ARBOR SCIENTIFIC

Spring Wave

P7-7220

INSTRUCTIONAL GUIDE

Contents

- Spring Wave
- Instructional Guide

Background

The spring wave is a long, helical spring that can be used to demonstrate waves and other phenomena. A mechanical wave is a disturbance that moves through a medium. The spring wave can demonstrate longitudinal and transverse waves. The particles move parallel to the direction of the wave in longitudinal waves. The spring coils move perpendicular to the direction of the wave in transverse waves. With the spring wave, you can also demonstrate standing waves. Standing waves appear to be stationary because of interference. With the spring wave and a rope, you can also show what happens when a wave enters a new medium. The spring wave can also be used to demonstrate Hook's Law and harmonic motion, and even Hubble's constant.

The spring wave is a helical spring with a diameter of 2 cm and a length of 20 cm, which can be stretched to 12 feet. Its silvery-white color makes the demonstration of its wave properties highly visible, while its lightweight construction makes it safe when it snaps back into shape after being stretched.

Activities

Most of the activities are best done on a tile floor. It keeps the motion in two dimensions and gives a convenient reference. Also, if the spring is accidentally let loose, it is less likely to hit someone in the face.

- **Longitudinal and transverse waves:** You can put a piece of tape on the spring to better show how the individual parts of the spring are moving. Stretch the spring lightly across the room. For transverse waves, strike and shake the spring side to side. For longitudinal waves, gather up several coils of spring and then let go.

- **The speed of a mechanical wave depends on the medium through which it travels:** Stretch the spring lightly across the room. Measure the time that it takes for one pulse to make one complete trip – back and forth – down the spring. Have the students predict methods to make the wave move faster, i.e. hit the spring harder, etc. The only way to make the wave travel faster is to stretch the spring more, changing the medium. This can also be done with two springs side-by-side as a race. Have one team of students change something to try to make their wave beat the other team's wave.

- **Behavior at wave boundaries:** Tie a rope to one end of the spring. Make a single transverse pulse by striking the spring sideways. If the other end of the spring is held, the reflected pulse will come back on the other side of the spring (inverted). If the rope is held instead, the pulse that is reflected at the boundary of the spring and rope will come back on the same side of the spring (erect or upright). You will also get a pulse that is reflected at the end of the rope.

- **Interference:** Have two students at opposite ends of the stretched spring hit the spring to the side. Watch what happens at the place where the two pulses meet. Also, watch what happens to the original pulses after they pass through each other. Try having the students hit the spring on the same side and opposite sides. Also, have them hit the spring with different amounts of force in both directions.

- **Standing waves:** Shake the spring slowly back and forth, adjusting the speed until you get one antinode in the middle of the spring. Try to get 2, 3, 4, etc. antinodes. How many can you get? The students can touch the spring at the node with a finger without disturbing the wave, but touch it anywhere else and the motion will be dampened. Also, try this with the rope attached to the other end. You will get an antinode at that end. Show the difference between guitar strings and clarinets this way.

- **Harmonic motion:** Using the same setup as above, pull a light mass down a few centimeters and let go. It should bob up and down harmonically. You may have to try a few different masses and a few lengths of spring to get it to sustain motion.

- **Expansion of the universe:** How can everything be moving away from us, even if we're not in the middle of the universe? How can astronomers estimate distances from speed? Put five or so sticky notes along the length of the spring wave. It does not matter exactly where they are. Pick one of them to be the Earth. The others are galaxies. With the spring wave held lightly between two people, measure the distances between the notes. Put a table of the distances on the board. Have the two people holding the spring take a step backward. Measure the distances again. Have them take another step back. Measure the distances again. With the table that you now have, show that the galaxies that are farthest from the Earth are moving away from the Earth the fastest. Try it again with the Earth in a different location. It still works! The Earth does not have to be in the center.

- **Earthquakes and elastic rebound theory:** Attach the spring wave to a box or other weighty object. Put the object on the floor (carpet works best). Pull the spring wave slowly to the side (You can grab the spring wave in the middle.) If there is enough friction between the object and the floor, the object will stick for a while, then suddenly move. Keep going. It will jump, again, but maybe not as much or more than before. This shows that as the tectonic plates slide past each other, they stick. When enough stress builds up, the plates suddenly move: an earthquake. Some earthquakes are big, some are small. You will need to find the right size, weight, and material for your box. Otherwise, it will slide too easily, or jump too much.

Related Products

Helical Spring (33-0140) 2cm diameter, 180cm long (collapsed) helical spring. "Snaky" is ideal for demonstrating fundamentals of wave theory, including transverse and longitudinal waves and wave behavior at the interface of two media.

Super Springy (33-0130) This extra-long version of the familiar and always popular spring toy provides an excellent demonstration of wave theory.

Standing Wave Kit (10pk) (P6-7700) Perfect for middle school and high school students, this kit includes all the materials you need to make 10 standing wave demonstrations. Instructions include qualitative and quantitative experiment ideas.