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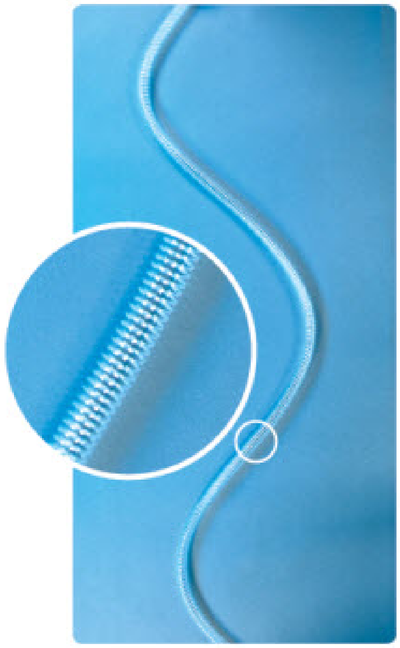

Spring Wave

P7-7220

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.

In using this product, many of the national and states' science education standards are covered. Some examples are provided here. These are representative. However, check with your state to find the exact standards.

Elementary and Middle School: Vibrations in materials set up wavelike disturbances that spread away from the source. Sound and earthquake waves are examples. Waves move at different speeds in different materials. Wave behavior can be described in terms of how fast the disturbance spreads, and in terms of the distance between successive peaks of the disturbance.

High School: The student knows the effect of waves on everyday life. The student should be able to demonstrate wave interactions including interference, polarization, and reflection within various materials. Analyze the processes that power the movement of the Earth's continental and oceanic plates and identify the effects of this movement including faulting, folding, and earthquakes.

PRODUCT INFORMATION:

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.

- **Hooke's Law:** Use a test tube clamp to hold the spring. Have ¼ meter or so extend below the clamp. Hang hooked masses from the spring. Show that there is a linear relationship between force applied and distance extended. (Be careful not to exceed the elastic limit.)

- **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? Take the spring wave and put five or so Post-It notes or pieces of paper along the length of it. 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 or overhead. 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 (moved the most distance in the time). 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:

The **Super Springy** (33-0130) can be used to show many of the same principles as the Spring wave. It is especially useful for showing longitudinal waves. You can also compare waves and elastic potential, etc. between the two kinds of springs.