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**Standing Waves Exploration**

Go to: <http://phet.colorado.edu/> Search “Wave on a String” and launch.

Start by Wiggling the Wrench. Spend about **3 minutes** experimenting with the Tension, Manual/Pulse/Oscillate, Fixed/Loose/No end, and changing the Amplitude, Frequency and Damping. Click on Show Rulers and Timer. Practice moving the rulers around and starting/resetting the timer. Click on the Pause/Play and Step buttons to see how they work.

Use these settings:

Pulse, Amplitude=0.75cm, Pulse Width=.50, Damping=0, Tension at High and No End. NOTE that the amplitude is just a relative scale (not centimeters).

Now, measure the time for a pulse to travel 6.5 cm. To do this:

* Reset the clock to 0:00 and reset the generator
* Click Pause 🡪 Play (on timer) 🡪 Pulse 🡪 Pause (when crest touches the window)

Record the time for a pulse to travel 6.5 cm in Table 1. Run 3 time trials, and record in the table. Calculate the average time.

🖎Now, measure the amplitude and timing of pulses for two other amplitudes (one smaller than .75 cm, one larger than .75 cm). Do three trials at each amplitude and calculate the average times. Calculate the average wave speed for each of the three amplitudes. See below for a sample calculation.

**Table 1**

|  |  |  |  |
| --- | --- | --- | --- |
| **Your measured amplitude, cm** | **Time for pulse to travel 6.5 cm, seconds** | **Average time, seconds** | **Speed=length of string / average time** |
| .75 cm | 1.48 sec |  |  |
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🖎 1. How does the amplitude of a wave affect the speed of a wave?

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Use these settings:

Click Oscillate. Amplitude=.50 cm, Frequency=1.00 Hz, Damping=0, Oscillate, No End. Reset the clock.

You can also measure the wave frequency. To do this, you should pair up with another student if possible. Watch the piston go up and down to make the wave. **One up and down motion represents one wave**. Use the clock to measure the time required for 10 complete cycles or waves. You will also need to **PAUSE** the wave to measure the wavelength of the wave in centimeters (cm). The frequency of the wave is calculated in the following way:

Frequency = 10 waves/# seconds for 10 cycles

For example, 10 waves/5 seconds = 2 cycles per second, or 2 Hertz.

Make several waves by changing the wave frequency. For each wave, measure the wavelength using the ruler. Now, calculate the frequency. See the example in the first row of Table 2. Record the wavelength and frequency of two waves with different wavelengths.

|  |  |  |
| --- | --- | --- |
| **Wavelength (cm)** | **Frequency (cycles/second or Hertz)** | **Speed (cm/s) =**  **Wavelength x frequency** |
| 6.0 cm | 9 waves/9.07 sec = .99 Hz | 6.0 cm x .99 Hertz = 5.94 cm/sec |
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**Based on the equation used to calculate the speed of a wave, answer questions 2 and 3.**

🖎 2. If you increase the wavelength of a wave, how does the speed change?

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🖎 3. If you increase the frequency of a wave, how does the speed change?

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**Reflection:**

1. Set the sim to pulse and fixed end. Set damping to 0 and tension to high. Send a single pulse and record your observations about the behavior of the pulse below.

2. Keep all other settings the same and set the sim to loose end. Record your observations about the behavior of the pulse below.

3. Keep all other settings the same and set the sim to no end. record your observation about the behavior of the pulse below.

**Interference.**

4. Set the sim the same as Fixed End. Send a single pulse down the string. When that pulse is about halfway to the other end, send a second pulse. Record your observations about the interaction between the two waves below. (Hint: you can pause the simulation and use the "step" button to view the interaction of the waves more slowly.)

5. Reset the sim and switch to Loose End. Send a single pulse down the string. When that pulse is about halfway to the other end, send a second pulse. Record your observations about the interaction between the two waves below.

6. As a group, decide on a question about the interaction of waves that you can test with the simulation. Briefly describe the experiment you devised to test your question.

Group question:

Experimental procedure:

Record your observations:

Based on your experiment and what you saw in steps 4 & 5, what claim(s) can you make about the interactions of waves?

Provide evidence from your experiment and your observations from steps 4 & 5 to back up your claims.