



Overview:

In this lesson, students examine the depth of different locations in the Pacific to determine the speed of a tsunami passing through that location.

Targeted Alaska Grade Level Expectations:

Science

- [9] 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.
- [10-11] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring, and communicating.

Math

- [9] F&R-3 The student demonstrates conceptual understanding of functions, patterns, or sequences including those represented in real-world situations by describing in words how a change in one variable in a formula affects the remaining variables (e.g., how changing the radius affects the volume of a cylinder) (M4.3.2).
- [10] F&R-3 The student demonstrates conceptual understanding of functions, patterns, or sequences including those represented in real-world situations by describing in words how a change in one variable or constant in an equation affects the outcome of the equation (M4.3.2).
- [10] F&R-7 The student demonstrates algebraic thinking by solving or identifying solutions to literal equations or formulas for a variable involving multi-steps (e.g., solve for h when $A = 1/2h(b_1 + b_2)$) (M4.4.2).

Objectives:

The student will:

- calculate the speed of a tsunami;
- convert meters per second to kilometers per hour; and
- explain the significance of calculating tsunami speed on society.

Materials:

- Calculators (must be capable of doing square roots)
- STUDENT WORKSHEET: "Tsunami Speed"

Whole Picture:

The speed of a tsunami is a function of ocean depth.

$$\text{speed} = \sqrt{g \times d}$$

g = acceleration due to gravity (9.81 meters/second²)

d = depth

Understanding the speed of tsunamis is useful in issuing warnings to coastal regions. Knowing the speed can help predict when the tsunami will arrive at a particular location.

Activity Procedure:

1. Explain students will calculate the speed of tsunamis as they travel over areas of the Pacific ocean.

Critical Thinking: Wait time method. Pose a question and wait at least 5 seconds for students to form a response, then call on students to share their response. Ask students to consider why calculating the speed of a tsunami is an important skill. (*This skill is useful in warning people in coastal regions of incoming tsunamis.*)

2. Distribute calculators and STUDENT WORKSHEET: "Tsunami Speed." Guide students through the worksheet and the example used. Assist students with use of the calculator if necessary.
3. Students should complete the worksheet. On completion, discuss student responses.

Extension Ideas:

- Ask students to use a map of labeled depths of the Pacific Ocean. (National Geographic Society.(1992). *World ocean floors: Pacific ocean.*) to choose an area of the Pacific and calculate the speed of a tsunami based on the depth of the chosen area.
- Continue the conversions by converting the speed from kilometers per hour to miles per hour. (Alaska Grade Level Expectation for Math [9] MEA-1)

Answers:

1. 185.3 m/s
2. 667.1 km/h
3. 230.6 m/s
4. 830.1 km/h
5. increase
6. Answers will vary, but should express the usefulness in calculating speed for tsunami warning centers

Lesson Information Sources:

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

National Geographic Society. (1992). *World ocean floors: Pacific ocean.*

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Tsunami Speed

Student Worksheet (page 1 of 2)

The speed of a tsunami is a function of ocean depth.

$$\text{speed} = \sqrt{g \times d}$$

g = acceleration due to gravity (9.81 meters/second²)

d = depth

An area in the Gulf of Alaska off of Southeastern Alaska has an approximate depth of 716 meters. To determine the speed of a tsunami wave traveling through this area, see the process below.

$$\text{speed} = \sqrt{9.81\text{m/s}^2 \times 716\text{m}} = \frac{83.81 \text{ meters}}{\text{second}}$$

Convert to kilometers per hour.

$$\frac{83.81 \text{ meters}}{\text{second}} \times \frac{60 \text{ seconds}}{\text{min}} \times \frac{60 \text{ min}}{\text{hour}} \times \frac{1 \text{ km}}{1000 \text{ m}} = \frac{301.71 \text{ km}}{\text{hour}}$$

Calculate the speed of a tsunami traveling across the Aleutian Basin, which is North of Adak and Atka Islands and extends Northeast to the northern end of the Kamchatka Peninsula. The approximate depth of this region is 3500 meters. Show your work.

1. Determine the speed in meters per second.

2. Convert to kilometers per hour.

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Tsunami Speed

Student Worksheet (page 2 of 2)

Calculate the speed of a tsunami traveling across a deep section of the ocean that lies south of the islands of Adak and Atka and north of the Hawaiian Islands. The approximate depth of this region is 5420 meters. Show your work.

3. Determine the speed in meters per second.

4. Convert to kilometers per hour.

Circle the correct answer.

5. As ocean depth increases, tsunami speed _____.
increases decreases.

6. Why would determining tsunami speed be a useful skill?
