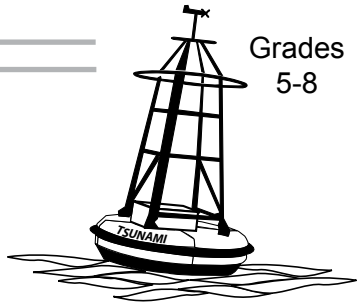
2004 Wave Propagation

Grades 5-8



Overview:

Students generate waves in containers of varying shapes and predict the relative arrival times for waves to reach different edges of the containers. Students record observations and write a conclusion describing how waves propagate, watch a global tsunami simulation and discuss its effects on a global level, and compare the way the waves traveled in the simulation with the way they traveled during the classroom activity.

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.

[5]SA1.2 The student demonstrates an understanding of the processes of science by using quantitative and qualitative observations to create inferences and predictions.

[5]SE3.1 The student demonstrates an understanding of how scientific discoveries and technological innovations affect our lives and society by describing the various effects of an innovation (e.g. snow machines, airplanes, immunizations) on the safety, health, and environment of the local community.

[5]SG2.1 The student demonstrates an understanding of the bases of the advancement of scientific knowledge by reviewing and recording results of investigations into the natural world.

[6]SE3.1 The student demonstrates an understanding of how scientific discoveries and technological innovations affect our lives and society by describing the various effects of an innovation on a global level.

[8]SE3.1 The student demonstrates an understanding of how scientific discoveries and technological innovations affect our lives and society by predicting the possible effects of a recent scientific discovery, invention or scientific breakthrough.

Objectives:

The student will:

- use qualitative observation of wave propagation in a container to predict how waves will propagate in containers of varying shapes;
- record observations and communicate results from wave propagation investigations in water containers of varying shapes;
- describe the potential effects of tsunami inundation mapping on the safety and health of coastal Alaska communities; and
- describe the potential effects of the global tsunami simulation model for the 2004 Indonesian Tsunami event on the safety and health of people around the world.

Materials:

- Eyedroppers (1 per center)
- Round clear baking dish
- Rectangular baking dish (9” x 13”)
- Square baking dish
- 2 or more irregularly shaped dishes (such as molded cake pans or angel food cake pans)

- Pitcher
- Water
- Permanent marker
- Overhead projector
- Red colored pencils (1 per student)
- Blue colored pencils (1 per student)
- Frontier of Discovery DVD (from the Arctic Region Supercomputing Center)
- STUDENT WORKSHEET: “Wave Propagation”

Science Basics:

Propagate is a word used to describe how waves move from a point of origin through a medium to more distant points. Coastlines, initial displacement, and the size of the area of initial movement all are factors in determining how a set of tsunami waves propagates. The wavelength depends on the size of the area of initial earth movement. The wave height corresponds to the vertical displacement. The direction the waves travel is determined by the surrounding coastlines in coastal areas and the bottom topography (bathymetry) of the sea floor in deep ocean. The speed at which tsunami waves travel varies depending on the depth of the ocean. In the deep part of the Pacific Ocean, tsunami waves travel 370-500 miles per hour. Most Alaskan tsunamis are generated by large earthquakes in coastal or marine regions, and the landslides those earthquakes cause. Alaska’s coastline is at greatest risk of tsunamis generated locally. These strike as early as a few minutes after the generating event. The local earthquakes that cause many of Alaska’s tsunamis can generate tsunamis that strike other pacific coastlines, particularly Hawaii, the west coast of Canada and the contiguous United States. Tsunami waves have an extremely long wavelength, which makes them difficult to detect on the open ocean.

Activity Preparation:

1. In the center of the round, square and rectangular baking dishes, draw a small X with a permanent marker. Select a location in each of the irregular pans and draw a small X there as well.
2. Set up at least 4 centers around the room. Each center should include: a baking dish (square, rectangular or irregularly shaped) filled with ½ inch of water and an eyedropper.

Activity Procedure:

1. Place the round, clear glass baking dish on the overhead projector. Fill the dish with ½ inch of water. Explain that during this activity students will observe how waves propagate. Propagate is a word used to describe how waves move from a starting point to more distant points.
2. Ask students to direct their attention to the dish of water projected on the screen. Explain that you are going to release a drop of water from above the X in the center of the dish to create waves in the water. Ask students which direction they think the waves will travel. Invite students to draw their predictions on the chalkboard.
3. Squeeze a drop of water into the dish and allow students to observe the waves. Ask students how the waves propagated in the dish. Students should understand that the waves propagated outward in all directions from the starting point. The waves should have reached all sides of the dish simultaneously because all sides are the same distance from the source (starting point) and the water is of uniform depth.
4. Ask a volunteer to draw their observations on the board. Discuss how class observations compared to predictions.

5. Distribute the STUDENT WORKSHEET: “Wave Propagation.” Divide students into four groups and ask groups to visit each center and complete the activity described on the worksheet. (NOTE: To accommodate English language learners and students with writing disabilities, two opportunities for students to state conclusions have been provided—see questions 1 and 2 on the STUDENT WORKSHEET. Feel free to omit question 1 for students with special needs.)
6. After students have completed the worksheet activity for each center, discuss results.
7. Watch the Tsunami Threat portion of the Frontier of Discovery DVD with students. Ask students to pay close attention to the global tsunami simulation animation on the video and to look for similarities and differences between this simulation and the observations they made during the class activity. (NOTE: To replay the global tsunami simulation animation, fast-forward to 1:40.)

Critical Thinking:

Case Study Method: Watch the Tsunami Threat portion of the Frontier of Discovery DVD. Discuss the following questions as a class:

1. What tool did scientists use to store more than two million data points needed for the global tsunami simulation?
2. How might the global tsunami simulation model of wave propagation for the 2004 Indonesian Tsunami affect the safety and health of people around the world?
3. How might Elena Suleimani’s tsunami inundation maps and visualizations impact the safety and health of coastal Alaska communities?
4. How did the global tsunami simulation compare to what students observed during the class activity?
5. Did the tsunami waves in the simulation reach the coastlines when students expected? Why or why not?

8. Ask students to complete the final questions on the STUDENT WORKSHEET.

Answers:

Hypothesis: *Answers will vary, but each section of the chart should include a pan sketch, an X at the starting point, at least one red mark on an edge of the pan, and at least one blue mark on an edge of the pan.*

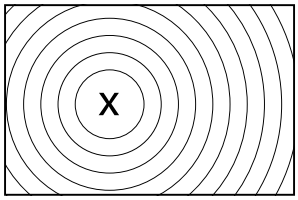
Data:

Square Pan	**Rectangular Pan**	**Irregular Pan 1**	**Irregular Pan 2**
The center of each side of the pan should be marked in red. The corners of the pan should be marked in blue.	The center of the two long sides of the pan should be marked in red. The four corners of the pan should be marked in blue.	Answers will vary according to shape of pan, but should include a pan sketch, an X at the starting point, and at least one red and one blue mark on the pan edge.	Answers will vary according to shape of pan, but should include a pan sketch, an X at the starting point, and at least one red and one blue mark on the pan edge.

Analysis of Data:

1. *A) At the X (the point where the water dripped into the pan)*
2. *A) The waves reached the edges nearest the starting point first.*
3. *B) The waves reached the edges farthest from the starting point last.*
4. *Answers will vary, but should convey that the waves changed direction in the irregularly shaped pans as they traveled around obstacles, making the path of travel irregular instead of straight outward from the source.*

Conclusion:

1. *Answers will vary but should convey: If a drop of water falls into a container of water, the waves will propagate outward from the starting point, traveling around obstacles as necessary.*
2. 

3. *Irregularly shaped*
4. *Answer should include at least one potential GLOBAL impact of the tsunami wave propagation simulation.*
5. *Answer should include at least one potential LOCAL impact of tsunami inundation maps.*

Name:_____

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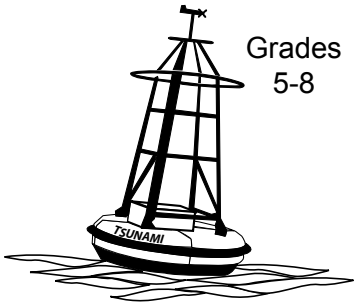

Student Worksheet

"Wave Propagation" (page 1 of 3)

Testable Question:

How do waves propagate in water containers of varying shapes?

Background Information:

Propagate is a word used to describe how waves move from a starting point to more distant points. Think about how the waves move in a round dish when a weight is dropped in the center of the dish. What edges of the dish will the waves reach first? What edges will they reach last? What if the dish were square, rectangular or irregularly shaped? Use what you know about how waves travel to complete the activity below.

Hypothesis:

At each center, draw the pan in the space provided. Make an X at the starting point where you will release a drop of water (the square and rectangular pans have been drawn and 'x'-ed for you). Using a red pencil, mark the edges of your drawing that you predict the waves will reach FIRST when a drop of water is released at the starting point. Using a blue pencil, mark the edges of the drawing that you predict the waves will reach LAST.

	Square Pan	**Rectangular Pan**	**Irregular Pan 1**	**Irregular Pan 2**
1. Draw pan 2. X start point 3. Predict: mark red the FIRST edge/s the waves reach 4. Predict: mark blue the LAST edge/s the waves reach	X	X		

Materials:

- Baking dish (filled with 1/2 inch of water)
- Eyedropper

Procedure:

1. Place some water in the eyedropper and hold it over the X in the pan of water. Wait until the water in the pan is still.
2. Squeeze one drop of water into the pan and observe the waves that are generated.
3. Wait for the water to become still. Drop and observe again.

Name:_____

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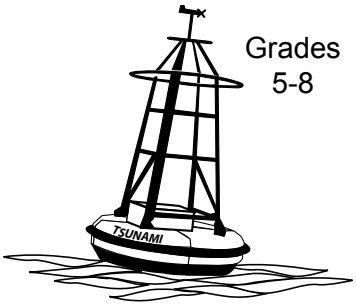

Student Worksheet

"Wave Propagation" (page 2 of 3)

4. Repeat this process until you are certain about which points along the edge of the pan the waves reach FIRST, and which points they reach LAST. Make sure each person in the group uses the eyedropper at least once.
5. Record your observations in the data chart.
6. Rotate to the next center and repeat steps 1-5 until your group has visited four centers.

Data:

	Square Pan	**Rectangular Pan**	**Irregular Pan 1**	**Irregular Pan 2**
1. Draw pan 2. X start point 3. Record: mark red the FIRST edge/s the waves reach 4. Record: mark blue the LAST edge/s the waves reach	X	X		

Analysis of Data:

1. Where did the waves begin in each pan?

   A. At the X (the point where the water dripped into the pan)
   B. At the edge of the pan farthest from the X
   C. At the edge of the pan closest to the X

2. Which edges of the square and rectangular pans did the waves reach first?

   A. The waves reached the edges nearest the starting point first.
   B. The waves reached the edges farthest from the starting point first.
   C. The waves reached all edges at the same time.

3. Which edges of the square and rectangular pans did the waves reach last?

   A. The waves reached the edges nearest the starting point last.
   B. The waves reached the edges farthest from the starting point last.
   C. The waves reached all edges at the same time.

Name:_____

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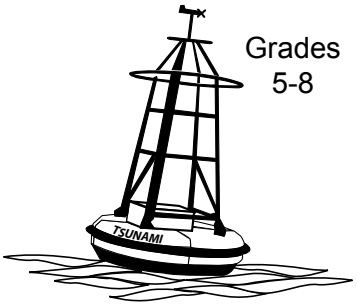

Student Worksheet

"Wave Propagation" (page 3 of 3)

4. How did the way waves traveled in irregularly shaped pans differ from the way waves traveled in the square and rectangular pans?

_____

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Conclusion:

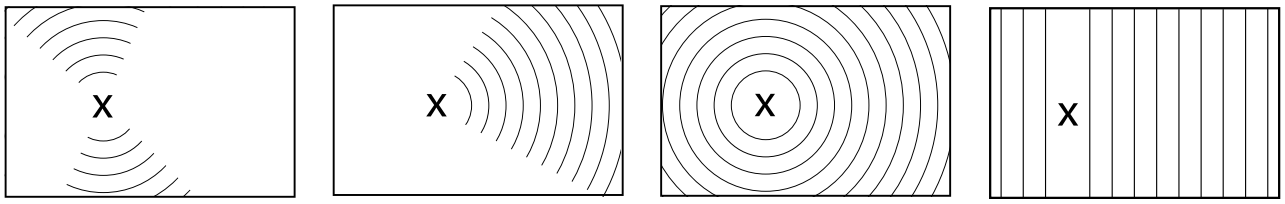
1. Complete the statement below to explain how waves propagate in water containers of varying shapes.

   If a drop of water falls into a container of water, the waves will

   _____

   _____

2. Circle the picture below that shows how the waves would propagate if a drop of water fell from above the X in this pan of water.



3. Are the world's oceans regularly or irregularly shaped?_____

4. Following the 2004 Indonesian Tsunami event, scientists successfully simulated tsunami wave propagation on a global scale. How might this capability affect people around the world?

   _____

   _____

   _____

5. In Alaska, scientists are working to create inundation maps for coastal communities. These maps show the highest points of flooding by potential tsunamis. How might these maps affect the safety and health of the communities they represent?

   _____

   _____