

# Shake and Quake

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## Introduction

When rocks move along a fault energy is released, causing an **earthquake**. The point in the earth where this energy release occurs is called a **focus**. The focus is the origin of the earthquake. Two types of seismic waves are released at the time the focus occurs. **Primary waves**, which will always come first as they travel the fastest and **secondary waves** (also called shear) which is a slower traveling wave.

There are other differences between the two **seismic waves**; **P wave** (primary wave) and the **S wave** (secondary wave). The P wave can travel through molten and liquid materials vs the S wave which can only travel through solids. The patterns of the seismic waves tracked through the earth provides evidence of a liquid outer core. They also provide evidence for a variety of boundaries in the layers of the earth.

The P waves are **compression waves** and the S waves are **transverse waves**. Which means that the direction of the wave and the vibration of the particles move in the same direction for the P wave but are opposite directions for the S wave. The S waves are a more destructive wave, causing most of the damage done by an earthquake.

To determine how far away an earthquake is we can simply track the arrival times of a P wave and S wave for a given earthquake and note the difference in time. The greater the difference in arrival times the farther away the earthquake started. Using a simple graph we can calculate the distance in this manner. We can find the exact location of the **epicenter** for an earthquake by using three different locations that have seismic data from the earthquake. The epicenter is the point on the surface of the earth directly above the focus. Where the three circles intersect determines the location for the earthquake.



The circle shows the location of the epicenter of the 8.9 magnitude earthquake that caused a tsunami and billions of dollars in damage in Japan on March 11, 2011.

# MOST\*

## VOCABULARY

Compressional wave

Earthquake

Epicenter

Faults

Focus

Primary wave

P wave

Richter scale

S wave

Secondary wave

Seismic waves

Transverse wave

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## New York State Standards

### Elementary Activity

#### Standard 1

Science: Key Idea: S1.1, S1.a, S1.1b

Key Idea 2: S2.1, S2.2

Key Idea 3: S3.2a, 3.4b

Engineering Design:

Key Idea1: T1.1b, T1.1d,  
T1.4, T1.5

**Standard 4:** Key Idea 2: 2.1e

## MATERIALS NEEDED

Toothpicks  
Gumdrops  
Cardboard box  
Rubber bands  
Masking tape  
Tacks  
Ziplock bags  
Scissors (that can cut cardboard)

## Students should be able to:

Explain the cause of an earthquake

Design, construct and test a building

## Problem:

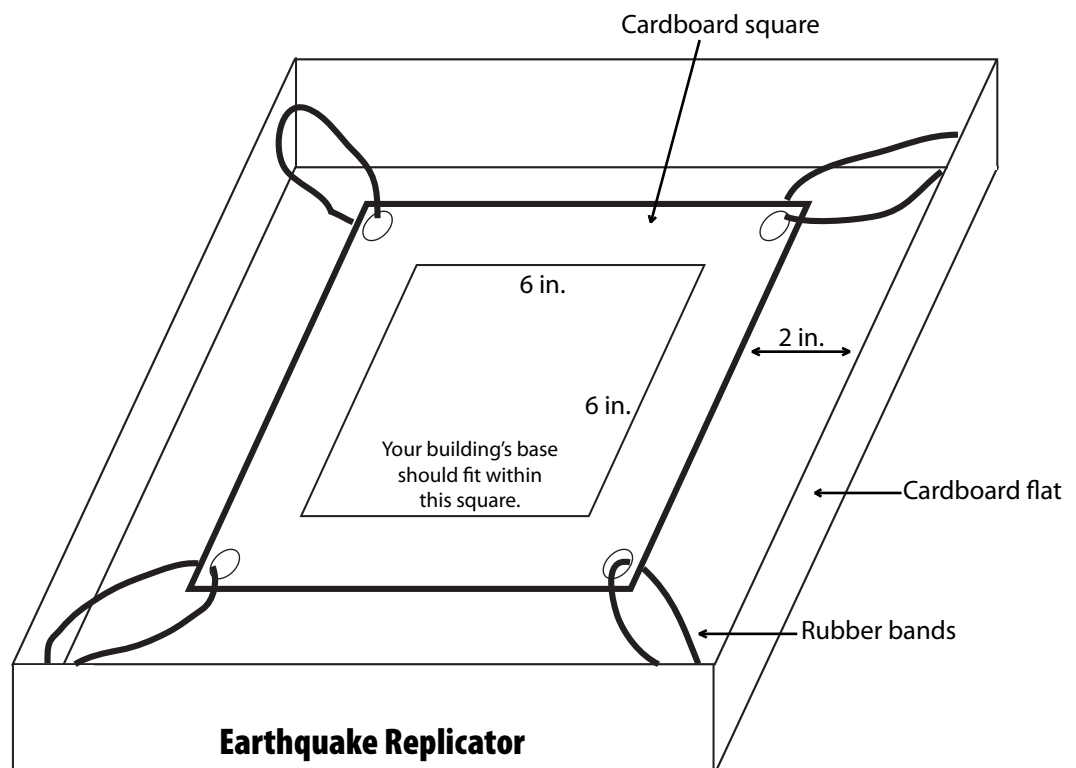
Using the materials, design a building to withstand an imitation of an earthquake. The base needs to fit within a 6-inch by 6-inch square.

## Process:

1. In your team, think about what shape is the strongest, how to secure the base, and how to help a building withstand shaking movement.
2. Take a look at the sample materials you will have available to build your structure.
3. Draw a sketch of your building design, be sure to include labels.
4. Ask your instructor to certify your drawing.
5. Go ahead and build your building according to your design. You will have about 15 minutes to build your building.  
REMEMBER: The base needs to fit inside a 6-inch by 6-inch square.

## Testing the Building

Once you are satisfied with the building, prepare to test your building. Place the building on the cardboard center and secure as planned. Prepare the earthquake simulator and give it a try. Record observations and results in your science notebook or the worksheet. If the building did not withstand the earthquake, determine what could be done to modify the building. Try the modification and retest the building.



# Will It Fall? Worksheet

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Partner: \_\_\_\_\_

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## Problem:

**U**sing the materials, design a building to withstand an imitation of an earthquake. The base needs to fit within a 6-inch by 6-inch square.

**S**ketch the plans for your building. Label the drawing.

**T**eacher Certification of Plan: \_\_\_\_\_

## Testing the Building

**M**ake note of observations.

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**W**hat was the result?

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**W**hat modifications could be made?

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**W**hat was the result after the modifications?

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# The Richter Scale

## Measuring the Strength of Earthquakes

The **Richter Scale** measures the strength of an earthquake. It is a logarithmic scale so the power difference between numbers increases as the strength of the quake increases. An earthquake that measures a 5 on the scale is ten times greater than that of a 4 value. The Richter scale is also known as the Local Magnitude scale.

Richter Magnitudes	Description	Earthquake Effects	Frequency of Occurrence
Less than 2.0	Micro	Micro earthquakes are not felt.	About 8,000 per day.
2.0-2.9	Minor	Generally not felt, but may be recorded.	About 1,000 per day.
3.0-3.9		Often felt, but rarely cause damage.	49,000 per year (est.)
4.0-4.9	Light	Noticeable shaking of indoor items accompanied with rattling noises. Significant damage unlikely.	6,200 per year (est.)
5.0-5.9	Moderate	Can cause major damage to poorly constructed buildings over small regions. At most slight damage to well-designed buildings.	800 per year.
6.0-6.9	Strong	Can be destructive in areas up to about 160 kilometers (100 mi) across in populated areas.	120 per year.
7.0-7.9	Major	Can cause serious damage over larger areas.	18 per year.
8.0-8.9	Great	Can cause serious damage in areas several hundred miles across.	1 per year.
9.0-9.9		Devastating in areas several thousand miles across.	1 per 20 years.
10.0+	Epic	Never recorded; see below for equivalent seismic energy yield.	Extremely rare (Unknown).

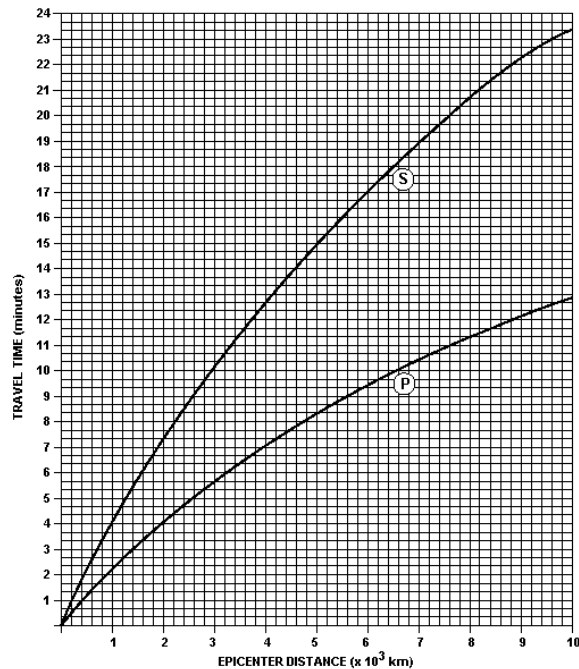
# Information for the Teacher

## Activity Teacher Notes:

Read together or individually a leveled reader on earthquakes. Scott Foresman offers a title called, "Changes On Earth", by Cassandra Jenkins about earthquakes. This is available to read on line. A little more complex reader is, "Changes To Earth's Surface", by Marcia Miller, pages 14-17.

Start the activity after reviewing Earth Quakes.

You may wish to draw a graph on your chalkboard or markerboard similar to this one to help describe the correlation of primary and secondary waves in regard to their distance from the epicenter of a quake.



**Activity Materials:** Prepare ahead of time 25 gum drops and 100 tooth picks inside a ziplock bag. Also provide 25 CM of masking tape per team. Once you check the sketch of a team and certify this as a manageable plan, give the team their building materials.

**To build the earthquake replicator:** Take a cardboard flat and cut a piece of cardboard to fit inside the flat with a minimum of 2 inches between all sides of the edges. Attach a rubber band to each corner and attach each corner to the flat. Make sure the rubber bands are taunt. Take one corner and pull it towards the edge and release this replicates an earthquake. Practice the release so that it is relatively horizontal in the release.

**To test the buildings:** Measure a square of 6 in by 6 in and highlight this with a marker on the cardboard inside the flat. The student's base of the buildings need to fit within this space. The students can decide to secure their building with tape if desired. Once secure, pull the cardboard to the side and release. Have the students write observations and notes down in their science notebooks.