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Educational Innovations Inc.®

Wave Modeling Spring

SPR-1

This six-foot-long spring stretches to over 30 feet! Perfect for modeling standing and moving transverse waves as well as moving sound waves. Demonstrate the relationship between wavelength and frequency in a way your students will never forget. You can even stretch the spring through a large slit in a piece of cardboard to demonstrate how a polarizing filter works. These gigantic springs have myriad uses in the classroom and laboratory.

NGSS Correlations

Our Wave Modeling Spring and these lesson ideas will support your students' understanding of these Next Generation Science Standards (NGSS):

Elementary

1-PS4-3
1-PS4-4
Students can use the Wave Modeling Spring to conduct an investigation of how light and sound waves travel.

Middle School

MS-PS4-1
Students can use the Wave Modeling Spring to model and describe simple waves that include how the amplitude of a wave is related to the energy in a wave.

High School

HS-PS4-1
Students can use the Wave Modeling Spring to model and describe simple waves that include how the amplitude of a wave is related to the energy in a wave, before launching mathematical representation among the frequency, wavelength, and speed of waves traveling in various media.

Suggested Science Idea(s)

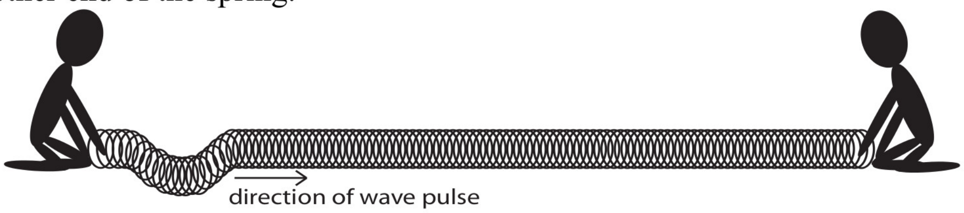
MS-PS4-1

With classroom demonstrations and investigations, the emphasis is on describing waves with both qualitative and quantitative thinking, which then can be linked with mathematical representation.

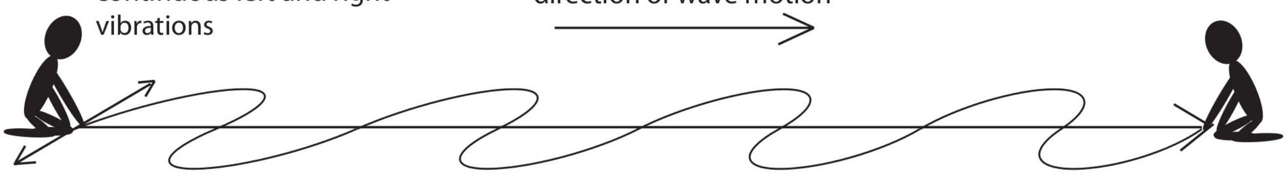
Name____
Activity 1: Transverse Waves

Eye Protection Required

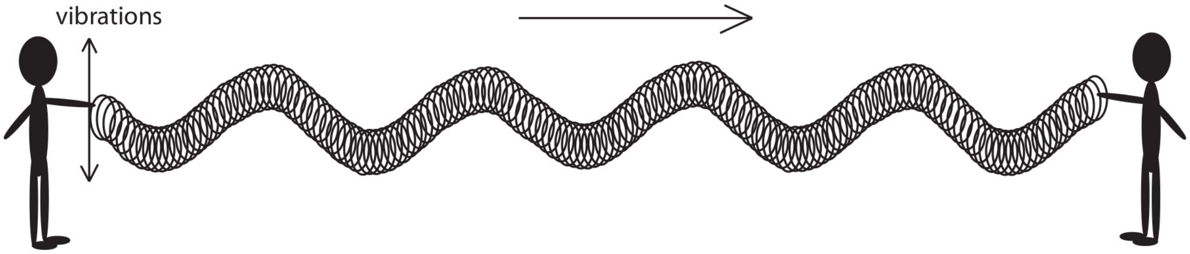
A. Hold one end of the coil spring against the floor and have a partner **firmly and securely** hold the other end. Slightly stretch the coil spring and create a single **wave pulse** with one quick snap of the wrist. The pulse will travel towards the other end of the spring.



B. Continuously move the end of the spring left and right against the floor.



C. Continuously move the end of the spring up and down in the air.



D. Describe the relationship between the direction of the vibrations and the direction of wave motion for transverse waves:

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____

E. Change the frequency of vibration by continuously moving the end of the spring faster or slower. Describe how the frequency of vibration affects the wavelength of the wave produced:

____

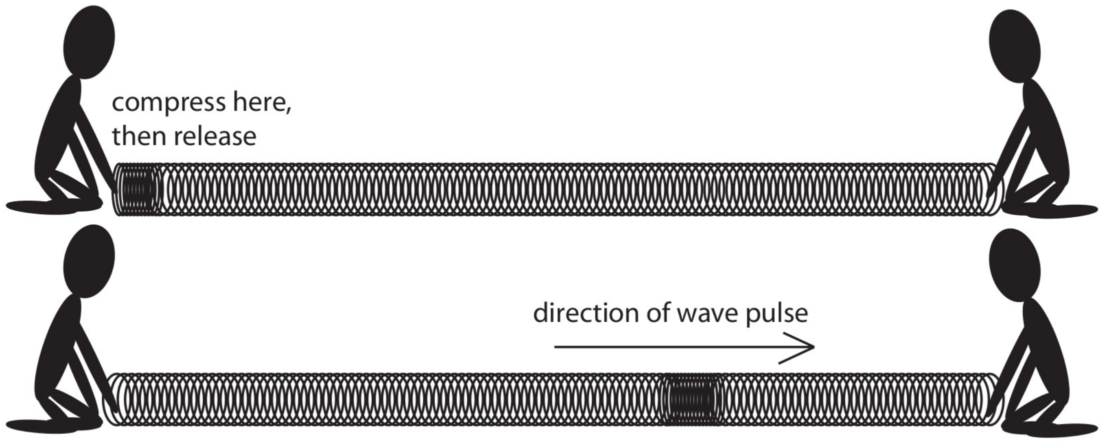
____

Name____

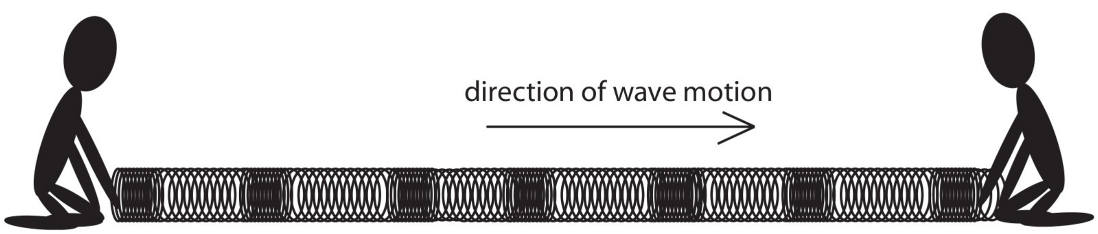
Activity 2: Longitudinal Waves

Eye Protection Required

A. Hold one end of the coil spring and have a partner **firmly and securely** hold the other end. Slightly stretch the coil spring against the floor. Create a single wave pulse by squeezing a small section of the spring and then releasing the compression. The pulse will travel towards the other end of the spring as shown below:



B. Continuously compress and release a small section of the coil spring.



C. Describe the relationship between the direction of the vibrations and the direction of wave motion for longitudinal waves:

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D. Change the frequency of vibration by continuously compressing and releasing a small section of the coil spring faster or slower. Describe how the frequency of vibration affects the wavelength of the wave produced:

____

____

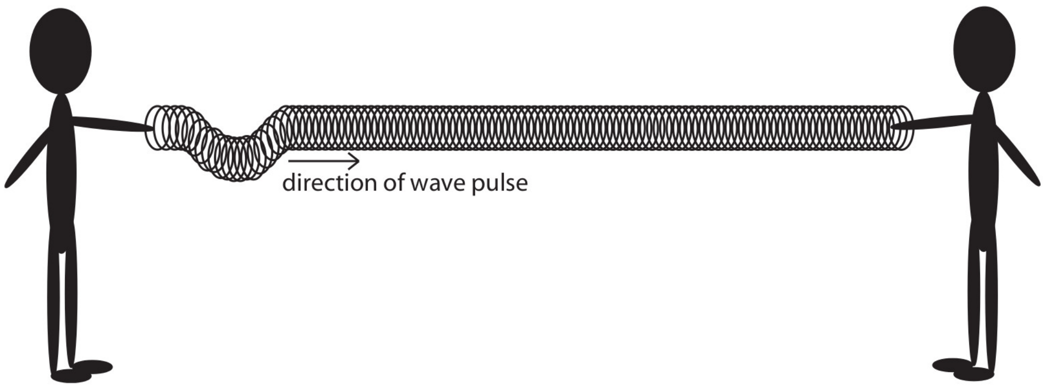
Name____

Activity 3: Reflection

Eye Protection Required

A. Fixed-End Reflection

Hold one end of the coil spring in the air and have a partner **firmly and securely** hold the other end. Slightly stretch the coil spring and create a transverse wave pulse with one quick snap of the wrist. The pulse will travel towards the other end of the spring.

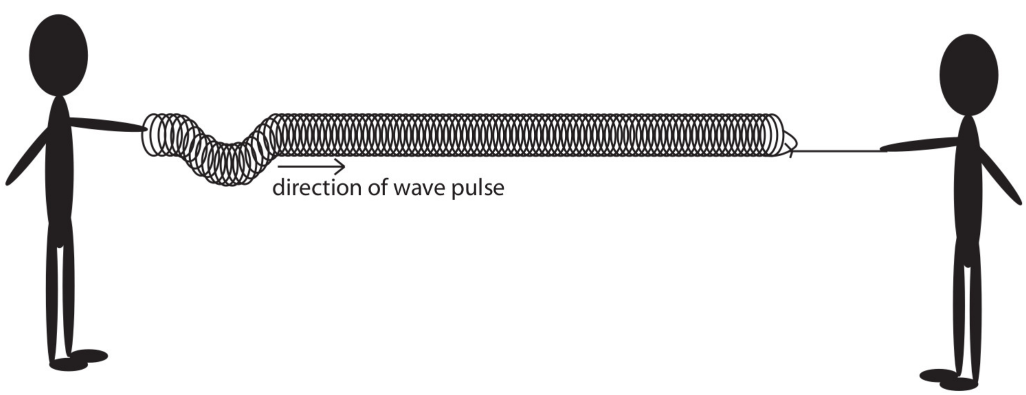


Does the reflection pulse return on the same side as the original pulse or on the opposite side?

____

B. Free-End Reflection

Hold one end of the coil spring in the air and have a partner hold a strong string that is attached to the opposite end of the spring. Create a transverse wave pulse with one quick snap of the wrist. The pulse will travel towards the other end of the coil spring. ***Caution: If the spring is stretched or the string is held too tightly, the end becomes fixed and the experiment will not produce accurate results.***



Does the reflection pulse return on the same side as the original pulse or on the opposite side?

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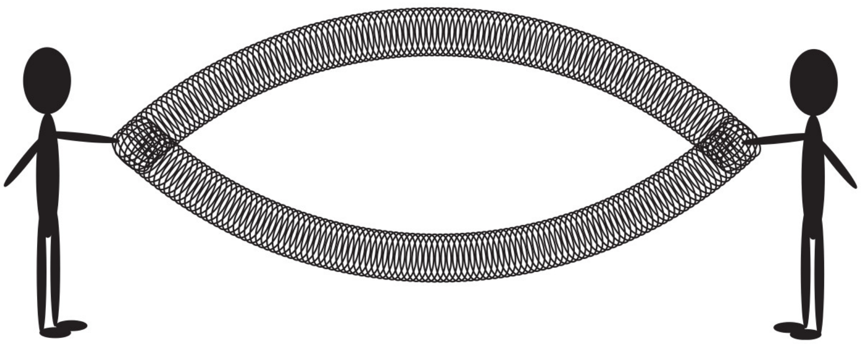
Name____

Activity 4: Standing Waves

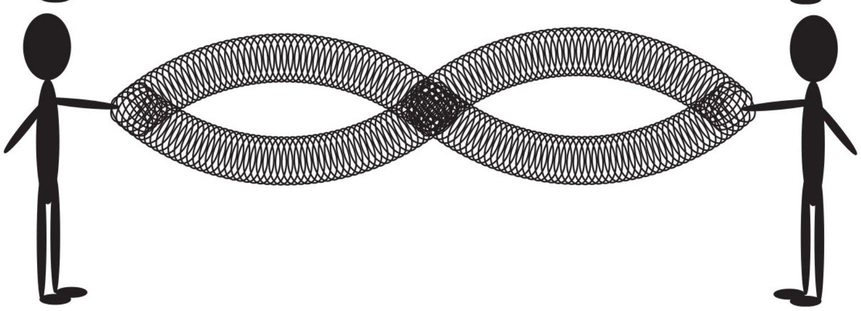
Eye Protection Required

Hold one end of the coil spring in the air and have a partner **firmly and securely** hold the other end. Slightly stretch the coil spring and continuously move the coil spring up and down. Standing waves can be created when the reflected waves interfere with the incident waves at specific frequencies.

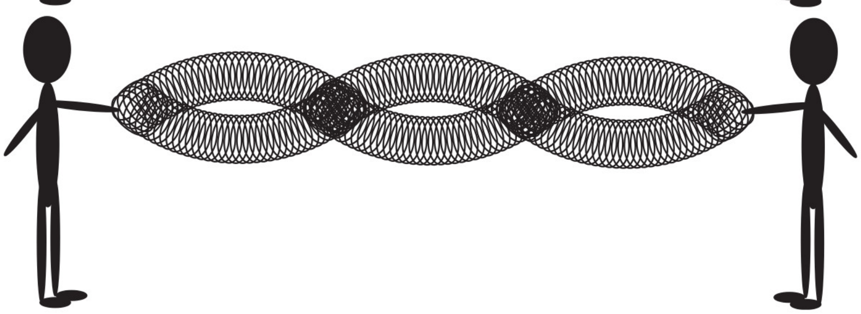
Create the first four standing waves pictured below then determine the wavelength of each standing wave based on the length of the coil spring.



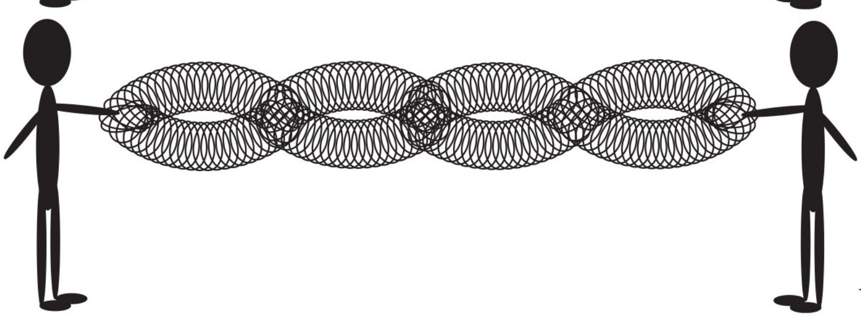
Wavelength = ________



Wavelength = _________



Wavelength = ________



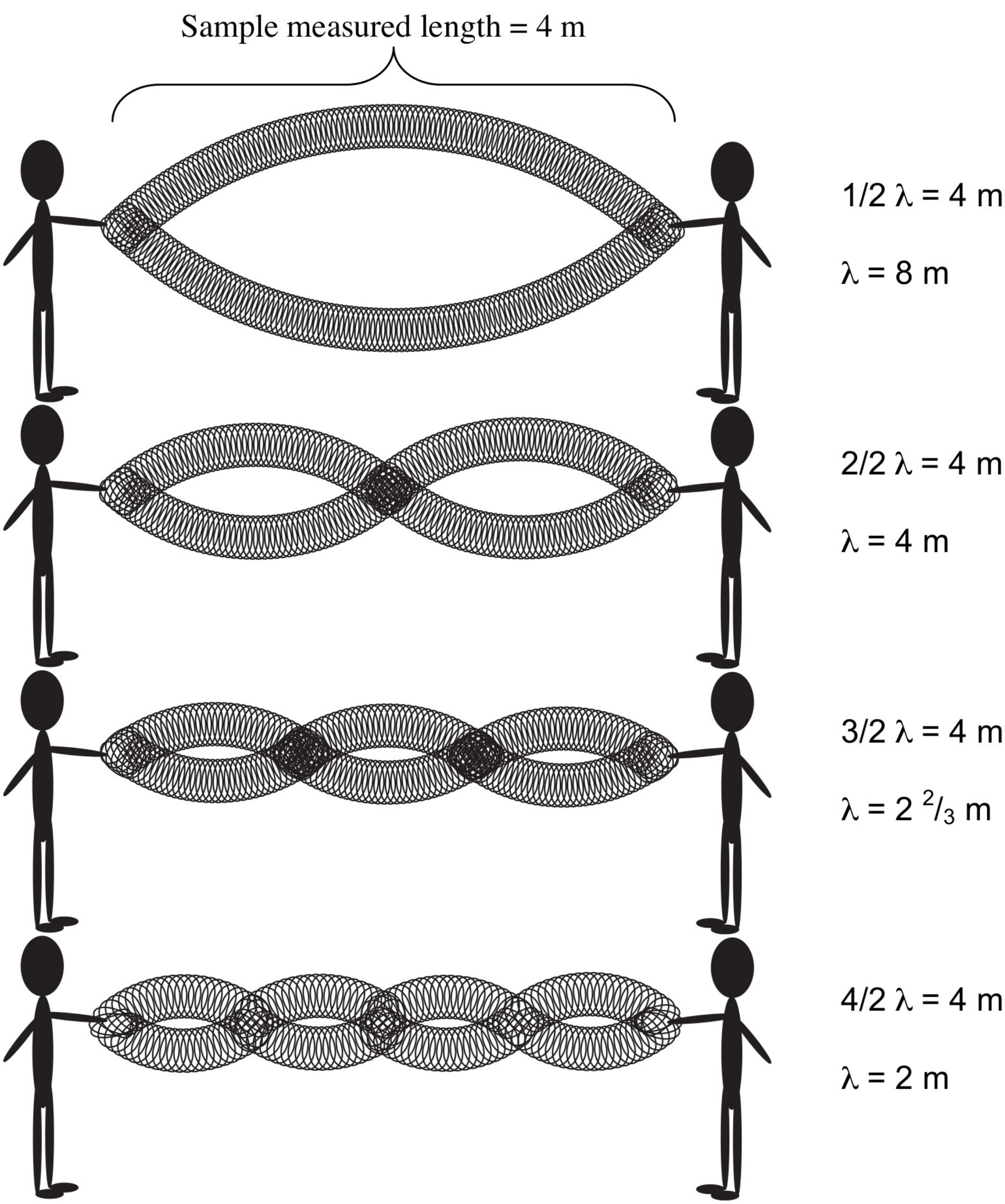
Wavelength = _________

Activity 1: Transverse Waves
Students will create transverse waves on the floor and in the air. The students can vibrate the spring left and right if the spring is on the floor. If the spring is in the air, the students can vibrate the spring left and right or up and down. Students can also shake the spring diagonally back and forth in the air to create transverse waves. As long as the vibrations are perpendicular to the direction of wave motion, a transverse wave will be produced. Students can change the frequency of vibration by moving the end of the spring either faster or slower and explore how the change in frequency affects the wavelength of the wave. The speed of a wave is equal to the frequency of vibration multiplied by the wavelength (v = lf) and waves of all frequencies and wavelengths travel at the same speed in the coil spring. Therefore, when the frequency of vibration is decreased, the wavelength increases and the distance between the top of one crest to the top of another crest will be longer. When the frequency of vibration is increased, the wavelength decreases and the distance between the top of one crest to the top of another crest will be shorter.

Activity 2: Longitudinal Waves
Students will create longitudinal waves on the floor by compressing and releasing a small section of the coil spring. Students can also continuously push on the spring back and forth towards and away from their partner. As long as the vibrations are parallel to the direction of wave motion, a longitudinal wave is produced.
Students can change the frequency of vibration by compressing and releasing a small section of the spring at different rates. The speed of a wave is equal to the frequency of vibration multiplied by the wavelength (v = lf) and waves of all frequencies and wavelengths travel at the same speed in the coil spring. Therefore, when the frequency of vibration is decreased, the wavelength increases and the distance between the center of one compression to the center of another compression will be longer. When the frequency of vibration is increased, the wavelength decreases and the distance between the center of one compression to the center of another compression will be shorter.

Activity 3: Reflection
The reflected pulse will travel down the opposite side of the coil spring when the end is fixed. The reflected pulse will travel down the same side of the coil spring when the end is free. When the pulse reaches a fixed end, the spring exerts a force on the fixed end and receives an equal but **opposite** force, which causes the reflected pulse to be inverted.

Activity 4: Standing waves
A third partner should measure the distance between the two students holding the coil spring to determine the length of the spring (especially if the spring is stretched). The first standing wave shows half a wavelength, therefore the wavelength (l) of this wave can be determined by doubling the length of the spring. The diagram below shows solutions for sample data:



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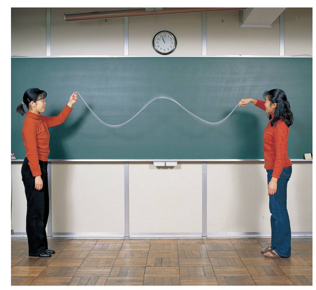

Plastic Wave Spring (SPR-225)

This highly visible, lightweight plastic spring is easier for students to manipulate than metal wave springs, allowing for more flexibility in classroom demonstrations and student lead experimentation. Investigations include the measurement of the phase of reflected waves, the velocity of transverse or longitudinal waves, determination of the frequency and wavelength of a wave, and experiments on standing waves.

Basic Boomwhacker Set (BOM-150)

These eight labeled tubes produce the C-Major Diatonic Scale. Included in package: eight tubes, 12 in. to 24 in. long. See optional Octavator End Caps to lower the pitch by an octave.

Sound Tubes (SS-600)

Sound Tubes are our absolute favorite sound toy. When spun in a circular motion, these tubes produce a tone. As the Sound Tubes are spun faster, the tone steps up in frequency. Due to the harmonics of the tube, there is not a gradual increase in frequency.

Pocket Sound Blaster (SNG-605)

Sounding like a loud truck air horn, it fits in your pocket. When air is blown through the side hole, the rubber diaphragm vibrates as the air pressure repeatedly increases and is released. By lightly touching the diaphragm, different sounds can be produced.