1 Wave Amplitude vs. Velocity

Materials: I used the Wave on a String PhET Simulation.

Constants: I used pulse mode with no damping, a pulse width of 0.50 s, high tension, and a fixed end. The length of the string, as measured with the ruler feature, is 7.5 cm.

Experiment: To see if wave speed is affected by the amplitude of the wave pulse, I measured the wave speed v at amplitudes 0.25 cm, 0.75 cm, and 1.25 cm. Since waves travel with a constant wave speed, I minimized error in my timing by letting the wave pulse travel back and forth on the string five times (a total distance of $5 \cdot 2 \cdot 7.5\,\text{cm} = 75\,\text{cm}$ per trial). For timing, I used the in-simulation timer, which I set to start as soon as I clicked the button on the wave pulse generator and manually stopped as best I could when the leading edge returned to the wave-pulse-generator end after the fifth cycle.

Data:

	Trial 1	Trial 2	Trial 3
0.25 cm	12.07	11.97	12.07
0.75 cm	12.07	12.03	11.97
1.25 cm	12.03	12.05	12.01

Table 1: Wave amplitude vs. time (to travel 75 cm).

Analysis:

$A = 0.25\,\text{cm}$: We know that

$$v = \frac{\Delta x}{\Delta t}$$

Since $\Delta x \approx 75\,\text{cm}$ and

$$\Delta T \approx \bar{t} = \frac{12.07 + 11.97 + 12.07}{3} = 12.04$$

we have that

$$v \approx \frac{75}{12.04} = 6.23\,\text{cm/s}$$

More specifically, since $\delta x = 0.1$ from the ruler gradations and

$$\delta t = \sqrt{\frac{(12.07 - 12.04)^2 + (11.97 - 12.04)^2 + (12.07 - 12.04)^2}{3}} = 0.05$$

we have that

$$\delta v = \sqrt{\left(\frac{0.1}{75}\right)^2 + \left(\frac{0.05}{12.04}\right)^2} \cdot 6.23 = 0.03$$

Therefore, we conclude that

$$v = 6.23 \pm 0.03\,\text{cm} \qquad (A = 0.25\,\text{cm})$$

By an analogous method to the above, we can conclude for the remaining two amplitudes that

$$v = 6.24 \pm 0.02\,\text{cm} \qquad (A = 0.75\,\text{cm})$$
$$v = 6.23 \pm 0.01\,\text{cm} \qquad (A = 1.25\,\text{cm})$$

Since all measurements are within their uncertainties of each other, we can conclude that the velocity did not significantly change based on the amplitude.

2 Standing Wave Diagram

As can be seen in the right side of Figure 1 (where the wave evens out), the distance between adjacent nodes and the distance between adjacent antinodes is, in both cases, equal to $\lambda/2$. The distance between a node and its nearest antinode (and vice versa) is $\lambda/4$.

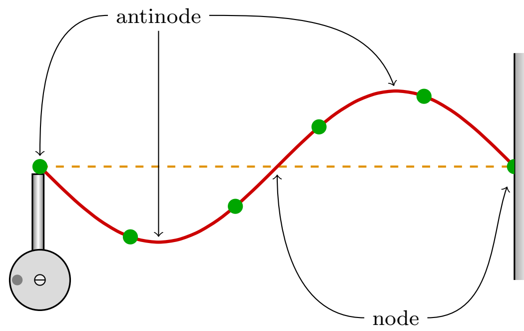

Figure 1: Nodes and antinodes on a standing Wave.

3 Five Questions

1. In general, what are the boundary conditions of a standing wave?
   - Fixed at one end; free or fixed at the other (consider the case in Figure 1 versus the case of a plucked string on a string instrument).
2. What is the type of a soundwave (longitudinal or transverse)?
   - Longitudinal compression wave.
3. What is the boundary condition of this specific setup?
   - Open-closed.
4. What is the type of the wave in the spring?
   - Longitudinal compression wave.
5. What is the boundary condition of this setup?
   - Open-closed.