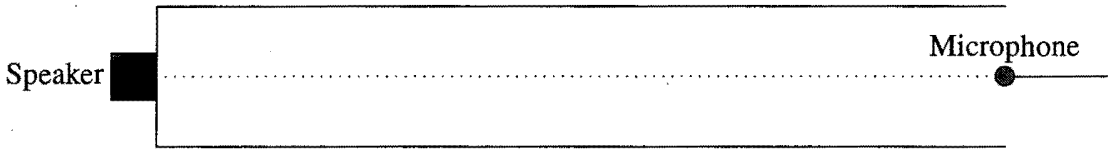
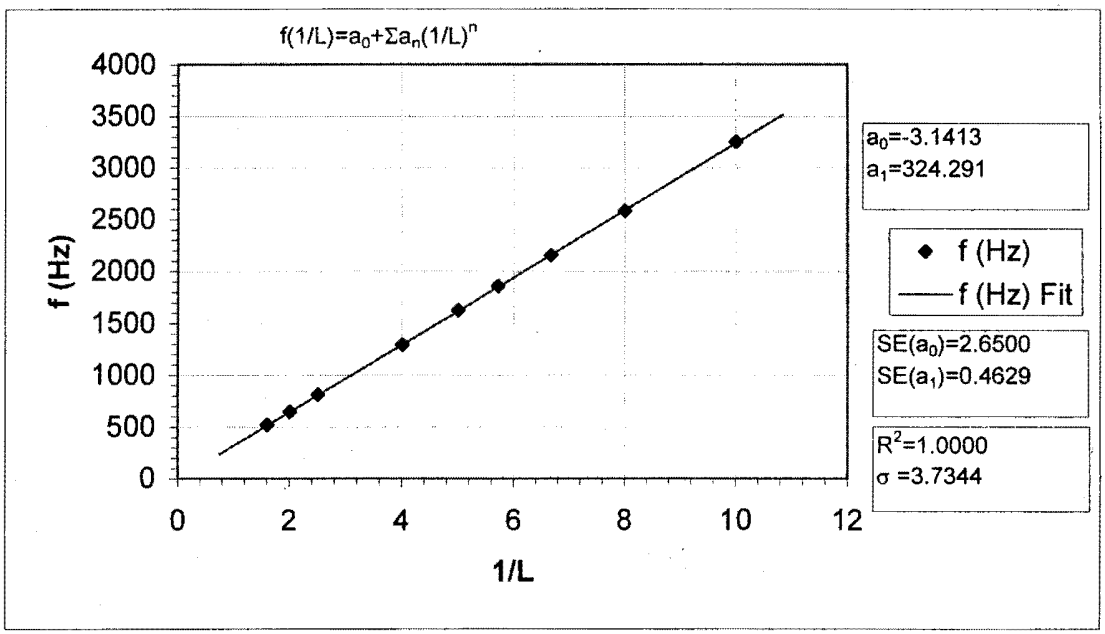
2. (40 pts.) A long tube of length 0.625 m is filled with carbon dioxide gas (CO_2, molecular weight 0.044 kg/mole). One end of the tube is open. At the other end is a speaker driven at a frequency f, where f can be varied with a function generator. There is a small microphone that can be moved along the axis of the tube to measure the sound intensity at different locations.



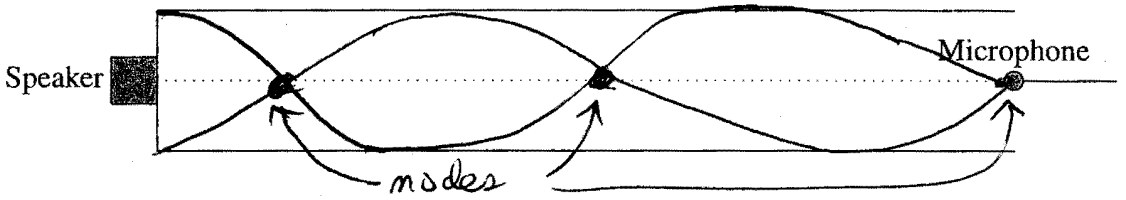
a. (10 pts.) A student adjusts the frequency until resonance occurs. Then, by measuring with the microphone, the student determines that there are two nodes (points of zero pressure variation) inside the tube. There is also a third node exactly at the open end of the tube on the right in the above diagram. The end with the speaker is an antinode. Sketch the mode and find the wavelength of the standing sound wave.

b. (30 pts.) The student now varies the length L of the tube, measures the resonant frequency f for the same mode as in part (a), and then plots f *vs.* $1/L$ as shown in the figure on the following page. The temperature of the gas is maintained at 273 K for the whole experiment. What is γ for this gas?

$f = +324.3/L$.


f(1/L)=a0+Σan(1/L)^n
4000
3500
3000
2500
2000
1500
1000
500
0
f (Hz)
0
2
4
6
8
10
12
1/L
a0=-3.1413
a1=324.291
f (Hz)
f (Hz) Fit
SE(a0)=2.6500
SE(a1)=0.4629
R2=1.0000
σ =3.7344

2. (40 pts.) A long tube of length 0.625 m is filled with carbon dioxide gas (CO_2, molecular weight 0.044 kg/mole). One end of the tube is open. At the other end is a speaker driven at a frequency f, where f can be varied with a function generator. There is a small microphone that can be moved along the axis of the tube to measure the sound intensity at different locations.



a. (10 pts.) A student adjusts the frequency until resonance occurs. Then, by measuring with the microphone, the student determines that there are two nodes (points of zero pressure variation) inside the tube. There is also a third node exactly at the open end of the tube on the right in the above diagram. The end with the speaker is an antinode. Sketch the mode and find the wavelength of the standing sound wave.

$L = \frac{5}{4}\lambda \Rightarrow \lambda = \frac{4}{5}L =$ **0.50 m**

b. (30 pts.) The student now varies the length L of the tube, measures the resonant frequency f for the same mode as in part (a), and then plots f *vs.* $1/L$ as shown in the figure on the following page. The temperature of the gas is maintained at 273 K for the whole experiment. What is γ for this gas?

$f = \frac{v}{\lambda} = \frac{v}{\frac{4}{5}L} = \frac{5v}{4L} = \frac{1}{L}\left(\frac{5}{4}v\right)$ ∴ slope of (f) vs. $(1/L)$ is $\frac{5}{4}v$

$\frac{5}{4}v = 324.3 \Rightarrow v = 259.4$ m/s

But $v = \sqrt{\frac{\gamma RT}{M}} \Rightarrow \gamma = \frac{Mv^2}{RT} = \frac{(0.044)(259.4)^2}{(8.3145)(273)} =$ **$\gamma = 1.30$**