Name _____ Class _____ Date _____

CHAPTER 8 Earthquakes

SECTION 2

Earthquake Measurement

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- How do scientists know exactly where and when an earthquake happened?
- How are earthquakes measured?

National Science Education Standards
ES 1b

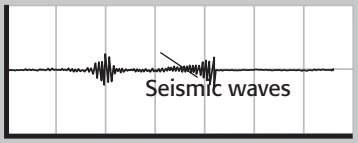
How Do Scientists Study Earthquakes?

Scientists who study earthquakes use an important tool called a seismograph. A **seismograph** records vibrations that are caused by seismic waves. When the waves from an earthquake reach a seismograph, it records them as lines on a chart called a **seismogram**.

STUDY TIP

Ask Questions Read this section quietly to yourself. As you read, write down questions that you have. Discuss your questions in a small group.

Seismogram of an Earthquake



Time after start of earthquake

Remember that earthquakes happen when rock in Earth's crust breaks. The rock might break in one small area, but the earthquake can be felt many miles away.

The place inside the Earth where the rock first breaks is called the earthquake's **focus**. The place on Earth's surface that is right above the focus is called the **epicenter**. Seismologists can use seismograms to find the epicenter of an earthquake. ☑

READING CHECK

1. Explain What is the difference between the epicenter and the focus of an earthquake?

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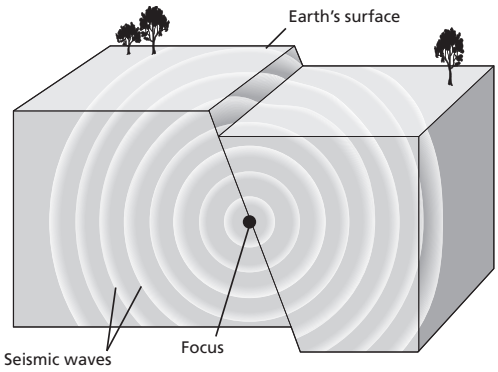
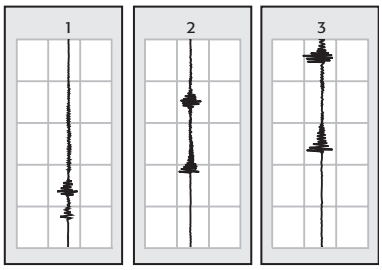


TAKE A LOOK

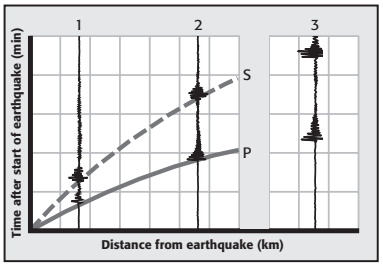
2. Identify On the figure, mark the epicenter of the earthquake with a star.

How Do Seismologists Know When and Where an Earthquake Happened?

Seismograms help us learn when an earthquake happened. They can also help seismologists find the epicenter of an earthquake. The easiest way to do this is to use the S-P time method. This is how the S-P time method works:



1. The seismologist uses seismograms of the earthquake made at three different places.



2. The seismologist lines up the P waves and S waves on each seismogram with the curves on a graph of time versus distance. The curves on the graph were made using information from earthquakes that happened in the past.

Math Focus

3. Read a Graph Look at the middle seismogram in step 3. What is the difference between the time the P waves arrived and the time the S waves arrived?

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4. Read a Graph Look at step 3. How far away from the epicenter is the farthest seismograph station?

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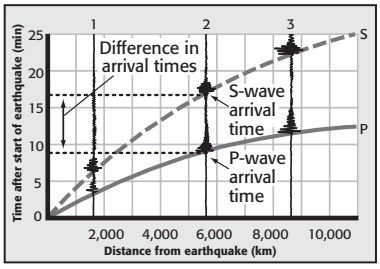
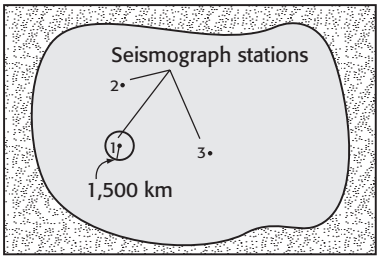
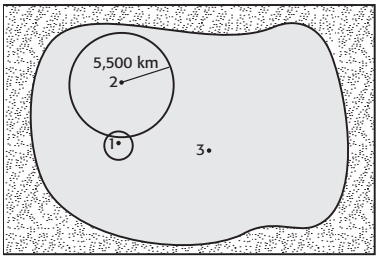


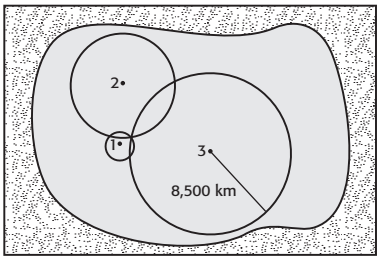
3. Then, the seismologist uses the graph to figure out the difference in arrival times of the P and S waves at each location. The seismologist can use the difference in arrival times to figure out when the earthquake happened. The seismologist can also determine how far away each station is from the epicenter of the earthquake.



4. On a map, a circle is drawn around a seismograph station. The radius of the circle equals the distance from the seismograph to the epicenter. (This distance is taken from the time-distance graph.)



5. When a second circle is drawn around another seismograph station, the circle overlaps the first circle in two spots. One of these spots is the earthquake's epicenter.



6. When a circle is drawn around the third seismograph station, all three circles meet in one spot—the earthquake's epicenter.

TAKE A LOOK

5. Identify On the map in step 6, draw a star at the earthquake's epicenter.

What Is the Magnitude of an Earthquake?

Scientists study seismograms to find out how much the ground moved during an earthquake. They can use the seismograms to figure out how strong the earthquake was.

Have you ever heard someone say that an earthquake was 6.8 or 7.4 "on the Richter scale"? The Richter scale is used to describe the strength, or *magnitude*, of an earthquake. The higher the number, the stronger the earthquake.

Richter magnitude	Effects
2.0	can be detected only by a seismograph
3.0	can be felt at the epicenter
4.0	can be felt by most people in the area
5.0	causes damage at the epicenter
6.0	can cause widespread damage
7.0	can cause great, widespread damage

The Richter scale can be used to compare the magnitudes of different earthquakes. When the Richter magnitude of an earthquake goes up by one unit, the amount of ground shaking caused by the earthquake goes up 10 times. For example, an earthquake with a magnitude of 5.0 is 10 times stronger than an earthquake with a magnitude of 4.0.

What Is the Intensity of an Earthquake?

The *intensity* of an earthquake describes how much damage the earthquake caused and how much it was felt by people. Seismologists in the United States use the Modified Mercalli Intensity Scale to compare the intensity of different earthquakes.

The effects of an earthquake can be very different from place to place. An earthquake can have many different intensity numbers, even though it has only one magnitude.

Mercalli intensity (from I to XII)	Effects
I	shaking felt by only a few people
IV	shaking felt indoors by many, no damage
VIII	damage to some buildings
XII	total damage

Critical Thinking

6. Infer How do you think scientists use seismograms to determine the magnitude of an earthquake?

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Math Focus

7. Calculate How many times stronger is a magnitude 6.0 earthquake than a magnitude 4.0 earthquake? Explain your answer.

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Name _____ Class _____ Date _____

Section 2 Review

NSES ES 1b

SECTION VOCABULARY

epicenter the point on Earth's surface directly above an earthquake's starting point, or focus **focus** the point along a fault at which the first motion of an earthquake occurs	**seismogram** a tracing of earthquake motion that is created by a seismograph **seismograph** an instrument that records vibrations in the ground and determines the location and strength of an earthquake

1. **Compare** What is the difference between a seismograph and a seismogram?

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2. **Apply Concepts** Which city would more likely be the epicenter of an earthquake: San Francisco, California, or St. Paul, Minnesota? Explain your answer.

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3. **Explain** How does a seismologist use the graph of time versus distance for seismic waves to find the location of an earthquake's epicenter?

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4. **Analyze Methods** What can you learn from only one seismogram? What can't you learn?

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5. **Infer** How can an earthquake with a moderate magnitude have a high intensity?

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