Lesson 3.1

Investigating Amplitude
Lesson Overview

Students explore one way in which sounds can be different from one another: volume. To begin the lesson, students receive a message containing new information from the park superintendent of Blue Bay National Park. Then, the teacher leads a discussion about how sounds can be different from one another. Students explore the Custom Sound mode of the Sound Waves Sim in order to discover that manipulating the amplitude, or height, of a sound wave affects the volume of the sound. Students then use the Sim to create a sound wave that has a changing amplitude. At the end of the lesson, students examine and discuss visual representations of waves in order to solidify their understanding of the relationship between amplitude and volume. The purpose of this lesson is for students to explore the concepts of amplitude and volume and to practice interpreting waveforms—visual representations of sound waves.

Anchor Phenomenon: Dolphins in Blue Bay National Park communicate with one another underwater and calves only respond to their mother’s call.

Everyday Phenomenon: Sounds can be loud or quiet.

Students learn:

• Amplitude refers to the height of a wave.
• When sound waves have different amplitudes, we hear sounds with different volumes.
• A curved line that shows the pattern of a wave is called a waveform. Scientists use waveforms to represent sound properties.
• Visual representations of sound waves can tell you about the properties of the sound.
Investigating Amplitude

Students use the Sound Waves Sim to investigate what happens when the amplitude of a sound wave changes.

Instructional Guide

1. **Set purpose for the Sim activity.** Explain that students will further investigate the volume of sounds, using the Sound Waves Sim.

2. **Project the Sound Waves Sim.** Go to the Student Apps Page. Explain that students will be using a new mode of the Sound Waves Sim called the Custom Sound mode, in which they will be able to control and change the sounds the Sim makes.

3. **Model how to select and use the Custom Sound mode of the Sound Waves Sim.** With the Sound Waves Sim projected, model the following steps:
   - Press the button in the upper-left corner of the screen to open a drop-down menu.
   - Select Custom Sound.
   - Press Play to play a sound.
   - Explain that the green wave is called a waveform—it shows the shape of the sound wave as the sound plays.
   - Encourage students to pay close attention to the patterns of motion they see in the waveforms.

4. **Project notebook.** Have students turn to page 47, Investigating Amplitude, in their notebooks. Review the directions with students:
   - Open the Custom Sound mode of the Sound Waves Sim.
   - Press Play to play a sound, and while the sound is playing, use the Amplitude slider to change the sound.
   - Observe what happens as you change the sound. Use your eyes and ears to make your observations.
   - Use what you observed to answer the questions below.
5. **Distribute digital devices.** Distribute one digital device to each pair of students and have them go to the Sound Waves Simulation. As needed, help students open the Custom Sound mode.

6. **Prompt partners to investigate in the Sim and record observations in their notebooks.** Circulate and support students as needed. After 5 minutes, remind partners to switch roles so both partners have an opportunity to “drive” the Sim.

7. **On-the-Fly Assessment: Students adjust amplitude in the Sim.** Circulate and take note of how students are connecting changing the amplitude via the Amplitude slider to the height of the wave in the waveform and to the volume of the sound.

8. **Have students share what they observed with the class.**

   - Ask a few volunteers to explain their findings. [When we moved the Amplitude slider toward Large, the sound got louder. When we moved the Amplitude slider toward Small, the sound got quieter. Amplitude has something to do with how loud or quiet a sound is.]
   - Ask volunteers to share what they observed about the waveform when the amplitude was set to Large and what they observed when it was set to Small. [When the amplitude was set to Large, the green line made larger waves. When the amplitude was set to Small, the green line made smaller waves.]

9. **Have students put digital devices aside.** Explain that students will use the devices again in a few minutes.
Embedded Formative Assessment

On-the-Fly Assessment 9: Initial Understanding of Amplitude

Look for: As you circulate, ask students what they observe about the waveform as they set the amplitude to Large. Note whether they are making the connection between the volume of the sound and the height of the sound wave. Do they observe that as the amplitude is set closer to Large, the sound gets louder and the sound wave height increases?

Now what? If you notice that some students are not making the connection between volume and the height of the wave in the waveform, check to determine whether students understand that amplitude is associated with the volume of a sound. If they do not, lead the following demonstration in the Custom Sound mode of the Sound Waves Sim:

- Ask students to cover their eyes.
- Press Play to play a sound, and as the sound plays, move the Amplitude slider from Small to Large.
- Ask students to tell you what they observed about the sound as they listened.
- Once students understand that amplitude and volume are connected, ask them to uncover their eyes.
- Play the sound with the amplitude set to Small and ask students to describe the waveform.
- Then, play the sound with the amplitude set to Large and ask students to describe the waveform.
- Ask students to describe the difference between the two waveforms and to connect the height of the wave to the volume of the sound.

Teacher Support

Background

Science Note: About the Amplitude of a Wave

In a waveform, or visual representation of a sound wave, the amplitude is the distance from the midpoint of the wave to the peak or trough. When we hear a loud sound, the amplitude of the sound wave is large. The amplitude of a wave is related to how much energy the wave has. Recall that energy is what moves in a wave. The amplitude of the sound wave is determined by the vibrations at the wave’s source. The greater the amplitude of a sound wave, the more energy the wave has. This means that the particles that are disturbed vibrate more, causing the areas of particle compression to be more compressed. For example, when you pluck a guitar string forcefully, you see the string vibrate a greater distance (back and forth) than it does when you pluck the string gently. The string vibrating back and forth more creates a wave that disturbs the particles of air more, and consequently you hear a louder sound. In this unit, we describe amplitude as the height of the wave. Some students may interpret this as meaning from the bottom of a trough to the top of a peak—a distance that is actually twice the amplitude of the wave. This is an acceptable understanding for this grade level.
Possible Responses

Sound Waves Simulation: Custom Sound mode

What students should do and notice:
Students should notice that when they move the Amplitude slider toward Large, the sound gets louder, and the height of the wave increases. When students move the Amplitude slider toward Small, the sound gets quieter, and the height of the wave decreases. Some students might also notice that the particles get more compressed when the amplitude is larger.

Investigation Notebook
Investigating Amplitude (page 47)

The amplitude is larger when the sound is louder. 
The amplitude is smaller when the sound is quieter. 
What happens to the waveform when you change the amplitude? 
When I make the amplitude smaller, the height of the waves in the waveform gets smaller. When I make the amplitude larger, the height of the waves in the waveform gets larger.

**Draw a waveform for a loud sound.**

![Waveform for a loud sound](image)

**Draw a waveform for a quiet sound.**

![Waveform for a quiet sound](image)
Analyzing Amplitude

Students analyze waveforms to apply their understanding of amplitude.

Instructional Guide

1. Project Waves Diagram 6. Ask students to explain what they see in this projection. [A waveform and arrow.]

Think back to the Sim. What changed as you moved the Amplitude slider? Explain what happened to the waveform. [The waves got taller. The up/down part of the wave changed.]

In the Sim, you were changing the amplitude of the sound wave. Amplitude is the height of a wave. Changing the amplitude changed the volume of the sound.

In this diagram, the arrow shows the height of the wave—this is the amplitude.
2. **Project Waves Diagram 7.** Ask students to point out what is new in this projection. [There is an image of particles with sound energy traveling through them.] Point to a place where the particles are lined up together and ask students what they notice about the particles and the position of the wave peaks in the waveform. [When the particles are lined up together, that is also where the wave peaks.]

![Waves Image]

The larger the amplitude of a sound wave, the more the particles move.

Point out the areas where the particles are closely lined up and colliding, and the areas where the particles are spread apart.

3. **Post the amplitude card on the classroom wall.**

Amplitude is how big or loud a wave is.

4. **Post the waveform card on the classroom wall.** Ask students to explain what they think the word *waveform* means based on what they observed in the Sim. Then confirm by providing a simple definition.

A waveform is a curved line that shows the pattern of a wave.

5. **Project the Custom Sound mode of the Sound Waves Sim and introduce the Wave Printout feature.** Go to the Student Apps Page. In the Custom Sound mode, the Wave Printout feature is on by default. Play a sound for the class and point out how the Wave Printout is a record of the sound wave that can be observed even after the sound has stopped playing.

6. **Project notebook.** Have students turn to page 48, Analyzing Amplitude, in their notebooks. Explain that this Wave Printout is from the Sim. Explain that students will use what they now know about amplitude to label the Wave Printout, and then they will try to make a sound wave in the Sim that matches the Wave Printout in their notebooks. Let students know that they should only use the Amplitude slider, and they should leave the Wavelength slider set to Medium.
7. Prompt partners to work in the Sim and complete the notebook page. Circulate as partners work. Provide support as needed.

8. Have students share what they recorded in their notebooks. Have students point to each section of the Wave Printout in their notebooks and explain what is happening to the volume of the sound in that part of the wave.

9. Collect all digital devices. Ask students to make sure that their digital devices are turned off.

Teacher Support

Instructional Suggestion

Supporting English Learners: Kinesthetic Response to Visualize Amplitude
Using a physical response can provide an entry point to help English learners access science ideas and give students practice using the language of science. Eventually, students will no longer need the physical reference, but it can help when they are first learning a new science term. Invite students to crouch. Then ask them to stand up straight and stretch their hands above their heads as they call out “amplitude” in unison. Making a wave peak with their bodies will give students a physical reminder of what amplitude means and can help them make connections to the new word as they are learning the concept.

Possible Responses

Sound Waves Simulation: Custom Sound mode

What students should do and notice:
Students analyze a waveform in their notebooks and place three descriptive labels (loud, medium, and quiet) along the waveform. Students then check their understanding in the Sim by using the Amplitude slider to create a Wave Printout that matches the one on the notebook page. Students may decide to revise their labels after creating waveforms in the Sim.

Investigation Notebook
Analyzing Amplitude (page 48)

Wave Printout labels, from left to right: medium, loud, quiet
Investigating Amplitude

1. Open the Custom Sound mode of the Sound Waves Sim.
2. Press Play to play a sound, and while the sound is playing, use the Amplitude slider to change the sound.
3. Observe what happens as you change the sound. Use your eyes and ears to make your observations.
4. Use what you observed to answer the questions below.

The amplitude is _________ (larger/smaller) when the sound is louder.

The amplitude is _________ (larger/smaller) when the sound is quieter.

What happens to the waveform when you change the amplitude?

__________________________________

__________________________________

__________________________________

Draw a waveform for a loud sound.

Draw a waveform for a quiet sound.
Analyzing Amplitude

1. Look at the Wave Printout below. Label the volume of the sound in each section of the waveform. You can use the following words as labels: loud, medium, quiet.

2. Open the Custom Sound mode of the Sound Waves Sim.

3. Press Play to play a sound, and as the sound is playing, use the Amplitude slider to try to make the Wave Printout match the one shown below. It may take a few tries!

4. Update your labels if needed.
Students use the Sound Waves Sim to investigate what happens when the amplitude of a sound wave changes.

Instructional Guide

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Draw a waveform for a loud sound.

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Analyzing Amplitude

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Instructional Guide

1. Project Waves Diagram 6. Ask students to explain what they see in this projection. [A waveform and arrow.]

Traten de recordar la Simulación. ¿Qué cambió mientras movían el deslizador Amplitude (amplitud)? Expliquen qué le pasó a la forma de onda.

[Las ondas se hicieron más elevadas. La parte de arriba/abajo de la onda cambió].

En la Simulación, estuvieron cambiando la amplitud de la onda de sonido. La amplitud es la altura de una onda. Cambiar la amplitud cambió el volumen del sonido.

En este diagrama, la flecha muestra la altura de la onda. Esto es la amplitud.
2. Project Waves Diagram 7. Ask students to point out what is new in this projection. [There is an image of particles with sound energy traveling through them.] Point to a place where the particles are lined up together and ask students what they notice about the particles and the position of the wave peaks in the waveform. [When the particles are lined up together, that is also where the wave peaks.]

3. Post the amplitude card on the classroom wall.

4. Post the waveform card on the classroom wall. Ask students to explain what they think the word waveform means based on what they observed in the Sim. Then confirm by providing a simple definition.

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Investigation Notebook
Analyzing Amplitude (page 48)

Wave Printout labels, from left to right: medium, loud, quiet
Nombre: _____________________________________ Fecha: ______________

Investigar la amplitud

1. Abre la modalidad “Custom Sound” (sonido personalizado) de la simulación Ondas de sonido.
2. Oprime “Play” para reproducir un sonido y, mientras se escucha el sonido, usa la barra de ajuste “Amplitude” (amplitud) para cambiar el sonido.
3. Observa lo que pasa mientras cambias el sonido. Usa tus ojos y oídos para hacer tus observaciones.
4. Usa lo que observaste para responder las preguntas siguientes.

La amplitud es __________ (más grande/más pequeña) cuando el sonido es más fuerte.

La amplitud es __________ (más grande/más pequeña) cuando el sonido es más débil.

¿Qué le pasa a la forma de onda cuando cambias la amplitud?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

Dibuja una forma de onda para un sonido fuerte.

Dibuja una forma de onda para un sonido débil.
1. Mira la impresión de la onda que aparece enseguida. Describe el volumen del sonido en cada sección de la forma de onda. Puedes usar las palabras siguientes para describir el volumen: fuerte, medio fuerte, débil.

2. Abre la modalidad “Custom Sound” (sonido personalizado) de la simulación Ondas de sonido.

3. Oprime “Play” para reproducir un sonido y, mientras se está escuchando el sonido, usa la barra de ajuste “Amplitude” (amplitud) para hacer que la impresión de la onda coincida con la que se muestra abajo. ¡Tal vez necesites varios intentos!

4. Actualiza tus descripciones si es necesario.

**Impresión de la onda**

![Imagen de la onda](image_url)