Part I: Waves on a String, Wave Speed

For this activity, we are picking up where we left off on the investigation of which properties of a string affect wave speed. The book derived the relationship $v^{wave} = \sqrt{F^{tens}/\mu}$.

1. To investigate the effect of various properties of the string or wave generation on sinusoidal waves, we'll use the PhET Interactive Simulation called Wave on a String. Go to http://phet.colorado.edu/en/simulation/wave-on-a-string and click the big "Play" button. You do not need to download the simulation, you can just play it in the browser.

2. Before exploring with the simulation, first choose the "No End" button in the top right corner. At the bottom, move the "Damping" slider over to "None". Click and drag the wrench up and then down quickly once. What happens?

3. For this simulation, we are interested in creating a continuous transverse wave. In the top left corner, choose "Oscillate". What do you observe?

4. Using the Rulers, Timers, and Slow Motion or frame-by-frame advance controls, devise a method to calculate the wave speed. What is the speed for these default settings (which should be Amplitude = 0.75 cm, Frequency = 1.50 Hz, Damping = None, Tension = High)?

5. Click the "Pause" button, click "restart", and set the tension to the "medium" setting. Use your method to calculate the wave speed now. Which of your measurements changed, and which stayed the same? Why?

6. Click the "Pause" button, click "restart", and set the tension to the "low" setting. Use your method to measure the wave speed now.

7. Use your results to determine the ratio of the force of tension on the "High" setting to the force of tension on the "Low" setting.

8. Let's keep the tension on the "Low" setting. **Predict** what you think will happen to the following quantities if we change the "Frequency" setting from 1.50 Hz to 0.50 Hz:
   Amplitude:
   Period:
   Wavelength:
   Wave speed:

9. Now, change the frequency to 0.50 Hz. Record what actually happened to each of the following quantities:
   Amplitude:
   Period:
   Wavelength:
   Wave speed:

10. What are the only two factors that control the wave speed on a string?

Part II: Waves on a String, Wave Energy

When we start a wave pulse, we provide the energy for the motion of the string. In your simulation, the energy is provided by the oscillating disk, which must be powered in some way, such as by electricity or by a hand crank and muscle energy. The wave can transport energy as kinetic energy and elastic potential energy.

11. Observe the behavior of the traveling wave. Where does a particle of string have the most kinetic energy? The least kinetic energy?

12. Where does a particle of string have the most elastic potential energy? (Look closely at a snapshot. Where is that segment of string "most stretched"?)

13. From *Understanding Physics*: "The oscillating string segment thus has both its maximum kinetic energy and its maximum elastic potential energy at $y = 0$. [… The regions of the string at maximum displacement have no energy, and the regions at zero displacement have maximum energy." Compare and contrast this with simple harmonic motion (*e.g.*, an object on a spring).