

Lab 4 solutions

$$\begin{aligned} 1) \quad f_1 &= v/2L \\ f_2 &= 2v/2L = v/L \\ f_3 &= 3v/2L \\ f_4 &= 4v/2L = 2v/L \end{aligned}$$

$$f_N = N f_1 \text{ for } N=1, 2, 3, \dots$$

$$\begin{aligned} 2) \quad f_1 &= v/4L \\ f_3 &= 3v/4L \\ f_5 &= 5v/4L \\ f_7 &= 7v/4L \end{aligned}$$

$$f_N = N f_1 \text{ for } N=1, 3, 5, \dots$$

Part I

$$\begin{aligned} 1) \quad \text{closed tube: } L_{\text{eff}} &= L + 0.61 r = 1.35 \text{ m} \\ \text{open tube: } L_{\text{eff}} &= L + 1.22 r = 1.40 \text{ m} \end{aligned}$$

$$2) \quad f_1 = v/2L_{\text{eff}} \rightarrow v = f_1 * 2L_{\text{eff}} = 339 \text{ m/s}$$

3) percent difference = $|346 - 339|/346 * 100 = 2\%$
Slightly lower than 346 m/s due in part to slightly lower temperature in the room

Part II

$$\begin{aligned} 1) \quad 0.37 * 4.2 &= 1.55 \text{ corresponding to } t=750 \text{ ms} \\ \text{Exponential decay time} &= 750 \text{ ms} - 400 \text{ ms} = 350 \text{ ms} \end{aligned}$$

$$\begin{aligned} 2) \quad L_{\text{eff}} &= L + 0.61 r = 1.22 \text{ m} \\ f &= v/4L = 346/(4*1.22) = 71.8 \text{ Hz} \end{aligned}$$

Part III.A

$$\begin{aligned} 1) \quad A &= \pi * r^2 = 0.0053 \text{ m}^2 \\ \text{vol} &= (4/3)\pi R^3 = 0.0141 \text{ m}^3 \\ L_{\text{eff}} &= L + 1.22*r = 0.13 \text{ m} \end{aligned}$$

$$\rightarrow f = (v/(2 \pi)) * \sqrt{A/(L_{\text{eff}} * \text{vol})} = 93.3 \text{ Hz}$$

Part III.B

$$\begin{aligned} 1) \quad L_{\text{eff}} &= L + (0.61+0.85)r_{\text{avg}} = 0.1004 \text{ m} \\ A &= \pi * r_{\text{avg}}^2 = 3.48e-4 \text{ m}^2 \\ \text{vol} &= 0.75e-3 \text{ m}^3 \end{aligned}$$

$$\rightarrow f = (v/(2 \pi)) * \sqrt{A/(L_{\text{eff}} * \text{vol})} = 118.4 \text{ Hz}$$

2) percent difference = $|113-118|/118 * 100 = 4.2\%$

3) $f \propto 1/\sqrt{\text{vol}}$
 $f_{1\text{-liter}}/f_{2\text{-liter}} = \sqrt{2} = 1.414$