EARTHQUAKES

If the ground beneath you suddenly starts to shake, rattle, and roll, you just might be feeling an earthquake! Earthquakes are very common on planet Earth with approximately 500,000 detectable quakes occurring every year. What causes earthquakes? First, we'll need to understand the structure of our planet.

The Earth is made up of four major layers: the **inner core**, **outer core**, **mantle,** and **crust**.

The **crust** and **outer layer** of the **mantle** make up the surface of the planet. The mantle is the rock layer between the crust and outer core. Although the Earth's surface looks solid, it is made up of many pieces which fit together much like puzzle pieces. These pieces are called **tectonic plates**, and the edges of these plates are called **plate boundaries**. According to the National Oceanic and Atmospheric Administration (NOAA), there are about 12 major and several minor tectonic plates on Earth.

Tectonic plates constantly and slowly move around. Sometimes the plates move toward each other and sometimes they move away from each other. This is known as **plate movement,** or **tectonic shift,** and it is caused by heat from within the Earth's interior. The plate boundaries are made up of **faults** (fractures, or breaks, in the Earth's crust), and this is where most earthquakes occur. The edges of the plate boundaries are often rough. As the plates move, the plate boundaries can get stuck until the plate has moved far enough to break them loose. This is what causes earthquakes.

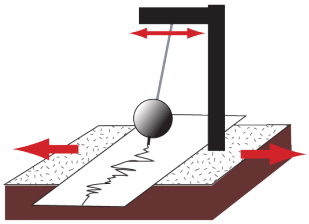
Tectonic plate landscape in Iceland

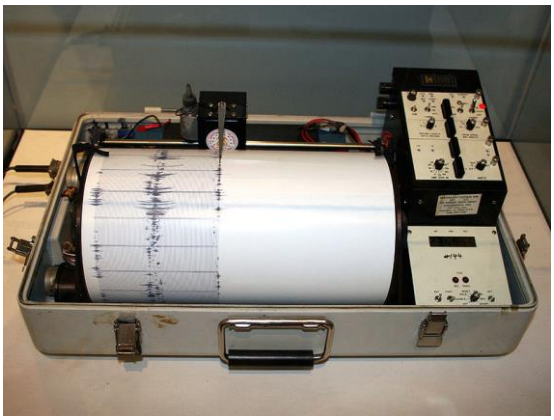
The spot directly above where the earthquake starts is called the **epicenter.** Energy is released after an earthquake in the form of shock waves, called **seismic waves**, which travel through the ground in all directions out from the epicenter. They move at 20 times the speed of sound! Scientists measure seismic waves to determine the **magnitude** (size) and the length of earthquakes using a machine called a **seismograph**. The recording of an earthquake is called a **seismogram**.

The strength of a quake is measured on the **Moment Magnitude Scale (MMS).** This was previously called the **Richter Scale**. The larger the number on the MMS, the bigger the earthquake. Every one-point increase in the magnitude of an earthquake represents 10 times the amount of shaking and 33 times the amount of energy!

Examples of the effect of different magnitude earthquakes on the MMS scale:

- 3.0 ~ Usually not noticeable
- 4.0 ~ May shake your house, not always noticeable
- 6.0 ~ Things are likely to fall from shelves, and windows and walls may crack
- 7.0 ~ Weaker buildings may collapse, and bridges and streets may crack
- 8.0 ~ Many bridges and buildings may fall
- 9.0 ~ Large amount of damage, and entire cities could be destroyed





Simplified image of a seismograph **"Kinemetrics seismograph" by Yamaguchi先生 is licensed under CC BY-SA 3.0**

Seismographs are very sensitive instruments. They can detect earthquakes that occur very far away, as well as other things that shake the ground, like explosions and volcanic eruptions. The base of a seismograph is set in the ground, and there is a heavy weight hanging above it. When the ground shakes, the base shakes but the weight does not. A seismograph records the difference in the position of the base and the weight. The data this produces is then analyzed. Modern seismographs use electrical signals to record movement. Older types of seismographs use a pen directly above paper to draw the signal. A short, squiggly line represents a small quake. A long line that wiggles a lot represents a large earthquake.

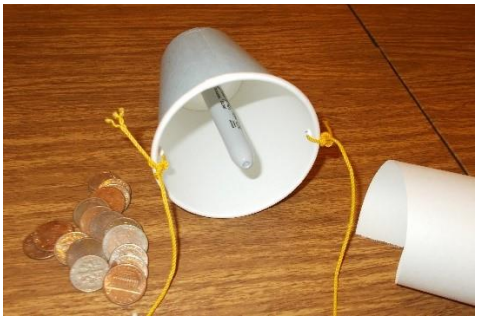
ACTIVITY: Make your own seismograph

Materials:

- cardboard box
- plastic or paper cup
- marker
- string
- strip of paper

- scissors
- tape
- small rocks or coins to use as weights inside the cup
- a helper

1. Stand the box up on one end.
2. Place two holes opposite each other near the top of the cup.
3. Tie a piece of string to each hole.



4. Poke a hole in the middle of the bottom of the cup and push a marker through so the tip just touches the bottom of the box.
5. Suspend the cup from the top of the box, making sure that the distance between the holes is the same distance as the holes in the cup. The cup will hang down inside the box and should be about a half inch from the bottom of the box.
6. Fill the cup with small rocks or coins to add weight. Make sure the marker stays straight.
7. With the help of an adult, cut two slits in the sides of the box near the bottom, wide enough to thread a strip of paper.
8. Tape pieces of paper together to form a strip or use adding machine paper or a grocery receipt.
9. Thread the paper through the slits across the bottom of the box making sure the tip of the marker is in the middle of the paper.

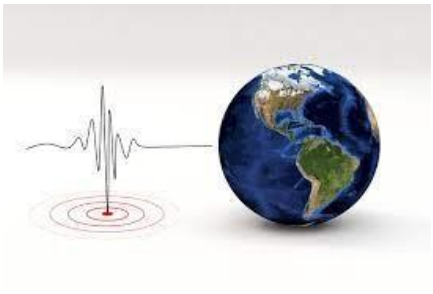
10. Have your helper slowly pull the paper through the box at a constant speed while you shake the box perpendicular (front to back) to the paper strip. Keep the box in contact with the surface while you shake it.

What happened?

You used a homemade seismograph to make a seismogram! Remove the paper from the box and look at your seismogram. Did you notice a change in the size of the squiggly line when you shook the box harder?

DISCUSSION

Until you shook the box, the marker made a straight line on the paper. Shaking the box will cause the box and paper to move, but the suspended marker doesn't move much. As the paper moves back and forth under the marker, the marker draws a squiggly line. The size of the squiggle shows how hard you shook the box. This is the way a seismograph records the strength of an earthquake!



What to do if you feel an earthquake!

DROP, **COVER**, and **HOLD ON**! Those are three important things to remember if you feel the ground begin to shake.

→ **Drop** down to your hands and knees before an earthquake knocks you down.
→ **Cover** your head and neck (and your whole body, if possible) by getting under a sturdy table or desk.
→ **Hold on** to something, or just hold onto your head and neck until the shaking stops.

Other facts about earthquakes:

- **Foreshocks** and **aftershocks** often occur before and after earthquakes.
- The largest earthquake on record in the United States occurred in Alaska in 1964 with a magnitude of 9.2.
- An underwater earthquake or volcano can cause a **tsunami** (very large, damaging ocean waves).

- Most of the world's earthquakes occur in the "Ring of Fire", an earthquake zone surrounding the Pacific Ocean.
- Alaska has more earthquakes than any other US state. Alaska often experiences a 7.0 magnitude quake each year. Other states with the most quakes, in descending order, are California, Hawaii, Nevada, Washington, Idaho, Wyoming, Montana, and Utah. Florida and North Dakota have the least number of earthquakes.
- Some earthquakes can be felt thousands of miles away!

ADDITIONAL RESOURCES

Books available from the Washoe County Library System

Dirtmeister's Nitty Gritty Planet Earth: All About Rocks, Minerals, Fossils, Earthquakes, Volcanoes, and Even Dirt! by Steve Tomecek aka the Dirtmeister

Earthquakes by Ker Than

Earthquakes: On Shaky Ground by Lesley McFadzean

Earth-shaking Science Projects about Planet Earth by Robert Gardner

Plate Tectonics: Earth's Moving Crust by Darlene R. Stille

Ring of Fire by Leonard Hort

Structure: Exploring Earth's Interior by Roy A. Gallant

Surviving Natural Disasters by Marcia Amidon Lusted

Why do Earthquakes Happen? by Wil Mara

Videos:

NOVA, "Earthquakes: The Seismograph"
https://knpb.pbslearningmedia.org/resource/ess05.sci.ess.earthsys.seismograph/earthquakes-the-seismograph/

SciShow Kids, "What Causes Earthquakes?" https://youtu.be/AArne-wh_Uc

Science Trek – Earthquakes https://www.pbs.org/video/science-trek-earthquakes/

Science Trek Earthquakes: Seismographs, Pizza, and Football https://www.pbs.org/video/earthquakes-video-short-jsfhd4/

Webpages:

Centers for Disease Control and Protection, Natural Disasters and Severe Weather, Stay Safe During an Earthquake: https://www.cdc.gov/disasters/earthquakes/during.html

Great ShakeOut, Earthquake Drills, ShakeOut Educational Resources
https://www.shakeout.org/schools/resources/

University of Nevada, Reno, The Nevada Seismological Laboratory
https://earthquake.usgs.gov/earthquakes/eventpage/nn00782942/executive

US Geological Survey (USGS), Earthquake Hazards Program, Earthquakes for Kids
https://earthquake.usgs.gov/learn/kids/

US Geological Survey, Earthquake Hazards, Seismographs - Keeping Track of Earthquakes
https://www.usgs.gov/natural-hazards/earthquake-hazards/science/seismographs-keeping-track-earthquakes?qt-science_center_objects=0#qt-science_center_objects