Exploring Wave Speed Virtual Lab Activity

Introduction:

When an object oscillates it causes a wave to be emitted in the medium that it is immersed in. For example, when a buoy bobs in the ocean, it creates waves in the water that it is sitting in. These waves radiate out from the buoy. There are called **propagating waves**. This is the same for electric charges that oscillate in an electromagnetic field or vibrating source on a string. The length of these waves (**wavelength**) is the distance between successive peaks.

The rate that the of the vibrating source moves up and down determines how many waves appear over a given time range. This is called the **frequency** of the wave. For example, if the vibrating body moves up and down 5 times per second, then we would say that the frequency is 5 times per second or 5 s^{-1} (also known as 5 Hz).

The **speed** of the wave is how fast each peak/trough of the wave moves away from the source. It is measured by the distance that the wave moves over a given time. The best way to track the speed of the wave is to watch one peak as it propagates and measure the distance with a ruler and the time with a timer. Dividing the distance by the time will give you the speed. The speed can also be determined by multiplying the **wavelength** by the **frequency**.

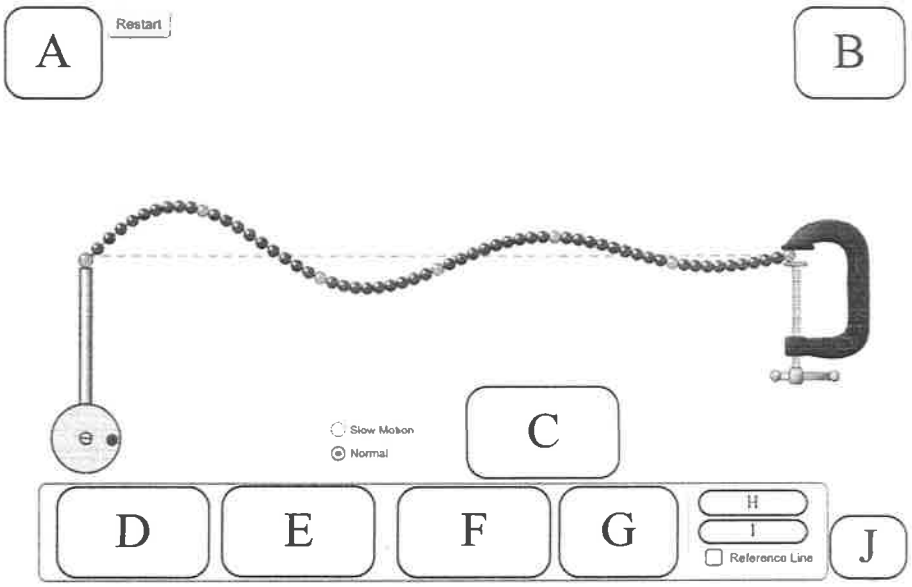
In the space below, write down the definitions of the words in bold above.

	Definition:
Propagating Wave	_____
wavelength	_____
frequency	_____
speed	_____

Method:
For this lab, you will be using the pHet app "Wave on a String." Click on the link and pull open it on your computer.

Warm-up:

1) Play with the program once you open it. This means you should click on EVERYTHING! Don't worry you can always hit the reset button.
2) On the diagram below identify the parts of the simulation that correspond to the actions that you would like to perform.



Match the correct area of the simulation screen above with the function that you would like to perform by placing the letter in the correct space below:

Area	**Function:**
_____	Change the frequency of the vibrating body.
_____	Stop the wave from moving so you can measure it.
_____	Change it so the end of the wave propagates out into space.
_____	Increase the amplitude of the wave. (only available in "Oscillate" mode)
_____	Make a ruler so you can measure wavelength.
_____	Make the body vibrate up and down automatically
_____	Reboot the simulation when you mess up.
_____	Change the tension of the string to make it more stiff.
_____	Bring out the timer so you can measure the speed of the wave.
_____	Make the vibrating object vibrate faster. (only available in "Oscillate" mode)

Skill #1: Determine the wavelength of a wave in "Oscillate" mode with "No End."

Evidence: Outline how you would measure the wavelength of a wave using the ruler function.

_____
_____
_____
_____

Skill #2: Determine the speed of a wave as it crosses the screen using the timer function.
Evidence: Outline the procedure for determining the speed of the wave.

Wave Speed Experiment:

Objective:
Observe relationships between frequency, wavelength, speed of waves in a rope, and observe how these change with changing tension in the rope.

Method:

Set to "Oscillate" and "No End" Keep the ruler and timer on

1) Set the frequency to 1Hz and tension to low
2) Pick a distance that you will use to measure the speed of the wave. The longer the better, try 6 or 7 cm. This distance will stay constant for all of your experiments.
3) Measure the time it takes for a wave to travel your determined distance and record in the table below.

   (hint: use the timer and the  function.)
4) Measure the length of a single wave (wavelength) and record in the table below.
5) Do the same measurements at Frequency = 2 Hz and 3Hz
6) Repeat the experiment at moderate and high tension

Calculations:
1) Calculate the speed of the wave by dividing the total distance traveled by the time it took for the wave to translate across write in the table.
2) Multiply the frequency by the wavelength and write in the table.

Data Table:

Tension	Frequency (Hz)	Distance on the string the wave travels (should be be 6-7 cm) (cm)	Time to travel the length of the string (s)	Wavelength (cm)	Speed of the wave (cm/s) (as measured by total distance traveled divided by time)	Frequency X wavelength (cm/s)
Low	1					
Low	2					
Low	2.5					
Moderate	1					
Moderate	2					
Moderate	2.5					
High	1					
High	2					
High	2.5					

Conclusion Questions:

1. Does the speed of the wave for a given tension change or stay constant?

2. For a constant tension, what happens to the wavelength as the frequency increases?

3. If the tension remains constant and the frequency increases, what happens to the wavelength?

4. Is there any pattern in the last two columns of the table (speed and Frequency X wavelength)?

5. How does the tension affect the speed of the wave?