Flipping Physics Lecture Notes:

Determining the Speed of a
Standing Wave – Demonstration
https://www.flippingphysics.com/standing-wave-speed.html

Today we will be building on what we learned last time about standing wave patterns.
http://www.flippingphysics.com/standing-wave.html

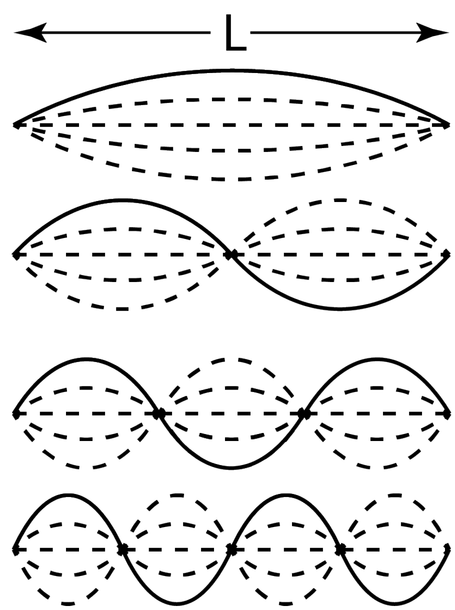
As we demonstrated before, standing wave patterns can only be created at specific wavelengths. To the right are some options for possible standing wave patterns in a string.

The equation for the speed of a wave is: $v = f\lambda$

- The speed "v" of the wave on the string is constant, therefore:
- as the frequency of the wave increases,
- the wavelength of the wave decreases.

Because standing wave patterns will only be created at specific wavelengths and therefore only specific frequencies. Frequencies that will create standing wave patterns on this string are:

- The 1st standing wave pattern: $L = 1\left(\frac{1}{2}\lambda\right) \Rightarrow \lambda = 2L$
- The 2nd standing wave pattern: $L = 2\left(\frac{1}{2}\lambda\right) \Rightarrow \lambda = L$
- The 3rd standing wave pattern: $L = 3\left(\frac{1}{2}\lambda\right) \Rightarrow \lambda = \frac{2L}{3}$
- The 4th standing wave pattern: $L = 4\left(\frac{1}{2}\lambda\right) \Rightarrow \lambda = \frac{L}{2}$
- The 5th standing wave pattern: $L = 5\left(\frac{1}{2}\lambda\right) \Rightarrow \lambda = \frac{2L}{5}$



Notice we can use this information to determine the speed of the wave on the string:

Frequency, f (Hz)	Wavelength, λ (m)	Velocity (m/s)
15	$\lambda_{15} = 2L = (2)(0.865) = 1.73\text{m}$	$v = f_{15}\lambda_{15} = (15)(1.73) = 25.95\dfrac{m}{s}$
30	$\lambda_{30} = L = 0.865m$	$v = f_{30}\lambda_{30} = (30)(0.865) = 25.95\dfrac{m}{s}$
45	$\lambda_{45} = \dfrac{2L}{3} = \dfrac{(2)(0.865)}{3} = 0.57\bar{6}\text{m}$	$v = f_{45}\lambda_{45} = (45)(0.57\bar{6}) = 25.95\dfrac{m}{s}$
61	$\lambda_{61} = \dfrac{L}{2} = \dfrac{0.865}{2} = 0.4325\text{m}$	$v = f_{61}\lambda_{61} = (61)(0.4325) = 26.815\dfrac{m}{s}$
76	$\lambda_{76} = \dfrac{2L}{5} = \dfrac{(2)(0.865)}{5} = 0.346\text{m}$	$v = f_{76}\lambda_{76} = (76)(0.346) = 26.296\dfrac{m}{s}$

$$v_{average} = \frac{(25.95 + 25.95 + 25.95 + 26.815 + 26.296)}{5} = 26.1922 \approx 26\frac{m}{s}$$

But remember, standing wave patterns are constructive and destructive interference of the waves which are traveling back and forth through the medium. So, we can also measure the speed of this wave by measuring the speed of a wave pulse moving through the medium.

Knowns: $L = 0.865m \;\&\; \Delta t = 0.068\,\text{sec}$

$$speed = \frac{distance}{time} = \frac{2L}{\Delta t} = \frac{(2)(0.865)}{0.068} = 25.441 \approx 26\frac{m}{s}$$

$$\%_{difference} = \frac{26.1922 - 25.441}{(26.1922 + 25.441)/2} \times 100 = 2.910 \approx 2.9\%$$