



Sound Waves¹

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Students explore the PhET Interactive Simulation “Sound” to understand how sound is modeled.

Science Topics	Process Skills	Grade Level
Parts of a Waves Speed of Sound Frequency	Scientific inquiry Observing Inferring Data Collection	6-12

Time Required			
Preparation	Set-Up	Activity	Clean-Up
None	5-10 minutes	50 minutes*	None

*If you are doing this with middle school students, it will take longer.

Learning Goals

Students will be able to...

- Explain how different sounds are modeled, described, and produced
- Design ways to determine the speed, frequency, period, and wavelength of a sound wave model

Materials		
In the Kit	Not in the kit	Optional
Worksheet (pg. 4) – 1 per student	Computer* with “Sound” from PhET Interactive Simulations	String or rope Slinky

*You’ll want at least one computer for every 3 students.

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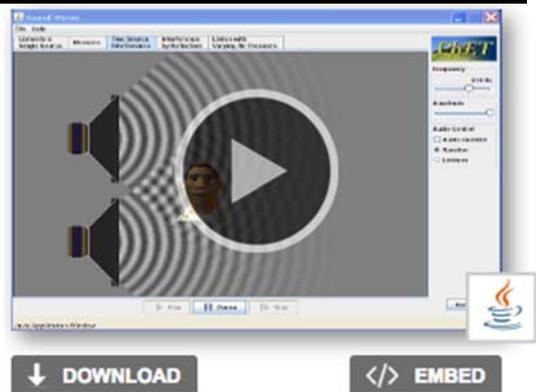
Advanced Preparations

Set up the simulator on classroom computers by going to:

<https://phet.colorado.edu/en/simulation/legacy/sound>

Please review the Software Requirements before downloading.

Download the simulator by clicking the play button or the download button.



Set-Up

Gather materials

¹ This lesson is designed as homework, but would also make a nice in class activity if computers are available. This is also good preparation for the Anatomy of a Wave lesson.

Introduce the Activity

This simulation has been tested with students from grade school to college, and the interface has been intuitive for all students tested. We have observed that too much instruction on the simulation creates a barrier between the students and the simulation.

Doing the Activity

Sound Waves

1. If you would like, use the slinky and rope to review longitudinal and transverse waves.
 - Discuss how waves on a string are generated and how energy moves through the string.
 - Ask a student to help you by holding the end of the slinky and demonstrate how energy travels from you to the student via the wave on the slinky.

2. Show the students how the simulator is modeling compression and rarefaction with dark and light colors.

NOTE: Some people think black represents emptiness and light represents more intensity, and some people think the inverse is true. Have students investigate using the first tab, to see that when the speaker is going out, the sound wave looks light. This can be a little tricky to observe, but using low frequency helps. Then go to the last tab and evacuate the chamber, it will make sense that the color goes black like space. Ask the students to determine what is being represented and they should choose black for low density.

3. Pass out the lab worksheet (page 3). Students should work individually or in groups of 2 or 3 to answer the questions.
 - When the worksheet asks students for citation, you should just be looking for the source of their information is fine. This is usually a website or from a textbook. It's good to get students into the habit of being able to back up their facts.
 - The last questions about ultra-sound are designed to get students thinking about the size of ultra-sound waves compared to audible sounds.

Explanation

In-depth background information for teachers and interested students.

Key Lesson Terminology

- Compression – The region of the wave where air particles are compressed together.
- Rarefaction – The region of the wave where air particles are spread apart.
- Frequency – Wiggles per second (moves back and forth)
- Amplitude – For transverse waves, it is the maximum height of the wave. Larger amplitudes create louder sounds.
- Period – The time it takes for one wave to go by.
- Wavelength – The distance between two successive, identical parts of the wave. Ex. Crest to crest, or trough to trough.

Extensions

- The Anatomy of a Wave (middle school & high school) is good to continue working on the basic properties of transverse and longitudinal waves, including resonance.
- Create a wave on a string in the classroom by using a long string/slinky or rope.
 - It should be possible to change the amplitude, frequency and tension while oscillating the string/slinky/rope. It is difficult to change damping, however.
- Earthquakes – after this, lesson students are more ready to learn about Primary and Secondary seismic waves and how they travel through the earth. The idea that depending on the part so the earth the wave travels through, it may arrive at a location at a different time.

Modifications

- The PhET website can be viewed in many languages, and learners can experiences the simulations in their native language to help them fully understand the material being presented

Supplemental Materials

Worksheet below, page 4-7.

Sound Waves

Name _____

Learning Goals: Students will be able to

- Explain how different sounds are modeled, described, and produced.
 - Design ways to determine the speed, frequency, period and wavelength of a sound wave model.
1. Use the **Listen to a Single Source** tab in the PhET simulation *Sound Waves* (phet.colorado.edu) to start your investigation of sound. Turn on the **Audio Enabled** so you can hear the sound.
 - When you change the frequency, how does the sound change?
 - How does the visual model change?
 - How does changing the amplitude affect the sound and its model?
 2. Sound is produced when something vibrates; this movement causes disturbances in the surrounding air pressure. Investigate how the speaker cone moves to produce different sounds. Then, explain the relationships between the movement of the speaker cone and the sound that is made; include drawings to support your explanation.

3. Use the tools on the **Measure** tab to find the speed of sound in air. $v = d/t$ where v = speed of sound, d = distance traveled and t = time

- Make a data table that demonstrates you have a good experiment and show sample calculations.

- How do your results compare to information that is published? (Include a citation)

4. How could you find the wave length of a sound?

- Test your idea with several different sounds. Check to see if the results for wavelength make sense. (Include a citation)

5. Describe how you might use the simulation tools to find the period of a wave without using the frequency information. Period is the time it takes for one wave to go by.

- Test your idea with a variety of waves. What waves did you use to test your ideas?
- Check your method by calculating the period using the frequency. Show data and calculations for several trials. Make corrections to the original plan as necessary.

6. Describe how you would find the frequency of a wave if the frequency slider did not have a number display.

- Test your idea with a variety of waves. What waves did you use to test your ideas?

- Show data and calculations for several trials. Make corrections to the original plan as necessary.

7. The prefix “ultra” means above. What is “above” in ultra-sonic sounds? (provide a citation)

8. Why do you think ultra-sound is useful for looking at small detail within the body?