Contents

Activity 1: Investigating Wave Properties

Objective

In this activity, you will learn about earthquakes. You will analyze and generate various wave forms. By the end of the activity, you will be ready to talk about and analyze earthquake data.

Time Required

45-90 minutes

Materials (per team)

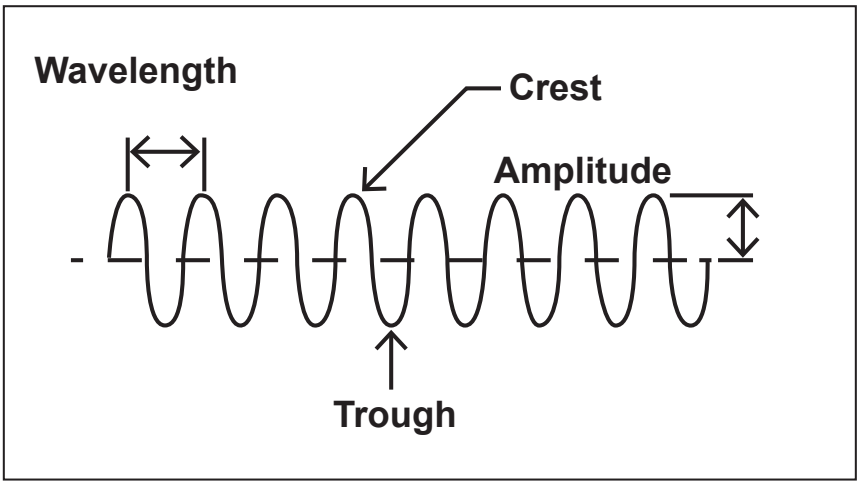
- None

Tips & Tricks

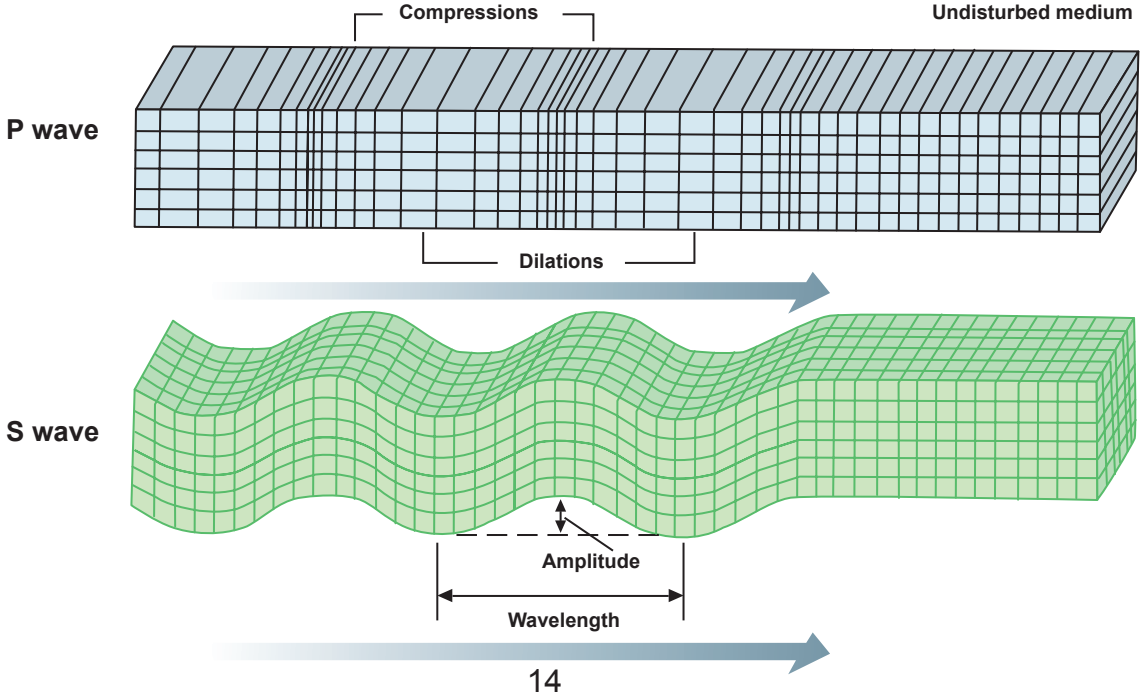
- None

Background

- An earthquake is a sudden shaking of the ground resulting from seismic waves. Small earthquakes happen often and don't cause much damage, but big ones can be devastating.
- Seismology is the study of earthquakes, and seismologists are the scientists who study earthquakes. A seismograph is the main tool used by seismologists. It measures and records seismic waves.
- The most sensitive seismographs can detect earthquakes thousands of miles away.
- Earthquakes are the result of the movement of tectonic plates and the resulting seismic waves. The waves cause damage to buildings, roadways, and other structures. So, to really understand earthquakes, you need to know more about waves.
- Visualize seismic waves as tiny ripples in water. The water that the waves, or ripples, move through is called the medium. The waves have several parts. These parts can be seen in the image below.



- The crest is the highest point of the wave.
- The trough is the lowest point of the wave.
- The wavelength is the distance from one point on a wave to the corresponding point on the next wave.
- The frequency represents the number of waves that move past a single point in a specific amount of time.
- The amplitude of a wave is the distance from the midpoint of the wave to the crest.
- The energy of the wave is directly proportional to the amplitude; the higher the amplitude, the more energy the wave has. If a small stone were dropped in water, the resulting wave would have a small amplitude, but if a large stone were dropped in water, the resulting wave would have a large amplitude. All of the aforementioned parts (crest, trough, wavelength, frequency, midpoint, amplitude, and energy) can be used to describe any wave type, including seismic and sound waves.
- Earth consists of four main layers. The crust is the outermost layer, and this layer is made up of tectonic plates.
- Tectonic plates are like puzzle pieces that fit together to form Earth's crust. They can move around, and sometimes they bump into each other. The locations where tectonic plates run into each other are called faults.
- At faults, the tectonic plates will get stuck. When these tectonic plates release or slide against each other, an earthquake occurs. At the moment when the tectonic plates move, there is a release of energy in the form of seismic waves that causes the earth to shake.
- The seismic waves consist of two kinds of waves: a primary wave, or P wave (which is a compression wave), and a secondary wave, or S wave (which is a transverse wave). P waves shake the ground parallel to the direction they are traveling, and S waves shake the ground perpendicular to the direction they are traveling.
- S waves, though slower, cause the majority of the damage in an earthquake. Notice that the S waves fit the definition of a wave previously discussed.



Activity Results

Challenge 1: Use the two sliders below to make the blue wave match the red wave exactly. The indicator light in the software will turn green when the waves are an exact match.

- The amplitude should be 3.
- The frequency should be 7.

Challenge 2: Most seismic waves have frequencies below 20 hertz. Can you determine some properties of the red seismic S wave shown? Use the sliders to measure the waveform and then enter your answers in the white boxes.

- The wave does not have a constant frequency.
- The frequency between Time 0 and Time 0.4 should be between 2.5 and 3.5.

Challenge 3: As you saw in the last challenge, a seismic wave's properties (frequency and amplitude) can vary throughout its duration. Use the sliders to measure the waveform and then enter your answers in the white boxes.

- The frequency between Time 1.6 and Time 2 should be between 9 and 11.
- The maximum amplitude of the S wave should be between 19 and 21.

Lab Report

A sample of the lab report that is printed for each student team is shown on the next page for reference.
It is suggested that the Pretest Score be used for informational purposes only.

Investigating Wave Properties Lab Report

Jane Doe

Pretest Score: 4 out of 10
Posttest Score: 10 out of 10

Challenge 1 What are the amplitude and frequency of the given wave?
Frequency: 7.0 Hz; amplitude: 3.0 A

Challenge 2: Does the wave have constant frequency?
No

Challenge 2: What is the frequency of the wave between Time 0 and Time 0.4?
3.0 Hz

Challenge 3: What is the frequency of the wave between Time 1.6 and Time 2?
11.0 Hz

Challenge 3: What is the maximum amplitude of the wave?
20.0 A

Assessment Key

1. A primary seismic wave is a destructive, slow-moving wave.
    - False – secondary seismic waves (S waves) are slower and more destructive because they shake the ground perpendicular to the direction they are traveling. Primary seismic waves (P waves) are compression waves that shake the ground parallel to the direction they are moving.
2. Earthquakes cause sinusoidal waves to travel through the earth.
    - True – the S waves are sinusoidal.
3. The sound of the music that you listen to is caused by sinusoidal waves traveling through the air.
    - True – sound waves have a typical "wave" shape.
4. Seismographs can detect earthquakes thousands of miles away.
    - True – the most sensitive seismographs can detect earthquakes thousands of miles away.
5. The smaller the amplitude of a wave, the more energy the wave has.
    - False – the bigger a wave's amplitude, the more energy it has.
6. The highest point of a wave is known as the _____.
    - Crest
7. Thirty-five waves pass a given point in seven seconds. What is the frequency of the wave in waves per second?
    - Five – because the frequency is defined as the number of waves per second, so 35 waves divided by 7 seconds = 5.
8. The _____ is the distance from one point on a wave to the corresponding point on the next wave.
    - Wavelength
9. Most earthquakes occur along or near the edges of _____.
    - Tectonic plates – the locations where tectonic plates run into each other are called faults, and when the plates get stuck and then release, an earthquake occurs.
10. The outermost layer of Earth is called the _____.
    - Crust