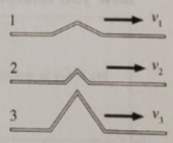
3. Three wave pulses travel along the same string. Rank in order, from largest to smallest, their wave speeds v_1, v_2, and v_3.



Order: all the same

Explanation:

Wave speed depends on the medium (tension and density of the string here). It does not depend on the shape of the wave pulse.

20.2 One-Dimensional Waves

4. A wave pulse travels along a string at a speed of 200 cm/s. What will be the speed if:
Note: Each part below is independent and refers to changes made to the original string.

a. The string's tension is doubled?

$v_{wave} \propto \sqrt{F}$, so doubling F multiplies v_{wave} by $\sqrt{2}$ to $200\sqrt{2}$ m/s

b. The string's mass is quadrupled (but its length is unchanged)?

$v_{wave} = \sqrt{F/\mu} = \sqrt{F/(m/L)}$. So $v_{wave} \propto \frac{1}{\sqrt{m}}$

multiplying m by 4 will divide v_{wave} by $\sqrt{4} = 2$

So the new v_{wave} is 200 cm/s / 2 = 100 cm/s

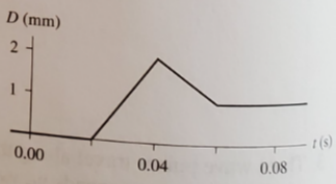
c. The string's length is quadrupled (but its mass is unchanged)?

From above: $v_{wave} \propto \sqrt{L}$. multiplying L by 4 multiplies v_{wave} by $\sqrt{4} = 2$, so $v_{wave,new} = 400$ cm/s

d. The string's mass and length are both quadrupled?

This leaves density unchanged, so v_{wave} is unchanged.

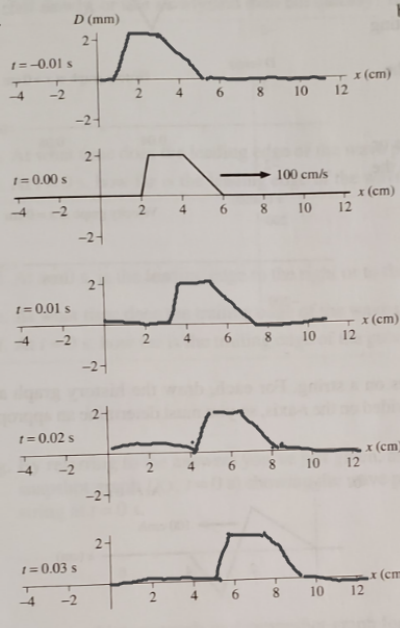
5. This is a history graph showing the displacement as a function of time at one point on a string. Did the displacement at this point reach its maximum of 2 mm *before* or *after* the interval of time when the displacement was a constant 1 mm? Explain how you interpreted the graph to answer this question.



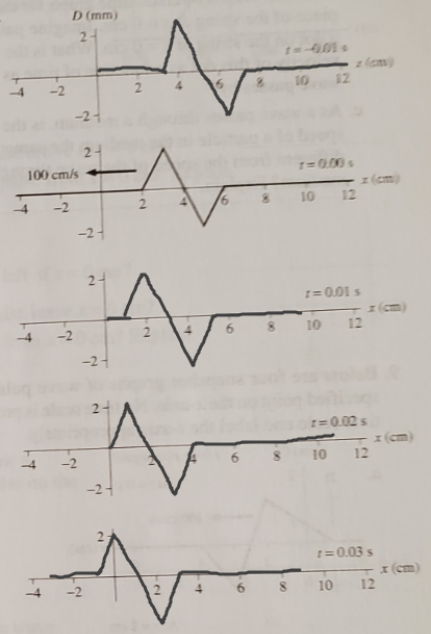
Before. The peak occurs at 0.04 s, while the constant 2mm occurs later

6. Each figure below shows a snapshot graph at time $t = 0$ s of a wave pulse on a string. The pulse on the left is traveling to the right at 100 cm/s; the pulse on the right is traveling to the left at 100 cm/s. Draw snapshot graphs of the wave pulse at the times shown next to the axes.

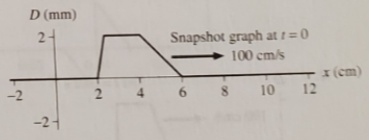
a.

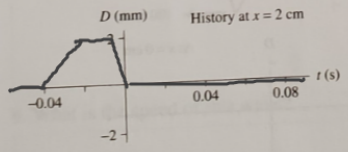


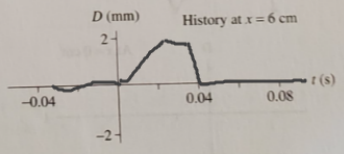
b.



7. This snapshot graph is taken from Exercise 6a. On the axes below, draw the *history* graphs $D(x = 2\text{ cm}, t)$ and $D(x = 6\text{ cm}, t)$, showing the displacement at $x = 2$ cm and $x = 6$ cm as functions of time. Refer to your graphs in Exercise 6a to see what is happening at different instants of time.

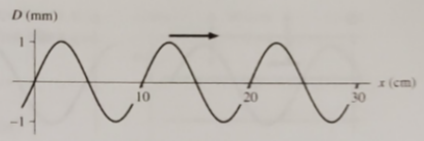




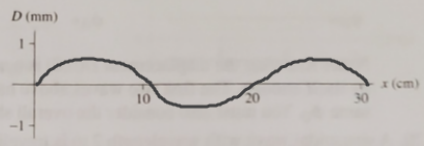


Note this is steeper on the right side.

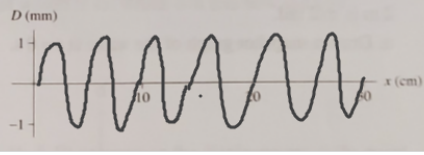
17. The figure shows a sinusoidal traveling wave. Draw a graph of the wave if:



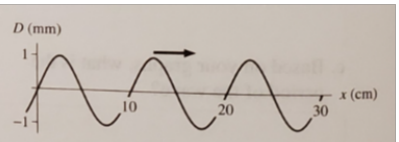
a. Its amplitude is halved and its wavelength is doubled.



b. Its speed is doubled and its frequency is quadrupled. $\lambda = \frac{v}{f}$ so this doubles λ by 2.

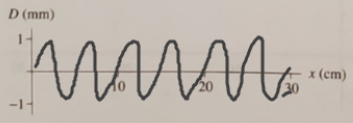


21. Consider the wave shown. Redraw this wave if:

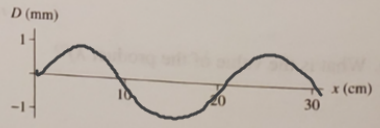


$k = \frac{2\pi}{\lambda}$ so doubling k halves λ

a. Its wave number is doubled.



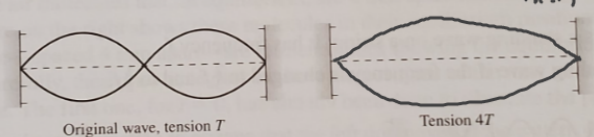
b. Its wave number is halved. λ is doubled



4. The figure shows a standing wave on a string.

a. Draw the standing wave if the tension is quadrupled while the frequency is held constant.

Multiplying T by 4 requires dividing n by 2 to keep 5 constant



b. Suppose the tension is merely doubled while the frequency remains constant. Will there be a standing wave? If so, how many antinodes will it have? If not, why not?

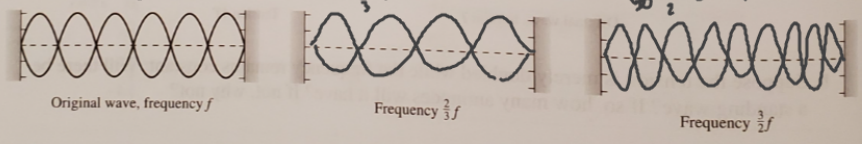
Multiplying T by 2 would require divide n by Sqrt(2) to keep f constant. But that gives a non-integer n-value, meaning the standing wave will not form.

6. The figure shows a standing wave on a string. It has frequency f.

$n \propto f$ according to the equation

a. Draw the standing wave if the frequency is changed to $\frac{2}{3}f$ and to $\frac{3}{2}f$.

$n = 6$ $\quad \frac{2}{3} \cdot 6 = 4$ $\quad \frac{3}{2} \cdot 6 = 9$



b. Is there a standing wave if the frequency is changed to $\frac{1}{4}f$? If so, how many antinodes does it have? If not, why not?

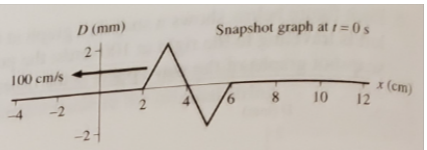
$\frac{1}{4} \cdot 6 = 1.5$ not an integer $\Rightarrow$ no standing wave

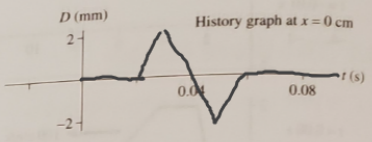
8. This snapshot graph is from Exercise 6b.

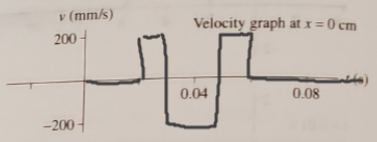
a. Draw the history graph $D(x = 0\text{ cm}, t)$ for this wave at the point $x = 0$ cm.

b. Draw the *velocity*-versus-time graph for the piece of the string at $x = 0$ cm. Imagine painting a dot on the string at $x = 0$ cm. What is the velocity of this dot as a function of time as the wave passes by?

c. As a wave passes through a medium, is the speed of a particle in the medium the same as or different from the speed of the wave through the medium? Explain.



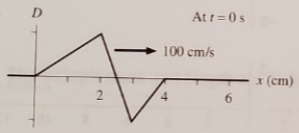


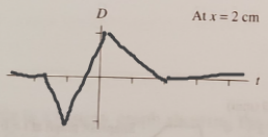


The wave speed is different from the particle speed. For example, in a wave at a sports stadium, the people move very little, but the moves very far

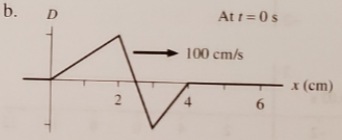
9. Below are four snapshot graphs of wave pulses on a string. For each, draw the history graph at the specified point on the x-axis. No time scale is provided on the t-axis, so you must determine an appropriate time scale and label the t-axis appropriately.

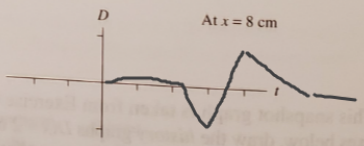
a.



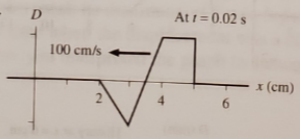


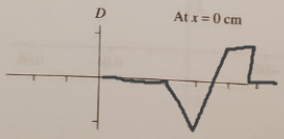
b.





c.





d.