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Wave on a String Lab

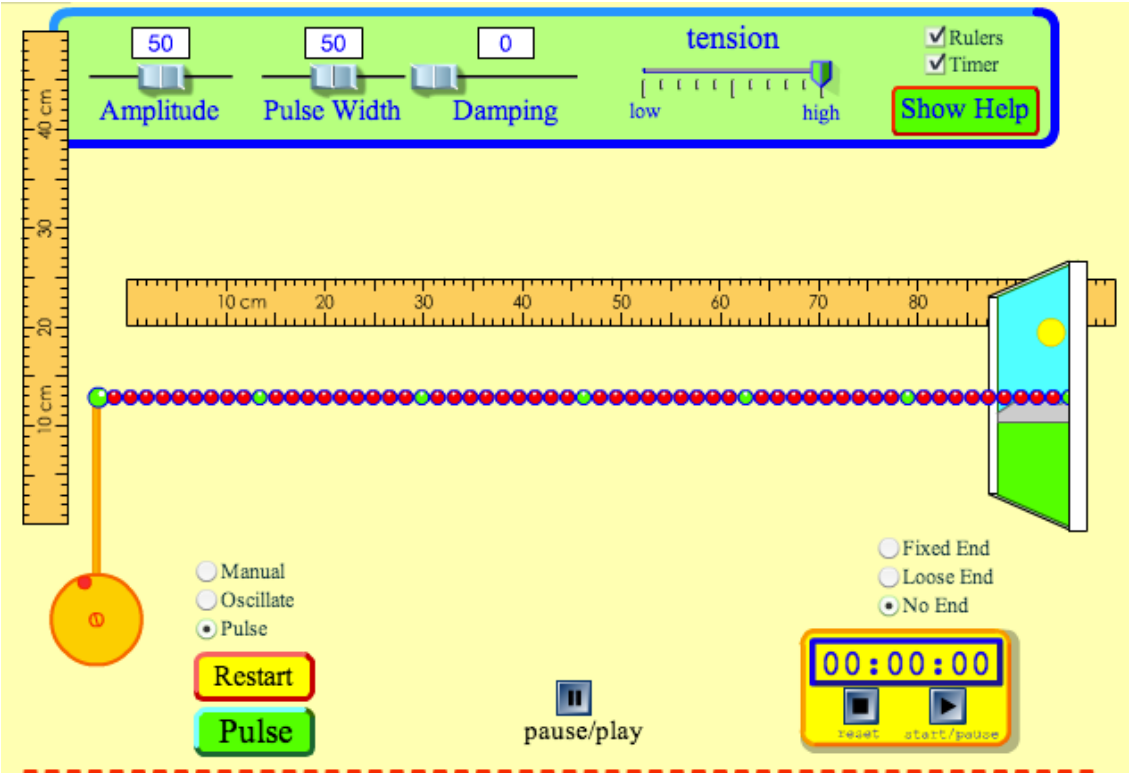
Goals

- Describe the difference between a wave pulse and a travelling (periodic) wave
- Identify crests and troughs on a graph
- Find amplitude and wavelength from a displacement-position graph
- Find amplitude and period from a displacement-time graph
- Describe the relationship between wavelength, frequency, and velocity of a wave

Directions

1. Open the PheT Resonance simulation at http://phet.colorado.edu/sims/wave-on-a-string/wave-on-a-string_en.html (or google Phet Wave on a String and click the Run Now! button). Set the end to "No End". Turn on the rulers and the timer. Set the Damping to zero.

2. Start with the tension on high and the Pulse option selected. Play with different values of amplitude, pulse width, and tension. (Vary them one at a time, keeping the others constant.) For each setting, use the timer to check how long it take from when you hit Pulse to when the pulse exits the window.



a) Does the amplitude affect the speed of the pulse?

b) Does the pulse width affect the speed of the pulse?

c) Does the tension affect the speed of the pulse?

d) Hypothesize: does wave propagation speed depend more on the characteristics of the initial disturbance or more on the properties of the medium through which the wave travels? Explain. Also test your idea with a slinkly.

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e) Describe a wave pulse in your own words.

3. Now change the source of the disturbance to Oscillate. Set the tension to high.
   a) This is a travelling or periodic wave. Describe in your own words how it is different from the wave pulses you just studied.

   b) Experiment with the amplitude slider. What does it do? Is this what you expect? Why?

   c) Experiment with the frequency slider. What does it do? Is this what you expect? Why?

   d) Experiment with the tension slider. Do your results match what you learned from the wave pulse? Explain.

   e) Set the amplitude and frequency both to 50 and once the wave as stabilized, pause it.
      i. Sketch the wave below. This is a displacement-position graph – label the axes.

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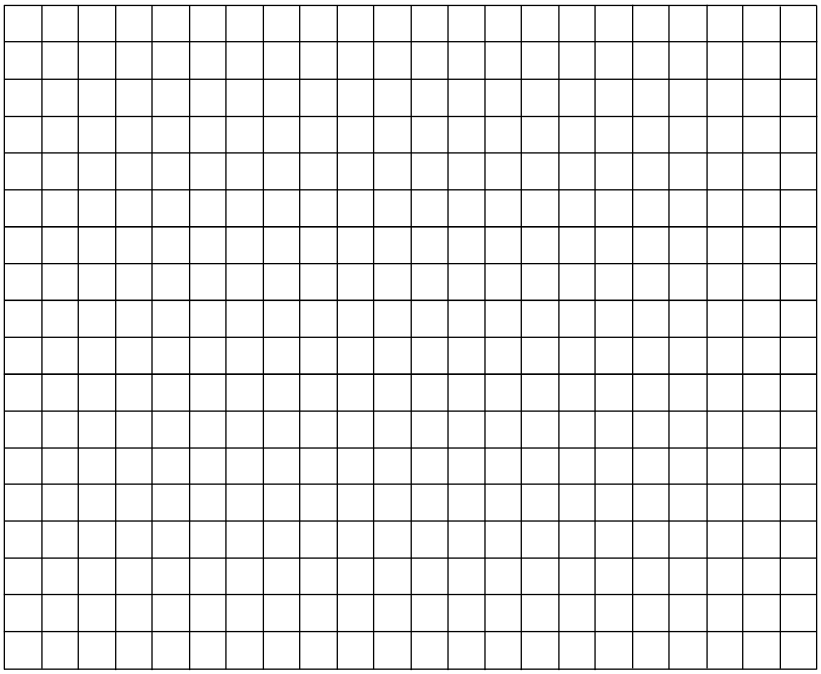
ii. A crest is the highest point of a wave and a trough is the lowest point. Label crests, and troughs on your sketch above.

iii. Wavelength (λ) is the length of one wave cycle. Amplitude is the maximum displacement away from the equilibrium position. Label one wavelength and the amplitude on the sketch above.

iv. How is the amplitude related to the crests and troughs? Try to write an equation describing this relationship.

4. Set the tension to low, the amplitude to high, and the frequency to low.
   a) Pick a single green particle somewhere in the middle of the wave and use the pause button to record its vertical position at several different times through a few wave cycles. Then use this data to make a displacement-time graph. Label the axes.

Time (s)	Vertical Position (cm)



   b) Label the amplitude and the period (time for one wave cycle) on this graph.

   c) Does it seem like the particle you chose is engaging in simple harmonic motion? How can you tell?

   d) Is it possible to label the period on the displacement-position graph in #2? Is it possible to label the wavelength on the displacement-time graph here? Why or why not?

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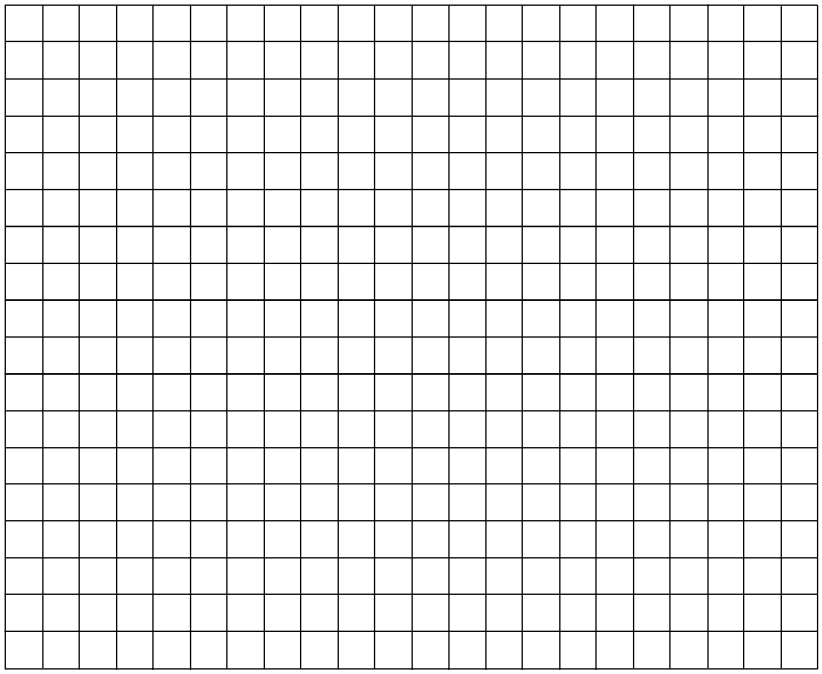
5. We will know explore the following question: How is the wavelength of a wave related to its frequency?
   a) Set the amplitude to high. Test three different values for the tension – low, medium, and high. For each tension value, test 5 different frequencies. Measure the frequency by using the timer and counting the number of peaks that pass through a given point (one of the green particles) per second. Also measure the wavelength using the moveable ruler and the pause button.

Low Tension		**Medium Tension**		**High Tension**	
Frequency (s^{-1})	**Wavelength (cm)**	**Frequency (s^{-1})**	**Wavelength (cm)**	**Frequency (s^{-1})**	**Wavelength (cm)**

   b) Use the data in your graphs to plot three lines (one for each tension level) on a frequency vs. wavelength graph. (Use a legend to distinguish your lines.)



   c) What kind of mathematical relationship do frequency and wavelength seem to have?

   d) For each level of tension, find a relevant proportionality constant for the frequency versus wavelength relationship. Pay special attention to the units! What does the proportionality constant tell you about the wave?