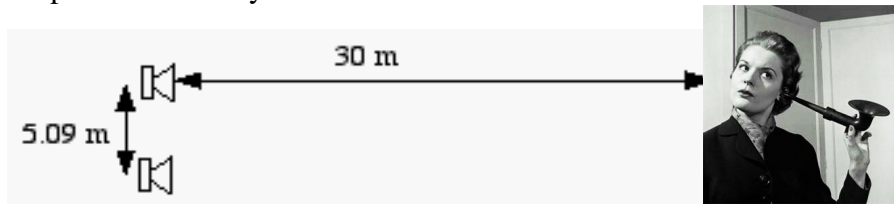


Sound Problems

Q1. Units Warm-up: An optimum human ear can hear a 1000 Hz sound at an intensity of 1.0×10^{-12} watts/m². What is the displacement amplitude for this sound? The threshold of pain is 1 watt/m². What is the displacement now? Compare these numbers to the size of an atom, roughly 3×10^{-10} m.

Q2. For the same intensity and wave speed, will low frequency or high frequency sounds produce larger displacement amplitudes?

Q3. Suppose you have two speakers, separated by 5.09 m, each emitting an 800 Hz sound in air, and you listen at a point 30 m away as shown.



(a) Assume that the speakers are in phase—that is, they both emit a peak at the same time. What will you hear, constructive or destructive interference?

(b) Now you move the bottom speaker vertically to a new position (up or down). At what speaker separation will you hear the other type of interference from part (a)?

(c) Suppose you double the frequency of the speakers, what will you hear for the two separations in (a) and (b) above?

Q4. Two identical sources emit sound of frequency 2 kHz. They are separated by 25.7 cm.

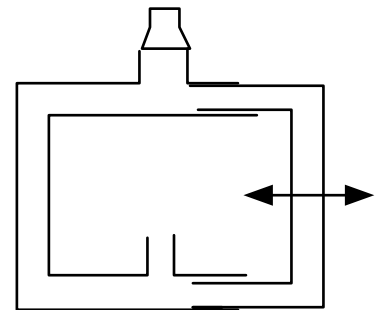


(a) What type of interference is heard at a distance of 5 m away along the axis joining the speakers?

(b) You now increase the frequency of both speakers. Find the next frequency for which you will hear destructive interference.

(c) Now return to 2 kHz. What, if anything, can you do to get the opposite type of interference as in part (a)?

Q5. The apparatus shown in the diagram is built with ordinary plastic pipes. Sound enters the tube at the top and can go either left or right, going around and leaving the tube at the bottom. The right hand C shaped section can be slid left or right. Assume that we have a 3 kHz sound.



(a) As you slide the tube out, what will you hear?

(b) Suppose you start with a maximum sound and pull the right hand tube out 5.71 cm. Describe what you hear: a loud (constructive interference) or quiet (destructive interference) sound?

Q6. Consider a string of length L with nodes at each end.

(a) Draw the lowest 3 frequency standing wave patterns and complete the other items.

<u>Pattern (Sketch)</u>	<u># of λ in L</u>	<u>λ</u>	<u>frequency</u>
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(b) Now label each picture with successive Nodes [N] and Antinodes [A]. for example, the lowest pattern would be NAN.

(c) Now suppose you touch your finger lightly at the center of the string, at $L/2$. Which of the above patterns could appear on your touched string?

Q7. Consider a tube open at one end and closed at the other. One end will have a node, and the other will have an antinode. Sketch and write in NAN notation the first 4 patterns that could be observed, and find the wavelength and frequency of each.

<u>Pattern (Sketch)</u>	<u># of λ in L</u>	<u>λ</u>	<u>frequency</u>
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Q8. You have a sound of some unspecified intensity. You then reduce the intensity by a factor of three ($I \rightarrow I/3$). By what amount does the sound level (dB) change?

Q9. Brain-Buster: You go out onto the RIT fields and set up two speakers 3.00 meters apart, both emitting the same 343 Hz tone, and run around them in a big loop (everyone needs a hobby). How many times in one circuit around the speakers do you hear destructive interference (where the two sounds are completely out of phase)?

