

# Measuring Earthquakes

**GRADE LEVEL**

4<sup>th</sup>-8<sup>th</sup>; California Content Standards for 4<sup>th</sup> and 6<sup>th</sup>

**SUBJECTS**

Earth Sciences

**DURATION**

Preparation: 5 minutes Activity: 30 minutes

**SETTING**

At home

## Objectives

In this lesson, you and your children will:

1. learn about the cause of earthquakes,
2. learn about how scientists measure earthquake intensity,
3. build their own seismograph to measure shaking.

## Materials

marker or felt-tip pen  
plastic or metal ruler that is flexible  
tape (masking tape is best)  
something heavy (a can of soup is perfect!)  
newspaper or other big scratch paper

## Vocabulary

- ❖ **earthquake:** a sudden rapid shaking of the ground caused by a rapid release of energy
- ❖ **epicenter:** the point on the Earth's surface that is vertically above the focus of an earthquake.
- ❖ **fault:** a break or fracture in a rock mass across which movement has occurred.
- ❖ **focus (hypocenter):** the point of origin of an earthquake.
- ❖ **seismograph:** any of various instruments for measuring and recording the vibrations of earthquakes.
- ❖ **tectonic plates:** massive irregularly-shaped sections of Earth's crust that are constantly in motion.

## Teacher Background

Most earthquakes are caused by the movement of tectonic plates. They typically occur along fault planes, and most frequently along boundaries of tectonic plates. There are three basic types of plate boundaries – divergent, convergent and transform. Use your hands to show the different ways that tectonic plates interact with each other. Plates moving away from each other, (divergent) crashing into each other (convergent) or sliding past each other (transform) all result in earthquakes (Figure 1).



Figure 1

In Figure 2, you can see the transform plate boundary, the San Andreas running through California and the direction that the two plates are moving. When rocks are pushed against each other, stress can build up. This can happen for many reasons, and often occurs along the boundaries of tectonic plates. When the stress exceeds the strength of the rock, the rock breaks and energy is released in the form of an earthquake. Not only can this energy make buildings fall down, but the biggest earthquakes actually make small changes in Earth's orbit!

Nobody can predict when earthquakes will happen, but earthquake scientists use historical records combined with measurements of ongoing plate movement to guess how likely an earthquake is in the future. The energy earthquakes release travels in the form of waves called seismic waves. Each earthquake produces three basic types of seismic waves. Each seismic wave has a different type of motion and travels through the earth at different speeds.

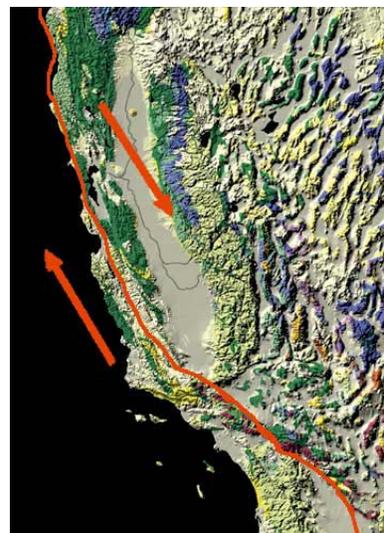


Figure 2

Scientists measure seismic waves produced by an earthquake using devices such as a seismograph (or seismometer). A seismograph records ground vibrations. With a sensor attached to the ground, it records the arrival of seismic waves at that point. The height of the largest waves indicates the size of an earthquake. Given the length of the earthquake record, and the arrival times of each wave, the distance of the focus from the recording point can be determined. It takes data from at least three seismographs to determine the location of an earthquake's focus. By using seismographs all over the world, scientists can pinpoint the location of an earthquake's epicenter deep below the earth using triangulation.

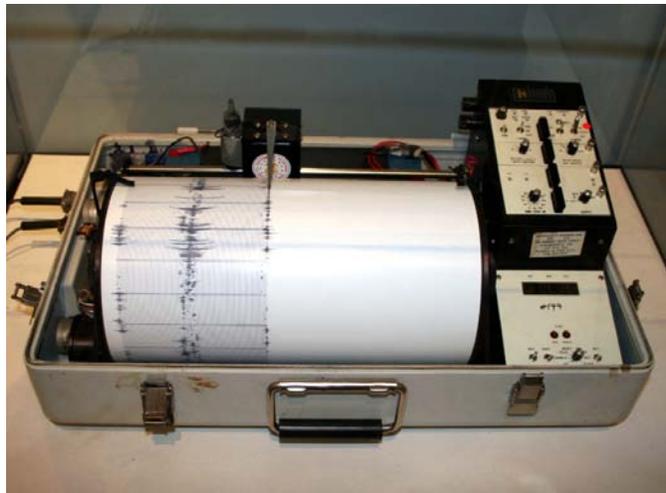


Figure 3

Do the lines created by the pen in the seismograph (Figure 3) look like anything you've seen before? Earthquake waves travel just like sound waves. In fact, earthquake waves can “echo” and be detected in different parts of the world.

### Activity

#### Introduction

- ❖ Start by thinking about these questions: who has felt an earthquake? What do we know about earthquakes? What famous earthquakes have happened in our history?
- ❖ Scientists use seismographs to record when and where earthquakes happen.
- ❖ Real seismographs are complicated instruments with weights, levers, and motors. We can make a simple model using some objects in our home (see Figure 4).

#### Procedure

1. Spread out your newspaper or scratch paper on the table.
2. Tape your marker to one end of the ruler so it makes a long L shape.
3. Place the soup can nearby, and tape the ruler to the side so the tip of the marker is touching the newspaper.
4. Try gently shaking the table: What happens on the paper? What happens with smaller or bigger shakes?
5. Real seismographs have rolls of paper that rotate slowly. Have one person try moving the paper as another person shakes the table. Can you see seismic (earthquake) waves being recorded?

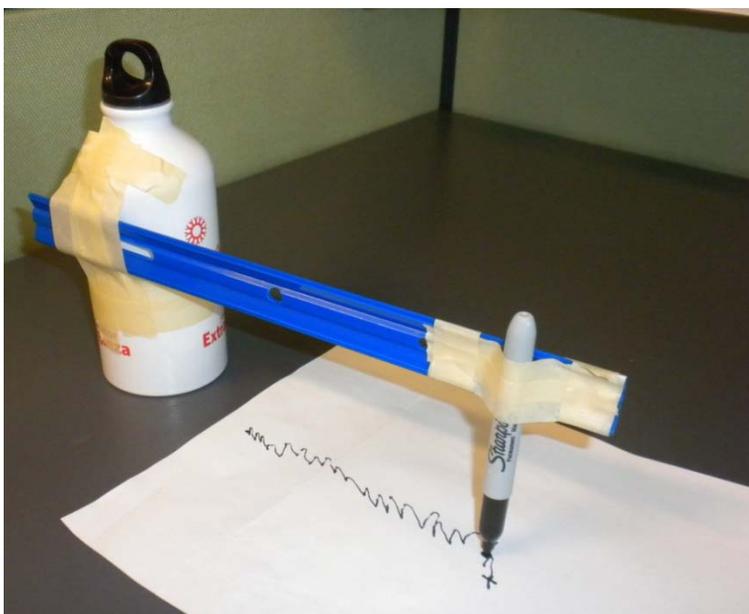


Figure 4

6. If you shake the table laterally and up and down, how does that affect the image of the waves on the paper?
7. If you feel really adventurous, make two seismographs, and place one in a tub of sand or water, and one on the hard table surface. How does what the seismograph rests upon on affect the readings on the scales?

### Wrap-Up

Discuss the following questions:

- ❖ What does it mean when the wavy lines on the paper are higher or lower? How could you use that to measure an earthquake?
- ❖ What could you do to improve the seismograph model that was built?
- ❖ How can scientists use seismographs all over the world to pinpoint the location of an earthquake? Think about ripples in a pond or GPS systems.

### Extension

Discuss earthquakes in our own lives:

- ❖ What does your family do to prepare for earthquakes? Do you have an emergency plan and earthquake kit?
- ❖ What are some earthquakes that you can remember?
- ❖ Have you heard of other places, besides San Francisco, where earthquakes happen?
- ❖ Can you think of any problems that earthquakes cause? What do we do to help fix these problems? (For instance, earthquake drills, earthquake-safe buildings, etc.)

### References

U.S. Geological Survey. *Earthquake Hazards Program*. Retrieved from <http://earthquake.usgs.gov/> on November 10, 2011.

U.S. Geological Survey. *Magnitude / Intensity Comparison*. Retrieved from [http://earthquake.usgs.gov/learn/topics/mag\\_vs\\_int.php](http://earthquake.usgs.gov/learn/topics/mag_vs_int.php) on November 10, 2011.

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Wikipedia. *Earthquake*. Retrieved from <http://en.wikipedia.org/wiki/Earthquake> on November 10, 2011.

Wikipedia. *Richter magnitude scale*. Retrieved from [http://en.wikipedia.org/wiki/Richter\\_magnitude\\_scale](http://en.wikipedia.org/wiki/Richter_magnitude_scale) on November 15, 2011.

## Image Credits

Figure 2: Wikipedia. *Seismometer*. Retrieved from <http://en.wikipedia.org/wiki/Seismometer> on May 15, 2012.

Figure 3: Wikipedia. *San Andreas Fault*. Retrieved from [http://en.wikipedia.org/wiki/San\\_Andreas\\_Fault](http://en.wikipedia.org/wiki/San_Andreas_Fault) on May 15, 2012.

## Lesson adapted from

Marcia Science Teaching Ideas, *Teaching Earthquakes*, <http://mjksciteachingideas.com/quakes.html>

Scholastic, *Severe Weather and Natural Disasters: Earthquakes*, <http://teacher.scholastic.com/activities/wwatch/earthquakes/experiments.htm>

Crayola, *Earthquake Detector*, <https://www.crayola.com/lesson-plans/detail/earthquake-detector-lesson-plan/>

## Resources

### Further Reading (Available in the Naturalist Center at the Academy of Sciences)

- ❖ *Earthquakes* by David E. Newton. A great introduction, ages 6-8.
- ❖ *Earthquakes* by Seymour Simon. Historical earthquakes and their effects, ages 8-12.
- ❖ *We Shake in a Quake* by Hannah Gelman Givon.
- ❖ *Measuring Earthquakes* by Nancy Cook.
- ❖ *Volcano & Earthquake* (DK Eyewitness Books) by Susanna Van Rose

### Online Resources

- ❖ *The Quake Catcher Network*: get your own free earthquake sensor and help thousands of scientist detect earthquakes around the world using your home computer. <http://qcn.stanford.edu/join-qcn>
- ❖ *USGS Earthquakes*: check here for up-to-the-minute earthquake maps and news, and report earthquake sensations. <http://earthquake.usgs.gov/>
- ❖ *Measuring Earthquakes FAQ*: <http://earthquake.usgs.gov/learn/faq/?categoryID=2>
- ❖ FEMA Emergency Planning: be prepared for earthquakes and other natural disasters. <http://www.ready.gov/>

## Correlated California State Content Standards

### Grade 4

#### Earth Sciences

5a. Students know some changes in the earth are due to slow processes, such as erosion, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes

### Grade 6

#### Earth Sciences

1d. Students know that earthquakes are sudden motions along breaks in the crust called faults and that volcanoes and fissures are locations where magma reaches the surface.

1e. Students know major geologic events, such as earthquakes, volcanic eruptions, and mountain building, result from plate motions.

1g. Students know how to determine the epicenter of an earthquake and know that the effects of an earthquake on any region vary, depending on the size of the earthquake, the distance of the region from the epicenter, the local geology, and the type of construction in the region.