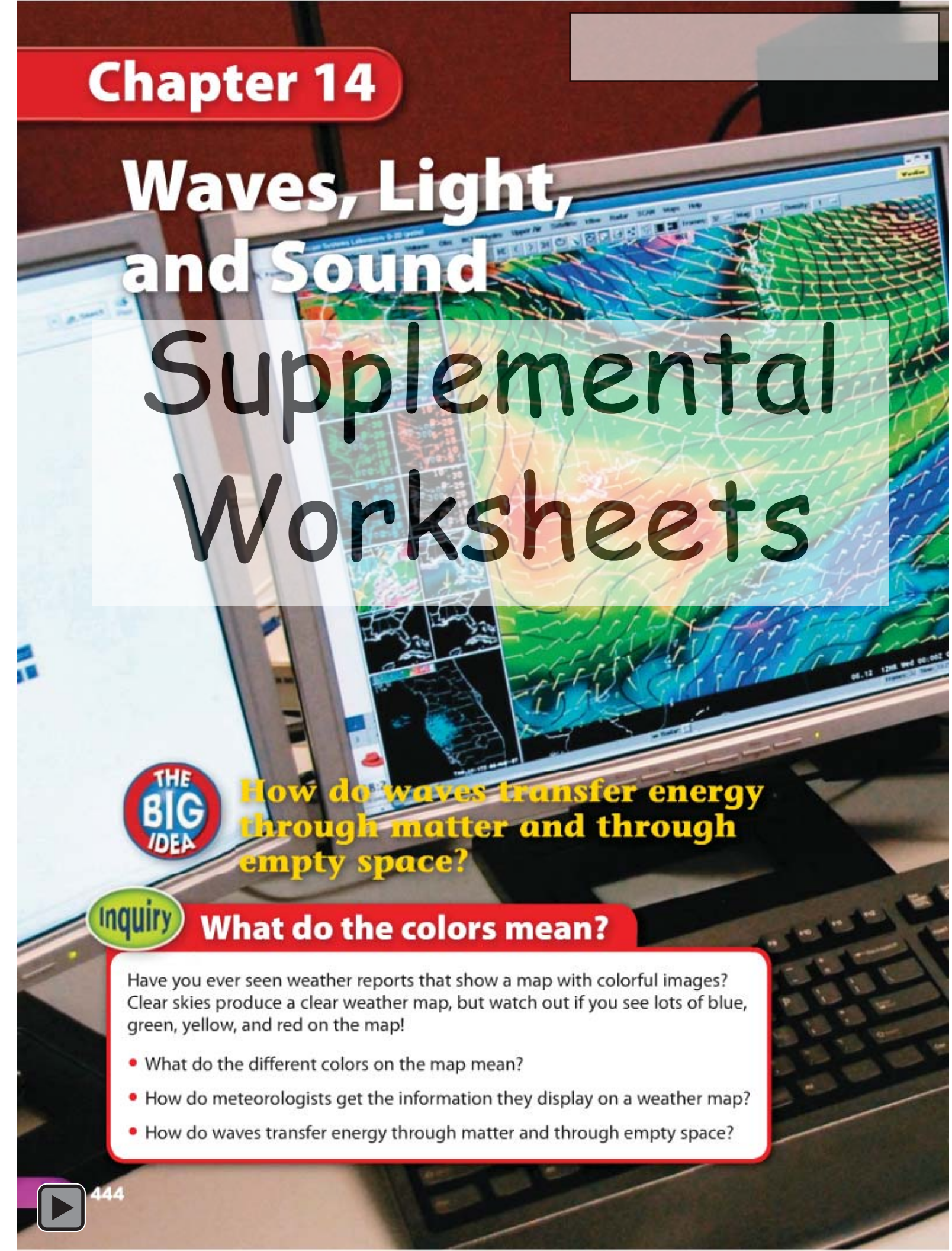
Chapter 14

Waves, Light, and Sound

Supplemental Worksheets



THE BIG IDEA

How do waves transfer energy through matter and through empty space?

Inquiry

What do the colors mean?

Have you ever seen weather reports that show a map with colorful images? Clear skies produce a clear weather map, but watch out if you see lots of blue, green, yellow, and red on the map!

- What do the different colors on the map mean?
- How do meteorologists get the information they display on a weather map?
- How do waves transfer energy through matter and through empty space?

Name _____ Date _____ Class _____

Quick Vocabulary

Lesson 1

amplitude maximum distance a wave varies from its rest position

electromagnetic wave travels through matter or through empty space

frequency number of wavelengths that pass a point each second

longitudinal wave particles of a medium move back and forth parallel to the direction the wave travels

mechanical wave travels only through matter

perpendicular at right angles

refraction change in direction of a wave as it changes speed, in moving from one medium into another

transverse wave the disturbance is perpendicular to the direction the wave travels

Lesson 2

infrared wave electromagnetic wave with a wavelength shorter than a microwave but longer than light

intensity amount of energy that passes through a square meter of space in one second

opaque material that light does not pass through

radio wave low-frequency, low-energy electromagnetic wave that has a wavelength longer than about 30 cm

range set of values from least to greatest

translucent material that allows most of the light that strikes it to pass through, but through which objects appear blurry

transparent material that allows almost all of the light striking it to pass through, and through which objects can be seen clearly

ultraviolet wave electromagnetic wave with a slightly shorter wavelength and higher frequency than light

Name _____ Date _____ Class _____

Quick Vocabulary

Lesson 3

compression region of a longitudinal wave where the particles in the medium are closest together

decibel (dB) unit used to measure sound intensity, or loudness

pitch perception of how high or low a sound seems

rarefaction region of a longitudinal wave where the particles are farthest apart

rest position the position of an undisturbed particle; particles are still in motion here

Lesson 1

Waves

Reading Guide

Key Concepts

ESSENTIAL QUESTIONS

- What are waves, and how are waves produced?
- How can you describe waves by their properties?
- What are some ways in which waves interact with matter?

Vocabulary

mechanical wave p. 448
electromagnetic wave p. 448
transverse wave p. 449
longitudinal wave p. 449
frequency p. 451
amplitude p. 452
refraction p. 454

Multilingual eGlossary

Video Science Video

inquiry What causes the waves?

Have you ever watched a surfer ride the waves? Ocean waves are produced by winds far out at sea. By the time they reach shore, some waves have so much energy that they are taller than a person or even a house. Why do waves get taller as they approach the shore? What properties do water waves have in common with other types of waves?

Name _____ Date _____ Class _____

Lesson Outline

LESSON 1

Waves

A. What are waves?

1. All waves begin with a source of _____ that causes a back-and-forth or up-and-down _____, or movement.

2. A(n) _____ is a disturbance that transfers _____ from one place to another without transferring _____.

3. When a flag waves in the wind, the flag ripples back and forth as the energy _____ along the flag, but the fabric does not _____ forward with the wave energy.

4. A(n) _____ wave travels only through matter.

5. A(n) _____ wave can travel through empty space or through matter.

6. There are _____ types of wave motion—transverse, _____, and a combination of both.

a. A(n) _____ wave is a wave in which the disturbance is perpendicular to the direction the wave travels.

b. A(n) _____ wave is a wave that makes the particles of a medium move back and forth parallel to the direction the wave travels.

7. Two common waves in nature are water waves and _____ waves.

a. In water waves, water particles move in _____, indicating that these waves are a combination of _____ and _____ waves.

b. _____ waves occur during an earthquake.

B. Properties of Waves

1. The _____ of a wave is the distance from one point, such as the crest, to the corresponding point on the next _____.

2. The _____ of a wave is the number of wavelengths that pass a point each second.

Lesson Outline continued

3. Frequency is measured in _____ (Hz); the _____ the wavelength, the lower the frequency.
4. Wave speed depends on the type of material, or _____, a wave travels through.
5. The maximum distance a wave varies from its rest position is the _____ of the wave; the more energy a(n) _____ wave has, the larger the wave's _____ will be.

C. Wave Interaction with Matter

1. When you knock on one side of a door, the sound travels as _____ sound waves through the door.
2. These waves travel through the _____ that makes up the door to the _____ on the other side.
3. The particles that make up the door _____ some of the sound energy; they increase their motion, changing to _____ energy. This causes a(n) _____ in the sound.
4. Some of the energy of your knock bounces, or _____, back into the room; that is why you _____ the sound.
5. Waves that bounce off a surface follow the law of _____: the angle between the _____ (incoming) wave and the _____ (the perpendicular to the surface) is equal to the angle between the _____ wave and the normal.
6. _____ is the change in direction of a wave as it changes speed, moving from one medium into another.
7. When entering a medium, waves refract toward the normal if they _____ and away from the normal if they _____.
8. The change in direction of a(n) _____ when it travels past the edge of an object or through an opening is called _____; sound waves spread around a(n) _____ due to diffraction.

Name _____ Date _____ Class _____

Content Practice A

LESSON 1

Waves

Directions: *On the line before each definition, write the letter of the term that matches it correctly. Each term is used only once.*

_____ **1.** a wave in which the disturbance is perpendicular to the direction the wave travels

_____ **2.** the number of wavelengths that pass a point each second

_____ **3.** the maximum distance a wave varies from its rest position

_____ **4.** a wave that can travel through empty space or through matter

_____ **5.** the change in direction of a wave as it changes speed, moving from one medium into another

_____ **6.** a wave that makes the particles of a medium move back and forth parallel to the direction the wave travels

_____ **7.** a wave that travels only through matter

A. mechanical wave

B. electromagnetic wave

C. transverse wave

D. longitudinal wave

E. frequency

F. amplitude

G. refraction

Name _____ Date _____ Class _____

Content Practice B

LESSON 1

Waves

Directions: *Circle the term in parentheses that correctly completes each sentence.*

1. Waves always begin with a source of energy that causes a back-and-forth or up-and-down (transfer/disturbance).

2. Waves transfer energy, not (heat/matter), from place to place.

3. The way in which waves transport energy (differs/is the same).

4. A(n) (electromagnetic/mechanical) wave forms when a source of energy causes particles that make up a medium to vibrate.

5. A (mechanical/transverse) wave that is produced by a vibrating electric charge is an electromagnetic wave.

6. (Longitudinal/Electromagnetic) waves are always mechanical waves because this type of motion can occur only when energy passes from particle to particle of a medium.

7. Two familiar types of waves in nature are seismic waves produced by (tornadoes/earthquakes) and water waves.

8. You can describe waves by their (properties/heights).

9. The speed of a wave depends on the medium, or (strength/type) of material, through which it travels.

10. Waves can carry different amounts of (energy/water).

11. As waves travel, some of the energy they carry is transmitted, some is absorbed, and some is (reflected/held) by the particles in matter.

Name _____ Date _____ Class _____

Key Concept Builder

LESSON 1

Waves

Key Concept What are waves, and how are waves produced?

Directions: *Complete the table by writing each sentence or phrase under the correct heading.*

An example is energy from the Sun.

These form when a source of energy causes particles that make up a medium to vibrate.

These waves can travel through empty space or through matter.

These form when a charged particle vibrates.

The energy of a pebble dropped in water produces these waves.

These waves travel only through matter.

Mechanical Waves	Electromagnetic Waves
•	•
•	•
•	•

Name _____ Date _____ Class _____

Key Concept Builder

LESSON 1

Waves

Key Concept What are waves, and how are waves produced?

Directions: *On the line before each statement, write the letter of the correct answer.*

_____ **1.** Waves are common in nature because many different _____ produce waves.
- **A.** energy sources
- **B.** bodies of water
- **C.** weather conditions

_____ **2.** _____ waves form because there is friction between sea wind and water.
- **A.** Water
- **B.** Seismic
- **C.** Longitudinal

_____ **3.** A(n) _____ wave is called a seismic wave.
- **A.** water
- **B.** sound
- **C.** earthquake

_____ **4.** Seismic waves can be _____.
- **A.** transverse
- **B.** longitudinal
- **C.** a combination of longitudinal and transverse

_____ **5.** Water waves move _____.
- **A.** as S waves
- **B.** in circular paths
- **C.** as transverse waves only

_____ **6.** All seismic waves are _____ waves because they move through matter.
- **A.** water
- **B.** mechanical
- **C.** electromagnetic

_____ **7.** _____ from the wind transfers to the water as the water moves toward land.
- **A.** Energy
- **B.** Moisture
- **C.** Vibrations

Name _____ Date _____ Class _____

Key Concept Builder

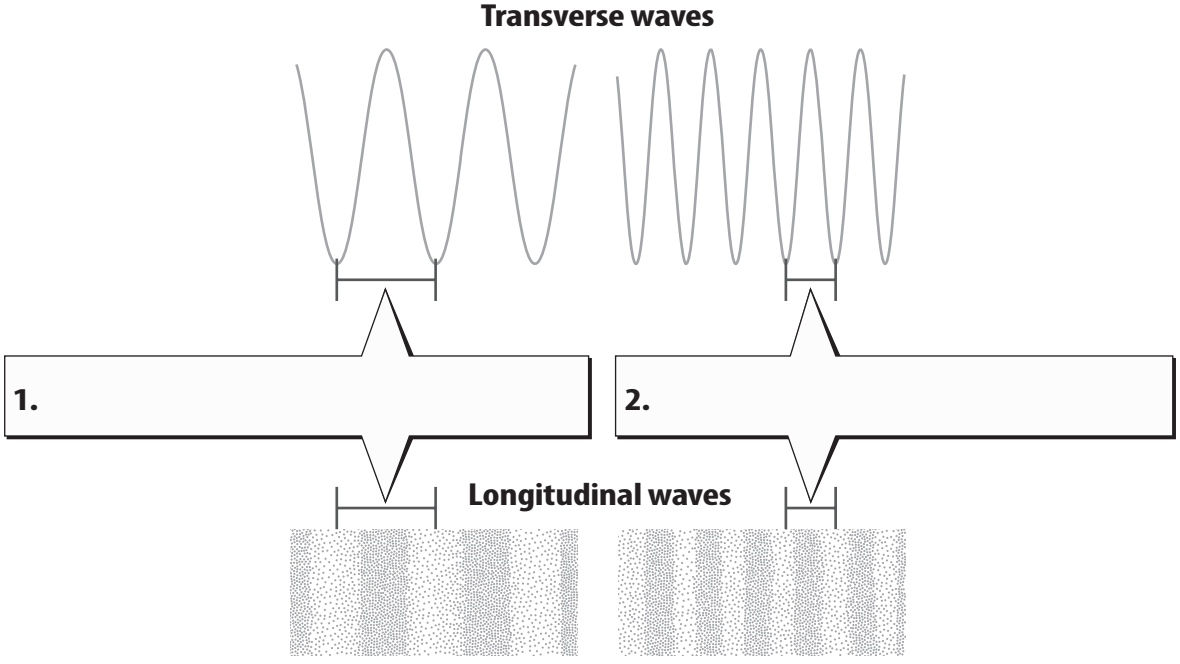
LESSON 1

Waves

Key Concept How can you describe waves by their properties?

Directions: *Label this diagram by writing the correct terms from the word bank in each text box.*

longer wavelength, lower frequency **shorter wavelength, higher frequency**



Directions: *Use the diagram to answer each question or respond to each statement on the lines provided.*

3. Define *crests* and *troughs*.

_____

_____

4. What is wavelength?

_____

_____

5. Describe the possible range of wavelengths.

_____

_____

6. How is frequency measured? _____

Name _____ Date _____ Class _____

Key Concept Builder

LESSON 1

Waves

Key Concept What are some ways in which waves interact with matter?

Directions: *On each line, write the term from the word bank that describes the statement. Some terms will be used more than once.*

absorption **diffraction** **reflection** **refraction** **transmission**

_____ **1.** Radio waves carry energy from an antenna to a plane.

_____ **2.** A plane reflects the radio waves back toward an antenna.

_____ **3.** A plane and particles in the air absorb some energy. The reflected wave carries less energy than the original wave.

_____ **4.** When someone knocks on a door, sound energy changes to thermal energy and remains in the door.

_____ **5.** Some of the energy used to knock on a door reflects, or bounces back.

_____ **6.** Some of the sound from a knock passes through the door.

_____ **7.** Instead of passing through the door, energy from a knock increases the motion of the particles in the wood.

_____ **8.** This is the change in direction of a wave when it travels past the edge of an object or through an opening.

_____ **9.** This is the change in direction of a wave as it changes speed, moving from one medium into another.

_____ **10.** An object blocks the path of a wave, causing the wave to change direction.

Name _____ Date _____ Class _____

Lesson Quiz A

LESSON 1

Waves

True or False

Directions: *On the line before each statement, write* T *if the statement is true or* F *if the statement is false. If the statement is false, change the underlined word to make it true. Write your changes on the lines provided.*

_____ **1.** Mechanical waves are waves that move through matter or empty space.

_____

_____ **2.** A wave in which the disturbance is perpendicular to the direction the wave travels is called a longitudinal wave.

_____

_____ **3.** The longer a wave's wavelength is, the lower its frequency will be.

_____

_____ **4.** The more energy a wave has, the smaller its amplitude will be.

_____

_____ **5.** When a wave changes direction as it moves from one medium to another, diffraction occurs.

_____

Multiple Choice

Directions: *On the line before each question or statement, write the letter of the correct answer.*

_____ **6.** Which term describes a wave bouncing back toward its source?
- **A.** reflection
- **B.** absorption
- **C.** transmission

_____ **7.** A change in direction in a wave when it passes through an opening is called
- **A.** reflection.
- **B.** refraction.
- **C.** diffraction.

Name _____ Date _____ Class _____

Lesson Quiz B

LESSON 1

Waves

Short Answer

Directions: *Respond to each statement on the lines provided.*

1. **Compare** and **contrast** mechanical waves and electromagnetic waves.

2. **Define** *longitudinal wave*.

3. **Explain** the relationship between a wave's frequency and its wavelength.

4. **Describe** the relationship between a wave's energy and its amplitude.

Completion

Directions: *On each line, write the term from the word bank that correctly completes each sentence. Not all terms are used.*

absorption **diffraction** **reflection** **refraction** **transmission**

5. The change in direction of a wave as it changes speed, moving from one medium to another, is _____.
6. _____ occurs when wave energy bounces back toward its source.
7. _____ occurs when a wave changes direction when it travels through an opening.

Lesson 2

Light

Reading Guide

Key Concepts
ESSENTIAL QUESTIONS

- How does light differ from other forms of electromagnetic waves?
- What are some ways in which light interacts with matter?
- How do eyes change light waves into the images you see?

Vocabulary

radio wave p. 459
infrared wave p. 460
ultraviolet wave p. 460
transparent p. 462
translucent p. 462
opaque p. 462
intensity p. 464

Multilingual eGlossary

Video

- BrainPOP®
- Science Video
- What's Science Got to do With It?

Inquiry Spreading Light?

Thick trees in a forest can block much of the sunlight, but some light still shines through. Why do you see bands of dim and bright light? Like all electromagnetic waves, light travels in straight lines. But light that moves past the trees can scatter and spread out.

Name _____ Date _____ Class _____

Lesson Outline

LESSON 2

Light

A. What are light waves?

1. _____ is a small range of electromagnetic waves that are detected by most people's _____.

2. Objects that produce light, including the Sun and lightbulbs, are _____ objects.

B. The Electromagnetic Spectrum

1. There are _____ main types of _____ that make up the electromagnetic spectrum; these waves have different wavelengths, _____, and energy.

2. The _____ produces energy that is carried outward in all directions as _____.

3. More than 90 percent of the Sun's energy that reaches Earth is carried by _____ and _____ waves.

C. Speed, Wavelength, and Frequency

1. The _____ of light in empty space is 3×10^8 m/s.

2. The _____ and the frequency of light determines the _____ of the light.

a. The light color that has the _____ wavelength and the _____ frequency is red.

b. Colors at the violet end of the spectrum have the shortest _____ and the _____ frequency.

D. Light and Matter Interact

1. A(n) _____ material allows almost all the light that strikes it to pass through; objects can be seen _____ through this material.

2. A(n) _____ material allows most of the light that strikes it to pass through; objects appear _____ through this material.

3. Light does not pass through _____ material.

Lesson Outline continued

4. You see a clear reflective image when rays reflect from a(n) _____ surface.
5. Light interacts with different types of _____ in different ways; some of the light is reflected, and some is transmitted or _____.

E. Color

1. Colors people see are due to the _____ of the light that enters their _____; with a(n) _____ object, the colors are the wavelengths emitted by the object.
2. Objects that are _____ absorb all of the wavelengths of light except the wavelengths of the color that people see when white light hits the object; so the _____ of an opaque object is the color of the light that the object _____.
3. The color of a transparent or _____ object is the color the object _____.

F. Intensity of Light

1. _____ is the amount of energy that passes through 1 m^2 of space in 1 second.
2. Intensity varies with _____ from the light source; the _____ the source, the greater the intensity of the light.
3. _____ is a person's perception of the light intensity.

G. Interaction of Sunlight and Matter

1. Particles that make up the air _____ the blue wavelengths of light more than they scatter longer wavelengths.
2. _____ of sunlight causes the Sun to be visible even after it has set below Earth's _____.

H. Vision and the Eye

1. Light enters the eye through the _____ which, along with the _____, focuses light onto the _____.
2. Cells in the retina _____ light and send signals about the light to the _____.

Name _____ Date _____ Class _____

Content Practice A

LESSON 2

Light

Directions: *Unscramble the terms. Then write the unscrambled term from the word bank that correctly completes each sentence. Each term is used only once.*

diora vewa _____ **redinfra weav** _____

oletultravi vwae _____ **nspartraent** _____

luctransent _____ **queopa** _____

nsitintey _____

1. _____ refers to the amount of energy that passes through a square meter of space in one second.

2. A(n) _____ material is a material through which light does not pass.

3. A material that allows almost all of the light striking it to pass through and through which objects can be seen clearly is _____.

4. A(n) _____ is an electromagnetic wave with a wavelength shorter than a microwave but longer than light.

5. A low-frequency, low-energy electromagnetic wave that has a wavelength longer than about 30 cm is called a(n) _____.

6. An electromagnetic wave with a slightly shorter wavelength and higher frequency than light is a(n) _____.

7. A material that allows most of the light striking it to pass through but through which objects appear blurry is _____.

Name _____ Date _____ Class _____

Content Practice B

LESSON 2

Light

Directions: *Complete the chart with the correct information in the space provided.*

Electromagnetic Wave	Definition	One Property
radio waves	**1.**	**2.**
microwaves	**3.**	**4.**
5.	an electromagnetic wave with a wavelength shorter than a microwave but longer than light	**6.**
7.	**8.**	includes a range of wavelengths
9.	**10.**	The shorter the wavelength of an electromagnetic wave is, the more energy the wave carries and the more harmful the wave can be.
11.	a high-energy electromagnetic wave that has a slightly shorter wavelength and higher frequency than an ultraviolet wave	**12.**
13.	**14.**	have shorter wavelengths and higher frequencies than any other form of electromagnetic wave

Name _____ Date _____ Class _____

Key Concept Builder

LESSON 2

Light

Key Concept How does light differ from other forms of electromagnetic waves?

Directions: *On the line before each statement, write the letter of the correct answer.*

_____ **1.** _____ and _____ are two main types of waves.
- **A.** Mechanical waves, transverse waves
- **B.** Transverse waves, electromagnetic waves
- **C.** Mechanical waves, electromagnetic waves

_____ **2.** _____ waves can move only through matter, but electromagnetic waves can move through matter or empty space.
- **A.** Sound
- **B.** Transverse
- **C.** Mechanical

_____ **3.** The most familiar type of electromagnetic wave is _____.
- **A.** light
- **B.** gamma
- **C.** microwave

_____ **4.** _____ of electrons produce electromagnetic waves that have many different wavelengths.
- **A.** Qualities
- **B.** Numbers
- **C.** Vibrations

_____ **5.** Your eyes are able to _____ only a narrow range of the wavelengths produced by electromagnetic waves.
- **A.** block
- **B.** detect
- **C.** produce

_____ **6.** Light differs from other forms of electromagnetic waves only in its wavelength, its frequency, and the amount of _____ it carries.
- **A.** heat
- **B.** color
- **C.** energy

Name _____ Date _____ Class _____

Key Concept Builder

LESSON 2

Light

Key Concept How does light differ from other forms of electromagnetic waves?

Directions: *Complete the chart by writing two characteristics of each electromagnetic wave.*

Electromagnetic Wave	Characteristics
radio waves	**1.** **2.**
microwaves	**3.** **4.**
infrared waves	**5.** **6.**
light	**7.** **8.**
ultraviolet waves	**9.** **10.**
X-rays	**11.** **12.**
gamma rays	**13.** **14.**

Name _____ Date _____ Class _____

Key Concept Builder

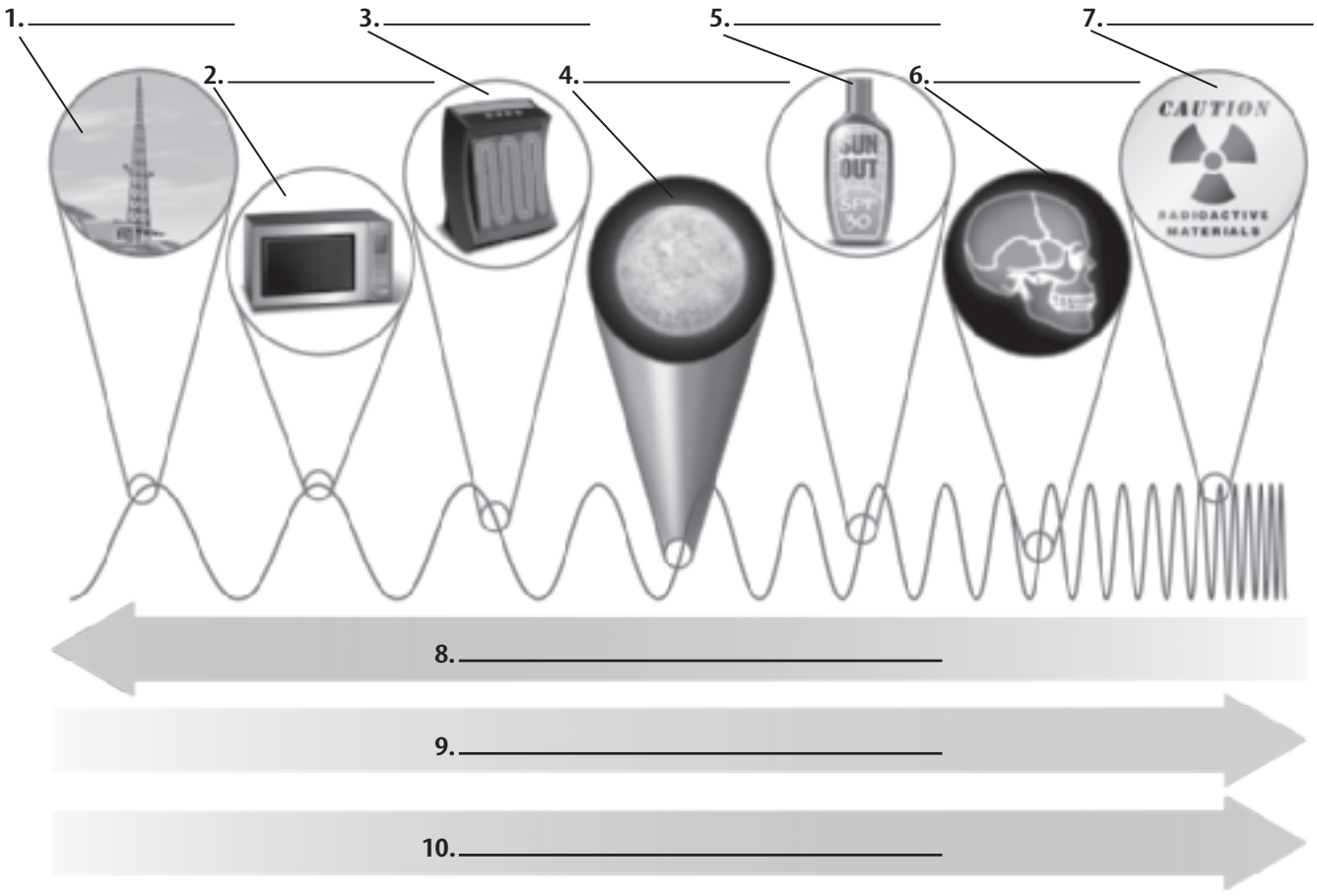
LESSON 2

Light

Key Concept What are some ways in which light interacts with matter?

Directions: *Label this diagram by writing the correct term from the word bank on each line.*

gamma	**increasing energy**	**increasing frequency**	**X-rays**
increasing wavelength	**infrared**	**light**	
microwave	**radio**	**ultraviolet**	



Directions: *Use the diagram to answer each question or respond to each statement on the lines provided.*

11. According to the diagram, how do electromagnetic waves differ?

_____

_____

12. Which electromagnetic wave has the longest wavelength? _____

13. Which electromagnetic wave has the most energy? _____

Name _____ Date _____ Class _____

Key Concept Builder

LESSON 2

Light

Key Concept How do eyes change light waves into the images you see?

Directions: *Write a question and an answer for the parts of the eye listed. Focus on how the parts work together to produce image signals for the brain.*

1. cornea

Question: _____

Answer: _____

_____

2. iris and pupil

Question: _____

Answer: _____

_____

3. lens and ciliary muscles

Question: _____

Answer: _____

_____

4. retina

Question: _____

Answer: _____

_____

5. rod cells and cone cells

Question: _____

Answer: _____

_____

6. optic nerve

Question: _____

Answer: _____

_____

Name _____ Date _____ Class _____

Lesson Quiz A

LESSON 2

Light

Matching

Directions: *On the line before each definition, write the letter of the term that matches it correctly. Each term is used only once.*

Matching Set 1

_____ **1.** a material through which objects can be seen clearly

_____ **2.** a material through which objects appear blurry

_____ **3.** a material through which light does not pass

A. opaque

B. transparent

C. translucent

Matching Set 2

_____ **4.** low-frequency, low-energy electromagnetic waves with a wavelength longer than 30 cm

_____ **5.** electromagnetic waves with a slightly shorter wavelength and a higher frequency than light

_____ **6.** electromagnetic waves with a wavelength shorter than a microwave and longer than light

A. radio waves

B. infrared waves

C. ultraviolet waves

Multiple Choice

Directions: *On the line before each question or statement, write the letter of the correct answer.*

_____ **7.** The color of an opaque object is the color of the light it
- **A.** reflects.
- **B.** absorbs.
- **C.** transmits.

_____ **8.** The intensity of light depends on
- **A.** its wavelength.
- **B.** how much of it is absorbed.
- **C.** the amount of energy it has.

_____ **9.** Which structure sends signals about what you see to the brain?
- **A.** lens
- **B.** retina
- **C.** cornea

Name _____ Date _____ Class _____

Lesson Quiz B

LESSON 2

Light

Matching

Directions: *On the line before each definition, write the letter of the term that matches it correctly. Not all terms are used.*

_____ **1.** a material through which objects can be seen clearly

_____ **2.** a material through which objects appear blurry

_____ **3.** a material through which light does not pass

_____ **4.** low-frequency, low-energy electromagnetic waves with a wavelength longer than 30 cm

_____ **5.** electromagnetic waves with a slightly shorter wavelength and a higher frequency than light

_____ **6.** electromagnetic waves with a wavelength shorter than a microwave and longer than light

A. intensity

B. radio waves

C. X-rays

D. opaque

E. transparent

F. translucent

G. infrared waves

H. ultraviolet waves

Multiple Choice

Directions: *On the line before each question or statement, write the letter of the correct answer.*

_____ **7.** A blue stained-glass window appears to be blue because it
- **A.** refracts blue light.
- **B.** scatters blue light.
- **C.** absorbs blue light.
- **D.** transmits blue light.

_____ **8.** The intensity of a light determines its
- **A.** color.
- **B.** brightness.
- **C.** absorption.
- **D.** transmission.

_____ **9.** What is a function of the cornea and lens?
- **A.** allows you to see color
- **B.** sends signals to the brain
- **C.** focuses light on the retina
- **D.** changes the size of the eye's pupil

Lesson 3

Sound

Reading Guide

Key Concepts

ESSENTIAL QUESTIONS

- What are some properties of sound waves?
- How do ears enable people to hear sounds?

Vocabulary

compression p. 471
rarefaction p. 471
pitch p. 471
decibel p. 473

Multilingual eGlossary

Video Science Video

Inquiry How does it make sounds?

Have you ever stood nearby as a marching band plays or carefully watched musicians during a concert? The notes they play can be high or low, loud or soft, or anything in between. Why are the sounds so different? How are sounds perceived?

Name _____ Date _____ Class _____

Lesson Outline

LESSON 3

Sound

A. What are sound waves?

1. Sound waves are _____ longitudinal waves that travel through a(n) _____.

2. Sound waves are _____ the ear can detect; they usually have frequencies in the range of 20 to 20,000 _____ for humans.

3. As sound waves move through air, the air particles bounce off objects and exert _____.

a. A(n) _____ is the region of a longitudinal wave where the particles of the medium are closest together.

b. A(n) _____ is the region of a longitudinal wave where the particles of the medium are farthest apart.

B. Properties of Sound Waves

1. Many properties of sound waves depend on the compressions and _____ of the sound waves.

2. The wavelength of a(n) _____ becomes shorter as the wave's _____ increases.

a. _____ is the perception of how high or low a sound seems.

b. A sound that has a high _____ is considered to have a(n) _____ pitch.

3. The greater the energy in a sound is, the _____ the particles move as they _____.

a. The _____ of a sound wave is the distance that a vibrating particle moves from its _____ position.

b. The more energy a sound _____ has, the _____ the amplitude of the wave will be.

4. Sound waves travel much _____ than electromagnetic waves do.

a. Sound waves travel _____ through gases than through solids because the particles in _____ are farther apart; so it takes longer to transfer sound energy between particles in a gas.

Lesson Outline continued

b. Sound waves travel faster as the temperature of a gas _____, and sound waves travel slower as the temperature of a liquid _____.

5. _____ is a person's perception of a sound's intensity.

6. The _____, abbreviated dB, is the unit used to measure sound intensity or loudness.

7. Sounds above _____ dB can result in permanent _____ loss.

C. Hearing and the Ear

1. The external _____ ear collects sound waves.

2. The middle ear includes the _____ and three small _____; this part of the ear _____, or intensifies, the sound waves.

3. The inner ear contains the _____, which converts sound waves to _____ signals that the _____ then processes, creating the perception of sound.

Name _____ Date _____ Class _____

Content Practice A

LESSON 3

Sound

Directions: *On each line, write the term from the word bank that correctly completes each sentence. Some terms will be used more than once.*

compression(s) **decibel** **pitch** **rarefaction(s)**

1. The perception of how high or low a sound seems is called _____.

2. The unit used to measure sound intensity, or loudness, is the _____.

3. A _____ is the region of a longitudinal wave where the particles are farthest apart.

4. A sound wave produces _____ and _____ as it passes through matter.

5. As the _____ level goes up, the amount of time you can listen to the sounds without risking hearing loss gets shorter and shorter.

6. The higher the frequency is, the higher the _____ of the sound will be.

7. A _____ is the region of a longitudinal wave where the particles in the medium are closest together.

Name _____ Date _____ Class _____

Content Practice B

LESSON 3

Sound

Directions: *Answer each question or respond to each statement on the lines provided.*

1. **List** two characteristics of sound waves.

_____

_____

2. **Describe** the relationship between age and hearing.

_____

_____

3. How do compressions and rarefactions differ?

_____

_____

_____

_____

_____

4. **Explain** how pitch and frequency are related.

_____

5. **Define** *amplitude*.

_____

6. Why do sound waves travel slower than other electromagnetic waves?

_____

7. What is the highest decibel level that you can listen to without risking permanent hearing loss? _____

8. How many main parts does the human ear have? _____

Language Arts Support **LESSON 3**

Reading Comprehension Activity: Reading Mathematics in Science

Mathematics is an important part of science. However, mathematics has its own language. Understanding this language will help you read and take notes about science. The language of mathematics uses many different symbols to represent relationships, operations, and variables. Some common symbols are shown in the table below.

Symbol	Meaning	Example
>	greater than	10 > 4
<	less than	4 < 10
λ	wavelength	The λ of a microwave is between 1 mm and 30 cm.
m/s	meters per second	A wave's speed can be measured in m/s.
Δ	change	Sound waves Δ to nerve signals in your ear.
⊥	perpendicular	Lines that are ⊥ cross at right angles.
||	parallel	Lines that are next to each other and do not intersect are ||.

Directions: *Study the table above. Then insert the correct symbol to complete the following sentences.*

1. Transverse waves move _____ to the direction that the wave travels.

2. A wave that has a shorter _____ has a higher frequency.

3. Dolphins and dogs have hearing ranges that are _____ the hearing range of humans.

4. The frequency of an infrared wave is _____ the frequency of an X-ray.

5. Refraction occurs when waves _____ speed and direction upon moving from one medium to another.

6. Longitudinal waves move _____ to the direction that the wave travels.

7. The speed of light is 3×10^8 _____.

Reading Comprehension Activity: Reading for Standardized Tests

Developing reading skills can help you when you take tests. Certain skills are particularly helpful for standardized tests. Follow these steps when you read a standardized test question:

1. Read the question carefully. Make sure that you understand what the question is asking.
2. Reread the question if necessary. Underline words or terms that are important.
3. Cover the response choices with your hand and answer the question.
4. Look at the response choices. Read every choice and cross out the ones that you know are incorrect.

Directions: *Underline words that are important in each question below. Then write the letter of the correct answer on the line before each statement.*

_____ **1.** Which kind of waves ripple out in all directions when a child throws a pebble into a pond?
- **A.** light waves
- **B.** sound waves
- **C.** mechanical waves
- **D.** electromagnetic waves

_____ **2.** Which term describes the maximum distance that a wave varies from its rest position?
- **A.** amplitude
- **B.** frequency
- **C.** wavelength
- **D.** transmission

_____ **3.** Which unit would you use to measure the loudness of an airplane taking off?
- **A.** hertz
- **B.** decibel
- **C.** centimeter
- **D.** meters per second

_____ **4.** Luis's T-shirt reflects green light waves. What color is Luis's shirt?
- **A.** red
- **B.** blue
- **C.** green
- **D.** black

Name _____ Date _____ Class _____

Math Skills **LESSON 3**

Use a Fraction

If you move away from the source of a sound, the sound gets softer. If you move toward the source of a sound, it gets louder. This is because the intensity of the sound decreases as you move away from its source and increases as you move toward a source. The fraction by which sound intensity changes depends on the starting distance from the source, r_1, and the ending distance from the source, r_2.

$$\textit{change in sound intensity} = \left(\frac{r_1}{r_2}\right)^2$$

By what fraction does sound intensity decrease if you start at **3** m from the source and move to **9** m from the source?

Step 1 Identify the values given in the problem.

$r_1 = \mathbf{3}$ m

$r_2 = \mathbf{9}$ m

Step 2 Insert the known values to solve.

$$\textit{change in sound intensity} = \left(\frac{r_1}{r_2}\right)^2$$

$$= \left(\frac{\mathbf{3}}{\mathbf{9}}\right)^2 = \left(\frac{\mathbf{1}}{\mathbf{3}}\right)^2 = \mathbf{\frac{1}{9}}$$

The sound intensity decreases to $\mathbf{\frac{1}{9}}$ of its original value.

Practice

1. By what fraction does sound intensity decrease if you start at 4 m from the source and move to 6 m from the source?

2. By what fraction does sound intensity decrease if you move from 6 m away to 8 m away from a source?

3. By how many times does the sound intensity increase if you move from 6 m away to 3 m away from a source?

4. You are standing at a distance of 1 m from a sound source. How does the sound intensity change if you move to a distance of 10 m from the source?

Name _____ Date _____ Class _____

Key Concept Builder

LESSON 3

Sound

Key Concept What are some properties of sound waves?

Directions: *On the line before each answer, write the letter of the question that matches it correctly. Each question is used only once.*

A. Which sound waves can healthy young humans hear?

B. In general, why does a female voice sound higher-pitched than a male voice?

C. How does the distance between the particles of a gas affect its ability to transfer sound?

D. The human ear is most sensitive to which frequencies?

E. How can you describe a sound wave?

F. Why do you hear a loud sound if you drop a book onto a wooden floor but not if you drop the book onto a pillow?

G. What are sound waves?

H. What happens as the temperature of a gas increases?

I. What is the effect of temperature on liquids and solids?

_____ **1.** vibrations that the ear can detect

_____ **2.** sound waves produced by vibrations between about 20 Hz and 20,000 Hz

_____ **3.** frequencies between 1,000 and 4,000 Hz

_____ **4.** because there is only a slight vibration

_____ **5.** because the range of frequencies produced is higher

_____ **6.** by its wavelength, frequency, amplitude, and speed

_____ **7.** They collide less often than particles in a liquid or a solid so it takes longer to transfer sound energy from one particle to another.

_____ **8.** The particles move faster and collide more often.

_____ **9.** As liquids and solids cool, the molecules slow down and move closer. They collide more often and transfer energy faster.

Name _____ Date _____ Class _____

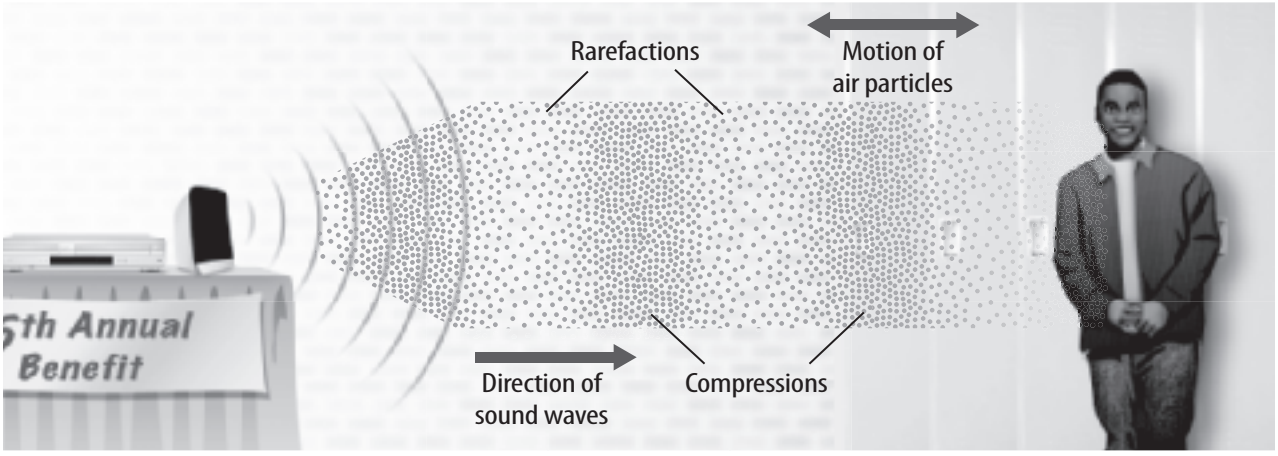
Key Concept Builder

LESSON 3

Sound

Key Concept What are some properties of sound waves?

Directions: *Use the diagram to answer each question or respond to each statement on the lines provided.*



1. According to the diagram, what does a sound wave produce as it passes through matter?

_____

2. **Describe** the motion of the air particles in the diagram.

_____

_____

_____

3. **Describe** the appearance of the air particles in areas of compression and rarefaction. Then explain how the appearances relate to air pressure.

_____

_____

_____

_____

_____

_____

Name _____ Date _____ Class _____

Key Concept Builder

LESSON 3

Sound

Key Concept What are some properties of sound waves?

Directions: *Change the underlined word(s) to make each false statement true. Write your changes on the lines provided.*

1. For light waves, many properties depend on the height and shape of the <u>longitudinal</u> waves. _____

2. Many <u>types</u> of sound waves depend on their compressions and rarefactions.

_____

3. People and instruments produce different ranges of sound <u>temperatures</u>.

_____

4. The wavelength of a wave gets <u>longer</u> as the frequency increases.

_____

5. You use more energy to <u>whisper</u> than to <u>shout</u>. _____

_____

6. The more <u>sound</u> that is used to produce the sound wave, the greater the amplitude will be. _____

7. Two factors that affect the speed of sound are the type of medium and <u>its height</u>.

_____

8. <u>A solid</u> takes longer than a liquid to transfer sound energy from one particle to another.

_____

Name _____ Date _____ Class _____

Key Concept Builder

LESSON 3

Sound

Key Concept How do ears enable people to hear sounds?

Directions: *On the line before each description, write the letter of the term or phrase that matches it correctly. Some terms or phrases will be used more than once.*

_____ **1.** has three main parts

_____ **2.** the part of the ear you can see

_____ **3.** amplifies, or increases, the intensity of sound waves

_____ **4.** includes the eardrum

_____ **5.** collects sound waves

_____ **6.** includes three tiny bones called the hammer, the anvil, and the stirrup

_____ **7.** contains the cochlea

_____ **8.** has a spiral shape and changes sound waves to nerve signals

_____ **9.** changes sound waves to nerve signals that the brain interprets

_____ **10.** work together to gather and interpret sound waves

A. cochlea

B. different parts of the ear

C. human ear

D. inner ear

E. middle ear

F. outer ear

Name _____ Date _____ Class _____

Lesson Quiz A

LESSON 3

Sound

Completion

Directions: *On each line, write the term from the word bank that correctly completes each sentence. Each term is used only once.*

compression **decibel** **pitch** **rarefaction**

1. The perception of how high or low a sound seems is called _____.
2. The region of a longitudinal wave where the particles of the medium are closer together is called a _____.
3. The unit used to measure sound intensity is called the _____.
4. The region of a longitudinal wave where the particles are farthest apart is called a _____.

Matching

Directions: *On the line before each definition, write the letter of the term that matches it correctly. Each term is used only once.*

_____ **5.** collects sound waves

_____ **6.** amplifies sound waves

_____ **7.** changes sound waves to nerve signals

A. outer ear

B. inner ear

C. middle ear

Name _____ Date _____ Class _____

Lesson Quiz B

LESSON 3

Sound

Completion

Directions: *On each line, write the term from the word bank that correctly completes each sentence. Not all terms are used.*

compression	**decibel**	**pitch**
rarefaction	**vibration**	**wavelength**

1. The perception of how high or low a sound seems is called _____.
2. The region of a longitudinal wave where the particles of the medium are closer together is called a _____.
3. The unit that is used to measure sound intensity is called the _____.
4. The region of a longitudinal wave where the particles are farthest apart is called a _____.

Matching

Directions: *On the line before each definition, write the letter of the term that matches it correctly. Not all terms are used.*

_____ **5.** the main function of the outer ear

_____ **6.** the main function of the middle ear

_____ **7.** the main function of the inner ear

A. collecting sound waves

B. reflecting sound waves

C. changing sound waves to nerve signals

D. amplifying sound waves

Lesson Outline for Teaching

Lesson 1: Waves

A. What are waves?

1. All waves begin with a source of energy that causes a back-and-forth or up-and-down disturbance, or movement.
2. A(n) wave is a disturbance that transfers energy from one place to another without transferring matter.
3. When a flag waves in the wind, the flag ripples back and forth as the energy travels along the flag, but the fabric does not move forward with the wave energy.
4. A(n) mechanical wave travels only through matter.
5. A(n) electromagnetic wave can travel through empty space or through matter.
6. There are three types of wave motion—transverse, longitudinal, and a combination of both.
   a. A(n) transverse wave is a wave in which the disturbance is perpendicular to the direction the wave travels.
   b. A(n) longitudinal wave is a wave that makes the particles of a medium move back and forth parallel to the direction the wave travels.
7. Two common waves in nature are water waves and seismic waves.
   a. In water waves, water particles move in circles, indicating that these waves are a combination of longitudinal and transverse waves.
   b. Seismic waves occur during an earthquake.

B. Properties of Waves

1. The wavelength of a wave is the distance from one point, such as the crest, to the corresponding point on the next wave.
2. The frequency of a wave is the number of wavelengths that pass a point each second.
3. Frequency is measured in hertz (Hz); the longer the wavelength, the lower the frequency.
4. Wave speed depends on the type of material, or medium, a wave travels through.
5. The maximum distance a wave varies from its rest position is the amplitude of the wave; the more energy a(n) mechanical wave has, the larger the wave's amplitude will be.

C. Wave Interaction with Matter

1. When you knock on one side of a door, the sound travels as longitudinal sound waves through the door.

Lesson Outline continued

2. These waves travel through the matter that makes up the door to the air on the other side.
3. The particles that make up the door absorb some of the sound energy; they increase their motion, changing to thermal energy. This causes a(n) decrease in the sound.
4. Some of the energy of your knock bounces, or reflects, back into the room; that is why you hear the sound.
5. Waves that bounce off a surface follow the law of reflection: the angle between the incident (incoming) wave and the normal (the perpendicular to the surface) is equal to the angle between the reflected wave and the normal.
6. Refraction is the change in direction of a wave as it changes speed, moving from one medium into another.
7. When entering a medium, waves refract toward the normal if they slow down and away from the normal if they speed up.
8. The change in direction of a(n) wave when it travels past the edge of an object or through an opening is called diffraction; sound waves spread around a(n) corner due to diffraction.

Discussion Question

In terms of waves, what is an echo? Based on what you have learned in this lesson, what generalization can you make about the direction an echo travels?

An echo is a sound wave that bounces back, or reflects, from a surface. An echo, like other reflected waves, will follow the law of reflection, which states that the angle of incidence is equal to the angle of reflection. This means that if you can identify the surface that the echo bounced off of, you can determine where the sound came from based on the angle the sound waves made when they hit that surface.

Lesson Outline for Teaching

Lesson 2: Light

A. What are light waves?

1. Light is a small range of electromagnetic waves that are detected by most people's eyes.
2. Objects that produce light, including the Sun and lightbulbs, are luminous objects.

B. The Electromagnetic Spectrum

1. There are seven main types of waves that make up the electromagnetic spectrum; these waves have different wavelengths, frequencies, and energy.
2. The Sun produces energy that is carried outward in all directions as electromagnetic waves.
3. More than 90 percent of the Sun's energy that reaches Earth is carried by light and infrared waves.

C. Speed, Wavelength, and Frequency

1. The speed of light in empty space is 3×10^8 m/s.
2. The wavelength and the frequency of light determines the color of the light.
   a. The light color that has the longest wavelength and the lowest frequency is red.
   b. Colors at the violet end of the spectrum have the shortest wavelength and the highest frequency.

D. Light and Matter Interact

1. A(n) transparent material allows almost all the light that strikes it to pass through; objects can be seen clearly through this material.
2. A(n) translucent material allows most of the light that strikes it to pass through; objects appear blurry through this material.
3. Light does not pass through opaque material.
4. You see a clear reflective image when rays reflect from a(n) smooth surface.
5. Light interacts with different types of matter in different ways; some of the light is reflected, and some is transmitted or absorbed.

E. Color

1. Colors people see are due to the wavelength of the light that enters their eyes; with a(n) luminous object, the colors are the wavelengths emitted by the object.
2. Objects that are opaque absorb all the wavelengths of light except the wavelengths of the color that people see when white light hits the object; so the color of an opaque object is the color of the light that the object reflects.
3. The color of a transparent or translucent object is the color the object transmits.

Lesson Outline continued

F. Intensity of Light

1. Intensity is the amount of energy that passes through 1 m^2 of space in 1 second.
2. Intensity varies with distance from the light source; the closer the source, the greater the intensity of the light.
3. Brightness is a person's perception of the light intensity.

G. Interaction of Sunlight and Matter

1. Particles that make up the air scatter the blue wavelengths of light more than they scatter longer wavelengths.
2. Refraction of sunlight causes the Sun to be visible even after it has set below Earth's horizon.

H. Vision and the Eye

1. Light enters the eye through the cornea, which along with the lens, focuses light onto the retina.
2. Cells in the retina absorb light and send signals about the light to the brain.

Discussion Question

Compare and contrast radio waves and microwaves.

Radio waves are similar to microwaves—both are types of electromagnetic waves with longer wavelengths than most other electromagnetic waves and both are used in communication. They also differ—microwaves are shorter than radio waves and have higher energy than radio waves, so they can be used to cook food in addition to their use in transmitting signals for communication.

Lesson Outline for Teaching

Lesson 3: Sound

A. What are sound waves?

1. Sound waves are mechanical longitudinal waves that travel through a(n) medium.

2. Sound waves are vibrations the ear can detect; they usually have frequencies in the range of 20 to 20,000 hertz (or Hz) for humans.

3. As sound waves move through air, the air particles bounce off objects and exert pressure (or force).

a. A(n) compression is the region of a longitudinal wave where the particles of the medium are closest together.

b. A(n) rarefaction is the region of a longitudinal wave where the particles of the medium are farthest apart.

B. Properties of Sound Waves

1. Many properties of sound waves depend on the compressions and rarefactions of the sound waves.

2. The wavelength of a(n) wave becomes shorter as the wave's frequency increases.

a. Pitch is the perception of how high or low a sound seems.

b. A sound that has a high frequency is considered to have a(n) high pitch.

3. The greater the energy in a sound is, the farther the particles move as they vibrate.

a. The amplitude of a sound wave is the distance that a vibrating particle moves from its rest position.

b. The more energy a sound wave has, the greater the amplitude of the wave will be.

4. Sound waves travel much slower than electromagnetic waves do.

a. Sound waves travel slower through gases than through solids because the particles in gases are farther apart; so it takes longer to transfer sound energy between particles in a gas.

b. Sound waves travel faster as the temperature of a gas increases, and sound waves travel slower as the temperature of a liquid decreases.

5. Loudness is a person's perception of a sound's intensity.

6. The decibel, abbreviated dB, is the unit used to measure sound intensity or loudness.

7. Sounds above 80 dB can result in permanent hearing loss.

C. Hearing and the Ear

1. The external outer ear collects sound waves.

2. The middle ear includes the eardrum and three small bones; this part of the ear amplifies, or intensifies, the sound waves.

Lesson Outline continued

3. The inner ear contains the cochlea, which converts sound waves to nerve signals that the brain then processes, creating the perception of sound.

Discussion Question

Which instrument, when playing its full range, produces the sound that has the highest frequency—bass guitar, flute, classical or acoustic guitar, or cello? Which instrument, played at full volume, produces the sound that has the lowest amplitude—triangle, tuba, violin, or bass drum? Explain your answers.

Of the choices, the flute can reach the highest pitch, so it can produce the sound that has the highest frequency. Of the choices, the triangle is by far the smallest, so it produces the sound that has the least energy; therefore, its sound waves would have the lowest amplitude.

