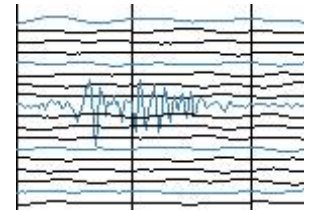




Shake it up with Seismographs!



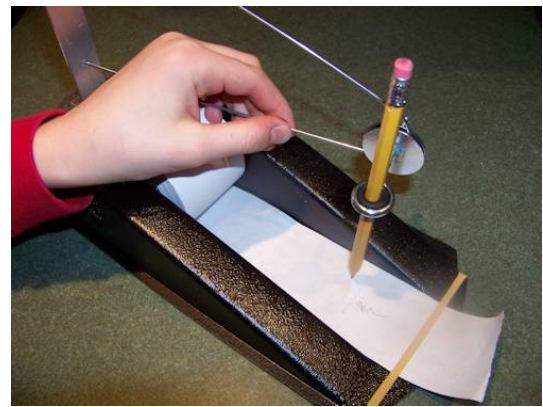
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Lesson Focus

Lesson focuses on exploring how the development of seismographs has helped save lives around the world. Students work in teams to design their own seismograph out of everyday items, and test its ability to record a simulated classroom earthquake. Students evaluate their own seismographs, those of classmate teams, and present findings to the class.

Lesson Synopsis

The "Shake it Up with Seismographs!" activity explores the engineering behind seismographs and how technology has improved accurate recording of earthquakes. Students work in teams to build a simple seismograph out of everyday items, test it during a simulated classroom earthquake, evaluate their results, and present findings to the class.



Year Levels

Year 6 – Term 3; Year 9 – Term 2

Objectives

- ✦ Learn about seismograph technology.
- ✦ Learn about engineering design.
- ✦ Learn about teamwork and problem solving.

Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- ✦ seismographs
- ✦ interaction of technology and environmental issues
- ✦ engineering design
- ✦ teamwork

Lesson Activities

Students learn how seismographs record and can help predict earthquakes and other earth movements. They explore the impact of how technology can positively impact the world. Students work in teams to design their own seismograph out of everyday items, and test its ability to record a simulated classroom earthquake. Students evaluate their own seismographs, those of classmate teams, and present findings to the class.

Resources/Materials

Shake it Up with Seismographs

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- ✦ Teacher Resource Documents (attached)
- ✦ Student Resource Sheet (attached)
- ✦ Student Worksheet (attached)

Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

Internet Connections

- ✦ TryEngineering (www.tryengineering.org)
- ✦ Earthquakes for Kids (<http://earthquake.usgs.gov/learning/kids/>)
- ✦ Global Seismographic Network
(<http://earthquake.usgs.gov/research/monitoring/gsn>)
- ✦ National Earthquake Information Center
(<http://earthquake.usgs.gov/regional/neic/>)
- ✦ International Registry of Seismograph Stations
(http://neic.usgs.gov/neis/station_book/)
- ✦ Curriculum Links (www.acara.edu.au)

Recommended Reading

- ✦ An Introduction to Seismology, Earthquakes and Earth Structure by Seth Stein and Michael Wysession (ISBN: 0865420785)
- ✦ Earthquakes by Bruce Bolt (ISBN: 0716775484)
- ✦ Introduction to Seismology by Peter M. Shearer (ISBN: 0521708427)

Optional Writing Activities

- ✦ Write an essay or a paragraph exploring why civil engineers might need to evaluate the seismic activity of a particular building site?
- ✦ Write an essay or a paragraph on how existing seismologic technology might have reduced death rates from the 1960 earthquake in Chile.

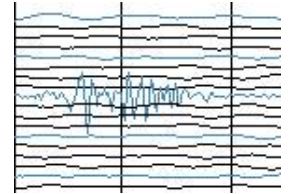
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Shake it Up with Seismographs!



For Teachers: Teacher Resources

◆ Lesson Goal

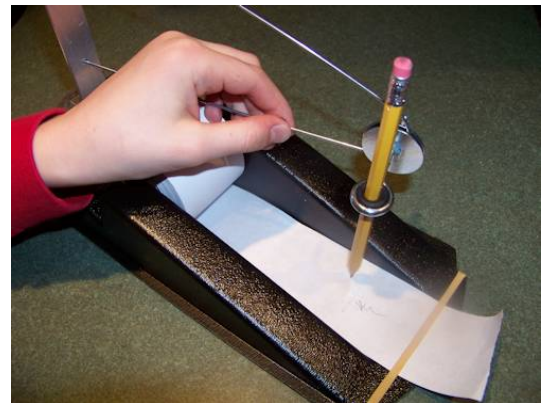
Explores seismographs and how technology can help notify society of impending dangers. Lesson focuses on exploring how the development of seismographs has helped save lives around the world. Students work in teams to design their own seismograph out of everyday items, and test its ability to record a simulated classroom earthquake. Students evaluate their own seismographs, those of classmate teams, and present findings to the class.

◆ Lesson Objectives

- ✦ Learn about seismograph technology.
- ✦ Learn about engineering design.
- ✦ Learn about teamwork and problem solving.

◆ Materials

- Student Resource Sheets
- Student Worksheets
- One set of materials for each team of students: String, wire, paper, pencil, marker pen, paper clips, glue, cardboard, poster board, foil, rubber bands, tape, pan or tray, clay
- Ladder or stool (from which to drop ball to simulate earthquake); strings cut to .5 metre, 1 metre, and 1.5 metres in length



◆ Procedure

1. Show students the student reference sheet. These may be read in class or provided as reading material for the prior night's homework.
2. Provide student teams with a set of materials and ask them to build their own seismograph that will allow them to record the intensity of a simulated classroom earthquake. The best design will record the smallest disturbance.
3. Student teams present their designs to the class and explain how they expect the recording to work.
4. Test each team's seismograph by placing it on top of a small table. The teacher will simulate a disturbance by dropping a small rubber ball on the table from three different heights (.5 metre, 1 metre, and 1.5 metres). We recommend standing on a secure ladder and measuring with lengths of string the point from which the ball will drop to ensure a consistent and fair test. (Note: you may wish to consider using different size balls as well -- tennis ball for example)
5. Students record and review their results and the results of other teams, and present their reflections to the class.

◆ Time Needed

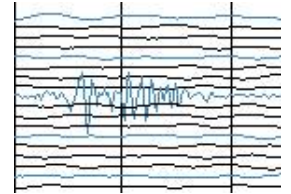
One to two 45 minute sessions.

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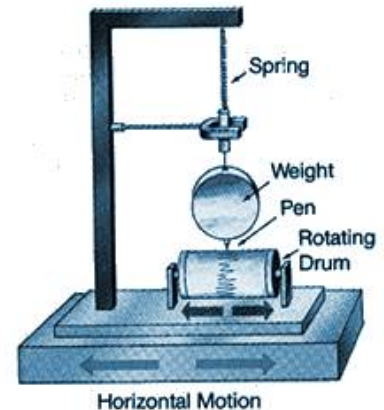
Shake it Up with Seismographs!



Student Resource: What is a Seismograph?

Seismometers are instruments that measure and record motions of the ground, including those of seismic waves generated by earthquakes, nuclear explosions, and other seismic sources. Records of seismic waves allow seismologists to map the interior of the Earth, and locate and measure the strength of these different sources. The word derives from the Greek σεισμός, seismós, a shaking or quake, from the verb σειώ, seiō, to shake; and μέτρον, métron, measure.

A seismograph, or seismometer, is an instrument used to detect and record earthquakes. Generally, it consists of a mass attached to a fixed base. During an earthquake, the base moves and the mass does not. The motion of the base with respect to the mass is commonly transformed into an electrical voltage. The electrical voltage is recorded on paper, magnetic tape, or another recording medium. This record is proportional to the motion of the seismometer mass relative to the earth, but it can be mathematically converted to a record of the absolute motion of the ground. Seismograph generally refers to the seismometer and its recording device as a single unit.



◆ Chang Heng's Seismoscope

In 132 CE, Chang Heng of China's Han dynasty invented the first seismoscope, which was called Houfeng Didong Yi. It was a large bronze vessel, about 2 metres in diameter; at eight points around the top were dragon's heads holding bronze balls. When there was an earthquake, one of the mouths would open and drop its ball into a bronze toad at the base, making a sound, and indicating the direction of the earthquake. On at least one occasion, probably at the time of a large earthquake in Gansu in 143 CE, the seismoscope indicated an earthquake even though one was not felt. The available text says that inside the vessel was a central column that could move along eight tracks; this is thought to refer to a pendulum, though it is not known exactly how this was linked to a mechanism that would open only one dragon's mouth. The first ever earthquake recorded by this seismograph was supposedly somewhere in the east. Days later, a rider from the east reported this earthquake. The image to the right is a drawing of Chang Heng's seismoscope, as visualized by Wang Chen-To (1936).



Chinese
Seismoscope
132 AD

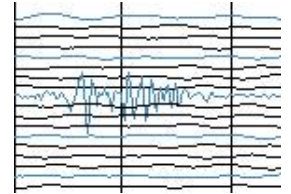
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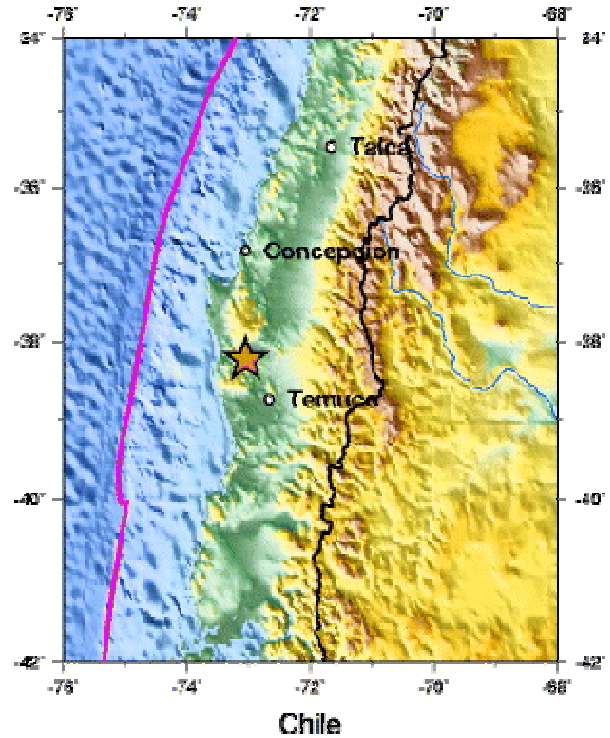
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Student Resource: Earthquake Tracking

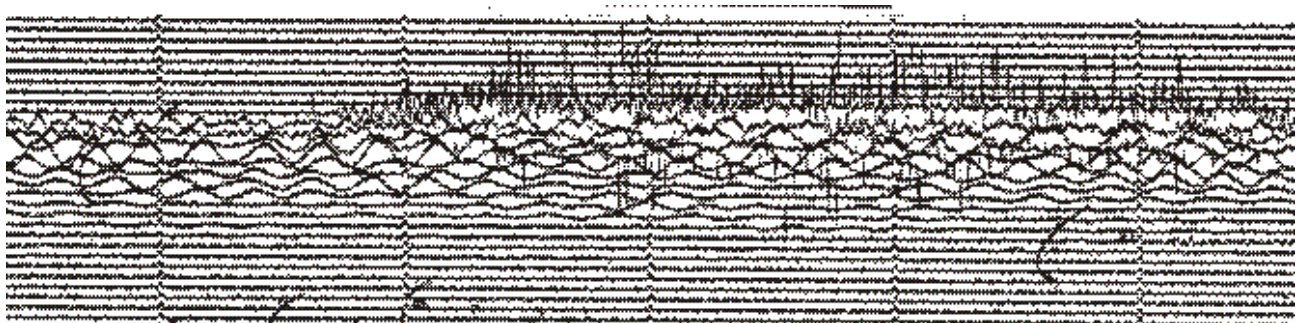
◆ The Richter Scale

The Richter magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to compare the strength of earthquakes. At first, the Richter Scale could be applied only to the records from instruments of identical manufacture. Now, instruments are carefully calibrated with respect to each other. Thus, magnitude can be computed from the record of any calibrated seismograph. The scale indicates the strength of earth movement on a scale from 1.0 to 10.0. The weakest earthquakes are 1.0, or less. Each level of the Richter scale increases by powers of 10. So an increase of 1 point means the strength of a quake is 10 times greater than the level before it. A 2.0 earthquake is 10 times stronger than a 1.0 quake. A 6.0 earthquake is 10 X 10 or 100 times stronger than a quake registering a 4.0.



◆ The Biggest Earthquake

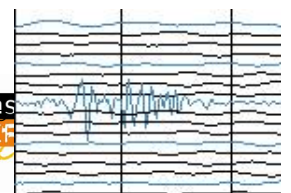
The largest earthquake ever recorded took place May 22, 1960 in Chile. Approximately 1,655 people were killed and 3,000 injured. Over 2,000,000 ended up homeless, and there was about \$550 million in resulting damage. This quake registered 9.5 on the Richter Scale. The seismograph record of this quake is below!



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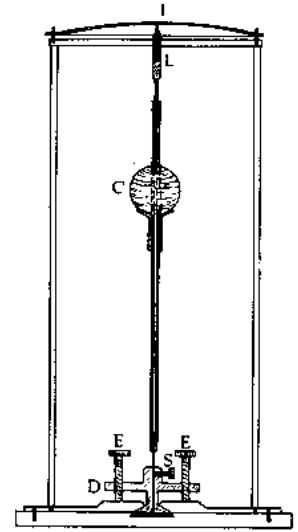


Student Resource: Pendulum Seismographs

◆ The Power of Pendulums

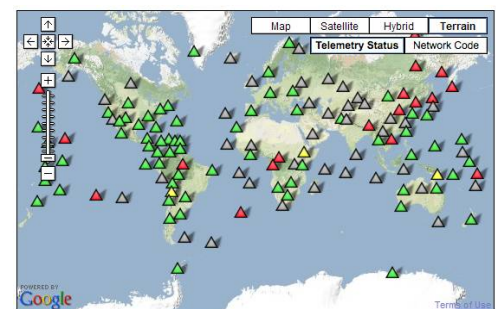
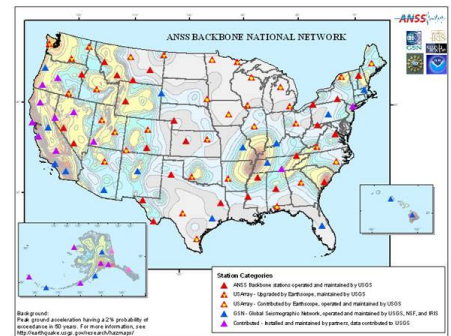
Before electronics allowed recordings of large earthquakes, scientists built large spring-pendulum seismometers in an attempt to record the long-period motion produced by such quakes. The largest one weighed about 15 tons. There is a medium-sized one three stories high in Mexico City that is still in operation.

Another example is an inverted-pendulum "seismometre", designed by James Forbes (Forbes, 1844). The seismometre is shown to the right. It consisted of a vertical metal rod that was supported on a vertical cylindrical steel wire. By adjusting the stiffness of the wire, or the height of the ball that hung from it, the swing of the pendulum could be changed. A pencil hung from the rod would "write" a line on paper that showed the movement of the earth.



◆ Current Technology

The Advanced National Seismic System (ANSS) is a United States Geological Survey initiative to upgrade and expand seismic monitoring capabilities in the United States. Major elements of the ANSS include national, regional, urban and structural monitoring systems. The ANSS will eventually be a nationwide network of at least 7000 shaking measurement systems, both on the ground and in buildings that will make it possible to provide emergency response personnel with real-time earthquake information, provide engineers with information about building and site response, and provide scientists with high-quality data to understand earthquake processes and solid earth structure and dynamics. Find out more at <http://earthquake.usgs.gov/research/monitoring/anss/>. In addition, the Global Seismographic Network (<http://earthquake.usgs.gov/research/monitoring/gsn/>) is a permanent digital network of state-of-the-art seismological and geophysical sensors connected by a telecommunications network, serving as a multi-use scientific facility and societal resource for monitoring, research, and education. The GSN provides near-uniform, worldwide monitoring of the Earth, with over 150 modern seismic stations distributed globally.

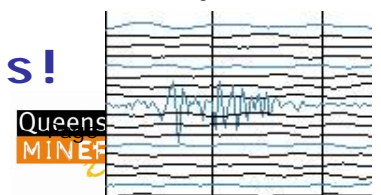


In addition, both 2-D and 3-D land and marine seismic data processing is used showing motion in both depth and time. Norway's Spectrum ASA focuses on this 2-D and 3-D data processing and maintains a library of multi-client data and reports cover all the major oil producing regions of the world.

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Student Worksheet: Build Your Own Seismograph

You are a team of engineers who have been given the challenge of designing a reliable seismograph to record earthquake activity in your classroom. Your machine must be able to record motion visually on a scale of your own design. The machine which is able to record the smallest disturbance will be considered the best design.

◆ Research/Preparation Phase

1. Review the various Student Reference Sheets.

◆ Planning as a Team

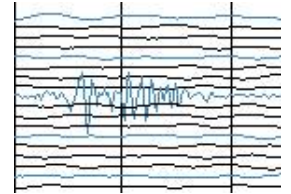
2. Your team has been provided with some "building materials" by your teacher. You may ask for additional materials.

3. Meet as a team and devising a design and materials list you would need to build your seismograph. Remember that your seismograph needs to record the intensity of a simulated classroom earthquake which will be created by dropping a ball from three heights: .5 metre, 1 metre, and 1.5 metres.

4. Draw your plan for the seismograph in the box below or on another sheet. Include a list of materials you plan to use to build your instrument. Present your design to the class. You may choose to revise your teams' plan after you receive feedback from class.

Materials Needed:
Describe Your Scale:

Shake it Up with Seismographs!



Student Worksheet (continued):

◆ Construction Phase

5. Build your seismograph and keep track of whether you needed additional materials as you were in the construction phase.

◆ Testing

6. Your team's seismograph will be placed on top of a stable, small table. Your teacher will create three simulated earthquakes by dropping a rubber ball onto the table from three heights: .5 metre, 1 metre, and 1.5 metres. Your machine will need to record each of these earthquakes. The most sensitive machines will be considered the best ones. These will be able to record the least severe of the quakes. Record your observations in the box below:

Quake	.5 metre	1 metre	1.5 metre
Measurement of quake in your scale			
Physical observations (what did you notice about your machine during the test...what worked, what didn't?)			

◆ Presentation

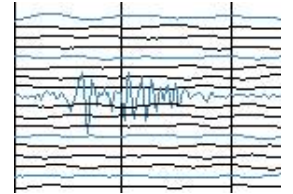
7. Present your findings and the results of your seismograph test to the class. Pay attention to differences in designs and results of the various seismographs created in your classroom.

◆ Evaluation Phase

8. Compare and evaluate your teams' results and measurement methods with those of other teams.

9. Complete the evaluation worksheet.

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Student Worksheet: Reflection

◆ Use this worksheet to evaluate your experience with the "Shake it Up with Seismographs!" lesson:

1. Did you succeed in creating a seismograph that could record on a scale the earthquake simulation for all three quakes?
2. Did you need to request additional materials while building your seismograph?
3. Do you think that engineers have to adapt their original plans during the manufacturing process of products? Why might they?
4. If you were to adapt your classroom seismograph to one that would actually record a real earthquake, what modifications would you need to make?
5. If you had to do it all over again, how would your planned design change? Why?
6. What designs or methods did you see other teams try that you thought worked well?
7. Do you think you would have been able to complete this project easier if you were working alone? Explain...

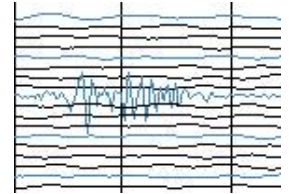
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For Teachers: Alignment to Curriculum Frameworks

Science Understandings

Year 6

Sudden geological changes or extreme weather conditions can affect the Earth's surface **(ACSSU096)**

Year 9

The theory of plate tectonics explains global patterns of geological activity and continental movement **(ACSSU180)**

Science Inquiry Skills

Year 6

Use equipment and materials safely, identifying potential risks **(ACSI105)**

Suggest improvements to the methods used to investigate a question or solve a problem **(ACSI108)**

Year 9

Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data **(ACSI166)**

Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies **(ACSI169)**

Science as a Human Endeavour

Year 6

Scientific knowledge is used to inform personal and community decisions **(ACSHE232)**

Year 9

People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions **(ACSHE160)**

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