



Science Objectives

- Students will construct an understanding of frequency, amplitude, and phase shift.
- Students will develop the understanding of the sine function and how it relates to sound waves.
- Students will simulate the addition of two waves and observe that this addition forms sound dampening and beats.

Vocabulary

- | | |
|---------------|---------------|
| • amplitude | • notes |
| • beats | • phase shift |
| • dampening | • sound |
| • frequency | • waves |
| • compression | |

About the Lesson

- In this lesson students change characteristics of a sine wave to discover the frequency, amplitude, and phase shift. They will also use these properties to see the effect of adding two waves to form dampening and beats.
- As a result students will be able to:
 - Define, describe, and use the different characteristics of waves (frequency, amplitude, phase shift)
 - Recognize and explain the result of adding two waves together.
 - Explain the effect phase shift has on the sum wave.
 - Recognize and explain the effect frequency and phase shift have on the sum wave.

TI-Nspire™ Navigator™ System

- Send out the *Sound_and_Waves.tns* file.
- Monitor student progress using Screen Capture.
- Use Live Presenter to spotlight student answers.
- Enter items as appropriate for use of TI-Nspire Navigator.

Activity Materials

- *Sound_and_Waves.tns* document
- TI-Nspire™ Technology



TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Grab and drag a point

Tech Tips:

- Make sure the font size on your TI-Nspire handhelds is set to Medium.
- You can hide the function entry line by pressing **ctrl** **G**.

Lesson Files:

Student Activity

- *Sound_and_Waves_Student.doc*
- *Sound_and_Waves_Student.pdf*

TI-Nspire document


- *Sound_and_Waves.tns*

Visit

<http://www.sciencenspired.com/>
for lesson updates and tech tip videos.

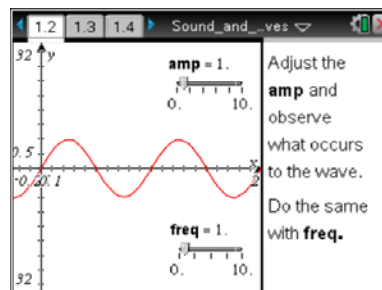


Discussion Points and Possible Answers

Tech Tip: To move a slider, place the cursor over the slider and press and hold the  button. The hand will close to allow students to drag the slider and see the effect on the graph.

Move to page 1.2.

1. Students should move the amplitude (**amp**) and the frequency (**freq**) and observe the effect of these movements on the graph.



TI-Nspire Navigator Opportunities

At the beginning of the lesson, you can use Live Presenter to ensure that students understand how to adjust the slider. If students are having difficulty grabbing the bar to drag, ask them to give each other tips on how to grab the correct location.

Move to pages 1.3–1.7.

Have students answer the questions on either the handheld, on the activity sheet, or both.

- Q1. What happens to the wave when amplitude (**amp**) is changed?

Answer: Changes occur in: 1. the height of the wave (representing the strength of wave compressions); and 2. the distance from the crest to the line of symmetry.

- Q2. What parts of the wave do not change when you adjust the amplitude?

Answer: The distance between x values where the wave has peaks (and valleys) does not change.

- Q3. If the amplitude is set to 5, how is the “5” seen on the graph?

Answer: An amplitude of 5 is the perpendicular distance from the line of symmetry to the peak or the valley.



Q4. What changes as frequency (**freq**) changes?

Answer: Changes occur in: 1. the distance between each peak, valley, or x-intercept; and 2. the distance between waves.

Q5. If the frequency is 2, in units used for the graph, how is this number represented on the graph?

Answer: The unit 2 is the number of waves that occur within one unit of time or one second.

Move to pages 1.8 and 1.9.

Students should use this information to answer the questions.

Amplitude is the height of the wave from the line of symmetry or the middle of the wave.

Frequency is the number of waves per unit of time.

Sound travels in waves with different frequencies and amplitudes.

Move to pages 1.10 and 1.11.

Have students answer the questions on either the handheld, on the activity sheet, or both.

Q6. What property of sound does wave amplitude affect?

Answer: B. volume

Q7. What property of sound does wave frequency affect?

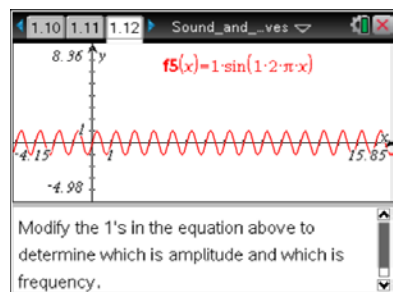
Answer: C. pitch.

TI-Nspire Navigator Opportunities

A Quick Poll could be used to have students input the answer to the above questions or to “vote” on a given answer if the class is split on which is the correct answer.

Move to page 1.12.

- Students will modify the 1's in the equation at the top of page 1.12 to determine which changes amplitude and which changes frequency. They can change the values by clicking in the text box, adjusting the value, and pressing **enter**.





Tech Tip: For students to change the equation they need to click on the equation once to select it and then a second time to get into editing mode. Once the equation is in edit mode, they can scroll left and right to the value they want to change. Have them place the cursor to the right of the value, press back space to delete the value, and then enter their new value.

Move to pages 1.13 and 1.14.

Have students answer the questions on either the handheld, on the activity sheet, or both.

Q8. In the equation $y = a \sin(b \cdot 2\pi \cdot x)$, what does a represent?

Answer: A. the amplitude

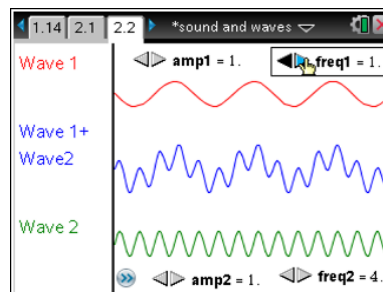
Q9. In the equation $y = a \sin(b \cdot 2\pi \cdot x)$, what does b represent?

Answer: B. the frequency

Move to pages 2.1 and 2.2.

Wave Addition

3. On page 2.2 students will modify one variable at a time starting with frequency of wave 1. They should change **freq1** and observe the effect it has on wave 1 + wave2.



Tech Tip: On the handheld there are numerous calculations going on in the background so the students need to be patient while the wave is changing.

Move to pages 2.3 and 2.4.

Have students answer the questions on either the handheld, on the activity sheet, or both.

Q10. What happens to the sum wave when the frequency of wave 1 is changed?

Answer: The sum wave changes shape, generating different patterns.

Q11. If wave 1 is a sound wave, a higher frequency will cause _____.

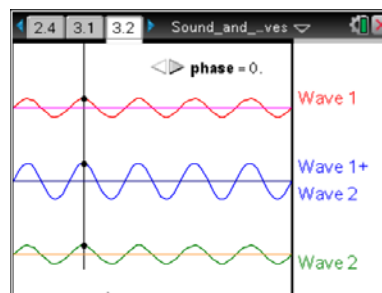
Answer: A. higher pitch



Move to pages 3.1 and 3.2.

Phase Shift

4. Students will change the phase by clicking on the slider. As they shift the wave, they should observe that the sum wave dampens or amplifies.



Move to pages 3.3–3.5.

Have students answer the questions on either the handheld, on the activity sheet, or both.

Q12. What effect does a phase shift have on the summation wave?

Answer: When the two waves are in phase, the sum wave is amplified. When they are out of phase, they cancel one another

Q13. The phase change will _____.

Answer: B. change the volume

Q14. What does it mean to be in phase?

Answer: The peaks of both waves happen at the same time creating an amplified wave.

TI-Nspire Navigator Opportunities

You can send this activity out to the students using TI-Nspire Navigator. Throughout the activity you can send them quick polls to determine how their understanding is developing.

Wrap Up

Create a discussion about waves and the characteristics. Talk to the students about the relationship these waves have to sound waves. Discuss the following features of waves (frequency, amplitude, phase, addition with frequency change, addition with phase shift, dampening and amplification.)

Assessment

- Give the students two waves with different frequencies and have them make a rough drawing of what they would expect the graph to look like.
- Give them a second set of waves with equal frequencies but with a phase shift– the peak of one wave should be over the trough the other. Ask students to sketch the resultant wave.