Demonstrating Seismic Waves

Introduction

Seismologists determine the location of the epicenter of an earthquake by studying seismograms which detect and record the vibrations of primary and secondary seismic waves traveling at different speeds. A super spring is a good demonstration device to help students compare and contrast the properties of *P*-waves and *S*-waves.

Concepts

- Compression versus transverse waves
- Earthquakes
- *P*-waves versus *S*-waves

Materials

String

Super spring

Safety Precautions

Take care not to suddenly release a stretched super spring. The spring may snap back rapidly, which may cause personal injury or damage to the spring. Do not extend the super spring more than 12 meters. Wear safety glasses.

Procedure

Primary Wave

1. Using a piece of string, fasten one end of the super spring to the bottom of the leg of a sturdy chair or table.
2. Hold the free end of the spring in one hand and stretch the spring across the floor. *Note:* A tile floor works best.
3. With your free hand, gather up a set of coils and then release them. Observe a longitudinal (compression) wave as it travels the length of the spring.
4. For continuous waves, push the spring in and out as shown in Figure 1. Observe the compressions and rarefactions created as the energy is transferred along the coils.

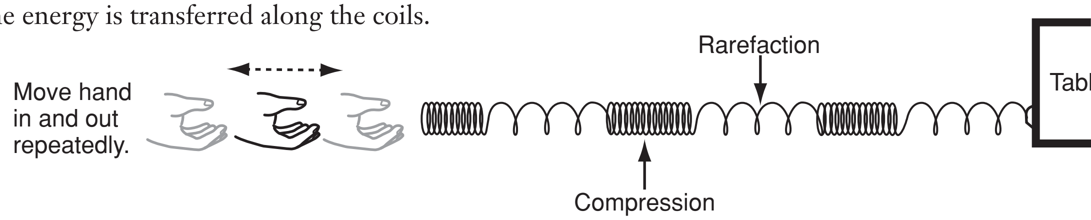

Figure 1. Longitudinal Wave (Overhead View)

Secondary Wave

5. Set up the super spring as in steps 1 and 2 for the primary wave procedure.
6. With a rapid motion, shake the end of the spring sideways once. Observe a transverse wave pulse as it travels the length of the spring (see Figure 2).

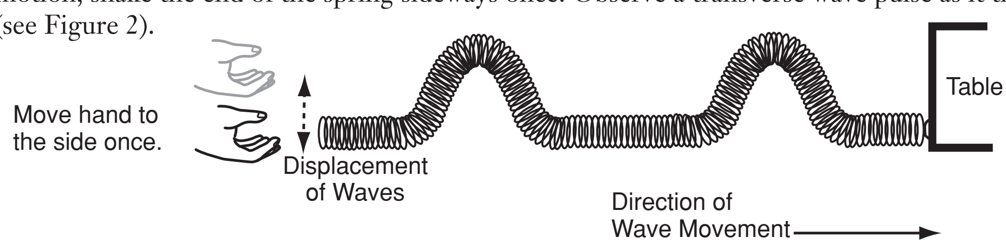

Figure 2. Pulse

7. For continuous waves, quickly shake the free end of the spring back and forth across the floor. Quick movements work best (see Figure 3).

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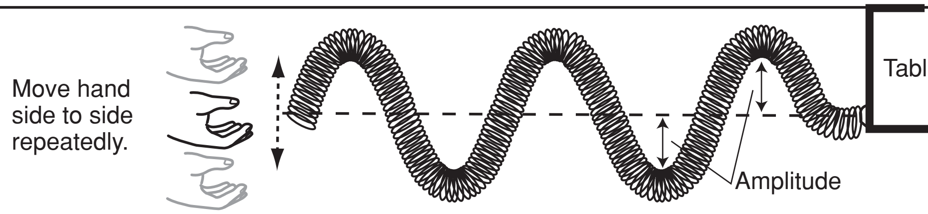

Figure 3. Transverse Wave

8. Observe how the coils of spring move perpendicular to the direction of wave propagation.
9. Increase the frequency by shaking the spring faster while keeping the amplitude the same. Next generate a larger amplitude by increasing the distance the free end of the spring is moved back and forth.

Storage

Store the super spring upright on its stand.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Constancy, change, and measurement

Content Standards: Grades 5–8
Content Standard B: Physical Science, understanding of motions and forces, transfer of energy
Content Standard D: Earth Science, structure of the Earth system

Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, motions and forces, conservation of energy and increase in disorder, interactions of energy and matter
Content Standard D: Earth and Space Science, energy in the Earth system

Tips

- Make sure objects are off the floor and away from the super spring to prevent tangling. At no time should students be allowed to touch the moving coils.
- Do not overstretch the super spring. The manufacturer's recommended limit is 12 meters.
- If the demonstration is performed on a tile floor, use the tiles for consistency in amplitude for the secondary wave.
- The length of the super spring allows sufficient time to observe each wave pulse. If enough space is not available, however, use a standard Slinky®, available from Flinn Scientific, Catalog No. AP1957.
- For further exploration of earthquakes, consider the Flinn Student Laboratory Kits "Find the Epicenter of an Earthquake" (Catalog No. AP7266) and "Mapping Earthquakes and Volcanoes" (Catalog No. AP6881).

Discussion

Two types of seismic waves travel outward from the *focus* (origin within the Earth) of an earthquake. The primary wave, or *P-wave*, is a compression wave that forces rock to compress and expand in the same direction the wave travels (see Figure 1). Compressions in the spring are areas of high pressure. Rarefactions (expansions) are areas of low pressure where the coils are stretched out. *P*-waves travel through the Earth at an average speed of about 5 kilometers per second. Secondary waves travel at a slower rate, averaging about 3 kilometers per second. Secondary or *S-waves* are transverse waves in which the vibrations displace matter perpendicular to the direction the wave is moving (see Figure 3).

Materials for *Demonstrating Seismic Waves* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP6565	Super Spring and Stand
AP4823	String
AP7266	Find the Epicenter of an Earthquake—Student Laboratory Kit
AP6881	Mapping Earthquakes and Volcanoes—Student Laboratory Kit

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.