States, except Hawaii and Alaska, are in one of these time zones. As you move west, the time in each zone is one hour earlier than in the previous time zone. As a result, when it is noon in New York, it is 11:00 AM in Chicago.

Look at the map of the time zones shown in Figure 1. Notice that time zones do not have straight boundaries. The boundaries were drawn this way to keep whole states or large neighboring cities in the same time zone.

California: If it is 12:00 noon in California, what time is it in Virginia?

International Date Line There are 24 standard time zones and 24 hours in a day. The first time zone is on one side of the **international date line**. The twenty-fourth time zone is on the other side of the international date line. As you cross the international date line, you either gain or lose 24 hours. If you were to travel west, you would have to move your calendar ahead one full day when you crossed the international date line.

Infer: What happens to the date if you cross the international date line going east?

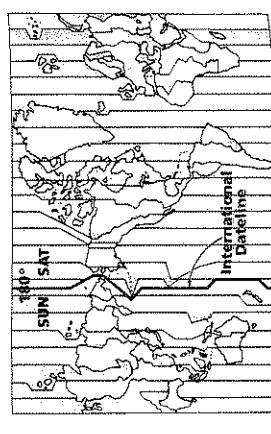


Figure 2

Name _____ Class _____ Date _____

17-4 What are time zones?

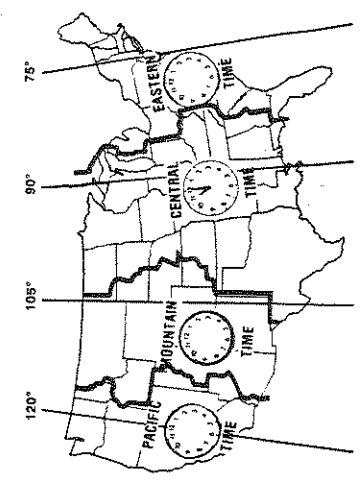
Lesson Review

Answer the following questions. Write your answers in the spaces provided.

1. How many time zones are there in the continental United States? _____
2. What are the names of the time zones? _____
3. How many standard time zones are there? _____
4. Why do the time zones not have straight boundaries? _____
5. What time of day is it when the sun is highest in the sky? _____
6. Where is the international date line located? _____

Skill Challenge

Skills: interpreting diagrams, applying concepts, calculating
Use the diagram to complete the following.



1. Draw hands on each clock to show the time when it is 11:00 in the Central time zone.
2. How many degrees of longitude are there between one time zone and the next? _____
3. a. In which time zone is most of Texas located? _____
b. California? _____
c. Florida? _____
d. Maine? _____
4. In which time zone do you live? _____
5. What happens as you move from one time zone to the next traveling from the west to the east? _____

17-5 What are the motions of the earth's moon?

Objective Describe and identify two motions of the earth's moon.

TechTerms

- ▶ **apogee** (AP-uh-jee): point at which the moon is farthest from the earth
- ▶ **perigee** (PER-uh-jee): point at which the moon is closest to the earth

Rotation and Revolution Like the earth, the moon rotates on an axis. The moon rotates very slowly. In fact, it takes the moon 27 1/3 days to rotate once on its axis.

The moon also revolves around the earth. The moon revolves around the earth at a speed of 3500 km/h. The moon takes 27 1/3 days to make one complete revolution around the earth. This is the same time that it takes the moon to make one rotation on its axis. As a result, the same side of the moon is always facing the earth.

Calculate: How many km does the moon travel in one day?

Apogee and Perigee The moon's orbit around the earth is shown in Figure 1. When the moon is farthest from the earth, it is at **apogee** (AP-uh-

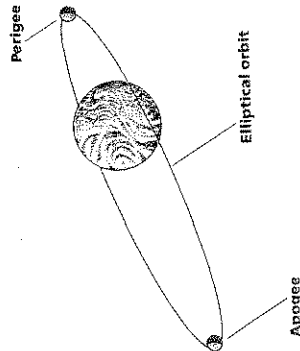


Figure 1

jee). The distance from the moon to the earth at apogee is 409,000 km. When the moon is closest to the earth, it is at **perigee** (PER-uh-jee). At perigee, the distance from the moon to the earth is 365,000 km.

Calculate: How much farther from the earth is the moon at apogee than at perigee?

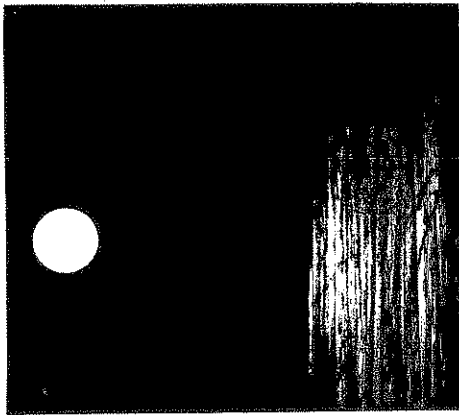


Figure 2

Moon Rise The earth's rotation brings the moon into view every day. Like the sun, the moon appears to rise in the east and set in the west. The moon rises and sets a little later each day. Suppose you saw the moon rise at 9:00 PM on Wednesday. On Thursday, you would see the moon rise at 9:50 PM. As the moon revolves around the earth, the earth must go through more than one rotation "catch up" with the moon. The earth must rotate 24 hours and 50 minutes to bring the moon back into view. As a result, the moon rises 50 minutes later each day.

Explain: Why does the moon rise 50 minutes later each day?

17-5 What are the motions of the earth's moon?

Lesson Review

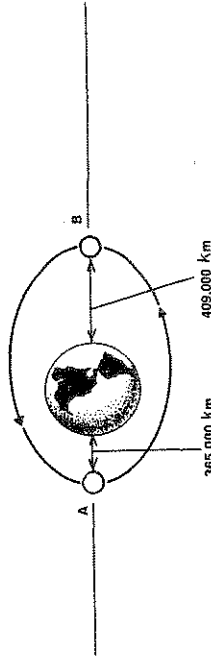
Complete the following.

1. When the moon is closest to the earth it is at _____.
2. When the moon is farthest from the earth it is at _____.
3. The moon takes _____ days to make one complete revolution around the earth.
4. The moon takes _____ to rotate once on its axis.
5. From earth, the moon appears to rise in the _____.
6. The moon appears to set in the _____.
7. The moon rises and sets _____ later each day.
8. Why does the same side of the moon always face the earth? _____

Skill Challenge

Skills: identifying, calculating, applying concepts

Use the diagram to complete the following.



1. The diagram shows the distance of the moon from the earth at apogee and at perigee. Label each of these positions on the diagram in the space provided.
2. What is the distance of the moon from the earth at apogee? _____
3. What is the distance of the moon from the earth at perigee? _____
4. How much closer to the earth is the moon at perigee than at apogee? _____
5. How much time does it take the moon to go from apogee to apogee? _____

17-8 What are the phases of the moon?

Objective Recognize and identify the different phases of the moon.

Tech Terms

- ▷ **crescent** (KRES-ent) phase: phase when less than half the moon is visible
- ▷ **gibbous** (GIB-us) phase: phase when more than half the moon is visible
- ▷ **phases** (FAYZ-uz): changing shapes of the moon

Phases of the Moon From the earth, the moon sometimes looks round. At other times, the moon looks like a thin sliver. Why does the moon appear to change shape? The moon appears to change shape because of the way it reflects light from the sun. The changing shapes of the moon are called **phases** (FAYZ-uz). The phases of the moon depend upon the positions of the sun, the moon, and the earth.

Activity What causes the moon to appear to change shape?

Waxing Phases Look at the picture of the phases of the moon. When the side of the moon facing the earth is dark, it appears as if there is no moon at all. This is called a new moon. As the moon revolves around the earth, a small part of the moon becomes visible. As the part of the moon that is visible increases, the moon is waxing. The

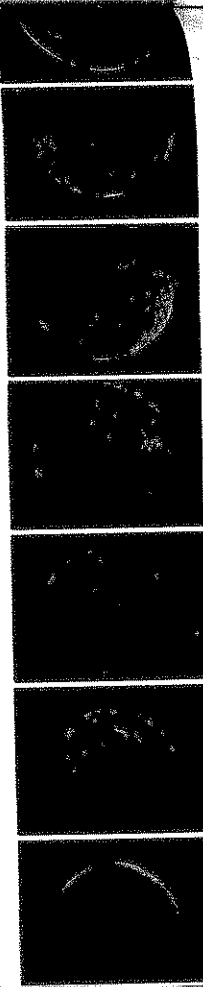
first phase is called the waxing **crescent** (KRES-ent) **phase**. During the crescent phase, less than half of the moon is visible. When the moon has moved one-quarter of the way around the earth, it enters the first-quarter phase. At the first-quarter phase, one-half of the side of the moon facing the earth is visible.

As the moon continues in its orbit, more and more of the side facing the earth becomes visible. This is called the waxing **gibbous** (GIB-us) **phase**. During the gibbous phase, more than half of the moon is visible. Finally, the moon completes half of its trip around the earth. The whole surface facing the earth is visible. This is the full moon.

Define What is the gibbous phase of the moon?

Waning Phases As the moon continues to move around the earth, less and less of the surface is visible. As the visible part of the moon decreases, the moon is waning (WAYN-ing). After the full moon, the moon enters the waning gibbous phase. At the last-quarter phase, only half of the moon's surface facing the earth is visible. The last phase of the moon is the waning crescent phase. The moon takes 29 1/2 days to go through all of its phases. This is a little longer than the time for one revolution of the moon around the earth.

Compare When do the waxing and waning crescent phases of the moon take place?



17-6 What are the phases of the earth's moon?

Lesson Review

Match each term in Column B with its description in Column A. Write the correct letter in the space provided.

Column A

1. changing shapes of the moon
2. phase when less than half of the moon is visible from the earth
3. phase when more than half of the moon is visible from the earth
4. part of the moon that is visible increases
5. part of the moon that is visible decreases
6. whole face of the moon is visible

Column B

- a. waning moon
- b. phases
- c. gibbous phase
- d. crescent phase
- e. waxing moon
- f. full moon

Skill Challenge

Skills: identifying, sequencing

In the spaces provided, identify the phase of the moon shown in each drawing. Then, place the phases in the correct order by writing the number of each drawing in the space provided. Begin with the new moon phase.



1. _____ 2. _____ 3. _____ 4. _____



5. _____ 6. _____ 7. _____ 8. _____

9. The correct sequence is: _____

How does an eclipse of the moon occur?

Objectives ▶ Describe a lunar eclipse. ▶ Distinguish between a total and partial lunar eclipse.

TechTerms

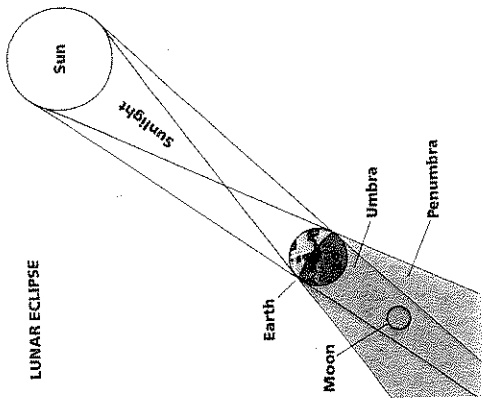
- ▶ **lunar eclipse** (uh-CLIPS): passing of the moon through the earth's shadow
- ▶ **penumbra** (peb-NUM-bruh): light part of a shadow
- ▶ **umbra** (UM-bruh): dark part of a shadow

Shadows When you walk outside on a sunny day, you can see your shadow. A shadow is formed when an object blocks a light source. A shadow has two parts. The center of a shadow is very dark. The dark part of a shadow is called the **umbra** (UM-bruh). Around the outside of a shadow, you will see a lighter part. The light part of a shadow is called the **penumbra** (peb-NUM-bruh). People and objects are not the only things that can cast shadows. The earth, the moon, and other bodies in space also cast shadows.

Identify: What are the two parts of a shadow?

Eclipse of the Moon As the moon revolves around the earth, it usually passes above or below the earth's shadow. Sometimes the moon passes directly through the earth's shadow. As a result, sunlight is blocked from reaching the moon. When sunlight is blocked from the moon, a **lunar eclipse** (uh-CLIPS) occurs. A lunar eclipse can occur only during the full-moon phase.

Define: What is a lunar eclipse?



Total or Partial Eclipses Sometimes the moon moves entirely into the earth's umbra. When this happens, all of the sun's light is blocked. The entire face of the moon darkens. This is called a total lunar eclipse. Total lunar eclipses are rare.

Sometimes only part of the moon moves into the earth's umbra. Sunlight can still reach the moon. As a result, only part of the moon darkens. This is called a partial lunar eclipse. A partial lunar eclipse is hard to see.

Describe: What does the moon look like during a total lunar eclipse?

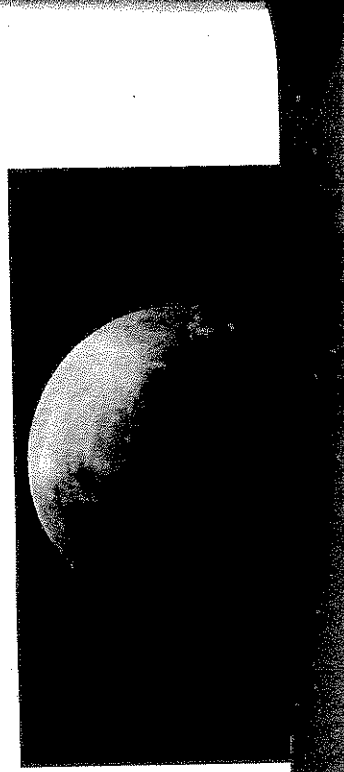


Figure 1

17-7 How does an eclipse of the moon occur?

Lesson Review

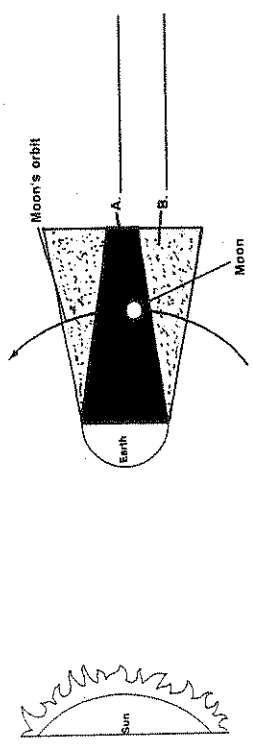
Part A Match each term in Column B with its description in Column A. Write the correct letter in the space provided.

	Column A	Column B
_____	1. formed when an object blocks a light source	a. lunar eclipse
_____	2. dark part of a shadow	b. penumbra
_____	3. passing of the moon through the earth's shadow	c. umbra
_____	4. occurs when the entire face of the moon darkens	d. shadow
_____	5. light part of a shadow	e. total lunar eclipse

Skill Challenge

Skills: identifying, analyzing

Use the diagram to complete the following.



1. Label the earth's umbra and penumbra on the diagram.
2. What is shown in the diagram?
3. What happens when the moon passes entirely into the earth's umbra?
4. What happens if only part of the moon moves into the earth's umbra?
5. What phase must the moon be in for a lunar eclipse to occur?

17-8 How does an eclipse of the sun occur?

Objective ▶ Explain how a solar eclipse occurs.

Tech term

▶ **solar (SOH-ler) eclipse:** passing of the moon between the earth and the sun

Solar Eclipses An eclipse of the sun is called a **solar (SOH-ler) eclipse**. A solar eclipse occurs when the moon passes directly between the earth and the sun. During a solar eclipse, the moon casts a shadow on the earth. Figure 1 shows a solar eclipse. During a solar eclipse the sun looks like it is covered by a black circle. This circle is the moon.

Define: What is a solar eclipse?

Kinds of Solar Eclipses Like lunar eclipses, solar eclipses can be either total or partial. A total solar eclipse occurs when the entire face of the sun is blocked by the moon. A partial solar eclipse happens when only part of the sun's face is blocked.

Describe: When does a total solar eclipse happen?

Viewing Solar Eclipses Look at Figure 2. When the moon's umbra touches the earth, people within the umbra see a total solar eclipse. The umbra of the moon is very small. Therefore, a total solar eclipse is visible from only a small area of the

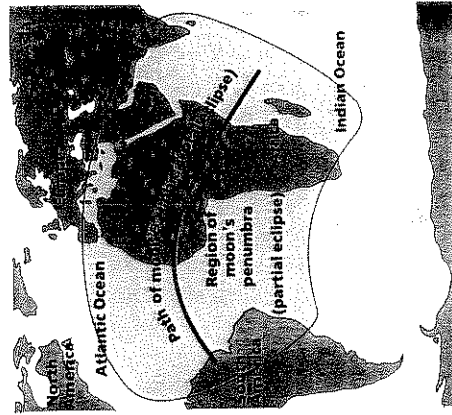


Figure 2

earth. People who are in the moon's penumbra see a partial solar eclipse.

The penumbra of the moon's shadow is much larger than the umbra. As a result, a partial eclipse can be seen over a larger area of the earth than a total eclipse. Partial solar eclipses are seen more often than total eclipses.

Identify: Which kind of solar eclipse is seen more often?

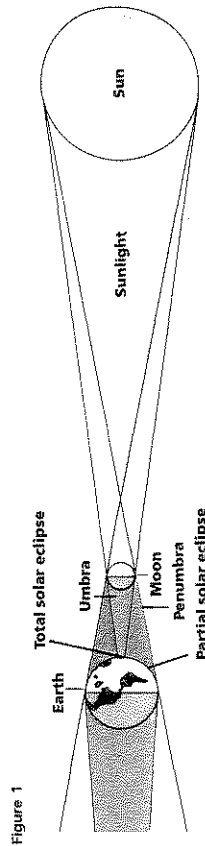


Figure 1

SOLAR ECLIPSE

Name _____ Class _____ Date _____

17-8 How does an eclipse of the sun occur?

Lesson Review

Write true if the statement is true. If the statement is false, change the underlined term to make the statement true. Write your answer in the space provided.

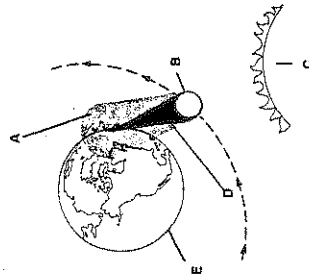
1. An eclipse of the sun is called a lunar eclipse. _____
2. A solar eclipse occurs when the moon passes directly between the earth and the sun. _____
3. During a solar eclipse, the moon looks like it is covered by a black circle. _____
4. A partial solar eclipse occurs when only part of the sun's face is blocked. _____
5. A partial solar eclipse occurs when the entire face of the sun is blocked. _____
6. When the moon's umbra touches the earth, people within the umbra see a partial solar eclipse. _____
7. When the moon's penumbra touches the earth, people within the penumbra see a total solar eclipse. _____
8. A partial solar eclipse can be seen over a larger area of the earth than a total solar eclipse. _____

Skill Challenge

Skill: identifying

Use the labels in the box to identify each of the lettered parts of the drawing. Write your labels in the spaces provided.

LABELS
sun
moon
Earth
umbra
penumbra



- A _____
- B _____
- C _____
- D _____
- E _____

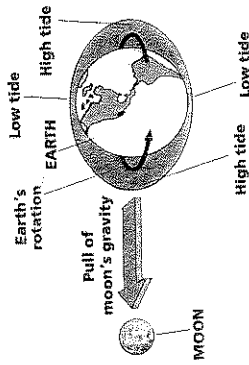
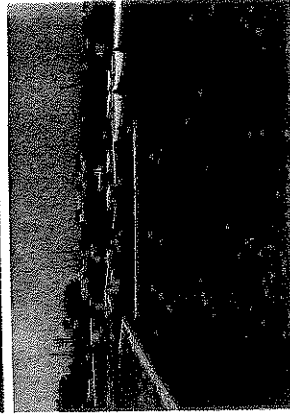
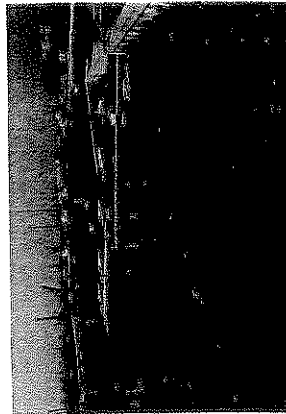
17-9 What are tides?

Objectives Describe how tides change each day. Identify the cause of tides.

Key Terms

- ▶ **ebb tide:** outgoing, or falling tide
- ▶ **flood tide:** incoming, or rising tide
- ▶ **tidal range:** daily change in the level of the ocean's surface

Tides Have you ever been at the beach and noticed a change in the ocean level? The water level of the ocean rises and falls throughout the day. During the day, ocean water rises and covers part of the beach. Later, the ocean level falls. The beach is uncovered. The changes in ocean water level are called **tides**. The time of low water level is low tide. The time of high water level is high tide.



Define: What are tides?

Cause of Tides Tides are caused mainly by the pull of the moon's gravity. Gravity is a force. The moon's gravitational force pulls water in the oceans toward the moon. The side of the earth facing the moon will have a high tide. The ocean water on that side bulges toward the moon. There is also a high tide on the opposite side of the earth, facing away from the moon. Low tides occur in the areas of the earth between the two high tides.

Identify: What causes tides on the earth?

Changing Tides Newspapers sometimes print tide tables. A tide table tells the times at which high tide and low tide will occur. If you look at a tide table, you will notice that the table shows two high tides and two low tides each day. The tides change about every 6 hours and 15 minutes.

Each quarter rotation of the earth causes a major change in tides. Water floods the beach slowly until high tide is reached. The incoming tide is a **flood tide**. As the earth rotates another quarter turn, the water begins to flow off the beach until low tide is reached. The outgoing tide is an **ebb tide**.

Relate: How many times a day does a flood tide occur?

17-9 What are tides?

Lesson Review

Part A Match each term in Column B with its description in Column A. Write the correct letter in the space provided.

Column A

1. force that causes a change in tides _____
2. incoming, or rising tide _____
3. outgoing, or falling tide _____
4. daily change in the level of the earth's oceans _____
5. period of low water level _____
6. period of high water level _____

Column B

- a. tide _____
- b. low tide _____
- c. high tide _____
- d. ebb tide _____
- e. flood tide _____
- f. gravity _____

Part B Complete the following.

1. About how often do the tides change? _____
2. a. How many low tides occur each day? _____ b. How many high tides occur each day? _____
3. How does the change in tides relate to the rotation of the moon? _____
4. a. How many times each day does a flood tide occur? _____ b. An ebb tide? _____

Skill Challenge

Skills: analyzing, calculating, applying concepts, predicting

Use the tide table to answer the questions.

Tide Table for July 10	
Low Tide	6:00 am
High Tide	12:15 pm
Low Tide	6:30 pm
High Tide	12:45 am

1. At what time on July 10 will the first low tide occur? _____
2. Shellfishers usually fish during lower tide. At what times on July 10 will shellfishing be best? _____
3. What is the difference in time between one low tide and the next? _____
4. Fishing usually is best during times of high water level. When will fishing probably be best on July 10? _____
5. What time will the first low tide occur on July 11? _____

17-10 Why do tides change?

Objective Explain the effects of the sun's gravity and the moon's gravity on tides.

Terms

- neap (NEEP) tide:** tide that is not as high or as low as normal tides
- spring tide:** tide that is higher and lower than normal tides

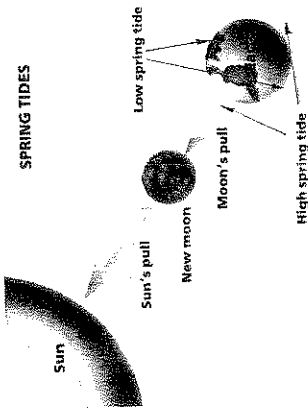
The Law of Gravity The British scientist Isaac Newton first stated the law of gravity in the seventeenth century. The law of gravity states that every object in the universe attracts every other object. The attraction between any two objects depends in part on the distance between them. If the objects are close together, the attraction is strong. If the objects are far apart, the attraction is weak.

State: What is the law of gravity?

Gravity and Tides The sun and the moon both attract the earth. The moon is much closer to the earth than the sun is. Therefore, the moon's gravitational pull on the earth is stronger than the sun's gravitational pull. As a result, the moon's gravitational pull is the main cause of tides on the earth.

State: Why does the moon have a greater gravitational pull on the earth than the sun?

Spring Tides Twice a month, the earth, the sun, and the moon line up in a straight line. This occurs during the new moon and the full moon phases. During these phases, the gravitational pulls of the sun and the moon on the earth combine. When these forces combine, high tides are higher than normal high tides. Low tides are lower than normal low tides. When tides are higher and lower than normal tides, they are called **spring tides**.

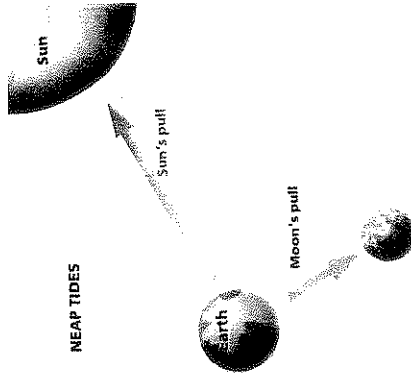


SPRING TIDES

Describe: When do spring tides occur?

Neap Tides During the moon's first- and last-quarter phases, the sun and the moon are at right angles to the earth. The gravitational pull of the moon works against the gravitational pull of the sun. These opposing pulls on the earth cause high tides that are not as high as usual. Low tides at these times are not as low as usual. Tides that are not as high as usual or as low as usual are called **neap (NEEP) tides**.

Identify: What causes a neap tide?



NEAP TIDES

17-10 Why do tides change?

Lesson Review

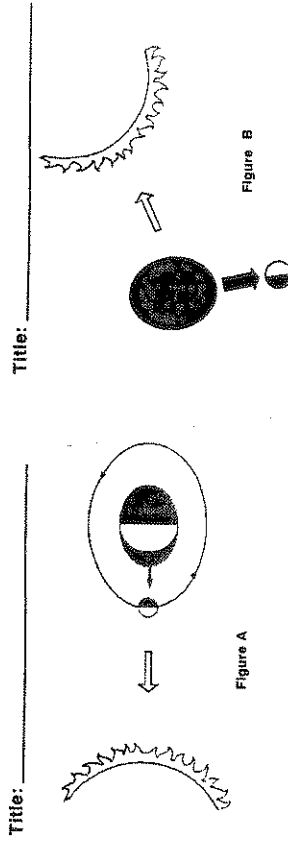
Complete the following.

- Who first stated the law of gravity? _____
- What does the law of gravity state? _____
- How does distance affect the gravitational pull between objects? _____
- What is a neap tide? _____
- What is a spring tide? _____
- Why is the moon's gravitational pull on the earth stronger than the sun's? _____
- What causes tides? _____
- During what phases of the moon do spring tides occur? _____
- During what phases of the moon do neap tides occur? _____
- How many times per month do neap tides and spring tides occur? _____

Skill Challenge

Skills: analyzing, identifying, modeling
Use the diagrams to complete the following.

- The diagrams show the positions of the earth, sun, and moon during neap tides and flood tides. Add the titles **Neap Tides** and **Spring Tides** to the proper diagram in the space provided.



Title: _____ Title: _____

Figure A

Figure B

- Label the sun, Earth, and moon in each diagram.