

## Waves on a Coiled Spring

Name: \_\_\_\_\_

**Problem:** How does a wave change when you add more energy? What kinds of waves are there? What changes the speed of a wave? How do waves respond when they encounter a barrier?

**Materials:** Loosely coiled spring, stopwatch, meter stick, 2 m long string

### Procedure:

1. Suppose a long spring is stretched across the floor and is held by students at both ends. One student pulls back the end of the spring then pushes it forward creating a single pulse. Now imagine that the spring is moved twice as far. Which of the wave properties will change? How will they change?
2. Try the above experiment:
  - a. What type of wave did you create?
  - b. What did you change when you pushed twice as far?
  - c. What is the height of the wave called?
  - d. What happens to the amplitude of the wave as it travels?
  - e. Why do you think this happens?
  - f. What did you learn?
3. Suppose that you now repeat the experiment but this time you pull the spring to one side and let go, creating a single pulse. Now imagine that you pull to the same side, but twice as far.
  - a. What type of wave did you create?
  - b. What did you change when you pulled twice as far?
  - c. What did you learn?
4. Suppose you now repeat the experiment with a pulse to the other side of the spring.
  - a. What type of wave did you create?
  - b. Did this change anything from number 3?
  - c. What did you learn?

Motion of particles in transverse and longitudinal waves

	Transverse	Longitudinal	
	Motion of energy transfer	Motion of particle	Motion of energy transfer
Diagram	Diagram	Diagram	Diagram
Describe	Describe	Describe	Describe

6. Now make a series of pulses by jiggling the spring back and forth at evenly spaced intervals.
  - a. What are the spacings between the pulses on the spring called?
  - b. Does the wavelength change as the wave travels down the spring?
  - c. What is the time it takes to jiggle the spring back and forth called?
  
7. Now repeat #5 but move your hand at a faster pace than before. Be sure to move it back and forth about the same distance as before.
  - a. What are you keeping constant?
  - b. What has changed about the wave?
  - c. How can you decrease the wavelength?
  - d. How can you increase the wavelength?
  - e. What have you learned?
  
8. Make a pulse on the spring and watch the pulse as it travels down the spring and back again.
  - a. What do you notice about the wave?

9. Repeat the experiment with a pulse on the other side of the spring.
  - a. What do you notice about the wave?
  
10. Now the stationary end of the spring is held in place by a light string at least 2 m long. Again make a pulse on the spring and watch the pulse as it travels down the spring and back again.
  - a. What do you notice about the wave?
  - b. Is it any different from reflected wave in part 8? How?
  
11. Repeat by making a pulse on the other side of the spring.
  - a. What do you notice about the wave?
  - b. What wave properties will change in the two situations compared to the spring without the string?

Fixed and Free End Reflection of Pulses

Variable	Diagram/Description of set up	Starting pulse	Reflected pulse	What did you learn?
Fixed end				
Free end				

12. Measure the speed of the wave.

Length of stretched spring \_\_\_\_\_ (This cannot change throughout the trials)

Lengths traveled	1 length	2 lengths	3 lengths	4 lengths	5 lengths
Time (s)					
Average speed (m/s)					

What did you learn about the speed of a wave?

13. Now change the following variables keeping the same length of spring.

Variable	Diagram or description of set up	Results	What did you learn?
Amplitude			
Frequency			
Tension (stretch of spring)			
Transverse vs Longitudinal			

14. Summarize in words the relationships you see between

a. Amplitude and wave speed

b. amplitude and wavelength

c. frequency and wave speed

d. frequency and wavelength

15. Take two springs of Different Linear Density (connect slinky and snakey together). Follow the instructions in the table below and fill in the table as you perform the experiments.

Two Springs of Different Linear Density (connect slinky and snakey together)

Diagram of starting pulse	Transmitted pulse	Reflected pulse	What did you learn?
Slinky → Snakey In Slinky	In snakey	In slinky	
Snakey → Slinky	In slinky	In snakey	

16. Stretch the spring on the floor between you and your partner. One person pull the spring out to one side and the other person pull the spring out to the other side. Let go and watch the wave as it travels down the spring. Do the waves go through one another or bounce back? How do you know?

17. Do the waves change shape as they go down the spring? If so when does this happen? Be specific.

18. Repeat the experiment but both people pull the spring out to the same side this time. Do the waves change shape as they go down the spring this time? Be specific.

19. Repeat the experiment for all variations in chart below and fill in chart with your findings.

### Superposition of Pulses

Pulse variation	Diagram	Waves crossing	After wave crosses	What did you learn?
Same size, same side				
Different size, same side				
Same size, opposite side				
2 pulses one side 1 pulse from other side				

20. When you made the tension of the spring different you changed the medium the wave was traveling through. What effect does changing the medium have on the wave?

21. How do the speeds of high frequency (short wavelength) transverse waves compare with the speeds of low frequency (long wavelength) transverse waves?

20. Would you expect the results of an experiment with longitudinal waves to be similar to the results of the transverse wave experiment? Explain why or why not.