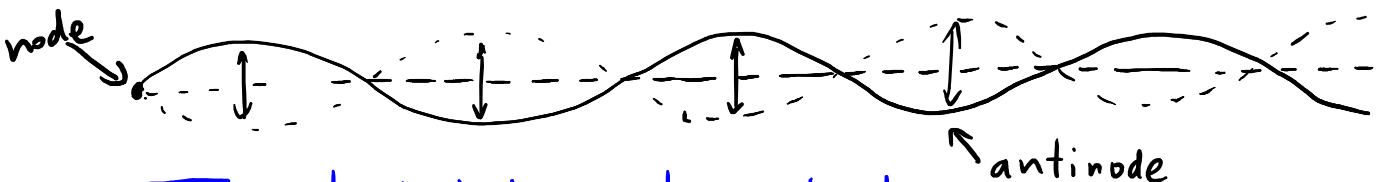
Name:
Student number:

Physics 157 Tutorial 10

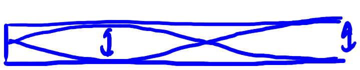
This tutorial will give you some practice with questions about standing waves, boundary conditions, and interference.

Problem 1): When tube is used as a musical instrument (e.g. as in a trumpet or trombone), the air in the tube vibrates (longitudinally) as a standing wave, with a node at the blower's mouth and an antinode at the open end of the tube. The frequencies that can be played are determined by the allowed wavelengths for standing waves in the tube. If we want a tube that can play middle C (261Hz), what is the shortest tube that would work? What is the second shortest tube that would work? (use v = 340m/s for the speed of sound)

Hint: A standing wave is a wave where the shape remains fixed and the wave oscillates in place as shown in the picture. If the picture below shows the wave corresponding to a frequency of middle C, a good start is to draw the appropriate tube lengths below the graph.



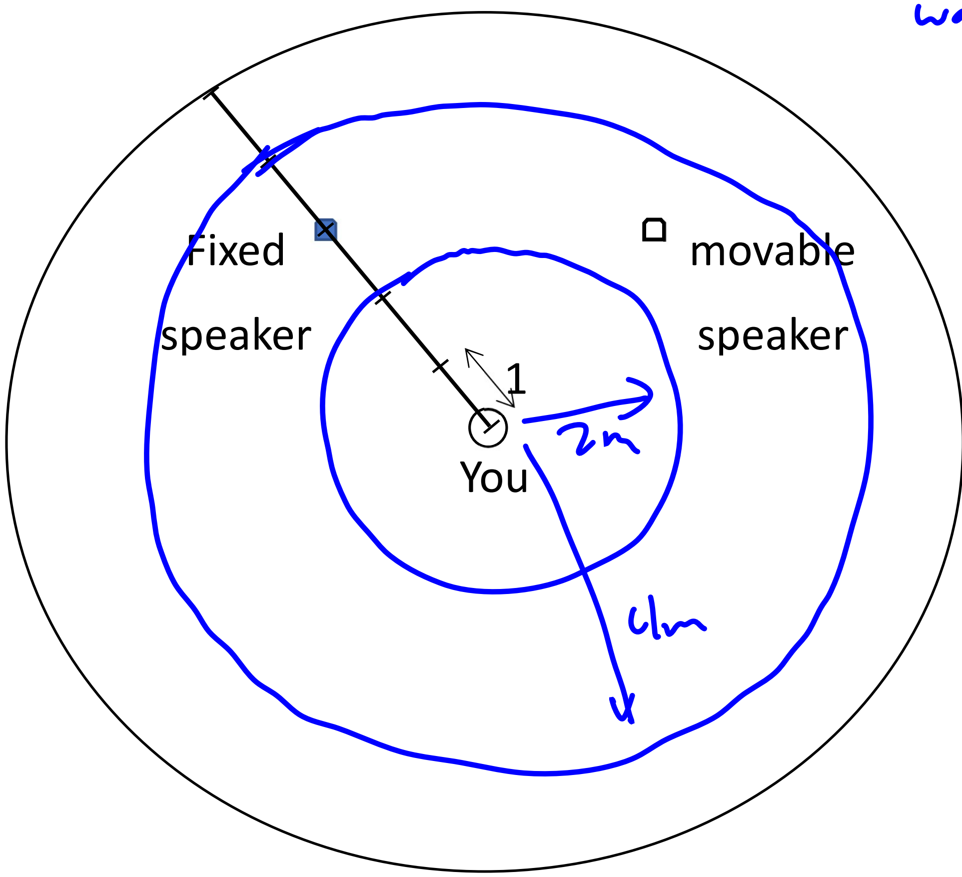
 shortest tube: $\frac{1}{4}$ wavelength

 2nd shortest tube: $\frac{3}{4}$ wavelength.

Wavelength for $f = 261\,s^{-1}$, $v = 340\,m/s$ is $1.3\,m$

So shortest tube lengths are $0.32\,m$ and $0.98\,m$.

Problem 2): You are sitting in the middle of a round room listening to your favorite Cardi B song on repeat. Several days later, you begin to get tired of listening to the song. Unfortunately, there is no way to turn off the music. Fortunately, you find that only one of the speakers is attached to the ground, the other one can be moved anywhere you like and also has an adjustable volume. On the picture below, indicate all the places where you can move the second speaker so that the most annoying part of the music (which has a frequency of 170Hz) will be as quiet as possible at the location of your chair. (Speed of sound = 340m/s).



wavelength is

$\lambda = \frac{v}{f} = \frac{340 m/s}{170 s^{-1}} = 2m$

we want

$|d_{movable} - d_{fixed}|$

$= \frac{1}{2}\lambda, \frac{3}{2}\lambda, \ldots$

$= 1m, 3m, \ldots$

$d_{fixed} = 3m$

so want

$d_{movable}$

$= 2m, 4m$

Hint: This problem makes use of the idea of destructive interference. If we have waves coming from two different in-phase sources, the waves will add up constructively at locations where the distance to the two sources differ by a whole number of wavelengths, but will add up destructively (i.e. cancel out) when the locations where the distance to the two sources differ by a 1/2 wavelength, 3/2 wavelength, etc…

EXTRA: *If the fixed speaker is 50W, what should you set the power of the movable speaker to at the various possible locations?*

★ we should adjust the volume on the movable speaker so that the amplitude at the center of the room is the same as from the fixed speaker