

What Is a Wave? Lesson 3

Galloping Gertie

Laura Halstied, Lindsey Link, Michael Laprarie, Mary Braggs
Published by *K20 Center*

This work is licensed under a Creative Commons CC BY-SA 4.0 License

Grade Level	9th – 10th Grade	**Time Frame**	135 minutes
Subject	Science	**Duration**	3 class periods
Course	Physical Science		

Essential Question

What are waves? How do waves behave differently from particles?

Summary

In this third lesson of the What Is a Wave? unit, students will experiment with long springs and whirly tubes as well as participate in a guided inquiry activity on constructive and destructive interference. Students will be assessed by explaining true or false statements.

Snapshot

Engage

Students view a video that demonstrates wave oscillation.

Explore

Students conduct experiments with long springs to study how wave oscillations reflect and combine.

Explain

Students complete an activity on constructive and destructive interference.

Extend

Students experiment with whirly tubes to understand resonance.

Evaluate

Students decide if statements are true or false and explain their choices.

Standards

Oklahoma Academic Standards (Physical Science)

PS.PS3.3 : Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*
PS.PS4.1 : Use mathematical representations to explain both qualitative and quantitative relationships among frequency, wavelength, and speed of waves traveling in various media.
PS.PS4.1.1: The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.

Attachments

- Lesson Slides—Galloping Gertie.pptx
- Long Spring Activity—Galloping Gertie - Spanish.docx
- Long Spring Activity—Galloping Gertie - Spanish.pdf
- Long Spring Activity—Galloping Gertie.docx
- Long Spring Activity—Galloping Gertie.pdf
- Vocabulary Packet Teacher Guide—Galloping Gertie.docx
- Vocabulary Packet Teacher Guide—Galloping Gertie.pdf
- Vocabulary Packet—Galloping Gertie - Spanish.docx
- Vocabulary Packet—Galloping Gertie - Spanish.pdf
- Vocabulary Packet—Galloping Gertie.docx
- Vocabulary Packet—Galloping Gertie.pdf
- Wave Interference Activity Teacher Guide—Galloping Gertie.docx
- Wave Interference Activity Teacher Guide—Galloping Gertie.pdf
- Wave Interference Activity—Galloping Gertie - Spanish.docx
- Wave Interference Activity—Galloping Gertie - Spanish.pdf
- Wave Interference Activity—Galloping Gertie.docx
- Wave Interference Activity—Galloping Gertie.pdf

Materials

- Lesson Slides (attached)
- Long Spring Activity handout (attached, one per group)
- Wave Interference Activity handout (attached, one per group)
- Wave Interference Activity Teacher Guide (attached)
- Vocabulary Packet (attached, one per student)
- Vocabulary Packet Teacher Guide (attached)
- Long springs
- Masking tape
- Meter sticks
- Whirly tubes

5 minutes

Engage

Use the attached **Lesson Slides** to guide the lesson. Begin by reviewing the essential questions on **slide 3** and the lesson objectives on **slide 4**.

Move to **slide 5** and introduce students to the I Notice, I Wonder strategy. Display **slide 6** and play the "Tacoma-Narrows Bridge Collapse" (also known as Galloping Gertie) video and have students write down things they notice and wonder about as they watch.

Embedded video

https://youtube.com/watch?v=13J76PXE6OA

Move to **slide 7.** Ask students to share what they observed and record any questions they have. Ask students to theorize how the bridge could have trapped and amplified vibrations on itself. Explain that the wind caused small vibrations that developed into larger vibrations until the bridge collapsed.

40 minutes

Explore

Teacher's Note: Activity Preparation

The next activity will require space for students to spread out. Consider using an area outside of the classroom to complete the activity. The activity could also pose a safety issue when the spring is stretched to 6 meters. Consider having student wear protective eye wear such as goggles. If you are further concerned, have a group of trusted students demonstrate the activity for the class to observe.

Arrange students in groups of three and explain that, in this activity, they will observe how multiple waves can occupy the same space.

Pass out a copy of the attached **Long Spring Activity** handout, one long spring, a meter stick, masking tape, and a marker to each group.

Move to **slide 8** and ask students to follow the directions on the handout to set up the activity. Once students have set up the tape markings, move to **slide 9** and have them decide on their roles.

Move to **slide 10** and instruct students to follow the directions on the handout carefully as they answer the questions.

Consider stopping after this activity and starting the next section on the next class day.

50 minutes

Explain

Display **slide 11** and arrange students into groups of three.

Pass out a copy of the attached **Wave Interference Activity** handout to each group and explain that each group member will have a designated role.

Instruct students to read the directions on the handout closely as they work together to answer the questions and sketch waves.

While students work, move around the classroom and observe the groups. Provide feedback and assistance as needed to clarify any misconceptions.

Sample Student Responses

Reference the attached **Wave Interference Activity Teacher Guide** document for a key with student responses.

After the groups have completed the activity, instruct each group to share their answer to one of the questions. Questions 3, 4, 6, 7, 10 should be covered in the discussion. Ask for volunteers to share their answers and encourage multiple groups to share responses. The reporter for each group should answer the questions.

Offer correct answers for any that are incomplete or inaccurate and encourage discussion and questions to ensure that students understand the essential concepts. Correct any misconceptions at this time.

Transition through **slides 12-14** and review key vocabulary introduced during this activity: interference, reflection, and phase.

45 minutes

Extend

Display **slide 15** and play the "Wave Reflection" video.

Embedded video
https://youtube.com/watch?v=1PsGZq5sLrw

Ask the reflection questions on **slide 16**:

- What is a reflection?
- What happens to the phase of a wave on a spring when it reflects off a hard barrier?
- What do we call this flip?
- What is constructive interference?

Have students share their thoughts with a partner. Ask for volunteers to share with whole class. Encourage discussion about the reflection questions.

Divide students into groups of three and provide each group with a whirly tube.

Show **slide 17** and have students experiment with the tubes and talk in their groups about the sound the whirly tube makes as they spin the tube at different speeds. Explain that the whirly tube is vibrating as a single frequency, which is called "resonance."

Ask students to split up from their groups and individually take notes on their attached **Vocabulary Packet** handout**.**

Sample Student Responses

See the attached **Wave Unit Vocabulary Teacher's Guide** document for a key with student responses.

Move to **slide 18** to introduce the concept of resonance and play the "CYMATICS: Science vs. Music" video.

Embedded video
https://youtube.com/watch?v=Q3oItpVa9fs

Explain to students that the flame in the video is a visual representation of resonance. Refer back to the Galloping Gertie video from the beginning of the lesson and tell students that was also an example of resonance.

Show **slide 19** and introduce the concept of interference patterns.

Explain to students that we are transitioning from reflection and mixing of *trapped* waves to the mixing of *freely traveling* waves.

Show **slide 20** to define an interference pattern.

Teacher's Note: Light Sensitivity Warning

The video on **slide 21** is not suitable for students with photosensitive epilepsy; please skip this video if it would affect one of your students.

Show **slide 21** and play the video, titled "PS4 1 LAB Physics Waves Ripple Tank Interference patterns WIS." The video shows ripple tank interference patterns as an example of an interference pattern in water waves.

Embedded video
https://youtube.com/watch?v=0c0gvy_OOKc

Show **slide 22** to introduce Thomas Young. Explain that Young first discovered interference patterns by shining light through a card with two narrow openings. The light passing through the two openings blended to produce an interference pattern of light and dark bands.

Move to **slide 23.** Play the video, titled "The Original Double Slit Experiment," which shows a recreation of Thomas Young's double slit experiment. This video provides a wealth of supplemental content about interference patterns as well as great interactive demonstrations and graphics.

Embedded video
https://youtube.com/watch?v=Iuv6hY6zsd0

Show **slide 24** and ask students to refer back to the Driving Question Board created in Lesson 1. Ask students if there are any questions that can be answered right now. Have a class discussion about any questions that remain.

5 minutes

Evaluate

Display **slide 25** and introduce students to the Justified True or False strategy. Ask them to read the statements on the following slides and determine whether each one is true or false.

Transition through **slides 26-30.** Ask students to use notebook paper to respond to each statement with "true" or "false." Ask them to write down their justification for that choice.

Collect students' responses to assess their understanding of the lesson.

Resources

- Atkinson, J. (2015, November 8). Tacoma-Narrows Bridge Collapse—Time Corrected [Video]. YouTube. https://www.youtube.com/watch?v=13J76PXE6OA
- Kamenícek, J. (2014, March 31). London Millennium Bridge from Saint Paul's [Image]. Wikimedia Commons. https://commons.wikimedia.org/wiki/File:London_Millennium_Bridge_from_Saint_Paul%27s.jpg
- K20 Center. (n.d.). I Notice, I Wonder. Strategies. https://learn.k20center.ou.edu/strategy/180
- K20 Center. (n.d.). Justified True or False. Strategies. https://learn.k20center.ou.edu/strategy/174
- K20 Center. (n.d.). Driving Question Board. Strategies. https://learn.k20center.ou.edu/strategy/1511
- LaunchSCIENCE. (2017, December 8). PS4 1 LAB Physics Waves Ripple Tank Interference Patterns WIS [Video]. YouTube. https://www.youtube.com/watch?v=0c0gvy_OOKc
- Stanford, N. (2014, November 12). Cymatics: Science vs. music - Nigel Stanford [Video]. YouTube. https://www.youtube.com/watch?v=Q3oItpVa9fs
- Veritasium. (2013, February 19). The original double slit experiment [Video]. YouTube. https://www.youtube.com/watch?v=Iuv6hY6zsd0
- Xmdemo. (2016, November 4). Wave Reflection — xmdemo 138 [Video]. YouTube. https://www.youtube.com/watch?v=1PsGZq5sLrw