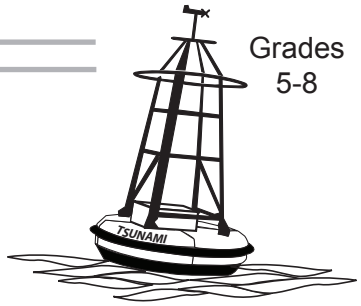
Speedy Tsunami



Grades 5-8

Overview:

In this lesson, students determine the speed of a tsunami using tsunami time travel maps and Google Earth.

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.

[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).

Math

[5] S&P-2 The student demonstrates an ability to analyze data (comparing, explaining, interpreting, evaluating; drawing or justifying conclusions) by using information from a variety of displays (tables, bar graphs, line graphs, or Venn diagrams) (M6.2.2)

[6] S&P-2 The student demonstrates an ability to analyze data (comparing, explaining, interpreting, evaluating; drawing or justifying conclusions) by using information from a variety of displays (tables, bar graphs, line graphs, circle graphs, or Venn diagrams) (M.6.2.2)

[7] S&P-2 The student demonstrates an ability to analyze data (comparing, explaining, interpreting, evaluating, making predictions; drawing or justifying conclusions) by using information from a variety of displays (e.g., as found in graphical displays in newspapers and magazines) (M6.3.2)

[7] PS-5 The student demonstrates the ability to apply mathematical skills and processes across the content strands by using real-world contexts such as science, humanities, peers, and community (M10.3.1 & M10.3.2)

Objectives:

The student will:

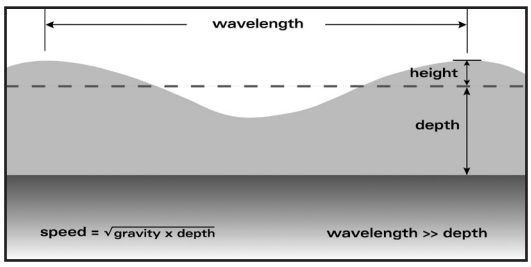
- model seismic waves; and
- differentiate among seismic waves.

Materials:

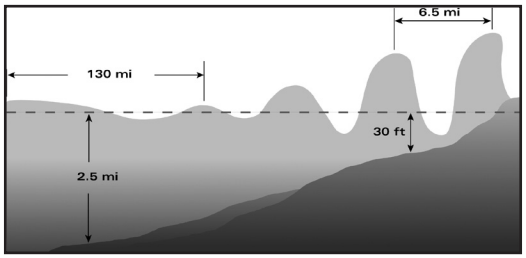
- Overhead Projector
- Clear plastic shoe box or plastic aquarium
- Water
- Clock or stopwatch
- Computer with Internet access
- Google Earth
- STUDENT WORKSHEET: “Speedy Tsunami”
- VISUAL AID: “Wave Characteristics and Speed”
- VISUAL AID: “1946 Tsunami Time Travel Map”

Whole Picture:

Tsunami waves are classified as shallow-water waves. They behave as shallow-water waves because the wavelength is much greater than the ocean depth. Wave speed is a function of ocean depth.



Speed decreases as waves enter shallow water.



The speed of a wave may also be determined using the equation, *rate = distance x time*. Using the properties of a wave, distance is wavelength (one crest + one trough), and time is period. The period of a wave is the time it takes for a wavelength to pass a given point.

In this lesson, students use a time travel map that shows the time it takes for a tsunami to propagate across the ocean. Students use Google Earth to determine distance.

Activity Procedure:

1. Explain students will explore the relationship between depth of water and wave speed.
2. Place a clear plastic shoebox or plastic aquarium on an overhead projector. Fill with water to a depth of 1 centimeter. Explain students will count how many waves will travel across the container in 3 seconds. Assign a student to be the timer to say when to start and stop. The other students count the number of times the waves travel across the container. The wave front will be dark as it projects on the screen or wall. Lift one end of the container 2 inches and wait till the water settles. When the student timer says start, drop that end of the container and count the waves until the timer says stop.
3. Fill the container with water to a depth of 2 centimeters. Ask for predictions on the number of waves then repeat the process of generating waves by dropping one end of the container from a height of 2 inches. Students should clearly see the increase in wave speed as water depth increases.
4. Display VISUAL AID: “1946 Tsunami Time Travel Map.” Explain this map displays the time travel of the tsunami generated near Unimak Island in 1946. Distribute STUDENT WORKSHEET: “Speedy Tsunami” and explain that students will use the visual aid and Google Earth to respond to questions on the worksheet and calculate tsunami speed. For younger students, it may be more appropriate to guide them through the worksheet as a class.
5. Discuss student responses. For #12 on the worksheet, remind students of the wave speed and depth demonstration at the beginning of the lesson and how it applies to the exercise.

Extension Ideas:

- Calculate the speed of the waves on the overhead by timing one wave and measuring the length of the container.
- Ask students to analyze time travel maps of other tsunamis at http://www.ngdc.noaa.gov/hazard/tsu_travel_time.shtml. Sources may be located by latitude and longitude at http://www.ngdc.noaa.gov/hazard/tsu_db.shtml. Students may repeat the process of calculating speed between the source and a point of interest.

Answers:

1. Approximately 4.5 hours
2. A placemark should be placed at 53.320°N and 163.190° W on Google Earth.
3. A placemark should be placed on Honolulu, HI on Google Earth.
4. A. Approximately 3580 kilometers

   B. Approximately 2225 miles
5. A. Approximately 3580 kilometers ÷ Approximately 4.5 hours = ~796 km/hr

   B. Approximately 2225 miles ÷ Approximately 4.5 hours = 494 mi/hr
6. 6-7 hours
7. A placemark should be placed on Mekoryuk, AK on Google Earth.
8. A. Approximately 807 kilometers

   B. Approximately 502 miles
9. A. Approximately 807 kilometers ÷ 6-7 hours = Approximately 115-135 km/hr

   B. Approximately 502 miles ÷ 6-7 hours = Approximately 72-84 mi/hr
10. Honolulu
11. Source to Honolulu
12. The depth of the ocean is greater between the source and Honolulu than between the source and Mekoryuk, therefore the wave would travel faster to Honolulu. The student may also note that the Aleutian Islands may form as a barrier to the wave and slow it down as it travels to Mekoryuk.

Lesson Information Sources:

The SALMON Project. Module 14: Shallow Waves Race. University of Alaska Fairbanks. Retrieved 16 October 2008. http://www.ims.uaf.edu/salmon/index.html.

National Geophysical Data Center (NGDC). *Tsunami Time Travel Maps*. Retrieved 16 October 2008. http://www.ngdc.noaa.gov/hazard/tsu_travel_time.shtml.

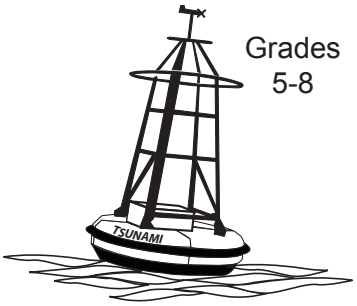
National Geophysical Data Center (NGDC). *NOAA/WDC Historical Tsunami Database at NGDC*. Retrieved 16 October 2008. http://www.ngdc.noaa.gov/hazard/tsu_db.shtml.

Name:_____

Speedy Tsunami

Student Worksheet (page 1 of 2)

Grades 5-8



How fast does a tsunami wave travel?

The speed of a tsunami wave may be calculated using the distance it traveled and the time it took for the wave to travel.

speed = distance ÷ time

The time travel map map displays the tsunami travel time for the tsunami that happened in 1946. The wave was generated near Unimak Island at 53.320°N and 163.190° W longitude.

1. Use the map to determine about how long it took for the wave to reach Honolulu, Hawaii.

   _____ hours

2. Make a placemark at the location where the wave was generated on Google Earth. Use the coordinates 53.320°N, 163.190° W

3. Make a placemark at Honolulu, Hawaii.

4. Use the ruler on Google Earth to determine the distance between the source of the tsunami and Honolulu. Change the settings so that your measurements are in kilometers and miles.

   A. _____ kilometers B. _____ miles

5. Use the equation, D (distance) ÷ T (time) = rate, to determine speed using kilometers and miles.

   A. _____ (from #4A.) kilometers ÷ _____ (from #1) hours = _____

   B. _____ (from #4B.) miles ÷ _____ (from #1) hours = _____

6. Use the map to determine about how long it took the tsunami to reach Mekoryuk, a village on the north end of Nunivak Island.

   _____hours

7. Make a placemark at Mekoryuk, Alaska using Google Earth.

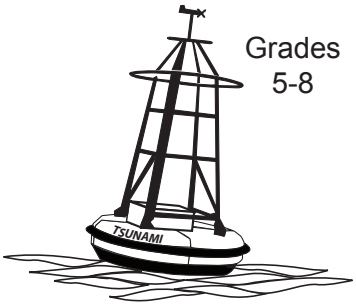
8. Use the ruler on Google Earth to determine the distance between the source and Mekoryuk. Change the settings so that your measurements are in kilometers and miles.

   A. _____ kilometers B. _____ miles

Name:_____

Speedy Tsunami

Student Worksheet (page 2 of 2)



Grades 5-8

9. Use the equation, D (distance) ÷ T (time) = rate, to determine speed using kilometers and miles.

   A. _____ (from #8 A.) kilometers ÷ _____ (from #6) hours = _____

   B. _____ (from #8B.) miles ÷ _____ (from #6) hours = _____

10. Circle your answer. Which location was further from the source?

    Honolulu Mekoryuk

11. Circle your answer. Which direction had a faster wave speed?

    Source to Honolulu Source to Mekoryuk

12. How do you account for the difference in wave speed?

_____

_____

_____

_____