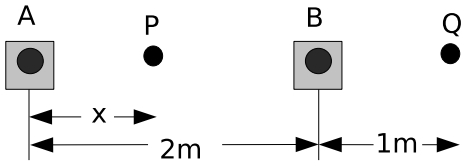
Problems 16.31,52,60,64 from MasteringPhysics with minor clarifications.

16.31 - Sound Interference



Two loudspeakers, A and B, are driven by the same amplifier and emit sinusoidal waves in phase. Speaker B is 2.00 m to the right of speaker A. Consider point Q along the extension of the line connecting the speakers, 1.00 m to the right of speaker B. Both speakers emit sound waves that travel directly from the speaker to point Q.

Part A

What is the lowest frequency, f_c, for which constructive interference occurs at point Q?

Part B

What is the lowest frequency, f_d, for which destructive interference occurs at point Q?

16.52 - A New Musical Instrument

You have designed a new musical instrument of very simple construction. Your design consists of a metal tube with length L and diameter $L/10$. You have stretched a string of mass per unit length μ across the open end of the tube. The other end of the tube is closed. To produce the musical effect you're looking for, you want the frequency of the third-harmonic standing wave on the string to be the same as the fundamental frequency for sound waves in the air column in the tube. The speed of sound waves in this air column is v_s.

Part A

16.60 - Organ Pipe

The frequency of the note F_4 is f_F.

Part A

If an organ pipe is open at one end and closed at the other, what length, L, must it have for its fundamental mode to produce this note at a temperature of T ?
Take the speed of sound to be v_s.

Part B

At what air temperature will the frequency be f? (Ignore the change in length of the pipe due to the temperature change.)

16.64 - Bat, Doppler, and Beats

A bat flies toward a wall, emitting a steady sound of frequency $f_s = 2.00$ kHz. This bat hears its own sound plus the sound reflected by the wall.

Part A

How fast should the bat fly in order to hear a beat frequency of $f_{\text{beat}} = 10.0$ Hz? Give your answer to two significant figures.
Take the speed of sound to be v =344 m/s.