Earthquakes 6–8

Earthquake Science

Dynamic Earth

Learning about faults and seismic waves will give students a deeper understanding of earth tremors and quakes.

Key Terms and Concepts

compression
dip-slip fault
epicenter
longitudinal
Love waves
normal slip fault
primary waves (P waves)
Rayleigh waves
reverse (thrust) fault
secondary waves (S waves)
seismic waves
seismogram
seismograph
strike-slip (lateral) fault
surface waves
transverse fault

Purposes

To help the students understand that seismic waves generated during an earthquake cause the earth's tremors and that tracking the origin of the waves will lead seismologists to an earthquake's epicenter

To explore different types of fault and how they react in an earthquake

Objectives

The students will—

- After research, work in small groups to write explanatory paragraphs describing seismic waves, using specified vocabulary.
- Use simple toys to demonstrate, describe and illustrate P waves and S waves.
- Analyze how the demonstrations typify the two types of wave.
- Create demonstrations of surface waves and analyze how each represents what occurs in a Rayleigh or Love wave. (Linking Across the Curriculum)
- Employ an interactive Internet site to simulate an earthquake and read seismograms to determine its epicenter. (Linking Across the Curriculum)
- Use *Building a Seismograph* to illustrate how a seismograph works. (Linking Across the Curriculum)
- If applicable, discuss with family members the sensations they felt during their experiences with earthquakes. (Home Connection)
- Observe fault animations and images of different types of fault on the Internet.
- Apply information about faults to evidence they might see if their school grounds were situated on or near a fault.

American Red Cross

Visit the American Red Cross Web site at *www.redcross.org/disaster/masters*

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- Use the U.S. Geological Survey database of faults in the United States to find and share information about faults in their area. (Linking Across the Curriculum)

Activities

"Seismic Waves"

"The Earth's Faults"

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"Seismic Waves"

SET UP 10 minutes **CONDUCT** 60 minutes

Science: Earth Science; Language Arts: Research and Writing

1. Write the following words on the chalkboard:

compression	perpendicular	wave
earthquake	pressure	seismogram
epicenter	primary	seismograph
longitudinal	S waves	transverse
P waves	secondary seismic	vibrations

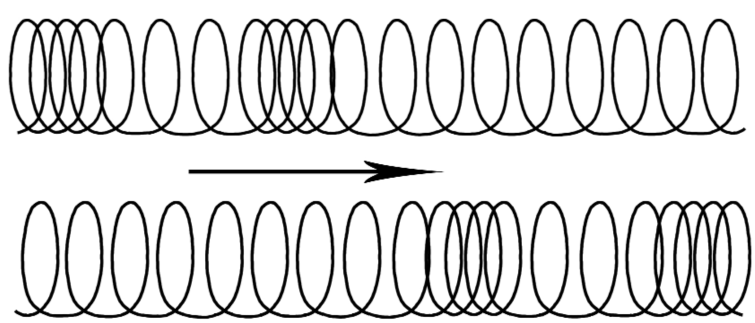
Divide the class into groups. Using as many of the words from the chalkboard as possible, have each group write a paragraph to describe seismic waves.

TEACHING NOTE Students may research their descriptive paragraphs in earth science textbooks or online.

Find out more about seismic waves at Michigan Tech UPSeis (*http://www.geo.mtu.edu/UPSeis/waves.html*) and ASPIRE from the National Science Teachers Association (*http://sunshine.chpc.utah.edu/labs/seismic/index.htm*).

2. After the students share their definitions and descriptions with the class, they will demonstrate P waves and S waves using simple toys:
   P wave: Have two students sit across from each other at a table and hold the Slinky between them. Then they will move their chairs back until the Slinky has no slack, but is not stretched tight. Now, direct one student to quickly push one end of the Slinky forward then back, as the other student holds the other end still.

   Ask the students to describe and/or draw what happened to the Slinky. (The links in the Slinky were pushed together, or compressed; then they were separated as the student pulled back.)



Materials

- Chalkboard and chalk or chart paper and markers
- Slinky®
- Rope, 6–10 ft. (180–300 cm) long (clothesline weight or heavier)
- *Building a Seismograph,* 1 copy per group (Linking Across the Curriculum)

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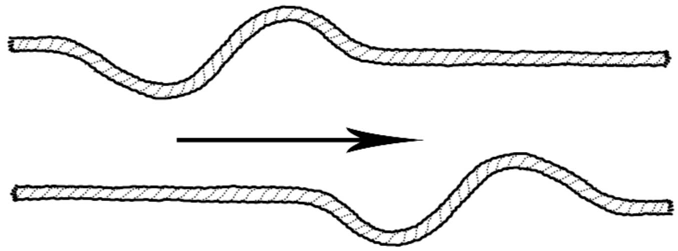
S wave: Have two students hold the length of rope between them. Direct one student to move his or her end of the rope quickly, up and down.

Ask the students to describe and/or draw what happened to the rope. (The rope ripples forward, up and down.)



Wrap-Up

As a class, discuss how the demonstrations illustrated the movement of seismic waves.

What type of wave did the Slinky demonstrate? (A P wave, or primary wave, can be thought of as a push-pull wave. As a P wave travels outward, it is pushed together, or compressed. Each compression is followed by an expansion, as the wave pulls apart or lengthens. The waves move longitudinally forward. P waves are primary waves and move much faster and arrive before S, or secondary, waves.)

What type of wave did the rope demonstrate? (An S wave, or secondary wave, can be thought of as a series of ripples, moving up and down as they move forward through the earth. These waves are transverse to the earth's strata, making the earth vibrate in motion that is perpendicular to the strata lines and causing great damage. S waves are much slower, but much more destructive than P waves.)

TEACHING NOTE If the class is unfamiliar with the word, explain that "strata" refers to the many layers of rock that compose the earth's crust.

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Linking Across the Curriculum

Science: Earth Science

Materials

- Slinky
- Rope (6–10 ft. (180–300cm) long
- LEGOs® or other interconnected building blocks

While researching seismic waves, students most likely found out about waves other than P waves and S waves—Love waves and Rayleigh waves. Challenge small groups of students to devise demonstrations that illustrate the characteristics of each of these waves. Have them present their demonstrations to the class, discussing each wave and how it compares to others they have studied. (Rayleigh waves and Love waves are surface waves. The Rayleigh wave moves longitudinally, like a P wave, and transversely, like an S wave. The ground vibrates back and forth and up and down. The Rayleigh wave rolls along the ground somewhat like a wave in an ocean rolls toward shore. Most of the shaking in an earthquake is caused by Rayleigh waves.

The Love wave is the fastest surface wave. It moves the ground from side to side. It's somewhat like a Rayleigh wave turned on its side—moving forward and backward and left and right at the same time.)

Mathematics: Charts and Graphs

Have the students use Virtual Quake from UCLA's geology department at *http://www.sciencecourseware.org/VirtualEarthquake/VQuakeExecute.html* to simulate an earthquake and then read the seismograms to determine the epicenter of the quake and its intensity.

Science: Earth Science; Fine Arts: Visual Arts; Mathematics: Measurement and Comparison

Distribute *Building a Seismograph* and the materials specified on the activity sheet to one or more small groups of students. Have them follow the directions on the activity sheet to set up a classroom demonstration of how a seismograph works.

Home Connection

If any students or their family members have experienced an earthquake, ask them to describe the shaking they felt. Have students share the descriptions to see if they can identify different types of wave motion. Remind the students that P waves arrive before S waves, and observers can estimate the distance of the epicenter by counting seconds between the arrivals of primary and secondary waves.

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Materials

Internet access

American Red Cross

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"The Earth's Faults"

SET UP 10 minutes **CONDUCT** 40 minutes

Science: Earth Science and Technology

> **TEACHING NOTE** The most effective way of teaching this activity is through Internet access for small groups of students. You may wish to project the interactive sites on an LCD projector. If Internet access is not available for your class, you may print and copy the information for the class to work through the activity on paper.

1. Having discussed plate tectonics earlier, students are aware of faults that occur where plates come together or where pressure is exerted as plates move. As a class, discuss what the students know about the earth's faults. Where do faults occur? What happens at a fault during an earthquake?

2. Review the animations in Fault Motion, from Incorporated Research Institutions for Seismology at *http://www.iris.edu/gifs/animations/faults.htm*. Discuss the different types of fault illustrated.

3. Use the slide show of fault images from the National Geophysical Data Center at *http://www.iris.washington.edu/gifs/slides/faults/slideshow/index.htm* to analyze, describe and discuss each of the faults as they appear on the surface of the earth.

Wrap-Up

Challenge students to describe how their school building and grounds might be affected if they were situated on any of these faults.

What evidence would they see? (Answers will vary, but may include—With a lateral fault, the playing field might crack and the marked lines would no longer meet. With a reverse fault, the school building might be lifted to overhang the parking lot. With an oblique slip fault, the parking lot could crack and move sideways with one side falling below the other.)

Linking Across the Curriculum

Science: Earth Science; Social Studies: Geography

To help predict where earthquakes will occur, the U. S. Geological Survey has created an extensive database of faults in the United States. The database doesn't contain all the faults (there are millions!), but it contains many faults in the western United States that that geologists know to be "active" (that have moved not long in the past), including those believed capable of causing damaging earthquakes.

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Using the site at *http://gldims.cr.usgs.gov/qfault/viewer.htm* students can discover—

- Where the closest faults or fault areas are located;
- How active have they been in the last 1.6 million years (the Quaternary Epoch); and
- When the last large earthquake occurred.

Assign interested students to use the interactive map to discover information about faults in their area and share that information with the class. Clicking the cursor on a mapped fault will show the name of the fault, and a hotlink then leads to a Web page with detailed information if desired. Be sure that Web browsers have pop-up blocking disabled.

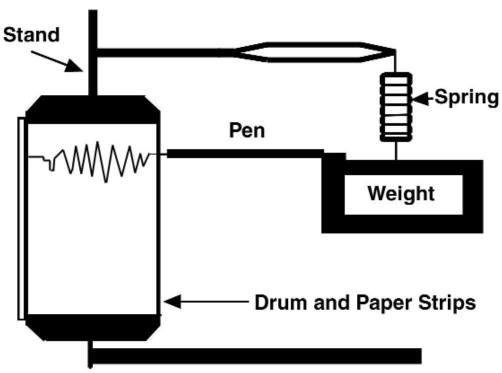
Building a Seismograph

Name ______________________________

Directions: A seismograph measures the magnitude of the seismic waves that shock the earth during an earthquake. Follow the steps below to build your own seismograph and demonstrate how it works.

Materials:

- Ring stand
- Cardboard oatmeal container (drum)
- Metal spring, at least 4 in. (10 cm) long that can support a heavy weight
- Pen
- 2 rubber bands
- White paper strips cut to fit around oatmeal container
- Glue
- Weight
- Gelatin, rectangular pan, materials for building simple structures (stackable or interconnecting blocks, etc.)



Procedures:

1. Wrap the paper around the oatmeal container and glue the edges.
2. Put a hole in the top and bottom of the container and put the upright pole of the ring stand through the holes. Secure in place by wrapping rubber bands around the pole at the top and bottom of the container.
3. Suspend the spring and the attached weight from the end of the ring stand. The weight should hang about 1 to 2 inches (2.5 to 5 centimeters) from the base of the ring stand.
4. Attach the pen to the weight, letting the point of the pen touch the paper on the oatmeal container.
5. Shake the structure that the ring stand is on, while a partner turns the drum. The pen will show the waves created by the shaking on the drum's paper covering.

Building a Seismograph

Try these demonstrations:

1. Make a rectangular pan of hard-gelled gelatin and set the seismograph on the gelatin. Shake the gelatin. Is the wave created on the gelatin similar to or different from the wave created when the seismograph rests on a hard surface such as a table? How do you explain that?

2. While the seismograph is sitting on the table, vary the shaking from gentle to quite hard. CAREFUL! Don't shake the table so hard that the seismograph falls! How does the wave record on the drum change? How do you explain that?

3. Try building some simple structures and setting them on the table near the seismograph. Shake the table gently. Did your structures fall? How big were the waves recorded by the seismograph? If necessary, rebuild your structures trying to make them more stable. Increase the power of the shaking gradually until the new structures fall. Set up a competition. The structure that is the most stable according to the seismograph wins. Repeat this experiment on the pan of gelatin. Is it easier or harder to build a stable structure resting on gelatin? Explain.

Adapted from "On the SafeSide with the Weather Channel."