

Name _____ Period _____



Investigation 3.1: Making Waves

Objectives:

- Learn vocabulary describing waves
- Calculate the speed of a wave
- Understand how amplitude affects the speed of a wave
- Understand how frequency and wavelength affect the speed of a wave

Open this web site:

[http://phet.colorado.edu/new/simulations/sims.php?sim=Wave on a String](http://phet.colorado.edu/new/simulations/sims.php?sim=Wave%20on%20a%20String)

You can click on **Run Now!** to run the simulation online, or **Run Offline** to save it to your desktop. It might run faster this way.

Start by **Wiggling the Wrench**. Spend about **5 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=50, Pulse Width=35, Damping=0, Tension at High and No End. NOTE that the amplitude is just a relative scale (not centimeters).

Send a single pulse down the string. This is called a **TRANSVERSE PULSE**. Watch the motion of the green dots.

✍ 1. As the pulse goes by from left to right, in what direction does the string move?

✍ 2. A definition of **TRANSVERSE** is “lying across”. Why is **TRANSVERSE** a good name for the wave you just observed?

✍ Make another pulse, and then **PAUSE** the wave. Use the vertical ruler to measure the **amplitude** of the wave in centimeters. This is the distance from the dotted orange line to the crest of the wave. Record the amplitude in Table 1 in the first row.

Now, measure the time for a pulse to travel 100 cm. To do this:

- Reset the clock to 0:00 and reset the generator
- Click Pause/Play—it should say **PAUSED** on the screen
- Click Pulse
- Click Pause/Play again to start a timed pulse. Pause again just as the crest (peak) of the pulse touches the window 100 cm away.

Record the time for a pulse to travel 100 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 50, one larger than 50). 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 100 cm, seconds	Average time, seconds	Speed=length of string / average time

Example of speed calculation:

Speed = string length/ average time

Speed = 100 cm/2 seconds = 50 cm/second

 3. How does the amplitude of a wave affect the speed of a wave?

Use these settings:

Oscillate, Fixed end. Try amplitude=20, frequency=51, damping=0.

The result is called a **periodic wave**.

✎ 4. Describe the appearance of the wave you created.

You should see waves that do not move along the string. You will also see points where the string does not move at all. These waves are called **STANDING WAVES**. The points where the wave doesn't move are called **NODES**. Pause the simulation.

✎ 5. Draw the standing wave in the box below, labeling the **AMPLITUDE**, **WAVELENGTH** and **NODES** of a standing wave.

Use these settings:

Amplitude=20, Frequency=50, 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—use numbers over 30 on the scale. 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 three waves with different wavelengths.

Wavelength (cm)	Frequency (cycles/second or Hertz)	Speed (cm/s) = Wavelength x frequency
33 cm	10 waves/5.45 sec = 1.8 Hertz	33 cm x 1.8 Hertz = 59.4 cm/second

Based on the equation used to calculate the speed of a wave, answer questions 6 and 7.

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

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