Section 5 Using Sound

Objectives

After this lesson, students will be able to

O.2.5.1 Explain why some animals use echolocation.

O.2.5.2 State the uses of ultrasound technologies.

Target Reading Skill

Comparing and Contrasting Explain that comparing and contrasting information shows how ideas, facts, and events are similar and different. The results of the comparison can have importance.

Answers

Sample compare/contrast table:

Echolocation — Ultrasound; Air, water; Navigate, find food

Sonar —Ultrasound; Water; Purposes; Find water depth, sunken objects, schools of fish

All in One Teaching Resources

- Transparency O26

Preteach

Build Background Knowledge

L2

Hearing Echoes

Ask: **What would happen if you yelled into the Grand Canyon toward the rock walls on the other side?** *(You would hear an echo.)* **What would cause this result?** *(Sample answer: Sound waves bouncing back from the rock wall of the canyon)* Tell students that in this section they will learn more about what happens when sound waves bounce back from surfaces.

Section 5 Using Sound

Reading Preview

Key Concepts

- Why do some animals use echolocation?
- What are ultrasound technologies used for?

Key Terms

- echolocation
- sonar
- sonogram

Target Reading Skill

Comparing and Contrasting

As you read, compare and contrast echolocation and sonar by completing a table like the one below.

Using Sound

Feature	Echolocation	Sonar
Type of wave	Ultrasound	
Medium(s)		Water
Purposes		

Lab zone Discover Activity

How Can You Use Time to Measure Distance?

1. Measure a distance 3 meters from a wall and mark the spot with a piece of masking tape.
2. Roll a soft ball in a straight line from that spot toward the wall. What happens to the ball?
3. Roll the ball again. Try to roll the ball at the same speed each time. Have a classmate use a stopwatch to record the time it takes for the ball to leave your hand, reflect off the wall, and then return to you.
4. Now move 6 meters away from the wall. Mark the spot with tape. Repeat Steps 2 and 3.
5. Compare the time for both distances.

Think It Over

Inferring What does the difference in time tell you about the distance the ball has traveled?

A dog trainer stands quietly, watching the dog a short distance away. To get the dog's attention, the trainer blows into a small whistle. You don't hear a thing. But the dog stops, cocks an ear, and then comes running toward the trainer. Dogs can hear ultrasound frequencies up to about 45,000 Hz, well above the upper limit for humans. Other animals, such as cats and mice, can also hear ultrasound frequencies.

Some types of animals not only hear ultrasound, but also produce ultrasound waves. They use ultrasound waves to "see in the dark."

◀ Dog hearing an ultrasound whistle

Lab zone Discover Activity

Skills Focus Inferring L2

Materials meter stick, masking tape, soft ball, stopwatch

Time 10 minutes

Tips Test the ball before using it with students. A softer ball works better than a hard one. Explain how the activity models the reflection of sound.

Expected Outcome When the ball hits the wall, it bounces back. The ball takes longer to roll back to the student when it is 6 meters away from the wall than when it is 3 meters away.

Think It Over The more time it takes the ball to return to the student, the greater the distance the ball has traveled.

Echolocation

Imagine trying to walk around in a totally dark room. You would probably bump into objects every few steps. Unlike you, bats find it easy to move around in dark places. This is because they use echolocation. **Echolocation** (ek oh loh KAY shun) is the use of reflected sound waves to determine distances or to locate objects. **Some animals, including bats and dolphins, use echolocation to navigate and to find food.**

Bats Bats use ultrasound waves with frequencies up to 100,000 Hz to move around and hunt. As a bat flies, it sends out short pulses of ultrasound waves—as many as 200 pulses per second! The waves reflect off objects and return to the bat's ears. The time it takes for the sound waves to return tells the bat how far it is from obstacles or prey. The bat uses the reflected sound waves to build up a "picture" of what lies ahead.

Dolphins, Porpoises, and Whales Dolphins, porpoises, and some whales must often hunt in darkness. Like bats, these animals use echolocation. For example, dolphins send out ultrasound waves with frequencies up to 150,000 Hz. The sound waves travel through the water and bounce off fish or other prey, as shown in Figure 19. Dolphins sense the reflected sound waves through their jawbones. They use echolocation to hunt at night or in murky or deep water.

Reading Checkpoint **What animals use echolocation?**

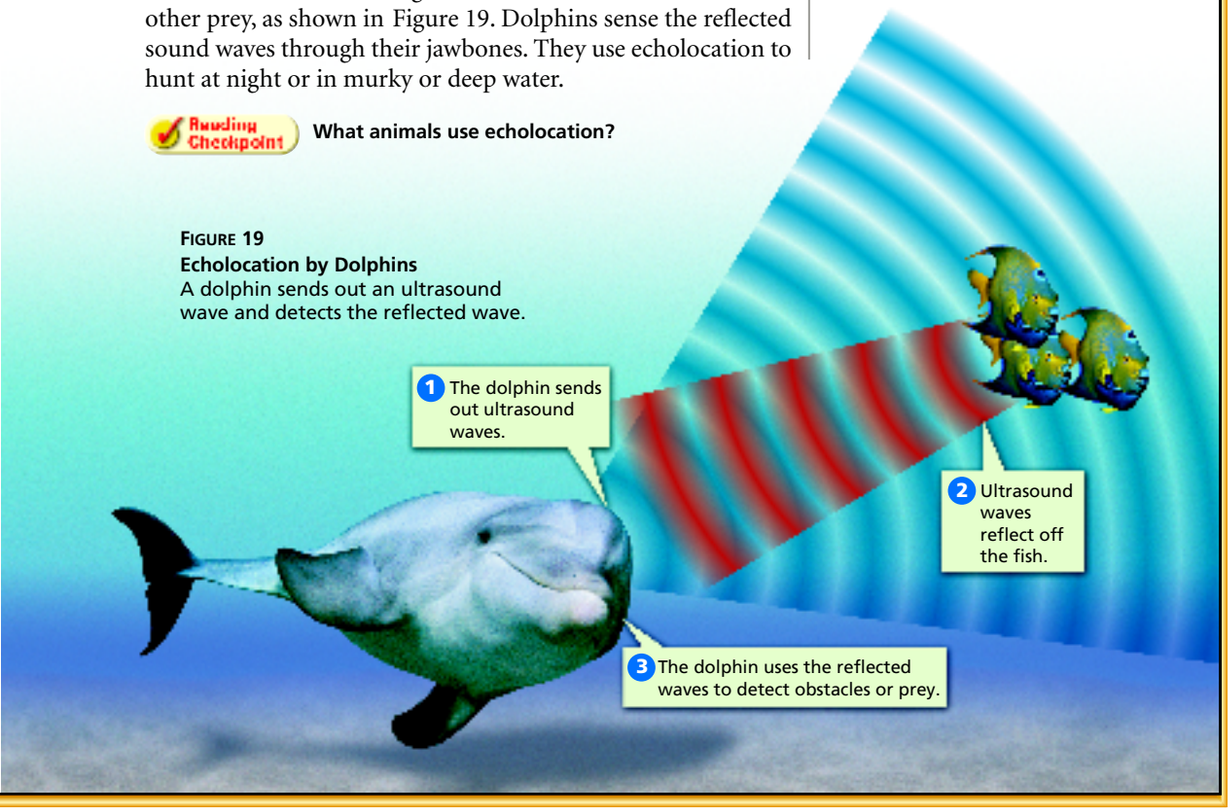

FIGURE 19
Echolocation by Dolphins
A dolphin sends out an ultrasound wave and detects the reflected wave.

Discovery CHANNEL SCHOOL
Sound
Video Preview
Video Field Trip
Video Assessment

Differentiated Instruction

Special Needs L1
Observing Ultrasound Waves Have students hold an ultrasound massage device and then turn it on. Tell students they are feeling ultrasound waves. Ask: **How do ultrasound waves feel?** *(Sample answer: Like very fast vibrations)* **learning modality: kinesthetic**

Less Proficient Readers L1
Applying Concepts Pair less proficient readers with students who excel in reading, and have the pairs create posters explaining echolocation. Posters might include diagrams showing how sound waves are reflected back from surfaces and pictures of organisms that use echolocation. **learning modality: visual**

Instruct

Echolocation

Teach Key Concepts L2

Visualizing Echolocation

Focus Introduce echolocation as a way that some animals use ultrasound to find food and avoid objects in their path.

Teach Make a sketch using an arrow to show sound waves traveling from an animal to an object. Ask: **What happens to the sound waves when they strike the object?** *(They are reflected.)* In the diagram, add an arrow to show the reflection of the sound waves back to the animal.

Apply Ask: **Under what conditions do animals use echolocation?** *(When it is too dark to readily see prey or obstacles)* **learning modality: visual**

Sound

Show the Video Field Trip to let students experience sound and understand its properties. Discussion question: **When does a dolphin use its echolocation system?** *(When it is navigating difficult spaces or finding food)*

Independent Practice L2

All in One **Teaching Resources**

- Guided Reading and Study Worksheet: *Using Sound*

Student Edition on Audio CD

Monitor Progress L2

Drawing Have students sketch what happens to ultrasound waves that travel from a dolphin to a school of fish.

Answer

Reading Checkpoint Dolphins, porpoises, some whales, and bats

Ultrasound Technologies

Teach Key Concepts L2

Introducing Sonar

Focus Introduce sonar by comparing and contrasting it with radar, with which students may be more familiar.

Teach Explain that both sonar and radar use reflected waves to locate objects, but sonar uses sound waves, whereas radar uses radio waves.

Apply Ask: **How might this difference affect where the two methods are used?** *(Sample answer: Sound waves are mechanical and travel best in relatively dense mediums such as water. Radio waves are electromagnetic and can travel without a medium. Because of these differences, sonar can be used underwater and radar can be used in space.)* **learning modality: verbal**

Lab zone Build Inquiry L3

Calculating Depth Using Sonar

Materials calculator

Time 5 minutes

Focus Tell students that sonar can be used to find water depth.

Teach Remind the class that the distance a wave travels is the product of time and speed. On the board, write $D = V \times T$. Tell students that D represents distance, V represents speed, and T represents time.

Apply Tell students that it takes 8.20 seconds for a sound wave to travel to the bottom of the ocean and back to the surface. Ask: **If the speed of sound in salt water is 1,530 m/s, how deep is the ocean at this point?**

$$V \times T = \frac{1,530 m/s \times 8.20 s}{2} = (6,270 m)$$

If necessary, explain why it is necessary to divide the distance by 2. **learning modality: logical/mathematical**

Go Online PHSchool.com
For: More on sonar
Visit: PHSchool.com
Web Code: cgd-5025
Students can review sonar in an online interactivity.

Lab zone Skills Activity

Designing Experiments

1. Stand a square piece of cardboard on a table. Prop it up with a book.
2. Lay two cardboard tubes flat on the table. The tubes should be angled to make a V shape, with the point of the V near the cardboard square. Leave a gap of about 6 cm between the cardboard square and the ends of the tubes.
3. Place a ticking watch in one tube. Put your ear near the open end of the second tube. Cover your free ear with your hand. What do you hear?
4. Design an experiment to determine how well sound reflects off different materials.

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Ultrasound Technologies

People cannot send out pulses of ultrasound to help them move around in the dark. But people sometimes need to explore places they cannot easily reach, such as deep underwater or inside the human body. **Ultrasound technologies such as sonar and ultrasound imaging are used to observe things that cannot be seen directly.**

Sonar A system that uses reflected sound waves to detect and locate objects underwater is called **sonar**. The word *sonar* comes from the initial letters of **so**und **n**avigation **a**nd **r**anging. *Navigation* means finding your way around on the ocean (or in the air), and *ranging* means finding the distance between objects. Today, sonar is used to determine the depth of water, to map the ocean floor, and to locate sunken ships, schools of fish, and other objects in the ocean.

A sonar device sends a burst of ultrasound waves that travel through the water. When the sound waves strike an object or the ocean floor, they reflect as shown in Figure 20. The sonar device detects the reflected waves.

The farther a sound wave travels before bouncing off an object, the longer it takes to return to the sonar device. A computer in the sonar device measures the time it takes for the sound waves to go out and return. Then, it multiplies this time by the speed of sound in water. The result is the total distance the sound waves traveled. The total distance is divided by two to find how far away the object is. You must divide by two because the sound waves travel out and back.

FIGURE 20
Using Sonar
A sonar device sends out ultrasound waves and then detects the reflected waves. **Interpreting Diagrams** *What happens to the reflected sound waves?*

Lab zone Skills Activity

Skills Focus Designing experiments L2

Materials square piece of cardboard, 2 cardboard tubes, metric ruler, ticking watch

Time 15 minutes

Tip Make sure that students place the tubes at the same angle relative to the piece of cardboard.

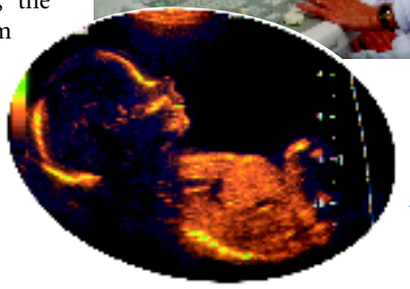
Extend Students can describe how they would send sound waves toward the materials and list the materials they would use. Challenge students to predict how well the different materials will reflect sound. If students carry out the experiment, have them record their observations in a data table. **learning modality: kinesthetic**

Ultrasound Imaging Doctors use ultrasound imaging to look inside the human body. Ultrasound imaging devices send ultrasound waves into the body and detect the reflected sound waves. Different parts of the body, such as bones, muscles, the liver, or the heart, reflect sound differently. The device uses the reflected ultrasound waves to create a picture called a **sonogram**. A doctor can use sonograms to diagnose and treat many medical conditions.

Ultrasound imaging is used to examine developing babies before they are born. A technician or doctor holds a small probe on a pregnant woman's abdomen. The probe sends out very high frequency ultrasound waves (about 4 million Hz). By analyzing the reflected sound waves, the device builds up a sonogram. The sonogram can show the position of the baby. Sonograms can also show if more than one baby will be born. In addition to a still picture, ultrasound imaging can produce a video of a developing baby.

Reading Checkpoint **What is a sonogram?**

FIGURE 21
Ultrasound in Medicine
An ultrasound imaging device uses reflected ultrasound waves to build up a picture of a developing baby.



◀ Sonogram

Section 5 Assessment

Target Reading Skill

Comparing and Contrasting Use your table about echolocation and sonar to help you answer the questions below.

Reviewing Key Concepts

1. a. **Defining** What is echolocation?
   b. **Summarizing** Why do bats and dolphins use echolocation?
   c. **Interpreting Diagrams** Look at Figure 19. Why would a dolphin need to continue sending out sound waves as it nears its prey?
2. a. **Reviewing** Why do people use ultrasound technologies?
   b. **Drawing Conclusions** A sonar device can show the size of a fish but not the type of fish. Explain why.
   c. **Comparing and Contrasting** How is sonar similar to ultrasound imaging used in medicine? How is it different?

Writing in Science

Advertisement Write a short advertisement for a depth finder used on fishing boats. Describe how the depth finder can determine the depth and direction of fish in the area. Include a diagram to show how the depth finder works.

Monitor Progress L2

Answers

Figure 20 They travel back to the ship and are detected by the sonar device.

Reading Checkpoint A picture created using reflected ultrasound waves

Assess

Reviewing Key Concepts

1. a. The use of reflected sound waves to determine distances or locate objects **b.** To navigate and find food **c.** Because its prey are also moving

2. a. To observe things that cannot be seen directly **b.** Reflected ultrasound waves determine the size and location of the fish but do not create an image. **c.** Both methods use reflected ultrasound waves to observe things that cannot be seen directly. Sonar sends sound waves through water; ultrasound imagining sends sound waves through body tissues. Sonar detects only size and location; ultrasound imaging creates images.

Reteach L1

Call on students to define each of the key terms.

Performance Assessment L2

Writing Have students describe one application of ultrasound in the natural world and one in medicine.

All in One Teaching Resources

- Section Summary: *Using Sound*
- Review and Reinforcement: *Using Sound*
- Enrich: *Using Sound*

Lab zone Chapter Project

Keep Students on Track Make sure students can play a range of notes and vary the loudness of their instruments. Encourage them to use a pitch pipe or piano to identify the notes produced and then try to play a simple song.

Writing in Science

Writing Mode Persuasion

Scoring Rubric

4 Exceeds criteria; includes a persuasive, creative advertisement with a clear, concise description and an accurate diagram

3 Meets criteria

2 Includes a diagram and explanation but contains some errors

1 Includes only a rough sketch and/or brief explanation or contains serious errors