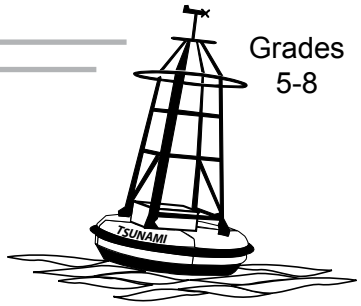
Slinky Tsunamis

Grades 5-8



Overview:

Tsunami waves and regular waves differ in how they are caused and in their characteristics as waves. Students learn the parts of a wave, the definition of wavelength, and the factors that determine wavelength. They simulate waves with a slinky, and compare the wavelengths of tsunami waves and regular waves.

Targeted Alaska Grade Level Expectations:

Science

[5-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.

[6] SA1.2 The student demonstrates an understanding of the processes of science by collaborating to design and conduct simple repeatable investigations.

[6] SB4.3 The student demonstrates an understanding of motions, forces, their characteristics, relationships, and effects by making waves move through a variety of media.

[7] SB4.3 The student demonstrates an understanding of motions, forces, their characteristics, relationships, and effects by describing the characteristics of a wave (i.e. amplitude, wavelength, and frequency).

[6] SG2.1 The student demonstrates an understanding of the bases of the advancement of scientific knowledge by recognizing differences in results of repeated experiments.

Objectives:

The student will:

- create waves of various wavelengths using a slinky;
- design and conduct an experiment;
- label the parts of a wave; and
- differentiate regular ocean waves and tsunami waves by wavelength.

Materials:

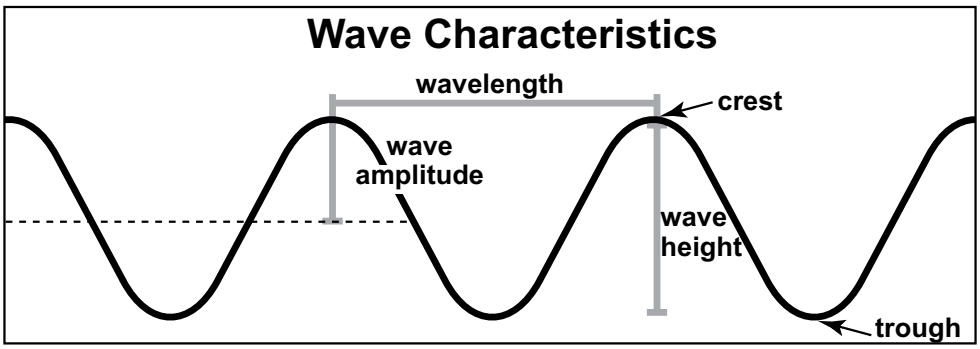
- Computer with Internet access
- Slinkies, long and narrow if available (one per pair of students)
- VISUAL AID 1: “Anatomy of a Wave”
- VISUAL AID 2: “Wind-generated Waves vs. Tsunami Waves”
- VISUAL AID 3: “Tsunami at the Coast”
- STUDENT WORKSHEET: “Slinky Tsunamis”.

Science Basics:

Regular waves are generated by wind, tides, the moon, and storms. Tsunami waves are generated most often by landslides and earthquakes. What distinguishes tsunami waves from regular ocean waves, in addition to the way they are generated, are the characteristics of the waves.

A wave has a crest and a trough. The height from the trough to the crest is called the wave height. Amplitude is the measure of the maximum vertical disturbance in the medium during one wave cycle. The wavelength of a wave is the distance from one identical point in a wave cycle to the next identical

point, most commonly viewed as crest to crest or trough to trough. Tsunami waves have a longer wavelength than regular waves. In fact, the crests of two neighboring tsunami waves can be as far as 300 miles apart.



Tsunami waves also have a greater period than wind-driven waves. The period of a wave is the time it takes for the wave to complete one cycle, or the time between wave crests. In the ocean, the period of a wave indicates how fast the wave is traveling. A regular wind-driven ocean wave has a period of up to several seconds. The period of a tsunami wave can be ten minutes to two hours.

The extreme height of tsunami waves, sometimes demonstrated as they hit the shore, is a result of the trough of the wave hitting the shoreline. When this occurs, the speed of the wave is decreased. However, the energy of the wave is not decreased. As a result, the height of the wave increases and the wavelength decreases: the steeper the shoreline, the more dramatic the wave height.

Activity Procedure:

1. Review how regular waves are generated by the moon, tides, winds, and storms. Ask students to recall how tsunami waves can be generated.
2. As a class, brainstorm the characteristics of a tsunami wave. Introduce wavelength and period into the discussion.
3. Explain that understanding the difference between wind-generated waves and tsunami waves requires a knowledge of the parts of a wave.
4. Show VISUAL AID 1: “Anatomy of a Wave.” Explain that a wave moves up and down. The top of a wave is called a crest. The bottom of a wave is called a trough. The wavelength is the distance from crest to crest or from trough to trough. The height of a wave is the distance from the crest to the trough.
5. Explain that tsunami waves have a much greater wavelength than regular wind-generated ocean waves. Show VISUAL AID 2: “Wind-generated Waves vs. Tsunami Waves.” Point out the specific wavelength of each type of wave.
6. Explain that tsunami waves also have a much greater period than regular wind-generated ocean waves. The period of a wave is the time between wave crests, or the time it takes for the wave to travel one wavelength. Wind-generated ocean waves have a period of several seconds. Tsunami waves can have periods of ten minutes to two hours.
7. Discuss how scientists can use this information to determine when a tsunami might hit. (Knowing the period of a wave allows one to calculate how long it will take the wave to reach a certain point.)
8. As a class or in small groups, use a computer with Internet access to navigate to the National Geographic Wave Simulator at http://www.nationalgeographic.com/volvooceanrace/interactives/waves/index.html.

   Use the sliders on the simulator to change the wave height, wavelength, and wave period in various ways. How do the changes affect the boat? Discuss as a class. Point out that waves move through material, they do not move the material itself. Ask students to click on the Water Particles link in the

Wave Simulator and observe the movement of the water particles under the ship.

9. Recruit a volunteer and demonstrate how to make a wave with a slinky. Let the slinky become still again before trying another method. Explain that one person in each pair should hold the slinky still, while the other does something to cause the slinky to move. The goal is to create a wave with a very long wavelength and a wave with a very short wavelength. Explain that a wave with a very long wavelength may only appear as one wave along the length of the slinky; whereas a wave with a short wavelength will appear as many waves along the length of the slinky.
10. Divide the class into pairs. Hand out STUDENT WORKSHEET: "Slinky Tsunamis."
11. Provide each pair of students with a slinky. Students take turns being the one to move the slinky.
12. Invite each pair of students to come up with one method that creates a wave with a long wavelength and one method that creates a wave with a short wavelength. Instruct students to note how the amplitude of the wave changes with each new approach. Ask students to complete their worksheets up to, but not including, the Further Questions section. The remainder of the worksheet will be completed after a class discussion.
13. Provide the class with approximately 30 minutes for this exercise.
14. After students have completed the experiment and the assigned portion of their worksheets, invite them to share their results with the class. Discuss the purpose of repeated trials, and the documentation of the procedure. (Trials are repeated to further validate results or attempt a different result. Documentation is important so that the experiment can be repeated precisely and can be communicated with others.)

Critical Thinking:

Puzzle Method: Develop students' critical thinking by providing clues to a puzzle involving aspects of the day's topic. Ask them to find the solution without providing input. Explain that as a tsunami wave reaches the coast, the wave often slows down, increases in height, and decreases in wavelength. Ask students to discuss, in pairs, why this might occur. Provide 3-5 minutes for this exercise. Invite students to share their solutions with the class.

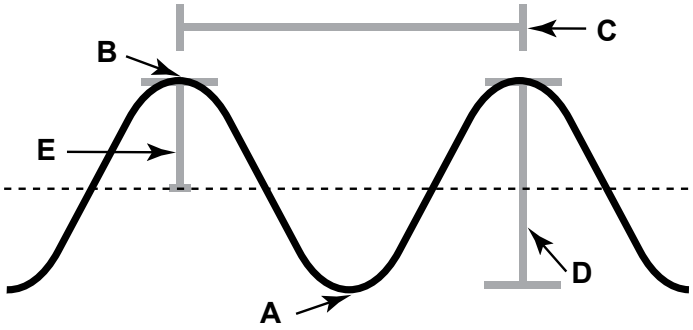
Show VISUAL AID 2: "Tsunami at the Coast." Reveal that as a tsunami wave approaches the coast, the trough of the wave hits the beach floor causing the wave to slow down, increase in height, and decrease in wavelength. Explain that the steeper the shoreline, the faster the wave slows and the higher the resulting tsunami wave.

15. Remind the class that tsunami waves have a much greater wavelength than regular wind-generated ocean waves.
16. Instruct students to complete the remainder of their worksheets.

Answers:

Hypothesis: *1-2. Answers will vary.*
Data, Analysis of Data, Conclusion: *Answers will vary.*
Further Questions: *6. Label the parts of the wave below*

A. trough
B. crest
C. wavelength
D. height
E. amplitude

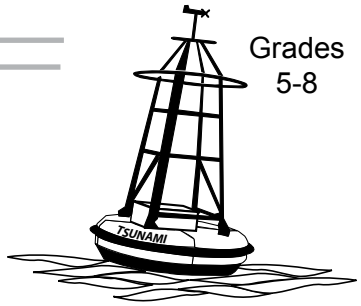


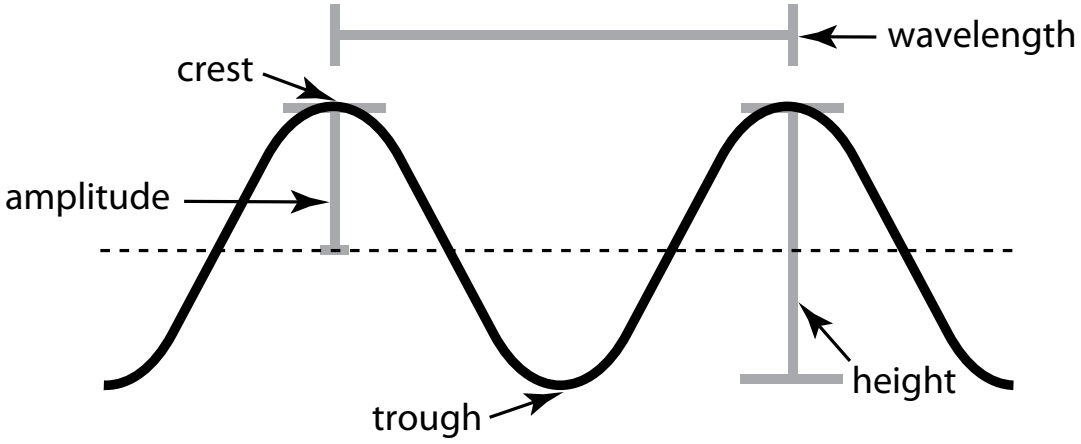
7. D
8. short
9. B and C
10. long
11. A and C
12. 120 minutes (2 hours)

Anatomy of a Wave

Visual Aid 1

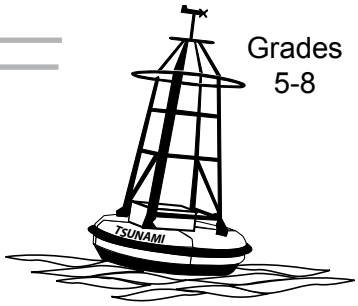
Grades 5-8



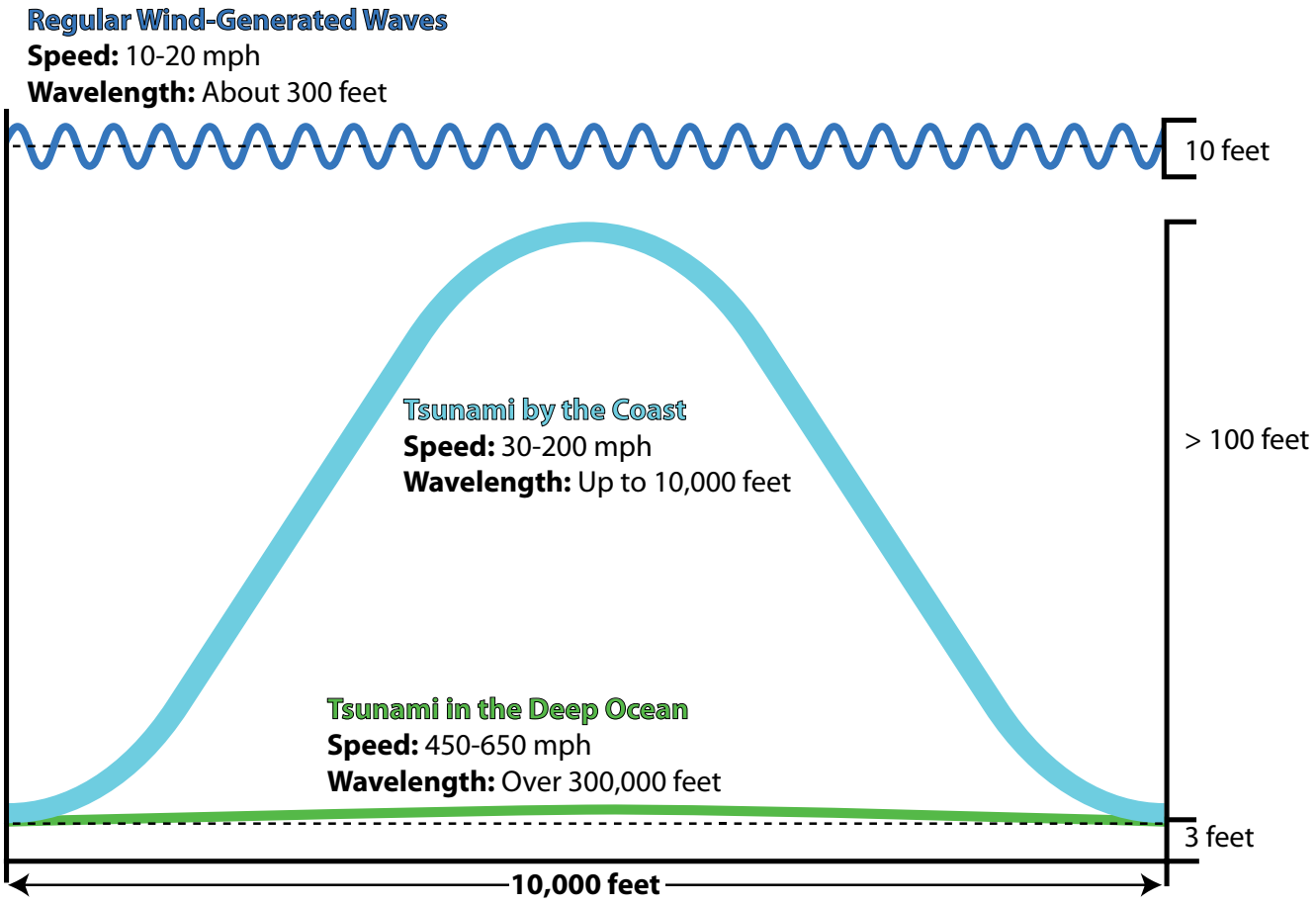


Wind-generated Waves vs. Tsunami Waves

Visual Aid 2



Grades 5-8



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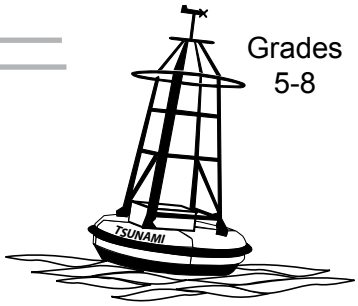

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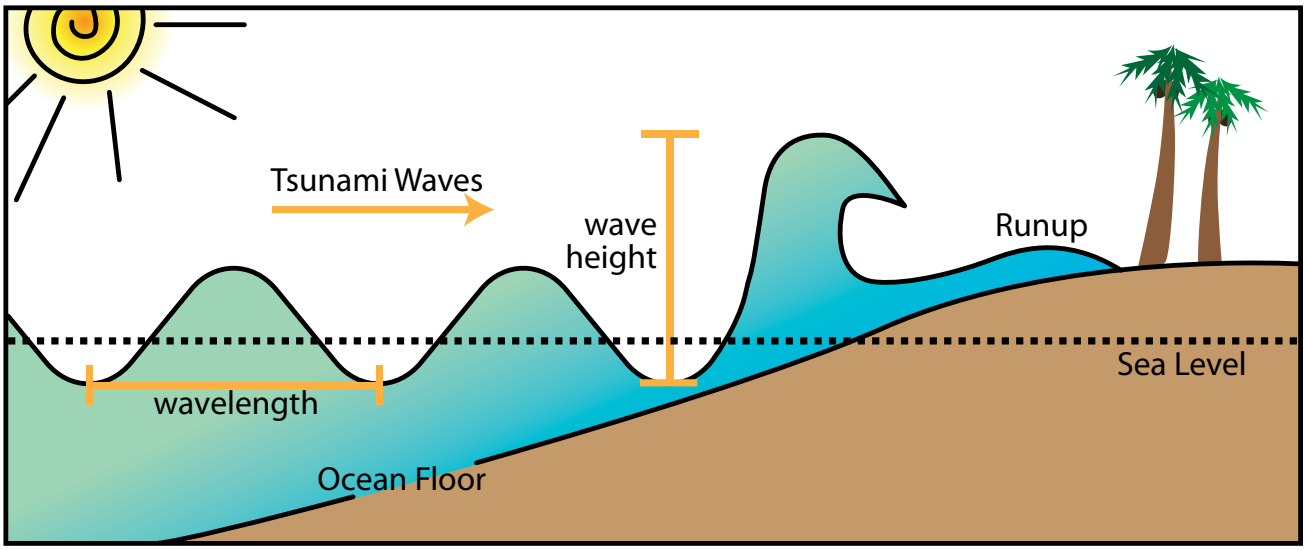

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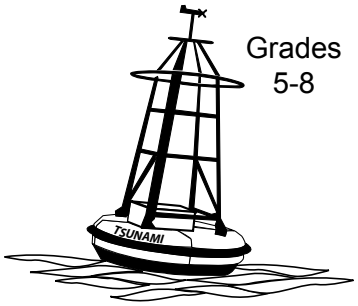
Grades 5-8



Student Worksheet

Slinky Tsunamis (page 1 of 4)

Testable Question:

How are a wave with a long wavelength and a wave with a short wavelength generated?

Hypothesis:

1. A wave with a long wavelength can be generated by _____

_____

2. A wave with a short wavelength can be generated by _____

_____

Experiment:

Materials:

- Slinky
- Clear, smooth table or floor

Procedure:

1. Work in pairs on a clean, smooth table or floor. Stretch the slinky so that one person holds each end.
2. As a team, decide one method of moving the slinky to generate a wave with a long wavelength. Try to make the wavelength long enough so that only one wave is generated.
3. In the Data section below, write your proposed method at Experiment #1: Long Wavelength, Trial #1, A. Method.
4. Test the method by asking one person to hold one end of the slinky still while the other moves the end in the manner written down for Trial #1.
5. Write the results in the Data section below at Experiment #1: Long Wavelength, Trial #1, B. Results.
6. Develop new long wavelength methods for Trial #2 and Trial #3 following the same steps as above.
7. Repeat the procedure, this time attempting to generate a wave with a short wavelength. A short wavelength wave will show up as many waves on the slinky.
8. Record the Methods and Results of three short wavelength trials for Experiment #2: Short Wavelength.

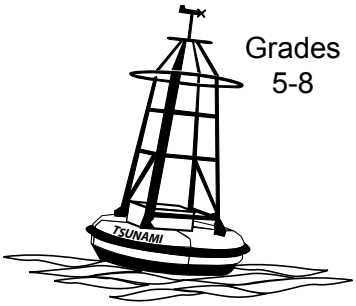
Data:

Experiment #1: Long Wavelength
Trial #1:
A. Method: _____

_____

Name:_____

Grades 5-8



Student Worksheet

Slinky Tsunamis (page 2 of 4)

B. Results:

_____

Trial #2:

A. Method: _____

_____

B. Results:

_____

Trial #3:

A. Method: _____

_____

B. Results:

_____

Experiment #2: Short Wavelength

Trial #1:

A. Method: _____

_____

B. Results:

_____

Trial #2:

A. Method: _____

_____

B. Results:

_____

Trial #3:

A. Method: _____

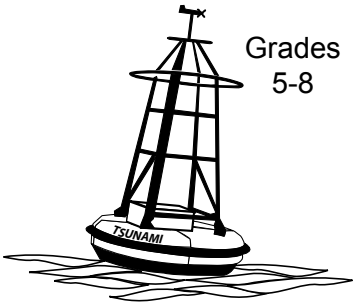
_____

B. Results:

_____

Name:_____

Grades 5-8



Student Worksheet

Slinky Tsunamis (page 3 of 4)

Analysis of Data:

1. Which experiment produced the longest wavelength? _____

2. Which experiment produced the shortest wavelength? _____

Conclusion:

3. A wave with a long wavelength can be generated by _____

_____

4. A wave with a short wavelength can be generated by _____

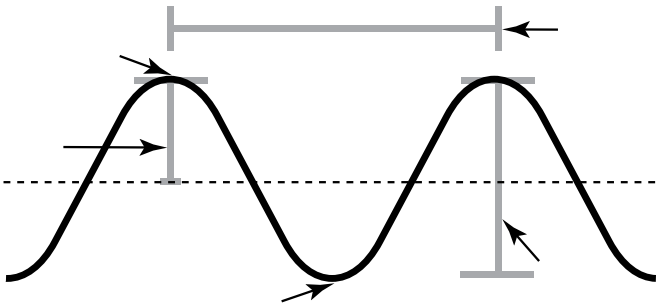
_____

5. Were your hypotheses proved or disproved? _____

_____

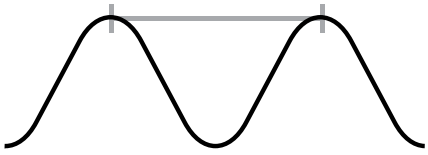
Further Questions:

6. Label the parts of the wave:
   - A. trough
   - B. crest
   - C. wavelength
   - D. height
   - E. amplitude

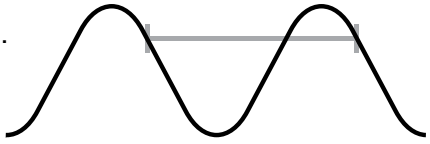


7. Which of the following is NOT a wavelength?

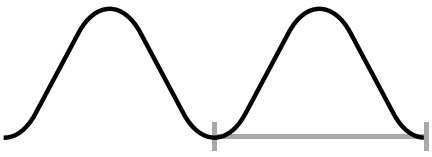
A.



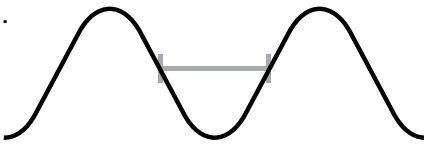
B.



C.



D.

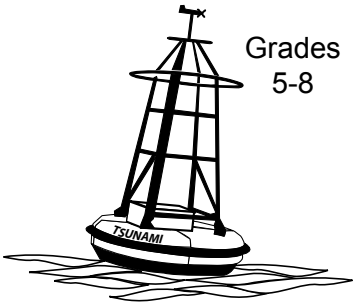


8. Do regular wind-generated ocean waves have short wavelengths or long wavelengths?

_____

Name:_____

Grades 5-8



Student Worksheet

Slinky Tsunamis (page 4 of 4)

9. How are regular waves generated? (Circle all that apply.)
   A. earthquakes
   B. tides
   C. the moon
   D. landslides

10. Do tsunami waves have short wavelengths or long wavelengths? _____

11. How are tsunami waves generated? (Circle all that apply)
   A. earthquakes
   B. storms
   C. volcanoes
   D. the moon

12. If the period of a tsunami is 20 minutes, the wavelength is 10,000 feet, and the tsunami is generated 60,000 feet (11.36 miles) off the coast of a small island, how long will it take for the first tsunami wave to reach the island? Show your work.