Family edition

Earthquake Lab: Two Waves, One Gap

Ages 11-14 · about 45 minutes, in one sitting

Your child breaks a fault in Earthquake Lab, watches two earthquake waves race to three seismograph stations, and finds out how the time between them tells how far away the quake was.

What you need

- A computer or Chromebook with a current browser.
- The lesson link: mytekdev.com/try/earthquakelab?lesson=two-waves-one-gap&ref=fam-earthquakelab-1. No account, no email and nothing to install.

Before you start: try it once yourself

Open mytekdev.com/try/earthquakelab?lesson=two-waves-one-gap&ref=fam-earthquakelab-1. A short guide opens over the app: a made-up map with a coast, mountains, nine towns and three seismograph stations, A, B and C. Under it, three strips of paper, one per station.

1. **The fault.** Drag across the map. A fault line draws, and the right side shows how it moves, how deep it breaks and how big it is.
2. **The break.** Press `Break the fault`. A star marks where it broke. The P ring leaves first and the S ring falls behind it. Each pen twitches when the P wave arrives and swings wider when the S wave does, then the big, slow surface waves.
3. **The table.** The right side lists each station's gap and distance as the S wave arrives, and says the rule: about 8 kilometers for every second.
4. **A station moved.** Drag a station. Its seismogram and its gap change as it goes.
5. **The side view.** The panel inside the map cuts the ground open: the focus underground, the epicenter on the map above it.

> The moment that lands is dragging a station away and watching its gap stretch while the quake stays put.

The ideas, in plain words

When a fault slips, waves leave the break in every direction. The P wave pushes and pulls the rock along its path and is the fastest, about 6 kilometers a second near the surface. The S wave shakes the rock side to side and travels about 3.5. Both start at the same moment, so the S wave falls further behind the farther they go: about one second for every 8 kilometers.

That makes the S-P gap a distance, like counting from lightning to thunder. One station gives a distance but not a direction; the next lesson uses three. The map is made up, and so is every quake on it. The waves travel at 6 and

3.5 kilometers a second in straight lines; in the real Earth they speed up with depth and bend, so the 8 km rule works best within about 200 kilometers.

Common mistakes: thinking the waves travel along the fault; marking the big surface waves as the S wave; and thinking a bigger quake sends faster waves (it sends bigger ones, at the same speed).

Do it together

1. Open mytekdev.com/try/earthquakelab?lesson=two-waves-one-gap&ref=fam-earthquakelab-1 together. A short guide opens over the app. Drag across the map to draw a fault, then press `Break the fault`.

   > **You'll know it worked when:** Two rings spread from a star, and three pens write under the map.

2. Read the table on the right: each station's gap and distance.

   > **If you get stuck:** Wait for the S wave to reach all three stations; the table fills in as it does.
   >
   > **You'll know it worked when:** The farthest station has the biggest gap.

3. Drag one station far from the fault, then right next to it. Ask: what happens to its gap?

   > **You'll know it worked when:** Far away the gap is big; close up the two waves nearly arrive together.

4. Divide a distance by its gap. Ask: what number keeps coming up?

   > **If you get stuck:** Use a calculator: 125 km and 14.9 seconds, for example.
   >
   > **You'll know it worked when:** About 8 kilometers for every second.

Talk about it

Ask these while you work together. A child who has understood it can answer them without help:

- Which wave arrived first at every station? Why?
- Which station had the biggest gap, and where is it?
- Point to the S wave on a strip. How do you know it is not the surface waves?
- What number did you get when you divided distance by gap?
- Could one station tell you which direction the quake was?

> The second question is the real test: a child who links the biggest gap to the farthest station has the idea.

For younger and older kids

Younger: For a younger child, set the level menu at the top to its youngest choice and stop after moving a station.

Older: For a teenager, set the quake 30 kilometers deep and explain why a station right above it still has a gap.

Keep going

- Make the quake 30 kilometers deep and put a station right over the star: why is the gap bigger than the map distance says?
- Turn the magnitude up one step and break again: what changes on the strips, and what stays the same?
- Open the Chart: each arrival is a dot. Why are the P dots and the S dots on two straight lines?

Bring it into other subjects

- Math: graph distance against gap for your five stations. What is the slope of the line?
- Physics: the P wave covers 125 km in about 21 seconds and the S wave in about 36. Work out each speed.
- English: write the trip of the two waves from the fault to the farthest station, as a race.
- History: find out how the first seismographs worked, with a pen, a drum and a heavy weight.

For your records

Ready to copy into an hour log, a portfolio or a transcript.

LESSON	Earthquake Lab: Two Waves, One Gap
SUBJECTS	Earth science
TIME	45 minutes
WHAT WE DID	Modeled an earthquake on a map, measured the gap between P and S waves at three stations, and found how the gap gives the distance to the quake.
SKILLS PRACTICED	Seismic waves; Reading a seismogram; Speed, distance and time

Activity sheet (optional)

Name: _____ Date: _____

Open the app: scan the QR code, or go to mytekdev.com/try/earthquakelab?lesson=two-waves-one-gap

Essential question: Two waves leave an earthquake at the same moment. How can the time between them tell you how far away it was?

Warm-up: You count six seconds from lightning to thunder. How far away was it, and how do you know?

_____

1. **Vocabulary.** Fault, P wave, S wave, seismogram, S-P gap: write each in your own words.

2. **The gap table.** For each place you put the station: its distance _____ km; its gap _____ s; distance divided by gap _____. One place on each line.

1. Which station had the biggest gap, and why?

2. A station records a 20-second gap. About how far away was the quake? Show your work.

Quick check

Name: _____

1. Which wave reaches a seismograph first? (A) the S wave (B) the P wave (C) the surface waves

2. Station X has a gap of 5 seconds and station Y a gap of 30. Which is farther from the quake? (A) X (B) Y (C) you cannot tell

3. Explain why the gap between the P and S waves is bigger at a station far from the quake.

Answers

QUESTION	ANSWER	WHY
1	B	The P wave is the fastest, about 6 km a second.
2	B	The bigger the gap, the farther the waves traveled: about 8 km per second of gap, so Y is about 240 km away and X about 40.
3	The S wave falls further behind	Both waves leave together, but the S wave is slower, so the longer the trip the more time it loses. Saying only that the station is far away is half.

If your state or umbrella school asks, this lesson covers NGSS MS-PS4-1, NGSS MS-ESS2-2.

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The app this lesson uses is free and runs in the browser, with nothing to install and no account needed. It is at mytekdev.com.

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