(TW.L1.4-212.sols) 212 Mastery Stage Solutions

Tuesday, February 18, 2020 6:01 PM

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.

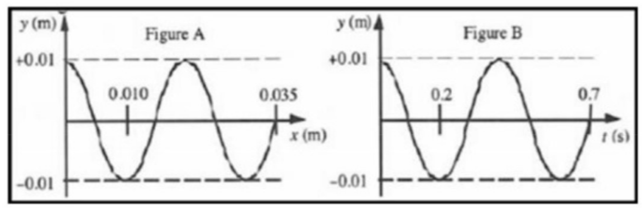
You will be asked to apply sense-making in most problems. Use the list below as a reference to the different sense-making techniques. More information about sense-making can be found on the BoxSand menu under Math Tools => Sense-making.

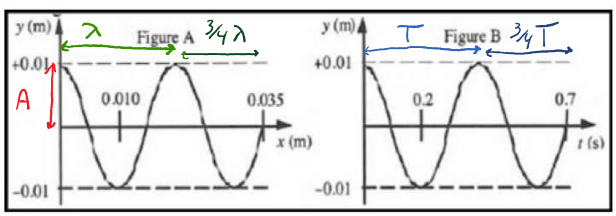
- *Sign:* Check the **sign** of each quantity makes sense.
- *Dimensionality:* Check the **dimensionality** and units of each quantity makes sense.
- *Order of Magnitude:* Check the **order of magnitude** of the final answer and other important quantities is within a a factor of 10 of what you think 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 x 10-4 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 s. Figure B shows the displacement of the particles at x = 0 m as a function of time. The particle positions are measured from the left end of the string (x = 0 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.





$\frac{7}{4}\lambda = 0.035\,m$ $A = y_{max} = 0.01\,m$ $\frac{7}{4}T = 0.7\,s$

$\lambda = 0.02\,m$ $T = 0.4\,s$

$f = 2.5$

a) $k = \frac{2\pi}{\lambda} = \boxed{100\pi\ 1/m} = 314\ 1/m$

b) $T = \boxed{0.4\,s}$

c) $V = f\lambda$

$V = \frac{\lambda}{T} = \boxed{0.05\ m/s}$

d) $V = \sqrt{\frac{|\vec{F}^T|}{\mu}}$ w/ $\mu = 8.0\times10^{-4}\ kg/m$

$|\vec{F}^T| = \mu V^2 = \boxed{2\times10^{-6}\,N}$

e) $y(x,t) = y_{max}\ \overset{\sin}{\underset{\cos}{or}}\ (kx \pm \omega t)$

$\boxed{y(x,t) = 0.01\,m\ \cos(100\pi\, x - 5\pi t)}$