Nasco education LESSON PLAN

K TO Career solutions

steamworks

LET'S SHAKE IT UP: AN EARTHQUAKE

VOL. 9

Developed with Kristin Hotter
Grades 6-8

Total time: 145 minutes
Introduction: 30 minutes
Activity 1: 45 minutes
Activity 2: 30 minutes
Conclusion: 40 minutes

LEARNING STANDARDS

MS-ETS1-2 — Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3 — Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria of success.

LESSON CONTENT

In this lesson, students will learn about earthquakes. They will start by analyzing some of the latest earthquakes. Then students will split into small groups and become experts on one particular area of earthquakes: body waves, surface waves, magnitude, and intensity. Representatives from each group will teach the other groups about their area of expertise.

Once students have a firm grasp on the basics of earthquakes, you will use a shake table to simulate a number of earthquakes. During those simulations, you'll place a variety of structures on the shake table. Students will predict how well each structure will withstand an earthquake. They will then evaluate the structure and suggest improvements to help it better survive a future earthquake.

When students have had time to make their own suggestions for improvements and design their own structure, you will show them another structure that does withstand the shake table. You'll discuss the features that help it maintain its structure despite the shaking.

To conclude the lesson, students will study ways to be prepared and safe before, during, and after an earthquake. They will participate in a variety of activities in which they'll gain crucial knowledge. Students will present what they have learned in a poster that illustrates safety measures that should be taken at all stages of an earthquake.

Note: You will want to build your shake table and building models prior to the lesson.

STEAM CONNECTIONS AND LESSON OBJECTIVES

Students will...

Science — Investigate the make up, magnitude, and intensity of earthquakes.

Technology — Use a variety of scientific websites to make their scientific investigations.

Engineering — Design a structure that can withstand an earthquake.

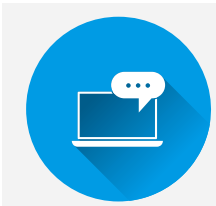
Art — Create a poster illustrating ways they can keep themselves safe before, during, and after an earthquake.

Math — Graph the location of earthquakes that have occurred in the last 24 hours.

RESOURCES / WEBSITES USED

- Earthquakes in the Last 24 Hours (http://on.doi.gov/3oXY3Ei)
- Seismic Waves website (http://bit.ly/3r3bioY)
- Earthquake Magnitude website (http://bit.ly/3oXYP4a)
- Earthquake Intensity website (https://on.doi.gov/3mrfLy4)
- Earthquake Powerpoint PDF
- Earthquake Jigsaw handout

ACCESSIBILITY FOR REMOTE LEARNING



Introduction: Students have access to the websites and digital copies of the handout. The jigsaw can take place through a platform like Zoom or Google Meet.

Activity 1: Since the materials are mostly everyday materials, the activity is easy to present to students using a digital platform. Students can access digital copies of the handout.

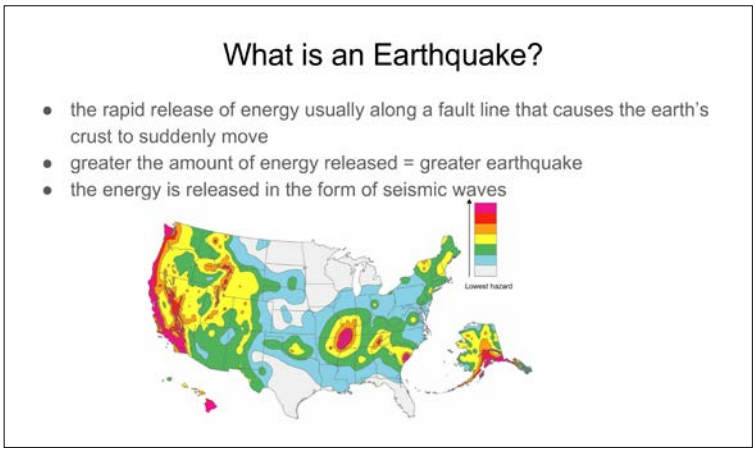
Activity 2: While the activity suggests students build a model that they think will withstand a simulated earthquake, the same can be accomplished with a design using pencil and paper. Students can use a cell phone to take a picture of and upload their building blueprints.

Activity 3: Students have access to the website. The only additional materials needed are paper and coloring materials. Their posters can be uploaded or presented using a digital platform.

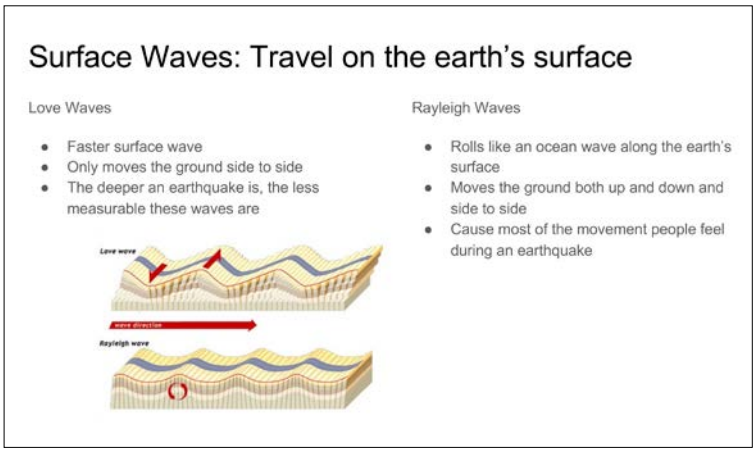
INTRODUCTION (USE SLIDES 2-8 FROM EARTHQUAKE POWERPOINT PDF)

1. Ask students to make predictions about how many earthquakes they think have occurred in the last 24 hours. Ask several students to share their predictions along with an explanation for that prediction.
2. Pull up this website (http://on.doi.gov/3oXY3Ei) to show students the actual number.
3. Guide students through the features of the website (the map, the clickable dots, and the bar on the left that provides locations, times, and magnitudes).
4. Click on some of the earthquakes listed and look at the depths of them. Explain that many of those earthquakes happened deep in the earth's crust.
5. Graph the locations of earthquakes that occurred in the last 24 hours.
6. Ask students to make observations regarding the magnitude numbers of earthquakes.*

   * Students should recognize that the magnitude consists of a number less than 10 and includes a decimal to the tenths place. They should also observe that most (if not all) numbers are below 5.0.
   Ask students to consider the location, depth, and magnitude of some of the earthquakes. Have them determine whether or not they think a particular earthquake was felt by humans or not. For instance, an earthquake measuring 6.2, at a depth of 150 km located in the middle of an ocean wasn't felt by humans, but a 4.8 earthquake, at a depth of 6.1 kilometers located off the coast of Costa Rica was probably felt by humans.
7. Explain that determining magnitude is one way to measure an earthquake. Another way is to measure the intensity of its seismic waves.
8. Divide students into four groups. Each group will be responsible for becoming experts in one area.
   - Body waves (http://bit.ly/2WnE1H4)
   - Surface waves (http://bit.ly/2WnE1H4)
   - Magnitude (http://bit.ly/3oXYP4a)
   - Intensity (http://bit.ly/3oXYP4a)
9. Distribute or provide digital copies of the Earthquake Jigsaw worksheet.
10. Give students 15-20 minutes to read their assigned section, take notes on the worksheet, and become an expert in their particular area.
11. Reconvene and have students from each group report back to the rest of the class.
12. As students are presenting, students from other groups should take notes on the presentation and learn from their peers.
13. Use slides 2-8 to provide students with another opportunity to grasp the concepts discussed in the jigsaw.



Example of Slide 2



Example of Slide 5

BUILDING A SHAKE TABLE
(Create prior to the lesson)

Step 1: Hold the two cardboard pieces horizontally. Keeping the two pieces together, put a rubber band around each side. It should be about an inch or so from the ends.

Step 2: Slip the four balls between the two cardboard pieces. The balls should be directly below each rubber band with one ball on each side of the cardboard.

Step 3: Tape a ruler to the front of the shake table to ensure that each time you pull back the cardboard, you are pulling the same distance.

SHAKE TABLE
(MATERIALS NEEDED)

- 2 pieces of sturdy cardboard (cardboard from a binder works well) **(BE01304[A])**
- 2 rubber bands **(BE01000)**
- 2 binder clips **(9729953)**
- 4 balls*
- Wooden ruler **(TB20569)**
- Masking tape **(9701124)**

*The size of the four balls used should be relational to the size of the cardboard used. For example, if you use two pieces of 8.5" x 11" cardboard for the shake table, use four 1" in diameter bouncy balls. If you use two pieces of 12" x 16" cardboard, use four golf balls. If you use two pieces of 18" x 24" cardboard, use four tennis balls.

BUILDING STRUCTURES (Create prior to lesson)

While any kind of building material will work (toothpicks, straws, coffee stirrers) and joints (marshmallows, gum drops, modeling clay), when put to the test, straws and modeling clay worked best.

The facilitator will build each structure on a small piece of card stock. You'll transfer and clip the card stock to the shake table before running your tests. It is suggested that you make each structure at least 6" tall.

Structure 1
Rectangular Prism–similar to a skyscraper

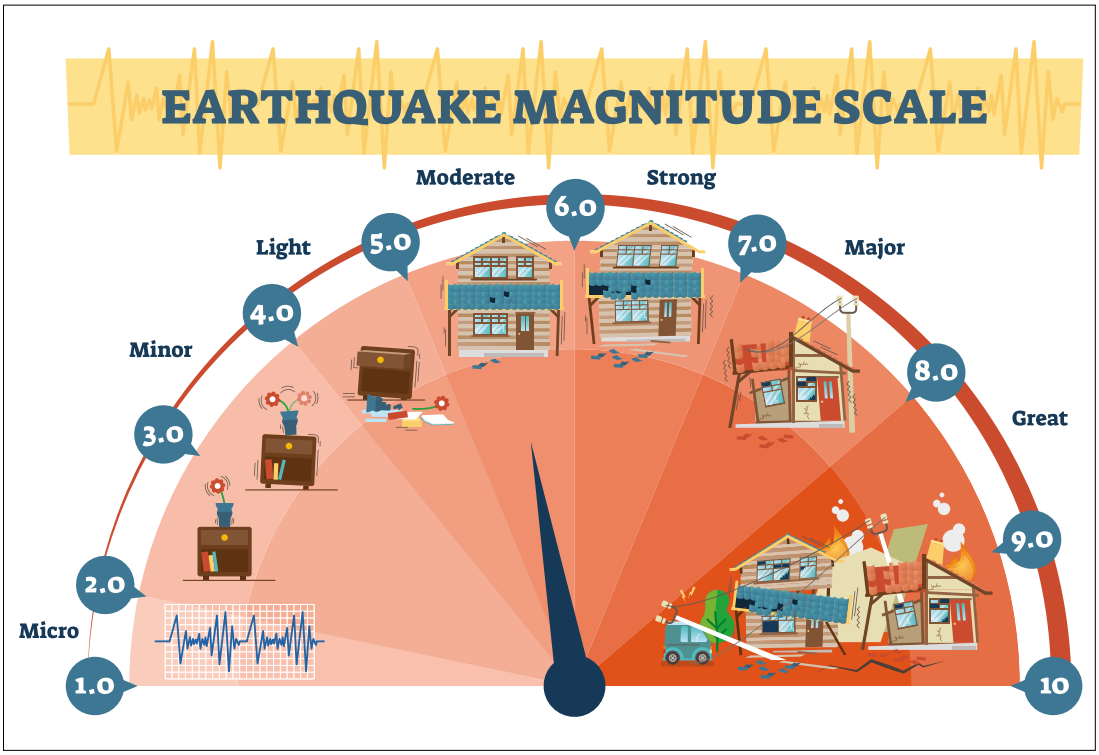
Structure 2
Cube

Structure 3
Rectangular Prism with triangular reinforcements

Optional Structure 4
Cube with triangular reinforcements

ACTIVITY 1 (Earthquake Simulations)

In this activity, the facilitator, will demonstrate what happens to these structures under the conditions of an earthquake. Students will not be building these structures, they will simply be observing and making predictions in this part of the lesson.



ACTIVITIES 1 & 2 (MATERIALS NEEDED)

- Building materials* **(TB27626)**
- Masking tape **(9701124)**
- How Well Will It Hold Up? handout
- Card stock **(9733611)**

*This kit is one example you could use to test out different materials. Other supplies can be used.

1. Remind students that an earthquake measuring 4.0 has a magnitude ten times greater than an earthquake measuring 3.0.
2. To illustrate this, pull one of the shake table's rubber bands back 1 cm. Tell them that it represents an earthquake with a magnitude of 3.0.
3. Pull the rubber band back again. This time, pull it to 10 centimeters and release. Explain this represents an earthquake with a magnitude of 4.0
4. Ask: How far would I need to pull the rubber band to demonstrate a 5.0, 6.0, 7.0, 8.0 earthquake?
5. What type of waves does the shake table simulate?
6. Engineers use shake tables to simulate earthquakes in order to design and construct buildings that can better withstand powerful earthquakes.
7. Provide each student with a copy of the How Well Will It Hold Up? worksheet. Place structure 1 on the shake table. Ask students to draw what they see in the first column of the worksheet. Make observations about the building. (It looks like a skyscraper. It's taller than it is wide.) Those observations should also go in the first column. Finally, ask students to predict what they think will happen to the structure during a simulated earthquake. That will go in the second column.
8. Pull the rubber band back 2" and ask students to observe as release the earthquake. Students should record their observations for that distance. If the structure fell, reassemble as students record their observations.
9. Repeat the simulation pulling the rubber band back to both 4" and 6".
10. Facilitate a discussion as to why students think the structure fell. Ask students what they think could have made the structure sturdier.
11. Repeat steps 7-10 for Structure 2.
12. Before showing students Structure 3, discuss the similarities and differences between Structures 1 and 2. What do those structures have in common that caused them to fall?
13. Facilitate a discussion where students can present ideas they think might help make those structures more structurally sound. Ask students to sketch a picture to illustrate their thinking. Record student ideas.
14. Show students Structure 3. Go through Steps 7-10 one more time. What makes this structure different from Structures 1 and 2?

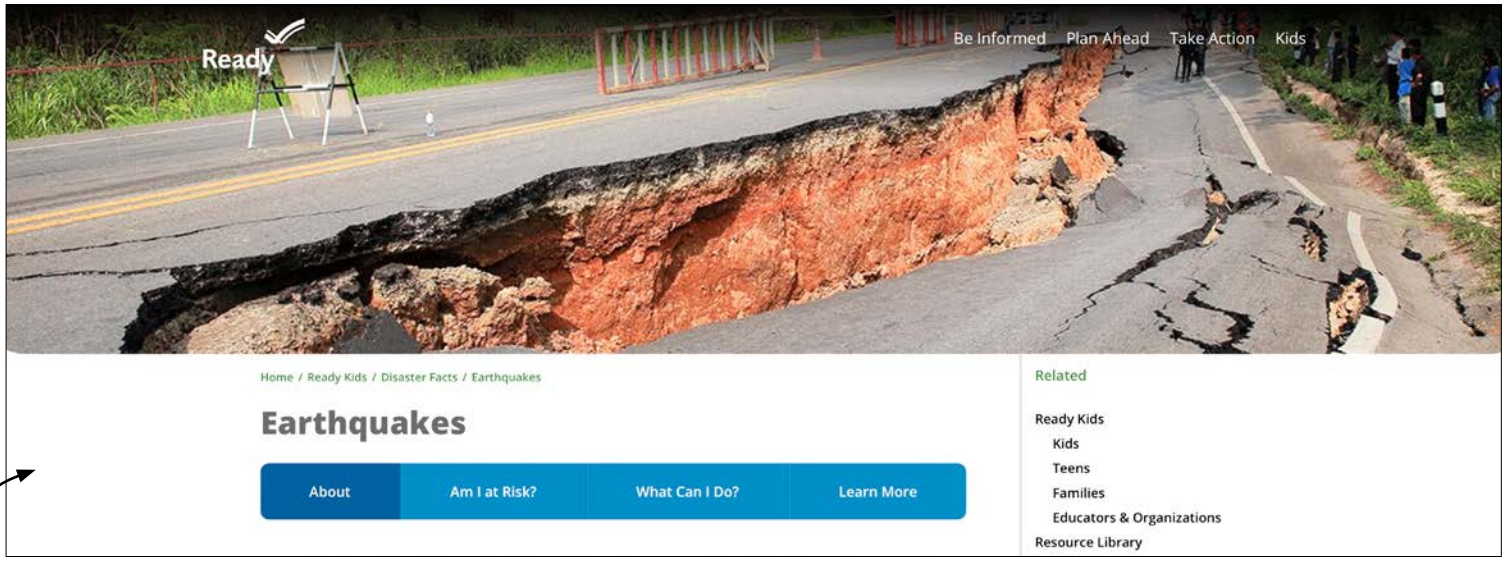
ACTIVITY 2 (Earthquake Simulations)

In this activity, students will make their own buildings. You may put whatever constraints on the building as you see fit for your students. For instance, you may suggest a maximum base width or you may suggest a minimum height.

If three-dimensional buildings are not an option, have students draw their structural ideas. As an additional challenge, you may want to have students complete this activity before showing them structure 3 in Activity 1.

1. Once you've facilitated a discussion on the similarities and differences between the three structures used in Activity 1, you'll ask students to design their own buildings.
2. Students will use building materials to create a building of their own that they believe will withstand a simulated earthquake.
3. If students have the opportunity to test their buildings on the shake table you have made, tell them they will be provided with only 4 small pieces of tape to adhere their building to a piece of card stock. That piece of card stock will then be clipped to the shake table in the same manner you used in Activity 1.

ACTIVITY 3 (Earthquake Simulations)



1. To draw the lesson to a close, direct students to this website (http://bit.ly/37pgifN), where you will find ways to be safe and prepared before, during, and after an earthquake.
2. Start by looking at the points in the "Before" section. Direct students to the first bullet point (Build an emergency kit).
3. Explain that an emergency kit provides supplies during a disaster. Often times, when earthquakes occur the power can be out for several days. A good disaster kit has supplies for three days.
4. Ask students to brainstorm items that should be kept in an emergency kit.
5. Have them compare their lists with this list (https://bit.ly/37myqH4).
6. Consider having students play this game (http://bit.ly/3oXgSav) about building an emergency kit.
7. Talk through each of the points in the "During" section. Facilitate the discussion by asking these questions.
   - Why should you cover your neck and head?
   - Why is it important to stay out of an elevator?
   - Where is the safest place to be in your house during an earthquake?
   - Why is it important to be cautious before entering your home after an earthquake?
8. Finally, talk through the points in the "After" section.
9. Ask students to create a three-section poster about earthquake safety. One section should be dedicated to safety before an earthquake, one for during an earthquake, and a third for after an earthquake.
10. Students should choose one or more safety measures to include in each section. The poster should include both text and illustrations that clearly show how a person can be prepared for an earthquake and safe during and after one as well.

POSSIBLE EXTENSIONS

Students can...

- Calculate the average magnitude and/or depth of the earthquakes from the last 24 hours.
- Experiment with a variety of building materials. They can build structures similar to Structures 1-3 in Activity 1. Students can use the shake table to determine if the building materials affect the buildings resistance to an earthquake.
- Research the similarities and differences of magnitude and intensity. They can compare and contrast one of the magnitude scales with the Mercalli Scale.
- Research the basics of designing a skyscraper. They can apply what they learn in their research to the structures they build in Activity 2.

POSSIBLE INTERVENTIONS

Students can...

- Work through the jigsaw activity as a whole group. Four different areas can be overwhelming for some students, so focus on either body and surface waves or magnitude and intensity.
- Think, pair, share their ideas for structural improvements. Give them time to think independently. Strategically pair students to help struggling students get helpful ideas from a partner and then have pairs share with the whole group.
- Focus their efforts on becoming an expert in one particular part (before, during, or after) of earthquake safety.

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EARTHQUAKE JIGSAW

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Name: _____ Period: _____ Date: _____

Directions: Record notes from the assigned sections.

Body Waves	Surface Waves
Magnitude	Intensity

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HOW WELL WILL IT HOLD UP?

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Name: _____ Period: _____ Date: _____

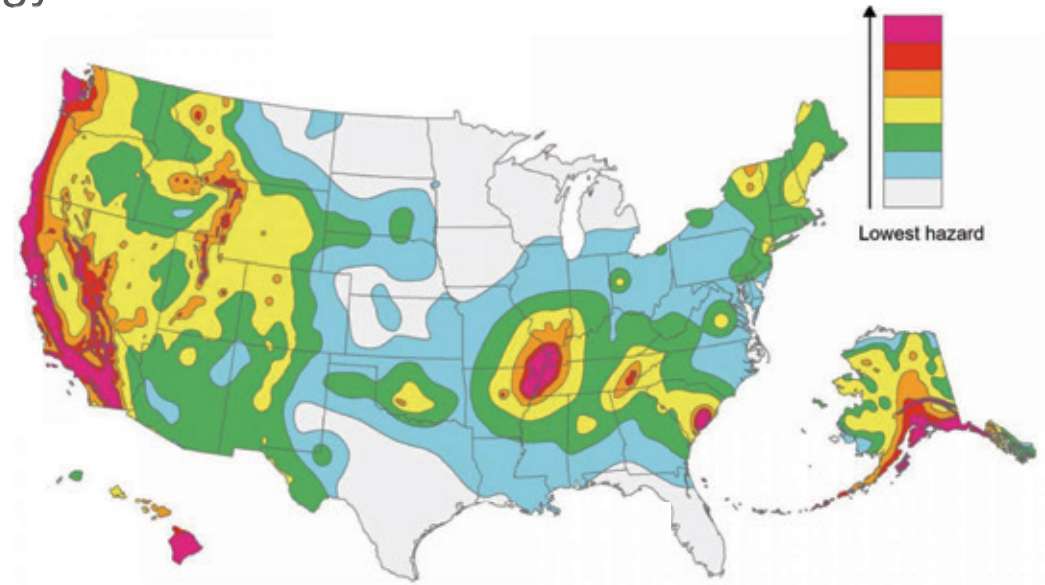
Directions: In the first column, draw what you see and write down observations about the building. In the second column, predict what you think will happen to the structure during a simulated earthquake. In the third column, describe how it held up.

Structural Observations	My Prediction	How Did It Hold Up?

Earthquakes

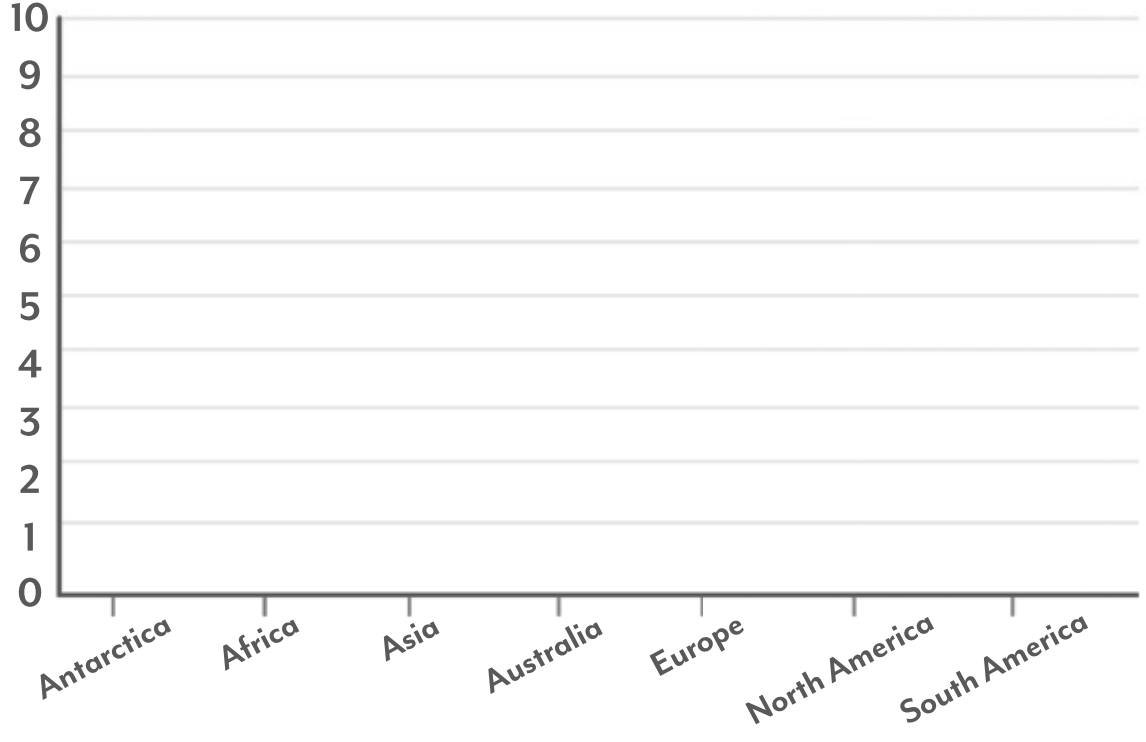
What is an Earthquake?

- the rapid release of energy usually along a fault line that causes the earth's crust to suddenly move
- greater the amount of energy released = greater earthquake
- the energy is released in the form of seismic waves



Graph It

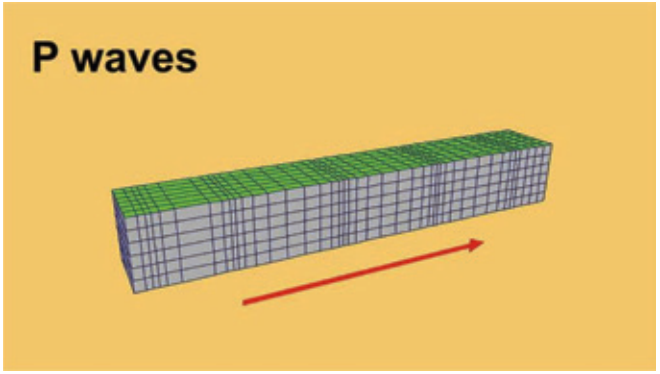
1. Determine how many earthquakes occurred in the last 24 hours.
2. Sort the earthquakes based on the continents on which they occurred
3. Create a bar graph to show the data.



Body Waves: Travel through the earth's interior

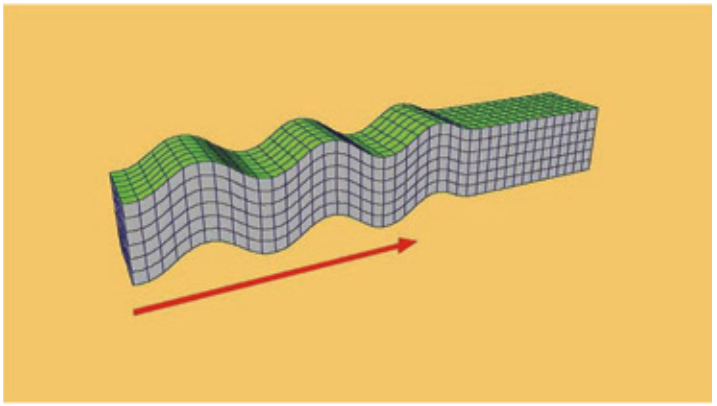
P waves (Primary Waves)

- Fastest seismic waves
- Shake the ground back and forth
- First seismic waves detected during an earthquake
- Travel through all types of matter



S Waves (Secondary or Shear Waves)

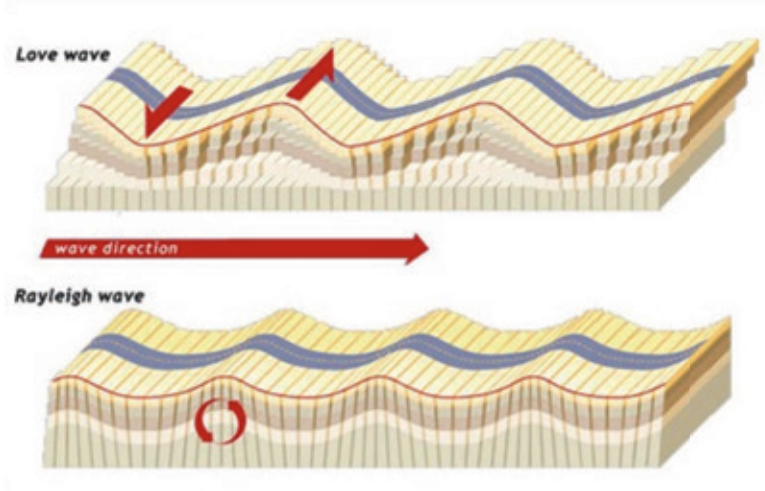
- Slower than P Waves
- Shake the ground up and down
- Second seismic waves detected
- Travel through rock



Surface Waves: Travel on the earth's surface

Love Waves

- Faster surface wave
- Only moves the ground side to side
- The deeper an earthquake is, the less measurable these waves are

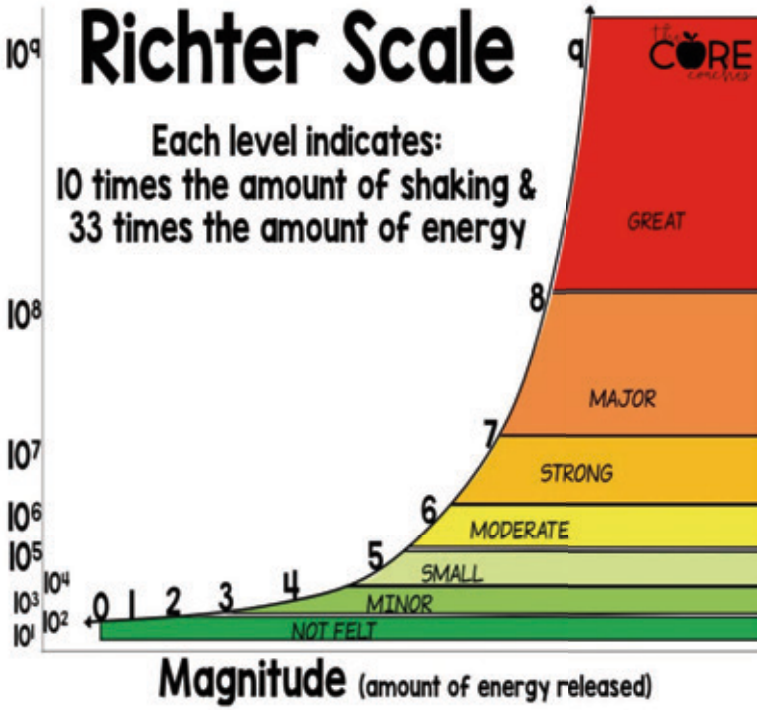


Rayleigh Waves

- Rolls like an ocean wave along the earth's surface
- Moves the ground both up and down and side to side
- Cause most of the movement people feel during an earthquake

An Earthquake's Magnitude:

- Measures the strength of an earthquake
- Often measured on the Richter Scale (0-9)
- Determined by a seismic wave's amplitude
- 6.1 quake is 10x stronger than 5.1 quake



Moment Magnitude Scale

- More universally used by seismologists
- Calculated by total moment release of an earthquake
- Ranges from negative numbers (unfelt) to greater than 10 (catastrophic)

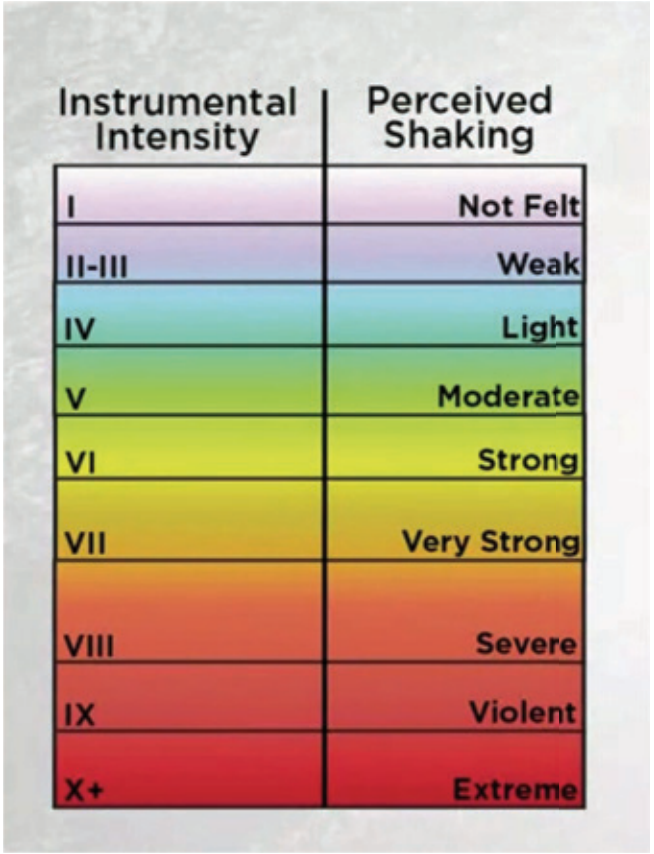
Magnitude Range	Effects	Frequency
2.5 or Less	Not felt	900,000 per year
2.5 to 5.4	Can cause minor damage	30,000 per year
5.5 to 6.0	Slight damage to structures	500 per year
6.1 to 6.9	Damage to populated areas	100 per year
7.0 to 7.9	Major and widespread damage	20 per year
8.0 or Greater	Catastrophic damage	One every 5-10 years

Intensity

Intensity: Measures the severity of an earthquake

Scale: Modified Mercalli Scale

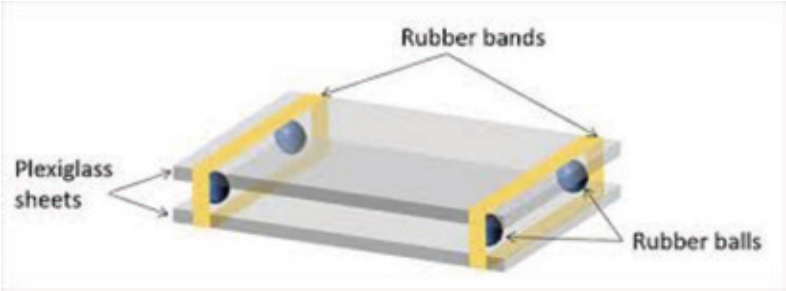
- Less scientific
- Relies heavily on human experience and observation
- Damage does not always equate to earthquake strength
- Based on a scale from I to XII



Instrumental Intensity	Perceived Shaking
I	Not Felt
II-III	Weak
IV	Light
V	Moderate
VI	Strong
VII	Very Strong
VIII	Severe
IX	Violent
X+	Extreme

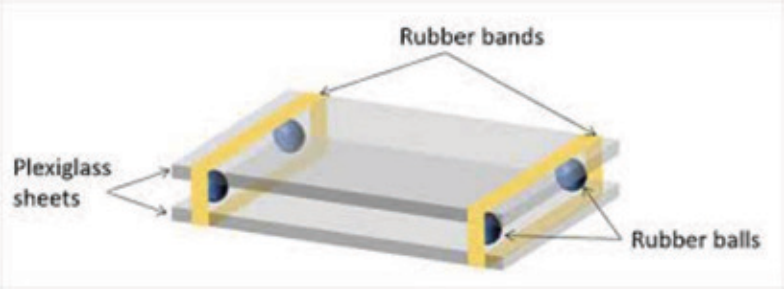
Building a Shake Table

Step 1: Hold the two cardboard pieces horizontally. Keeping the two pieces together, put a rubber band around each side. It should be about an inch or so from the ends.



Building a Shake Table

Step 2: Slip the four balls between the two cardboard pieces. The balls should be directly below each rubber band with one ball on each side of the cardboard.



Building a Shake Table

Step 3: Place a ruler in front of the shake table to ensure that each time you pull back the cardboard, you are pulling the same distance.