Lesson 1.4
Exploring Sound Waves
Lesson Overview

Using new models, students observe the movement of waves and begin to focus their investigation on sound waves. To begin the lesson, students reread a portion of Warning: Tsunami! to learn more about what travels in a wave. Students then participate in a stadium wave and gain firsthand experience observing what travels in a wave. Next, students are introduced to the Sound Waves Simulation (Sim), a digital model that students will use to study sound. The purpose of this lesson is for students to establish an understanding that sound energy travels as a wave and the thing it travels through (e.g., rope, spring toy, water) moves only a little.

**Anchor Phenomenon:** Dolphins in Blue Bay National Park communicate with one another underwater.

**Investigative Phenomenon:** Tsunamis are powerful and dangerous ocean waves.

**Everyday Phenomenon:** Musical instruments make sound.

**Students learn:**

- The energy that travels in a sound wave is sound energy.
- Sound energy travels as a wave. The thing it travels through moves only a little.
Students return to the book and use the text and a visual representation to learn more about what travels in a tsunami wave.

Instructional Guide

1. **Reflect on the previous lesson.** Remind students that they learned that sound travels as a wave.

   In the previous lesson, we read the book *Warning: Tsunami!* and we learned that tsunami waves have a pattern of motion. What kind of wave pattern did we read about in the book?

   [The tsunami wave pattern is up and down.]

   We also learned that a wave is a pattern of motion that travels away from a source. Who can recall from *Warning: Tsunami!* what the source of a tsunami is?

   [When the seafloor lifts after an earthquake.]

   Confirm that when the seafloor lifts, it starts the wave pattern of a tsunami.

2. **Set a purpose for reading.**

   Now we understand what starts a wave and the patterns of motion that occur in waves. Today, we will investigate what moves in a wave. Let’s reread part of the book that explains more about this.

3. **Distribute one copy of *Warning: Tsunami!* to each pair of students.** Ask them to turn to page 13. Read aloud the section heading “What Moves in a Tsunami?” Explain that they will read to see if this question is answered in this section. Point out that students should refer to the visual representation on pages 14 and 15 to try to identify what moves in a tsunami, since they can’t see the tsunami in person.

4. **Have a student read page 13 aloud.**

   The text states, “The water itself is hardly even moving in a tsunami.”
Point out that this might be confusing since water flows over areas of land that are usually dry when a tsunami wave, or a regular ocean wave, meets the shore. Students may have experienced this at the beach. Explain that this is an exception to the general pattern that there is no net motion in the direction of the wave, and it happens because the water is shallower near the shore.

If the water is hardly moving as a tsunami wave moves across the ocean, what do you think could be traveling?

Call on a few students to share their ideas.

5. Have another student read page 14 aloud.

The text states, “All that travels is the energy of the wave.” What do you think this means—what is energy?

Have students turn and talk about their ideas with a partner. Then call on a few students to share ideas with the class.

6. Have students turn to the book’s glossary on page 20. Read the definition of energy aloud.

Energy is the ability to make things move or change.

Let’s use the visual representation of the tsunami wave to try to get an idea of how the energy travels in a tsunami. Visualize the energy traveling through the ocean in the diagram on pages 14 and 15.

7. Call on volunteers to share ideas. Ask students to describe how they visualize the energy traveling in the tsunami.

8. Direct students’ attention to the Science/Everyday Words chart. Remind them that scientists use certain words to explain their ideas that are similar to words students may use every day, but the science words have more specific meanings. Remind students that when they communicate with the park superintendent, they will use scientific language to explain their ideas about what is happening in Blue Bay National Park, so it is important to remember the scientific words they are learning. Explain that this chart can help them remember to use the scientific words in science class.

9. Discuss the word visualize. Write “visualize” in the “Science words” column of the chart. Remind students that they have just visualized how energy moves. Ask students to suggest everyday words that mean something similar to visualize. [Imagine, think about, see in your mind.] With class consensus, write the everyday words in the “Everyday words” column of the chart.

10. Point out that visualizing is not the same as imagining. Explain that visualizing is making a picture in your mind, but using real information from different sources.

11. Post the visualize card on the classroom wall. Remind students that they can refer to the classroom wall, as well as the Science/Everyday Words chart, for help remembering and using the science vocabulary they are learning.

12. Collect all copies of Warning: Tsunami!
Teacher Support

Instructional Suggestion

Providing More Experience: Today’s Daily Written Reflection
We have explored up-and-down patterns of motion and back-and-forth patterns of motion. What patterns of motion do you see in your everyday life? This prompt (on page 13 in the Investigation Notebook) asks students to think about what they have been learning about different patterns of motion. Encouraging students to respond to this prompt can help them connect what they did in the previous lesson to any lingering ideas or questions they still have. This can help you learn about students’ prior knowledge about patterns of motion.

Background

Science Note: What Travels in a Wave?
One of the more challenging concepts that students learn in this unit is the idea that material doesn’t travel from the source of the wave to its endpoint; rather, it is the energy of the initial vibration that moves away from the source. Warning: Tsunami! points out that ocean water from Alaska doesn’t travel to Hawaii in a tsunami. You can return to this example in Lesson 2.4 as students use a spring toy to model how energy travels and to visualize particle collisions. In Chapter 2, students will have more opportunities to discuss how the actual material moves when a wave is traveling through it.

Background

Science Note: What Is Energy?
Energy is the ability to make things move or change. Energy is a big concept in science, and this unit focuses on just one aspect of energy: how it can travel as a wave. Most students are familiar enough with energy from their everyday lives to understand that it can make things move—e.g., when you plug in a fan, it starts to rotate; when a child has a lot of energy, he tends to move around more. It is useful to describe a wave as energy traveling away from a source because it helps explain how an earthquake can happen in one place and result in something (a tsunami) happening far, far away. In this unit, students are not expected to understand what energy is or does beyond energy’s ability to make things move.

Instructional Suggestion

Student Thinking: Visualizing Energy
Inviting students to visualize the energy of a tsunami wave traveling through the ocean helps them create images to keep in mind as they continue to build their understand of waves. You may wish to provide students a few moments to visualize the motion of energy and then share their ideas with a partner. After all students have had a chance to articulate what they visualized, you can invite a few students to share their ideas with the class.

Background

Science Note: Why Do We Call It a Pattern?
Students may have a variety of experiences with common uses of the word pattern. Some students may describe a pattern as repeating numbers, such as 0 and 5 when counting by fives. Some may think of a consistent arrangement, such as colors in a rainbow, and others may think of patterns in fabric or works of art. All of these understandings of patterns can help students come to understand patterns as defined in this unit: something we observe to be similar
over and over again. Highlight that the meaning of pattern in science is a little different from what they might be used to, and help students connect to the patterns they are learning about in this unit. Students will get many opportunities to discuss the crosscutting concept of patterns in this unit.
Students are introduced to the Sound Waves Sim and to the concept of modeling in science.

Exploring the Sound Waves Simulation

Students are introduced to the Sound Waves Sim and to the concept of modeling in science.

Instructional Guide

1. Discuss sound waves.

   As marine scientists, we’ve been asked to study sound and how sound travels from the mother dolphin to her calf. Using what we know about waves, it is time to more closely examine the specific kind of wave that we need to understand: a sound wave.

   Based on our investigation of waves, we determined that energy is what travels in a wave, and whatever the wave is traveling through—in the case of a tsunami, that’s water—moves only a little.

   All sound—including the sound of our voices, the sound of music, and the sound of dolphins communicating—travels as waves.

2. Introduce the Sound Waves Simulation. Engage students in a brief conversation about studying sound.

   How might we study sound waves so we can better understand how the mother and calf dolphins are communicating?

   Can we study sound waves by looking at them? Why or why not?

   Call on volunteers to share their responses. Make sure that students understand that sound waves are not visible.

   Just like readers visualize when they read science text, scientists often make models to help them visualize things they can’t see easily. Since we can’t see sound, we will use a model called the Sound Waves Simulation to better understand what happens when sounds travel.
3. Introduce the word *model*.

In science, the word *model* means something that scientists make to answer questions about the real world. Sometimes scientists use models to investigate questions about how the world works, and sometimes they use them to show their ideas about the answers.

As marine scientists, we will use the Sim as a model to investigate our questions about sound and how it works, so we can explain it to others, including the park superintendent.

4. **Project the Sound Waves Simulation.** Go to the Student Apps Page. Show students how to open the Sound Waves Simulation. Explain that the Sim shows how sound is created and how it travels.

5. **Demonstrate the basic features of the Instruments mode of the Sim.** Make sure the Waveform toggle is turned off. (This is the default setting.) With the Instruments mode projected, model the following:

   - The image on the right side of the screen shows what is making the sound. To change the instrument, select **VIEW ALL SOUNDS**.
   - To play a sound, press **Play**.

6. **Explain how students will record their observations and questions.** Have students turn to page 14, Exploring the Sound Waves Simulation, in their notebooks. Explain that students should read the prompts in the first column of the table.

   You will make observations as you explore the Sim. Observations may be things you see or things you hear. Record what you notice about the things you see and hear in the second column of the table.

   You will probably think of many questions you have about sound. Asking questions and wondering about a topic are things that scientists do all the time. Record what you wonder about in the third column of the table.
7. Project and read aloud Guidelines for Using Apps. Explain the behavior guidelines for using apps and digital devices in the classroom. Let students know that when half of the Sim exploration time remains, you will give a signal, at which time each pair should switch “drivers” so that everyone has a chance to work with the Sim.

Guidelines for Using Apps

- Only one person “drives” at a time.
- Anyone can make suggestions about how to use the app.
- Talk about what you observe.
- Rotate the role of “driver.”

8. Distribute digital devices. Distribute one digital device to each pair of students and have them go to the Sound Waves Simulation. Let them know that they will have about 15 minutes to explore the Instruments mode.

9. Give partners about 15 minutes of free exploration time. Remind students to record observations and questions in their notebooks while their partners “drive” the Sim. Halfway through the free exploration time, remind students to switch roles if they have not already done so.

10. Ask the class to share what they observed about how the Sim works. Project the Sim and ask the following questions (or similar questions) to prompt students to reflect on and share what they observed about the Sim. Invite students to point to features of the Sim as they respond.

- “Where did the sound come from?”
- “What pattern did you see?”
- “What do you think was traveling?”
- “What happened to the moving dots?”

11. Invite students to share observations or questions they recorded in their notebooks. Have students turn to page 14, Exploring the Sound Waves Simulation, in their notebooks.

What is something interesting that you observed?
What is something that you wonder or a question that you have about the Sim?
12. **Project and discuss Scale of the Sim.** Give students a few moments to silently observe the projection, then call on students to share what they notice about the image. If it is not mentioned, point out that this image shows the scale of the Sim—the Sim represents a very, very zoomed in version of something that is too tiny to see. Point out that sound waves move away from a source in circular motions as shown in the projection, but the Sim is so zoomed in that it just shows a tiny portion of the circle.

![](sound_waves.png)

13. **Collect digital devices.** Ask students to make sure that their digital devices are turned off.

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**Teacher Support**

**Instructional Suggestion**

**Providing More Experience: Multiple Meanings of Model**

When you introduce the word *model*, you may need to discuss the fact that this word, like many words in English, has more than one meaning. In this case, students may be thinking of fashion models instead of the meaning that is intended. Students may also think of model cars or planes. Lead a brief discussion about the different meanings of the word. You may wish to show students some examples or images to help them understand the difference between the meanings of the word. Emphasize that when the word is used in science class, we always mean something scientists make to answer questions about the real world. You may want to keep track of this and other science words that have multiple meanings on a class chart.

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**Instructional Suggestion**

**Technology Note: Sharing Devices with a 1:2 Ratio**

Throughout this unit, pairs share digital devices. We recommend that instead of working individually, students work with partners so they can engage with and talk to each other while using apps. Try to establish clear expectations for the use, handling, and storage of digital devices in order to decrease transition time between activities as well as to minimize any potential conflict that could come from sharing a limited number of devices.
**Rationale**

**Pedagogical Goals: Time for Exploration**
The first time students use a Simulation, they need a few minutes to freely explore the Simulation features. Students are generally quite facile in discovering Simulation features independently or with a partner. This type of open-ended exploration enhances student interest, as well as provides students with the opportunity to share their thinking and learn from their peers. Giving students this exploration time initially reduces distraction in later Sim activities that have more focused goals.

**Rationale**

**Technology Note: Sound Waves Simulation**
The Sound Waves Simulation is an integral part of this unit. It is an interactive digital simulation that allows students to observe that sound is a wave. The Sound Waves Sim includes three modes: Instruments, Custom Sound, and Xylophone. The Sim was designed to be used throughout this unit to help students discover increasingly complex qualities of sound waves. For this initial exposure to the Sim, it is important for students to explore only the Instruments mode. Students do not yet have the background to understand other features of the Sim without more teacher guidance. Please allow students to gradually make sense of the Sim and keep in mind that they will learn more about its other features and modes in future lessons.

**Rationale**

**Science Note: About the Sound Waves Simulation**
Like all models, the Sound Waves Simulation represents some things about the phenomenon (sounds traveling) accurately and other things inaccurately. In making a useful model, compromises are always made. One important compromise in this model is scale—in reality, molecules are far too small to be seen on the same scale as the wavelengths of sound waves. In this Sim, the molecules are large enough to be seen on the same scale as the wave patterns to help students visualize the way that sound waves travel via particle collisions. A second compromise is that the Sim does not show molecules as different from one another. There are a variety of molecules that make up materials through which sound can travel, but including those differences would complicate the model in a way that would not support students’ understanding of sound.

A third compromise in this Sim is that all waveforms are represented as pure tones, which take the shape of a sinusoidal wave. This means that at any single point in the wave, the sound has a single frequency and amplitude. In reality, most musical instruments emit sounds with a dominant frequency (the fundamental frequency), which is the tone that the listener hears, in addition to a few other simultaneous harmonic frequencies. Thus, waveforms of sounds emitted from musical instruments are typically much more complex than those represented in the Sim. Simplifying the waveforms in this way enables students to more easily see the connection between waveform characteristics and the changes in pitch and volume that they are hearing. It is good to be aware of these simplifications as you teach the unit and use the Sim, but it is not necessary to share them with students, unless they come up during instruction.
Possible Responses

Investigation Notebook
Exploring the Sound Waves Simulation (page 14)

Answers will vary.

Examples for second column of the table:
Row 1: There are many orange dots moving around on the screen.
Row 2: When you play a sound, the dots move back and forth.
Row 3: The sounds of different instruments, higher and lower sounds.
Row 4: The instrument.

Examples for third column of the table:
Row 1: What are they? Why are they moving this way?
Row 2: Why do sounds make the dots move in this pattern?
Row 3: What makes the instruments sound different?
Row 4: How does the instrument make the sound?
Exploring the Sound Waves Simulation

1. In the second column of the table, record what you notice about the Simulation.

2. As you explore the Simulation, record what you wonder about in the third column.

<table>
<thead>
<tr>
<th>Observations</th>
<th>What I notice</th>
<th>What I wonder</th>
</tr>
</thead>
<tbody>
<tr>
<td>What I see moving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The pattern I see</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The sounds I hear</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The source of the sound</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Rereading Warning: Tsunami!

Students return to the book and use the text and a visual representation to learn more about what travels in a tsunami wave.

Instructional Guide

1. Reflect on the previous lesson. Remind students that they learned that sound travels as a wave.

**Question:** En la lección anterior, leímos el libro Peligro: ¡tsunami! y aprendimos que las ondas de tsunami tienen un patrón de movimiento. ¿Sobre qué tipo de patrón de onda leímos en el libro? [El patrón de onda de los tsunamis es arriba y abajo].

**Question:** También aprendimos que una onda es un patrón de movimiento que viaja alejándose de una fuente. ¿Quién puede recordar de lo que leímos en Peligro: ¡tsunami! cuál es la fuente de un tsunami? [Cuando el suelo marino se levanta después de un terremoto].

Confirm that when the seafloor lifts, it starts the wave pattern of a tsunami.

2. Set a purpose for reading.

**Question:** Ahora entendemos qué comienza una onda y los patrones de movimiento que ocurren en las ondas. Hoy investigaremos qué se mueve en una onda. Leamos de nuevo la parte del libro que explica más sobre esto.

3. Distribute one copy of Warning: Tsunami! to each pair of students. Ask them to turn to page 13. Read aloud the section heading “What Moves in a Tsunami?” Explain that they will read to see if this question is answered in this section. Point out that students should refer to the visual representation on pages 14 and 15 to try to identify what moves in a tsunami, since they can’t see the tsunami in person.

4. Have a student read page 13 aloud.

**Question:** El texto dice: "El agua en sí apenas se mueve durante un tsunami".
Point out that this might be confusing since water flows over areas of land that are usually dry when a tsunami wave, or a regular ocean wave, meets the shore. Students may have experienced this at the beach. Explain that this is an exception to the general pattern that there is no net motion in the direction of the wave, and it happens because the water is shallower near the shore.

Call on a few students to share their ideas.

5. Have another student read page 14 aloud.

Have students turn and talk about their ideas with a partner. Then call on a few students to share ideas with the class.

6. Have students turn to the book's glossary on page 20. Read the definition of energy aloud.

Ask students to describe how they visualize the energy traveling in the tsunami.

8. Direct students' attention to the Science/Everyday Words chart. Remind them that scientists use certain words to explain their ideas that are similar to words students may use every day, but the science words have more specific meanings. Remind students that when they communicate with the park superintendent, they will use scientific language to explain their ideas about what is happening in Blue Bay National Park, so it is important to remember the scientific words they are learning. Explain that this chart can help them remember to use the scientific words in science class.

9. Discuss the word visualize. Write “visualize” in the “Science words” column of the chart. Remind students that they have just visualized how energy moves. Ask students to suggest everyday words that mean something similar to visualize. [Imagine, think about, see in your mind.] With class consensus, write the everyday words in the “Everyday words” column of the chart.

10. Point out that visualizing is not the same as imagining. Explain that visualizing is making a picture in your mind, but using real information from different sources.

11. Post the visualize card on the classroom wall. Remind students that they can refer to the classroom wall, as well as the Science/Everyday Words chart, for help remembering and using the science vocabulary they are learning.
12. Collect all copies of *Warning: Tsunami!*

Teacher Support

**Instructional Suggestion**

Providing More Experience: Today’s Daily Written Reflection

*We have explored up-and-down patterns of motion and back-and-forth patterns of motion. What patterns of motion do you see in your everyday life?* This prompt (on page 13 in the Investigation Notebook) asks students to think about what they have been learning about different patterns of motion. Encouraging students to respond to this prompt can help them connect what they did in the previous lesson to any lingering ideas or questions they still have. This can help you learn about students’ prior knowledge about patterns of motion.

**Background**

**Science Note: What Travels in a Wave?**

One of the more challenging concepts that students learn in this unit is the idea that material doesn’t travel from the source of the wave to its endpoint; rather, it is the energy of the initial vibration that moves away from the source. *Warning: Tsunami!* points out that ocean water from Alaska doesn’t travel to Hawaii in a tsunami. You can return to this example in Lesson 2.4 as students use a spring toy to model how energy travels and to visualize particle collisions. In Chapter 2, students will have more opportunities to discuss how the actual material moves when a wave is traveling through it.

**Background**

**Science Note: What Is Energy?**

Energy is the ability to make things move or change. Energy is a big concept in science, and this unit focuses on just one aspect of energy: how it can travel as a wave. Most students are familiar enough with energy from their everyday lives to understand that it can make things move—e.g., when you plug in a fan, it starts to rotate; when a child has a lot of energy, he tends to move around more. It is useful to describe a wave as energy traveling away from a source because it helps explain how an earthquake can happen in one place and result in something (a tsunami) happening far, far away. In this unit, students are not expected to understand what energy is or does beyond energy’s ability to make things move.

**Instructional Suggestion**

**Student Thinking: Visualizing Energy**

Inviting students to visualize the energy of a tsunami wave traveling through the ocean helps them create images to keep in mind as they continue to build their understanding of waves. You may wish to provide students a few moments to visualize the motion of energy and then share their ideas with a partner. After all students have had a chance to articulate what they visualized, you can invite a few students to share their ideas with the class.

**Background**

**Science Note: Why Do We Call It a Pattern?**

Students may have a variety of experiences with common uses of the word *pattern*. Some students may describe a pattern as repeating numbers, such as 0 and 5 when counting by fives. Some may think of a consistent arrangement,
such as colors in a rainbow, and others may think of patterns in fabric or works of art. All of these understandings of patterns can help students come to understand patterns as defined in this unit: something we observe to be similar over and over again. Highlight that the meaning of pattern in science is a little different from what they might be used to, and help students connect to the patterns they are learning about in this unit. Students will get many opportunities to discuss the crosscutting concept of patterns in this unit.
Students are introduced to the Sound Waves Sim and to the concept of modeling in science.

Instructional Guide

1. **Discuss sound waves.**

   - Como científicos marinos, se nos ha pedido que estudiamos el sonido y cómo viaja el sonido desde la madre delfín hasta su cría. Usando lo que sabemos sobre las ondas, es hora de examinar más de cerca el tipo específico de onda que necesitamos entender: una onda de sonido.

   - Basándonos en nuestra investigación de las ondas, determinamos que la energía es lo que viaja en una onda, y el medio a través del cual viaja la onda (en el caso de un tsunami, es el agua) se mueve solo un poco.

   - Todo el sonido, incluido el sonido de nuestras voces, el sonido de la música y el sonido de los delfines comunicándose, viaja como ondas.

2. **Introduce the Sound Waves Simulation.** Engage students in a brief conversation about studying sound.

   - ¿Cómo podríamos estudiar las ondas de sonido para poder entender mejor cómo se están comunicando los delfines madre y cría?

   - ¿Podemos estudiar las ondas de sonido mirándolas? ¿Por qué sí o por qué no?

   Call on volunteers to share their responses. Make sure that students understand that sound waves are not visible.

   - Igual que los lectores visualizan cuando leen textos científicos, los científicos a menudo hacen modelos para ayudarles a visualizar cosas que no pueden ver fácilmente. Como no podemos ver el sonido, usaremos un modelo llamado Simulación Ondas de sonido para entender mejor qué sucede cuando viaja el sonido.
3. Introduce the word *model*.

En la ciencia, la palabra *modelo* significa algo que los científicos crean para responder preguntas sobre el mundo real. A veces los científicos usan modelos para investigar preguntas sobre cómo funciona el mundo, y a veces los usan para mostrar sus ideas sobre las respuestas.

Como científicos marinos, usaremos la Simulación como un modelo para investigar nuestras preguntas sobre el sonido y cómo funciona, para que podamos explicarlo a otros, incluida la superintendente del parque.

4. Project the Sound Waves Simulation. Go to the Student Apps Page. Show students how to open the Sound Waves Simulation. Explain that the Sim shows how sound is created and how it travels.

5. Demonstrate the basic features of the Instruments mode of the Sim. Make sure the Waveform toggle is turned off. (This is the default setting.) With the Instruments mode projected, model the following:

- The image on the right side of the screen shows what is making the sound. To change the instrument, select VIEW ALL SOUNDS.
- To play a sound, press Play.

6. Explain how students will record their observations and questions. Have students turn to page 14, Exploring the Sound Waves Simulation, in their notebooks. Explain that students should read the prompts in the first column of the table.

Harán observaciones mientras exploran la Simulación. Las observaciones pueden ser cosas que ven o cosas que oyen. Apunten lo que notan sobre las cosas que vean y oigan en la segunda columna de la tabla.

Probablemente pensaran en muchas preguntas que tienen sobre el sonido. Hacer preguntas y tener dudas sobre un tema son cosas que hacen los científicos todo el tiempo. Apunten lo que se pregunten en la tercera columna de la tabla.
7. Project and read aloud Guidelines for Using Apps. Explain the behavior guidelines for using apps and digital devices in the classroom. Let students know that when half of the Sim exploration time remains, you will give a signal, at which time each pair should switch “drivers” so that everyone has a chance to work with the Sim.

Reglas para usar aplicaciones

- Solo una persona “maneja” a la vez.
- Todos pueden hacer sugerencias sobre cómo usar la aplicación.
- Hablen sobre lo que observan.
- Roten en el rol de “conductor”.

8. Distribute digital devices. Distribute one digital device to each pair of students and have them go to the Sound Waves Simulation. Let them know that they will have about 15 minutes to explore the Instruments mode.

9. Give partners about 15 minutes of free exploration time. Remind students to record observations and questions in their notebooks while their partners “drive” the Sim. Halfway through the free exploration time, remind students to switch roles if they have not already done so.

10. Ask the class to share what they observed about how the Sim works. Project the Sim and ask the following questions (or similar questions) to prompt students to reflect on and share what they observed about the Sim. Invite students to point to features of the Sim as they respond.

- “Where did the sound come from?”
- “What pattern did you see?”
- “What do you think was traveling?”
- “What happened to the moving dots?”

11. Invite students to share observations or questions they recorded in their notebooks. Have students turn to page 14, Exploring the Sound Waves Simulation, in their notebooks.

¿Qué es algo interesante que observaron?

¿Qué es algo que les cause dudas o una pregunta que tengan sobre la Simulación?
12. **Project and discuss Scale of the Sim.** Give students a few moments to silently observe the projection, then call on students to share what they notice about the image. If it is not mentioned, point out that this image shows the scale of the Sim—the Sim represents a very, very zoomed in version of something that is too tiny to see. Point out that sound waves move away from a source in circular motions as shown in the projection, but the Sim is so zoomed in that it just shows a tiny portion of the circle.

13. **Collect digital devices.** Ask students to make sure that their digital devices are turned off.

**Teacher Support**

**Instructional Suggestion**

**Providing More Experience: Multiple Meanings of Model**

When you introduce the word *model*, you may need to discuss the fact that this word, like many words in English, has more than one meaning. In this case, students may be thinking of fashion models instead of the meaning that is intended. Students may also think of model cars or planes. Lead a brief discussion about the different meanings of the word. You may wish to show students some examples or images to help them understand the difference between the meanings of the word. Emphasize that when the word is used in science class, we always mean something scientists make to answer questions about the real world. You may want to keep track of this and other science words that have multiple meanings on a class chart.

**Instructional Suggestion**

**Technology Note: Sharing Devices with a 1:2 Ratio**

Throughout this unit, pairs share digital devices. We recommend that instead of working individually, students work with partners so they can engage with and talk to each other while using apps. Try to establish clear expectations for the use, handling, and storage of digital devices in order to decrease transition time between activities as well as to minimize any potential conflict that could come from sharing a limited number of devices.
Rationale

Pedagogical Goals: Time for Exploration
The first time students use a Simulation, they need a few minutes to freely explore the Simulation features. Students are generally quite facile in discovering Simulation features independently or with a partner. This type of open-ended exploration enhances student interest, as well as provides students with the opportunity to share their thinking and learn from their peers. Giving students this exploration time initially reduces distraction in later Sim activities that have more focused goals.

Rationale

Technology Note: Sound Waves Simulation
The Sound Waves Simulation is an integral part of this unit. It is an interactive digital simulation that allows students to observe that sound is a wave. The Sound Waves Sim includes three modes: Instruments, Custom Sound, and Xylophone. The Sim was designed to be used throughout this unit to help students discover increasingly complex qualities of sound waves. For this initial exposure to the Sim, it is important for students to explore only the Instruments mode. Students do not yet have the background to understand other features of the Sim without more teacher guidance. Please allow students to gradually make sense of the Sim and keep in mind that they will learn more about its other features and modes in future lessons.

Rationale

Science Note: About the Sound Waves Simulation
Like all models, the Sound Waves Simulation represents some things about the phenomenon (sounds traveling) accurately and other things inaccurately. In making a useful model, compromises are always made. One important compromise in this model is scale—in reality, molecules are far too small to be seen on the same scale as the wavelengths of sound waves. In this Sim, the molecules are large enough to be seen on the same scale as the wave patterns to help students visualize the way that sound waves travel via particle collisions. A second compromise is that the Sim does not show molecules as different from one another. There are a variety of molecules that make up materials through which sound can travel, but including those differences would complicate the model in a way that would not support students’ understanding of sound.

A third compromise in this Sim is that all waveforms are represented as pure tones, which take the shape of a sinusoidal wave. This means that at any single point in the wave, the sound has a single frequency and amplitude. In reality, most musical instruments emit sounds with a dominant frequency (the fundamental frequency), which is the tone that the listener hears, in addition to a few other simultaneous harmonic frequencies. Thus, waveforms of sounds emitted from musical instruments are typically much more complex than those represented in the Sim. Simplifying the waveforms in this way enables students to more easily see the connection between waveform characteristics and the changes in pitch and volume that they are hearing. It is good to be aware of these simplifications as you teach the unit and use the Sim, but it is not necessary to share them with students, unless they come up during instruction.
Possible Responses

Investigation Notebook
Exploring the Sound Waves Simulation (page 14)

Answers will vary.

Examples for second column of the table:
Row 1: There are many orange dots moving around on the screen.
Row 2: When you play a sound, the dots move back and forth.
Row 3: The sounds of different instruments, higher and lower sounds.
Row 4: The instrument.

Examples for third column of the table:
Row 1: What are they? Why are they moving this way?
Row 2: Why do sounds make the dots move in this pattern?
Row 3: What makes the instruments sound different?
Row 4: How does the instrument make the sound?
Explorar la simulación **Ondas de sonido**

1. En la segunda columna de la tabla, apunta lo que notas acerca de la simulación.

2. A medida que exploras la simulación, apunta lo que te preguntas en la tercera columna.

<table>
<thead>
<tr>
<th>Observaciones</th>
<th>Lo que noto</th>
<th>Lo que me pregunto</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lo que veo moviéndose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>El patrón que veo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Los sonidos que oigo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>La fuente del sonido</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>