# Waves in a Slinky

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# Sample Calculations

$$F_A = F^* - F_0$$
$$F_A = (0.650 \pm .02N) - (0.0 \pm .02N)$$
$$F_A = 0.650 \pm .04N$$
$$k = \frac{F_{A1} - F_{A2}}{l_1 - l_2}$$
$$k = \frac{0.950 \pm .04N - 0.650 \pm .04N}{1.50m - 1.00m}$$
$$k = .6 \pm .2 \tfrac{kg}{s^2}$$
$$v_{observed} = \tfrac{d}{t}$$
$$v_{observed} = \tfrac{2.00 \pm 04m}{.95 \pm .05s}$$
$$v_{observed} = 2.11 \tfrac{m}{s}$$
$$m = \frac{m}{l}$$
$$m = \frac{.23750 \pm .00002g}{1.0m}$$
$$m = .23750 \frac{kg}{m}$$
$$v_{theo} = \sqrt{\tfrac{F}{m}}$$
$$v_{theo} = \sqrt{\frac{.650N}{.23750 \frac{kg}{m}}}$$
$$f = \tfrac{oscillations}{time}$$
$$f = \tfrac{20 oscillations}{11.56s}$$
$$f = 1.73 \tfrac{osc}{s}$$
$$v = fl$$
$$v = (1.73 \tfrac{osc}{s})(3m)$$
$$v = 5.19 \tfrac{m}{s}$$

# Discussion

The objective of this experiment was to determine the tension and elongation characteristics, observe how tension and linear mass affect the wave speed, and determine the relations among frequency, wavelength, and wave speed.

In order to complete the first objective, the slinky was stretched the given length across the table. The tension was determined by observing the force applied on a scale. To determine the spring coefficient, the data was plotted on a graph. The slope of this line was the spring coefficient.

The second objective was accomplished by again stretching the slinky given distances across the table. A single wave was sent down the slinky and the travel time of this wave was determined. Because the distance traveled and the time of travel were now known, the experimental velocity could be determined. To determine the percent error in our measurements we calculated the theoretical velocity of a wave in the medium. The linear mass density of the slinky is equal to the mass divided by the length that the slinky stretched. The theoretical velocity is then $\sqrt{\frac{F}{m}}$. We encountered rather large errors in our calculations; however, this was unavoidable because of the large amount of friction which we were forced to ignore.

The third objective was the completed by stretching the slink to a distance of three meters. The wave was then oscillated until a standing wave with a wavelength of three meters was reached and then the frequency was increased until two standing waves, three standing waves, and four standing waves were produced. The frequency was determined by calculating the time for a number of oscillations. The wave speed was determined by using the equation $v = fl$ . We then compared the average velocities of the waves to the theoretical velocity of a slinky wave at three meters to determine the percent error. Another large percent error was calculated, this was due to the amount of friction in the system and to the fact that due to high frequency of the waves we may have counted incorrectly. It is entirely possible that 21 or 19 oscillations were time instead of 20.