Physics 102 Homework #3

first draft due Wednesday, February 8th
final draft due Sunday, February 12th

1. Two speakers are 4.5 meters apart, in phase, and produce a single sound wave with wavelength $\lambda = 0.8\text{m}$. Three points labelled A, B, and C are 4.0m, 8.0m, and 12.0m below the speaker on the left, as shown. Fill in the table with the required information, and indicate whether the point sees **C**onstructive or **D**estructive interference. (Hint: remember the Pythagorean theorem!)

	L_1	L_2	$\Delta L = \lvert L_1 - L_2 \rvert$	$\frac{\Delta L}{\lambda}$	C/D
A	4.0	6.0	2.0	2.5	D
B	8.0	9.2	1.2	1.5	D
C	12.0	12.8	0.8	1.0	C

2 points for these

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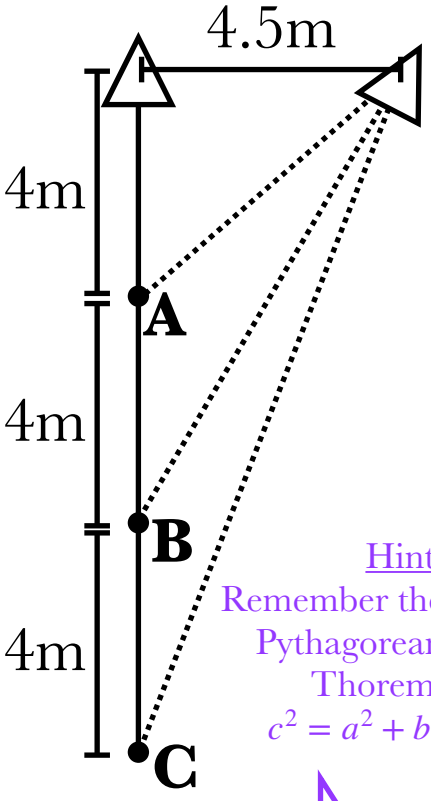
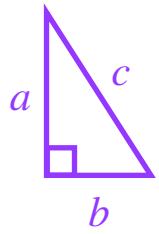
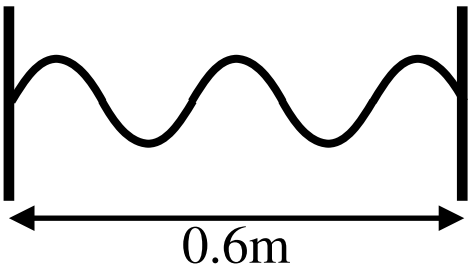


Hint:
Remember the Pythagorean Thorem:
$c^2 = a^2 + b^2$



2. The figure shows a standing wave that is 0.6m long. The frequency of this standing wave is 400Hz.



a. What is the wavelength of this wave?

The mode of this standing wave is $n = 5$, so the wavelength is $\lambda_5 = \frac{2L}{n} = \frac{1.2}{5} = \mathbf{0.24m.}$

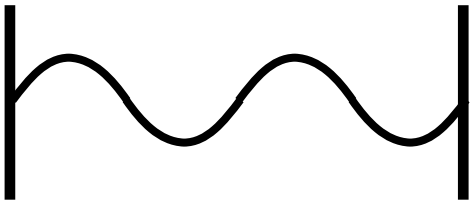
b. What is the fundamental frequency f_1 of this string?

The fundamental frequency is $f_1 = \frac{f_n}{n} = \frac{400\text{Hz}}{5} = \mathbf{80Hz.}$

c. How fast would a wave travel on this string?

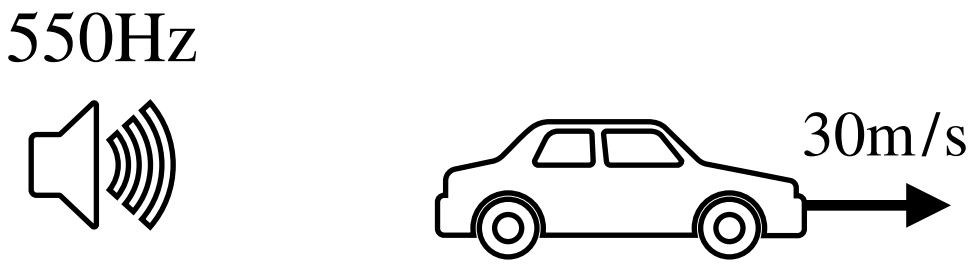
$v = \lambda_n f_n = (0.24\text{m})(400\text{Hz}) = \mathbf{96m/s}$.

3. This standing wave has a frequency of 150Hz. The waves on this spring travel at 90m/s. What is the wavelength of this wave?



$\lambda_n = \frac{v}{f_n} = \frac{90\text{m/s}}{150\text{Hz}} = \mathbf{0.6m}$.

4. A car is driving away at 30m/s from a speaker that is generating a 550Hz sound. What frequency does the driver of the car hear? The speed of sound in air is 343m/s.



The formula we want is $f_{obs} = f_{src}\dfrac{v_w \mp v_{obs}}{v_w \pm v_{src}}$.

In this formula, $f_{src} = 550\text{Hz}$ and $v_w = 343\text{m/s}$. The observer (the car) is moving but the source is stationary, so $v_{src} = 0$ and $v_{obs} = 30\text{m/s}$. They are moving away from each other, so we use the top sign:

$$f_{obs} = (550)\frac{343 - 30}{343} = \mathbf{502Hz.}$$

The observed frequency is lower than the source frequency, which is what we exist when they move apart.