

TW.L1.4 | Wavelength Frequency Speed Equation of Motion | Challenge Homework

Submit a digital copy (PDF, jpg, etc.) to gradescope.com. Every page should be labeled on the top left with the question code (e.g. GR.L1.4-01) and there should be only be one solution per page. The questions should be in order. If a solution takes more than one page, be sure to label that it is a continuation of the previous page's solution (e.g. GR.L1.4-01 continued). One question will be randomly selected and graded. Challenge homework for a given week are due the following week by Tuesday at midnight. If data is needed to complete a problem, be sure to cite the source you've acquired your data from. See the course website for further details.

You will be asked to apply sense-making in most problems. Use the list below as a reference to the different sense-making techniques. More information about sense-making can be found on the BoxSand menu under Math Tools => [Sense-making](#).

- *Sign*: Check the **sign** of each quantity makes sense.
- *Dimensionality*: Check the **dimensionality** and units of each quantity makes sense.
- *Order of Magnitude*: Check the **order of magnitude** of the final answer and other important quantities is within a a factor of 10 of what you think it should be.
- *Graphical Analysis*: Use a **graph** to see if the behavior of a solution makes sense.
- *Proportionality*: Using a symbolic solution, check the behavior of the answer when you change a given quantity on which it is dependent. Does the answer vary **proportionally** to what you expect?
- *Special Cases*: Check the behavior of a derived equation in limiting (**special**) cases makes sense, e.g. as x goes to 90 degrees in $\sin(x)$.
- *Self-consistency*: Check derived equations, functions, or values, are **self-consistent**, e.g. check that the slope of a derived position plot matches the values of the given velocity plot
- *Known Values*: Compare given or derived quantities with common well **known values**.
- *Related Quantities*: Compare the relative magnitude of two **related quantities**.

TW.L1.4-01

A periodic traveling wave is generated on a string of linear density $8 \times 10^{-4} \text{ kg/m}$. Figure A shows the displacements of the particles in the string as a function of position x along the string at $t = 0 \text{ s}$. Figure B shows the displacement of the particles at $x = 0 \text{ m}$ as a function of time. The particle positions are measured from the left end of the string ($x = 0 \text{ m}$) and the wave pulses move to the right.

- (a) What is the wavenumber of the wave?
- (b) What is the minimum time required for the particles to return to their respective positions at $t = 0$ seconds?
- (c) Determine the speed of the wave.
- (d) What is the tension in the string.
- (e) Write an equation for the displacement of the traveling wave as a function of position (x) and time (t) using SI units.

