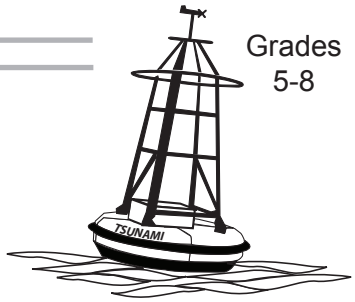
Seismometer: Source Mechanisms

Grades 5-8



Overview:

In this lesson, students build a seismometer and investigate how forces are reflected in seismometer data.

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] SB4.1 The student demonstrates an understanding of motions, forces, their characteristics, relationships, and effects by investigating that the greater the force acting on an object, the greater the change in motion will be.

[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).

[5] SE2.1 The student demonstrates an understanding that solving problems involves different ways of thinking, perspectives, and curiosity by investigating a problem or project over a specified period of time and identifying the tools and processes used in that project.

[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.

[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.

[7] SE3.1 The student demonstrates an understanding of how scientific discoveries and technological innovations affect our lives and society by recognizing the effects of a past scientific discovery, invention, or scientific breakthrough (e.g., DDT, internal combustion engine).

Objectives:

The student will:

- build a model seismometer;
- evaluate possible sources of surface motion using seismograms; and
- describe how seismometers may contribute to the safety of communities.

Materials:

- register tape (~ 5 feet per pair of students)
- box (1 per pair of students)
- string (~18 inches per pair of students)
- fine-tipped markers (1 per pair of students)
- weights (sand or gravel) (~ 1 cup per pair of students)
- plastic or paper cups (1 per pair of students)
- scissors (1 per pair of students)
- clay (~ 1/2 cup per pair of students)
- small stick or small tongue depressor (1 per pair of students)
- an assortment of materials to produce different “seismic signatures” (e.g., balls of different sizes/weights, electric pencil sharpeners, etc.)

- STUDENT INFORMATION SHEET: “Build a Seismometer”
- STUDENT WORKSHEET: “Seismic Signatures”
- VISUAL AID: “Seismic Data”
- VISUAL AID: “Seismic Signatures”
- VIDEO FILE: “Seismometer”

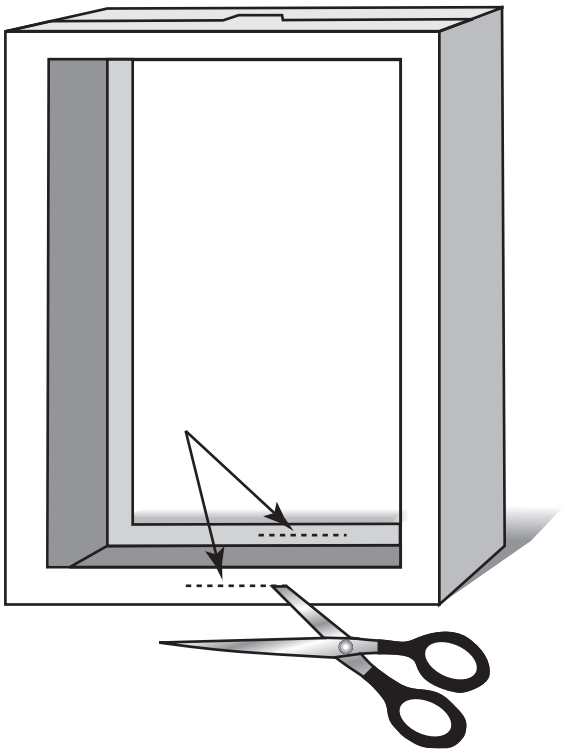
Whole Picture:

A seismometer, or seismograph, is a tool used to record and measure seismic waves. Seismograms, or “seismic signatures” are the records produced by seismometers that show the ground displacement over time. Through analysis of seismograms, scientists at tsunami warning centers can determine the likelihood that a tsunami will form and issue warnings to communities if necessary.

Seismometers display the strength of the ground motion. Additionally, close analysis of the data reveals the source mechanism of the ground motion. The VISUAL AID: “Source Signatures” displays four major types of signatures identified by seismologists at Mount St. Helens. These signatures include: (1) deep earthquakes and those located away from the volcano, which produce high-frequency signatures and sharp arrivals similar to tectonic earthquakes, (2) shallow earthquakes, located under the dome at depths of less than 3 kilometers, which produce medium-to low-frequency seismic arrivals, (3) surface events, such as gas and tephra events, rockfalls associated with dome growth, and snow and rock avalanches from the crater walls, which produce complicated signatures with no clear beginning or end, and (4) harmonic tremor (volcanic tremor), which is a long-lasting, very rhythmic signal whose origin is not well understood but which is often associated with magma movement in active volcanoes.

Activity Preparation:

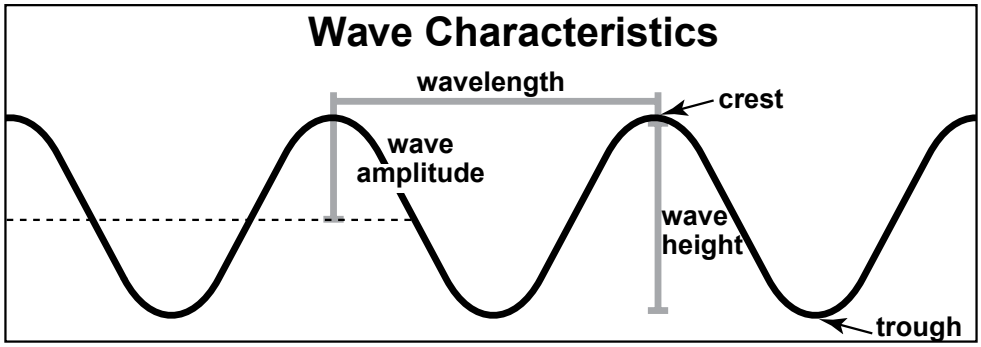
1. Cut slits in the bottom of each box (one box per pair of students) wide enough for register tape to slide through.



2. Make a model seismometer using the directions on STUDENT INFORMATION SHEET: “Build a Seismometer.”

Activity Procedure:

1. Explain that students will make their own seismometers. Review the parts of a wave by drawing a wave on the board and label amplitude, wavelength, crest and trough.



2. Display VISUAL AID: “Seismic Data” and share information from *Whole Pictures* to explain the technology and the data.
3. Display VISUAL AID: “Seismic Signatures” and share the information from *Whole Pictures* to explain how scientists evaluate the data to determine the source of the ground motion. Also display VIDEO FILE: “Seismometer.”
4. Distribute STUDENT INFORMATION SHEET: “Build A Seismometer” along with necessary supplies for each pair of students. Guide students through the directions and display the model seismometer.
5. Distribute STUDENT WORKSHEET: “Seismic Signatures” and review Part A. Encourage students to get creative within reason in coming up with sources to investigate with their seismometers. Some ideas include bouncing balls of different weights, dragging a heavy object across the table or floor, using an electric pencil sharpener on the surface, placing the seismometer by playground equipment etc.
6. Students complete the activity and the worksheet.
7. Ask students to share their findings and have their peers try to determine the source mechanisms for each displayed seismogram.

Extension Ideas:

- Carry out the activity of collecting seismometer data using SeisMac on a laptop or a seismometer application on an iPod.
- Present seismometers to another class and ask those students to guess the sources of each seismometer signature.

Answers:

1. Answers will vary

2. A. time *B. ground motion* *C. amplitude*

3. Seismometers, or seismographs, measure ground displacement over time and they permit scientists at tsunami warning centers detect the magnitude of earthquakes and the likelihood that a tsunami will happen. Tsunami warning centers can issue warnings to communities if necessary.

Lesson Information Sources:

Brantley and Topinka, 1984, *Volcanic Studies at the David A. Johnston Cascade Volcano Observatory*, Earthquake Information Bulletin, March-April 1984, v.16, n.2

Levy, M., Salvadori, M. G., & Blatt, C. (1997). Earthquake games: Earthquakes and volcanoes explained by 32 games and experiments. New York: M.K. McElderry Books.

US Contribution to the Indian Ocean Tsunami Warning System. (2006). *Fact sheet: How do seismometers contribute to a tsunami warning system?* Retrieved Feb. 5, 2009 from http://apps.develebridge.net/usiotws/page04seismic.html

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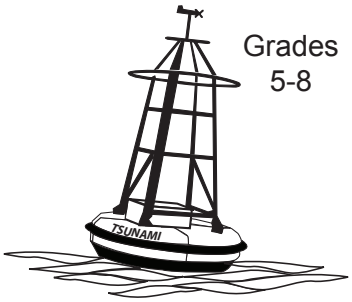
Build a Seismometer

Student Worksheet (page 1 of 3)



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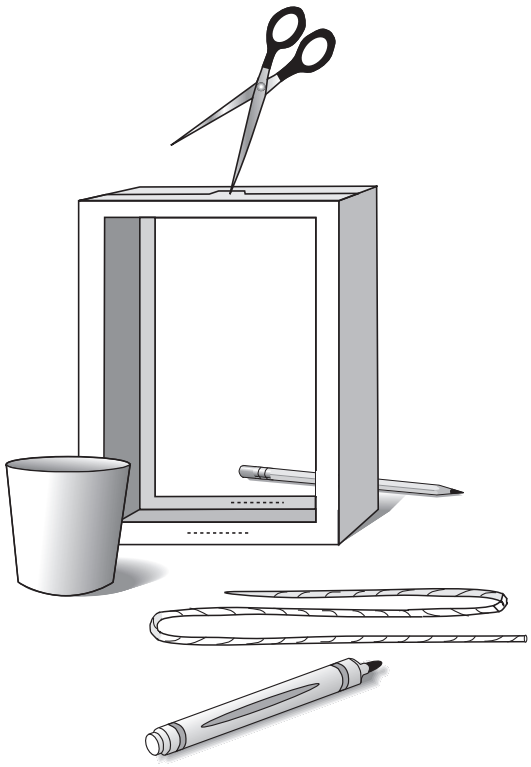
You will need:

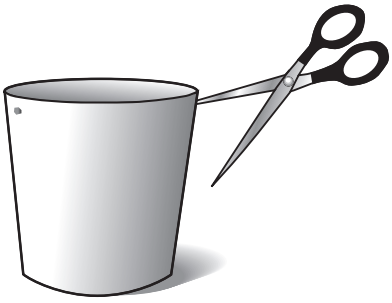
cardboard box	scissors	small stick marker
cup	sand or gravel	register tape
string	clay	

Directions

STEP 1. Stand the box on end and poke a hole in the top.



STEP 2. Poke a hole in the bottom of the cup and two holes in the opposite side of the cup.



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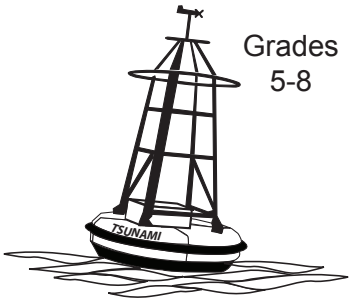
Build a Seismometer

Student Worksheet (page 2 of 3)



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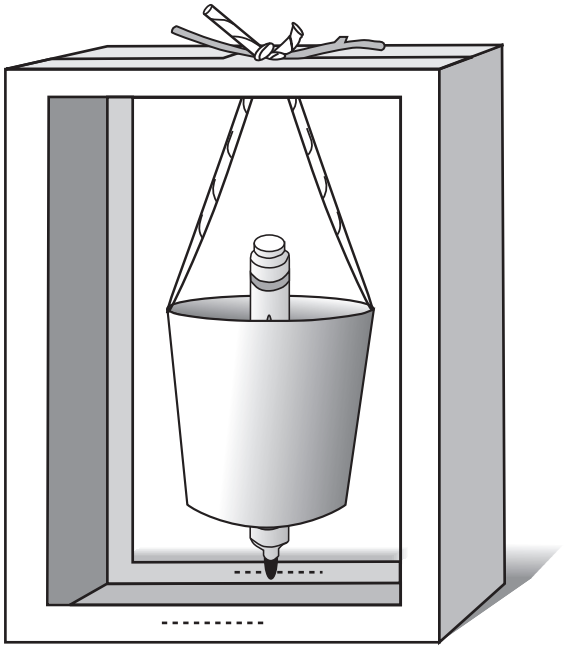
STEP 3. Poke the marker through the hole in the bottom and push the clay around the marker at the hole.

STEP 4. Loop the string through the holes in the side of the cup and feed both ends of the string through the hole in the top of the box. Place the small stick and tie off the string so that the marker is hanging but touching the bottom of the box.



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Build a Seismometer

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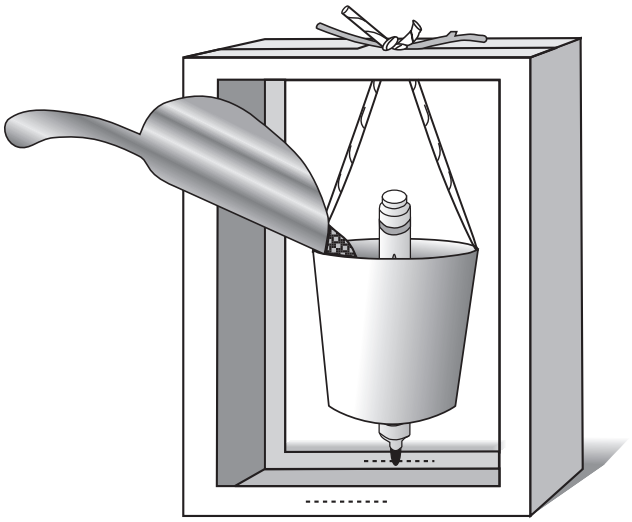
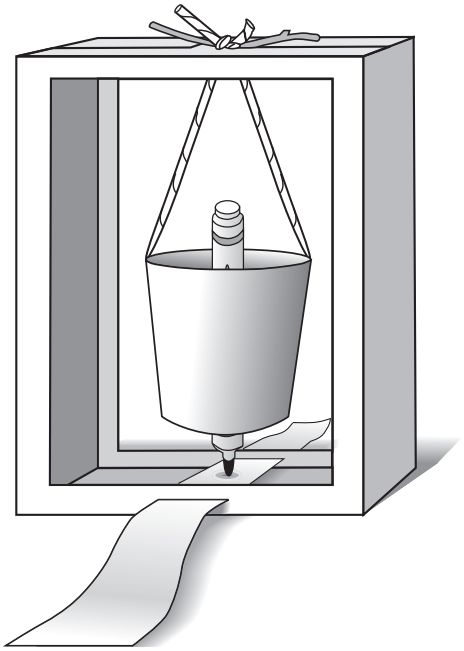
STEP 5. Fill the cup with sand or gravel to weigh the cup down and steady the marker.



STEP 6. Feed the register tape through the slits in the bottom of the box.



Your seismometer is now ready. One person pulls the register tape as another person applies a force to the surrounding surface.

Name:_____

Seismic Signatures

Student Worksheet (page 1 of 2)

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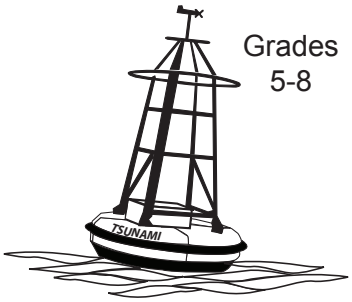


1. Investigate how different forces affect the seismometer.

STEP 1. Think of at least three different sources to test. Record the list of sources below.

_____

_____

_____

STEP 2: Place the seismometer by one of the sources. One person stays with the seismometer to pull a strip of register tape through the seismometer.

STEP 3: One person applies the force as the partner pulls the register tape through the seismometer.

STEP 4: Repeat the force at least two more times.

STEP 5: Label the seismograms with their sources.

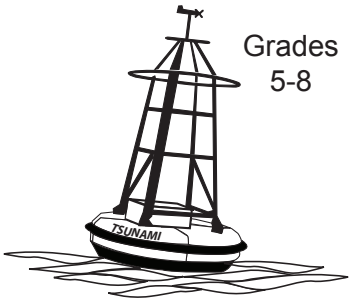
STEP 6: Repeat the process with other sources.

STEP 7: Share your seismograms with your class and ask them to determine the sources.

Name:_____

Seismic Signatures

Student Worksheet (page 2 of 2)



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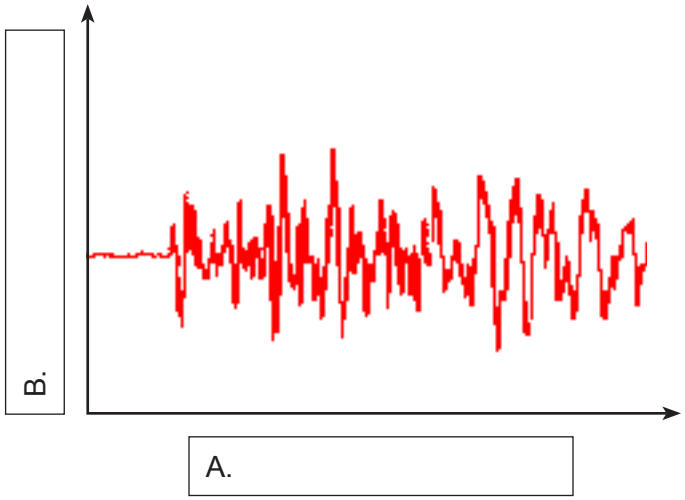
2. Fill in the blanks with a word from the bank.

amplitude	ground motion
time	wavelength



C. As force increases, the _____ on a seismogram increases.

3. How do seismometers contribute to the safety of communities?

_____

_____

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