DELTA SCIENCE READER

Sound

Delta Science Readers *are nonfiction student books that provide science background and support the experiences of hands-on activities. Every* ***Delta Science Reader*** *has three main sections: Think About . . . , People in Science, and Did You Know?*

Be sure to preview the reader Overview Chart on page 4, the reader itself, and the teaching suggestions on the following pages. This information will help you determine how to plan your schedule for reader selections and activity sessions.

Reading for information is a key literacy skill. Use the following ideas as appropriate for your teaching style and the needs of your students. The After Reading section includes an assessment and writing links.

OVERVIEW

In the Delta Science Reader *Sound*, students read about what causes sound, how sound travels, and how sounds are different. They learn how our voices and ears work to allow us to speak and hear. They discover how different types of musical instruments make sounds. They also read about audiologists, people who test hearing. Finally, students find out how certain animals use echo-location to find out about their surroundings.

Students will

- learn that sound is a form of energy that is caused by vibration
- discover that sound can travel through any of the three states of matter
- read about the properties of sound—pitch and volume—and their causes
- learn how we speak and hear
- examine nonfiction text elements such as table of contents, headings, and glossary
- interpret photographs and diagrams to answer questions
- complete a KWL chart

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READING IN THE CONTENT AREA SKILLS

- Recognize causes and effects related to sound
- Compare and contrast the loudness of different sources of sound
- Draw conclusions from text information
- Identify main ideas about text passages
- Describe the sequence of events in speaking and hearing
- Classify musical instruments
- Demonstrate critical thinking
- Interpret graphic devices
- Summarize

NONFICTION TEXT ELEMENTS

Sound includes a table of contents, headings, photographs, illustrations, diagrams, captions, boldfaced terms, a graph, and a glossary.

CONTENT VOCABULARY

The following terms are introduced in context and defined in the glossary: *absorb, amplitude, auditory nerve, compression, decibel, ear canal, eardrum, echo, echolocation, energy, inner ear, loudness, middle ear, noise pollution, percussion instrument, pitch, reflect, sonar, sonic boom, sound, sound wave, speed of sound, stringed instrument, tuning fork, ultrasonic, vibrate, vocal cords, volume, wavelength, wind instrument.*

BEFORE READING

Build Background

Access students' prior knowledge of sound by displaying and discussing the cover. Ask, *Have you ever played or seen someone play a drum? How does a drum make sounds?* (by being struck with drumsticks or a hand) *How does the drummer make the sound louder or softer?* (by striking the drum harder or more gently)

Read the title aloud, and invite students to share what they know about the topic from their personal experiences and hands-on explorations in science. To stimulate discussion, ask questions such as these: *What do you think sound is? How do sounds reach our ears? How are sounds different?*

Begin a group KWL chart by recording facts students know about sound in the K column and questions they have about sound in the W column. You may want students to copy the KWL chart so they can maintain their own charts as they read.

K What I Know	W What I Want to Know	L What I Learned	+ What I Want to Explore Further

Preview the Book

Explain that when students preview nonfiction, they should look at the title, the table of contents, headings, boldfaced words, photographs, illustrations, charts, graphics, and captions.

Then preview the book with students. Call attention to the various nonfiction text elements and explain how they can help students understand and organize what they read. Ask questions such as these: *How do the headings help you predict what you will read about? What do you see in this picture? How do you think it will help you understand the text?* Explain that the words in boldface type are important words related to sound. Point out that these words are defined in the glossary. Choose one word and have students find its definition in the glossary.

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Preview the Vocabulary

You may wish to preview some of the vocabulary words before reading, rather than waiting to introduce them in the context of the book. Possibilities include creating a word wall, vocabulary cards, sentence strips, or a concept web.

For example, some of the words can be categorized according to whether they relate to characteristics of sound or how objects affect sound. Develop a two-column chart like the one that follows.

Properties of Sound	How Objects Affect Sound
loudness pitch volume	absorb reflect

Set a Purpose

Discuss with students what they might expect to find out from the book, based on their preview. Encourage them to use the questions on the KWL chart to set an overall purpose for reading.

GUIDE THE READING

Preview the book yourself to determine the amount of guidance you will need to give for each section. Depending on your schedule and the needs of your class, you may wish to consider the following options:

- **Whole Group Reading** Read the book aloud with a group or the whole class. Encourage students to ask questions and make comments. Pause as necessary to clarify and assess understanding.
- **Shared Reading** Have students work in pairs or small groups to read the book together. Ask students to pause after each text section. Clarify as needed and discuss any questions that arise or have been answered.
- **Independent Reading** Some students may be ready to read independently. Have them rejoin the class for discussion of the book. Check understanding by asking students to explain in their own words what they have read.

Tips for Reading

- If you spread out the reading over several days, begin each session by reviewing the previous day's reading and previewing what will be read in the upcoming session.
- Begin each text section by reading or having a volunteer read aloud the heading. Have students examine any illustrations or graphics and read accompanying captions and labels. Discuss what students expect to learn, based on the heading, illustrations, and captions.
- Help students locate context clues to the meanings of words in boldface type. Remind them that these words are defined in the glossary. Provide help with words that may be difficult to pronounce.
- As appropriate, model reading strategies students may find helpful for nonfiction: adjust reading rate, ask questions, paraphrase, reread, visualize.

Think About . . . (pages 2–13)

Pages 2, 3 *What Causes Sound?*

- Stimulate interest in the topic by asking students to be very quiet and listen carefully for a few moments. If possible, close the classroom door and windows. Then ask them what they heard. (Students might mention voices, footsteps in the hall, traffic noises, and other environmental sounds.) Invite volunteers to tell what caused each sound. Then have students read the text on page 2, study the diagrams, and read the captions.
- Ask, *What is sound?* (a form of energy) *What causes sound?* (something that vibrates) *What happens when something vibrates?* (It causes changes in the air.)

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Have students summarize the changes made by a vibrating ruler. (When the vibrating ruler moves up, it squeezes, or compresses, the air particles above it together. When it moves down, it compresses the air particles below it, so there are fewer air particles above it.) Direct students' attention to the illustration on the right. Ask, *What do the dots show?* (areas of high pressure, or compression, and low pressure) *What do these areas of high and low pressure form?* (sound waves)

- You might wish to demonstrate or have volunteers demonstrate the experiment with the ruler shown in the illustrations.

- Then have students study the diagram on page 3 and read the text to learn about sound waves. Ask, *What is the main idea—the most important point—about the way sound waves move?* (Sound waves move away from a vibrating object in a series of compressions.) *What causes changes in the wavelength?* (how quickly or slowly something vibrates) *What happens when something vibrates slowly?* (The compressions are farther apart, and the wavelength is long.) *What happens when something vibrates quickly?* (The compressions are closer together, and the wavelength is short.)

- If a spring toy is available, have two volunteers use it to demonstrate how sound waves move, as described on page 3.

Pages 4, 5 *How Does Sound Travel?*

- Before students read, ask them whether they were able to hear sounds from the hallway with the classroom door closed or sounds from outside with the windows closed. Ask, *What conclusion can you draw from that?* (Sounds can travel through solid material such as walls, doors, and window glass.) Then have students read page 4 to learn how sound travels.

- After students finish reading, ask, *What did you find out about how sound travels?* (Sound travels out in all directions from a vibrating object.) *What materials can sound travel through?* (solids, liquids, and gases) As needed, review solid, liquid, and gas as the three states of matter. Invite students to suggest examples of each. (solid, book; liquid, milk; gas, air) *Could sound travel through space, where there is no air?* Point out that science fiction movies or TV programs that show space battles accompanied by loud sounds are in error. Space battles would be totally silent, since sound cannot travel through empty space.

- Ask students whether they think sound always travels at the same speed. Then have them read page 5 to find out about the speed of sound. Ask, *What affects the speed of sound?* (the kind of material sound travels through and the temperature of the material) *In what kind of material does sound travel the fastest?* (solids) *In what does it travel the slowest?* (air) *How does temperature affect the speed of sound?* (Sound travels more slowly in cold air than in warm air.)

- Students may be interested to know that before Chuck Yeager's flight in a specially designed plane (described as a "flying bullet"), the speed of sound was referred to as the "sound barrier." It was believed that it was impossible to go faster than that speed.

Pages 6, 7 *How Are Sounds Different?*

- After reading the heading, ask students to name as many differences in sounds as they can think of. (Students may mention loud, soft, high, low, and so on.) Then have them read page 6 to discover what causes differences in sounds.

- Ask, *What is amplitude?* (the amount of energy a sound wave has) *How does amplitude affect sound?* (The greater the amplitude, the louder the sound.) *What are you actually doing when you turn the volume control of a CD player or TV up or down?* (changing the amplitude) As

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appropriate, relate the dots in the wave diagram on page 6 to the dots showing sound waves in the illustration on page 2.

- Have students read page 7 and study the diagram. Ask, *What is pitch?* (how low or high a sound is) *What causes differences in pitch?* (how quickly or slowly something vibrates) *What is the relationship between pitch and wavelength?* (Low-pitched sounds have a long wavelength; high-pitched sounds have a short wavelength.) *How did the diagram help you understand this relationship?* (It shows the differences in the wavelengths.) Discuss whether the diagram could be an adult and child talking to each other. (Yes. It shows two sounds with different pitch but the same volume.) *Why do you think that a child's voice has a higher pitch than an adult's voice?* (Accept all ideas. Students may suggest that a child's vocal cords vibrate faster than an adult's or that they are thinner or shorter.) Tell students that the tighter the vocal cords, the higher the pitch of the voice.

- If necessary, provide help with the pronunciation of *amplitude* (AM-plih-tood).

Page 8 *How Is Sound Absorbed and Reflected?*

- Ask students whether they have ever heard an echo. Encourage volunteers to tell what they think causes an echo. (Some students may know that it is caused by sound bouncing off a surface.) Then have them read page 8. Ask, *What causes an echo?* (Sound waves reflecting off a hard surface.) *Why are sounds softer in a room with curtains, carpets, and furniture?* (These soft materials absorb sound. They do not reflect sound.)

- Direct attention to the illustration of how sonar works. Ask, *What do the curved lines in the picture show?* (sound waves going from a ship to the ocean floor and back) *How do you suppose people use math to figure out how deep the water is?* Explain that scientists measure the time it takes for the echo to return and multiply that figure by the speed of sound. Then they divide by 2 because the sound traveled to the ocean bottom *and back*. Sonar findings are displayed on a screen or readout, which gives a picture of the depths to which the sound traveled.

- Discuss how sonar might be used to locate an object, such as a shipwreck or a mountain, on the ocean floor. Elicit that sound striking an object on the ocean floor would have a shorter distance to travel to return to the ship. Many sonar readings would provide an outline of the object.

Page 9 *What Is Noise Pollution?*

- Have students read the first paragraph on page 9 and examine the graph. Explain: *This is a bar graph. It compares the loudness of different sounds. The column at the left shows the kind of sound. The numbers along the bottom of the graph show the number of decibels each sound makes. The length of the bars shows how loud the sound is.* Model how to read the bar graph by going across to the end of a bar and looking down to the numbers at the bottom of the graph. Check comprehension by having students identify the number of decibels made by some sounds. Ask, for example, *How many decibels is the sound a jet engine makes?* (140) *How many decibels is the sound of a person speaking?* (60) Then have students compare and contrast various sounds. Ask, *What sounds are louder than a car horn?* (loud music, jet engine) *Which is the softest sound?* (a soft whisper)

- Ask students what they think noise pollution is. (Accept reasonable responses.) Then have them read the text in the second column, look at the photograph, and read the caption. Ask, *What are some of the problems noise pollution can cause?* (trouble sleeping, tiredness, crankiness, headaches, hearing loss, ear pain) *What should people who work around loud noises do to protect*

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their hearing? (wear ear protectors) Encourage students to suggest workers who should wear ear protectors. (Answers may include heavy equipment drivers, people who operate jack hammers or chain saws, factory workers, or rock musicians.)

- You may wish to point out that the following careers are considered to have a higher risk for hearing loss because of continuous exposure to loud noise: carpentry, plumbing, mining, transportation, the military, agriculture, construction, and concrete work.

- If necessary, provide help with the pronunciation of *decibel* (DESS-uh-buhl).

Pages 10, 11 *How Do We Speak and Hear?*

- Have students read the text on page 10 and look at the accompanying diagram. Have students touch their fingers to their throats as the text describes and hum. Ask, *Can you feel your vocal cords vibrating?* Then have them describe the sequence of events that takes place so that we can speak. (Air from our lungs passes through a narrow opening between the vocal cords and makes them vibrate. When the vocal cords vibrate, they make a sound.) *How do our vocal cords make louder sounds?* (When air passes between them quickly, the sound gets louder.) *How do our vocal cords make higher sounds?* (When the vocal cords are tighter, the pitch gets higher.)

  Students may be interested to know that one reason different people have higher- or lower-pitched voices is that the length and shape of the vocal tract—the part of the body from the larynx to the lips—varies. The longer and wider the vocal tract, the deeper and fuller the voice. A short, narrow vocal tract produces a higher, lighter voice.

- Have students read the text on page 11 and look at the accompanying diagram. Then have students describe the sequence of events involved in hearing. (Sound waves travel through the ear canal until they reach the eardrum. When they strike the eardrum, it vibrates. The vibration makes the hammer, anvil, and stirrup vibrate. These bones send the vibrations to the inner ear. The cochlea in the inner ear changes the sound energy into electrical signals. These signals pass along the auditory nerve to the brain. The brain understands the signals as sounds.)

- Remind students that some workers wear ear protectors to protect their ears from loud sounds. Ask, *How do ear protectors work?* (They block sound waves from entering our ears.)

- If necessary, provide help with the pronunciation of *larynx* (LAIR-inks), *trachea* (TRAY-kee-uh), and *cochlea* (KOK-lee-uh).

Pages 12, 13 *How Do Musical Instruments Make Sounds?*

- Invite students to name as many different musical instruments as possible. List instruments on the board as they are named. Ask students how each instrument is played—by strumming or bowing it, blowing into it, or striking it. Then have students read pages 12 and 13.

- Ask, *What are the three kinds of instruments?* (stringed instruments, wind instruments, percussion instruments) Write these headings on the board, and ask, *Which of the instruments you named should I write under the heading "stringed instruments"?* Continue categorizing the instruments students mentioned earlier. Call on volunteers to identify additional instruments mentioned in the text, and add these to the lists.

- Remind students that all sounds are created by vibrations. Ask, *In a stringed instrument, what vibrates to make sounds?* (strings) *What vibrates in a wind instrument to make sounds?* (air inside the instrument) *What vibrates in a*

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percussion instrument? (the material the instrument is made of, or part of the instrument such as the cover of a drum) After students read the caption for the photograph of the inside of a piano, ask, *Why is a piano both a stringed instrument and a percussion instrument?* (A piano has strings that are hit by hammers to make sounds.)

- Determine students' familiarity with tuning forks. Ask if anyone has ever seen or used one. Let them share their experiences. Ask what the photograph of the tuning fork on page 12 would look like if the fork were struck and dipped in the water. (There would be ripples moving in circles from the tuning fork to the edges of the pan.)

- If necessary, provide help with the pronunciation of *viola* (vee-O-luh), *cello* (CHEL-o), *oboe* (O-bo), *bassoon* (buh-SOON), *cymbals* (SIM-buhlz), *tambourine* (tam-buh-REEN), and *xylophone* (ZI-luh-fone).

Further Facts

- Benjamin Franklin invented an instrument called a glass harmonica. He was inspired by the sounds produced when a person rubs a wet finger around the rim of a drinking glass. The instrument consisted of glass bowls that were ground so that each produced a different pitch. The bowls were mounted on a spindle that was turned by a foot treadle. The musician placed wetted fingers on the edges of the spinning bowls and moved his or her hands from bowl to bowl quickly to blend the sounds together.

- The theremin is a unique electronic musical instrument—it is played without being touched. It was invented in 1919 by a Russian physicist named Leon Theremin. The instrument consists of a wooden box with two metal antennae, one controlling pitch, the other, volume. Sounds are produced when the musician moves his or her hands near the antennae. This changes the frequency. The interaction of the two frequencies produces a variety of sounds.

People in Science (page 14)

Audiologists

- Before they read, ask students to raise their hands if they have ever had their hearing tested. Ask volunteers to describe the experience. Encourage them to give details about the instruments the audiologist used and the procedure itself. Then have them read page 14 to find out about the work of audiologists.

- Ask, *Why do you think hearing tests are important for people of all ages?* (So problems with hearing can be discovered early.) *What parts of the ear might an audiologist look at through an otoscope?* (the ear canal and eardrum) *Why do you think an audiologist plays sounds of different volumes and pitches?* (To find out which kinds of sounds the person being tested can and cannot hear.)

- If necessary, provide help with the pronunciation of *audiologist* (aw-dee-AW-luh-jist) and *otoscope* (O-tuh-skope).

Further Facts

- The earliest hearing aid was the ear trumpet, a large tube shaped like a horn with a narrow opening at one end that fits into the ear and a large mouth at the other end for collecting sound waves.

- The first electronic hearing aid was invented in the 1890s. It consisted of a small case that held batteries and a receiver that was worn on the ear. Queen Alexandra of England was one of the first users; she wore it during her coronation ceremony in 1902.

- The cochlear implant takes over the work of the cochlea changing sound energy into electrical current. Georg von Bekesy won the Nobel Prize in 1961 for his research on the cochlea, which led to the invention of

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the implant. The first implant surgery was carried out in 1978.

Did You Know? (page 15)

About Echolocation

- Before students read, invite volunteers to share any knowledge they have about how bats find insects in the dark. Then have students read page 15 to find out about echolocation.

- After students read, ask, *How does echolocation work for both bats and dolphins?* (The animal sends out sounds that reflect off objects. The animal can tell from the echoes what kinds of objects are around it.) *Why do bats use echolocation?* (They hunt at night when it is hard to see.) *How do you think echolocation helps dolphins?* (They may have trouble seeing in dark or unclear water.) *What is the most interesting or surprising fact you learned about echolocation?* (Responses will vary.)

Further Facts

- Using echolocation, a bat can determine the size, shape, direction, distance, and movements of an object. A bat can detect insects as tiny as a gnat and objects as fine as a human hair.

- Several kinds of birds, some shrews, and other kinds of toothed whales besides dolphins also use echolocation.

- A bottlenose dolphin can discriminate between objects that are nearly identical. It can also echolocate on near and distant targets at the same time.

- Not all echolocation involves high-frequency sounds or ultrasonic sounds. Humans can hear the echolocation sounds made by some species of birds and bats.

AFTER READING

Summarize

Complete the KWL chart you began with students before reading by asking them to share the answers to their questions. Call on volunteers to retell each text section. Then have students use the information in the KWL chart to write brief summary statements.

Discuss with students how using the KWL strategy helped them understand and appreciate the book. Encourage them to share any other reading strategies that helped them understand what they read. Direct attention to the fourth column in the chart and ask: *What questions do you still have about sound? What would you like to explore further?* Record students' responses. Then ask, *Where do you think you might be able to find this information?* (Students might mention an encyclopedia, science books, and the Internet.) Encourage students to conduct further research.

Review/Assess

Use the questions that follow as the basis for a discussion of the book or for a written or oral assessment.

1. What are sound waves, and how do they move? (Sound waves are the areas of high and low pressure that carry sound energy from one place to another. They move in a series of compressions.)

2. In what direction does sound travel? (Sound travels out in all directions from its source.) What materials can sound pass through? (It can pass through solids, liquids, and gases.)

3. What causes differences in sounds? (The amplitude, or height of the wavelength, makes a sound loud or soft. Objects vibrating with a lot of energy have greater amplitude. The greater the amplitude, the louder the sound. The speed at which something vibrates makes a sound high or low. The greater the frequency, the higher the pitch.)

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4. What happens when sound waves hit a surface? (Sounds are absorbed by soft surfaces such as carpeting, curtains, and furniture, making a room quieter. Sounds are reflected, or bounce off, hard surfaces, causing echoes.)

5. Name the three kinds of musical instruments. Give an example of each kind and describe how it makes sound. (The three kinds of instruments are percussion, stringed, and wind. A drum is a percussion instrument. It makes sound when something, such as a drumstick, hits it and causes the cover to vibrate. Violins and guitars are stringed instruments. They make sound when their strings are plucked or rubbed with a bow. Horns such as trumpets and clarinets are wind instruments. They make sound when a person blows into them, causing air in the instrument to vibrate.)

Writing Links/Critical Thinking

Present the following as writing assignments.

1. Think about noise pollution and the kinds of things that can cause it. Where do you think noise pollution is more of a problem, in the city or in the country? Explain your reasons. Suggest at least one way to reduce noise pollution. (Students will probably respond that it would be worse in the city because of the numbers of people, the amount of traffic, building construction, and so on. However, agricultural workers who use heavy farm equipment also suffer from noise pollution. Solutions might include better sound insulation or sound barriers; laws to ban certain kinds of loud machines from certain areas; putting decibel limits on machines; having quiet hours; setting up no-noise areas; fining people who break noise rules; or rewarding companies that reduce noise levels.)

2. What is the connection among (a) the speed with which something vibrates, (b) the wavelength, and (c) the pitch of a sound? (A rapidly vibrating object has a short wavelength, which creates a high-pitched sound. An object that vibrates more slowly has a long wavelength, which creates a low-pitched sound.)

Science Journals: You may wish to have students keep the writing activities related to the Delta Science Reader in their science journals.

References and Resources

For trade book suggestions and Internet sites, see the References and Resources section of this teacher's guide.

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