Standing Waves in an Air Column

(Speed of Sound in Gases)

Name_____ ID_____ TA_____

Partners_____

Date_____ Section_____

Please be careful not to touch the tuning fork to the glass tube. See the last page of this data sheet.

1. Speed of sound in air

➢**Speed of sound in air (reference value)**

Room temperature $T = \left(\frac{5}{9}\right)\left(^{\circ}F - 32\right)$_____$\left(^{\circ}C\right)$

Wave velocity in air $v = (331.45 + 0.61 \cdot T)$_____$\left(m/s\right)$ ← **(1)**

- **Finding a speed of sound with a trial and error method**

Frequency of a tuning fork, f_1:_____ (Hz)

Distances of water levels for intensity maxima, L = the lengths between a node and the next node:

(m)	(m)	(m)
(m)	(m)	(m)

The average length between nodes: L_1:_____(m)

Wavelength $\lambda_1 = 2L_1$:_____ (m)

Wave velocity $v_{air} = f_1\lambda_1$:_____(m/s) ← **(2)**

♣Did you obtain the close results in **(2)** to the reference value **(1)**?

- **Finding a speed of sound with a theoretically guessing method**

Frequency of a tuning fork, f_2:_____ (Hz)

Theoretical water levels for intensity maxima, L = the lengths between a node and the next node:

The length between nodes: $L_2 = v_{air} \big/ 2f_2 =$_____(m)

In accordance with the above L_2, the length between rubber bands should be close to it.

(m)	(m)	(m)
(m)	(m)	(m)

The average length between nodes: L_2:_____(m)

Wavelength $\lambda_2=2L_2$:_____ (m)

Wave velocity $v_{air}=f_2\lambda_2$:_____(m/s) ← **(3)**

♣Did you obtain the close results in **(3)** to the reference value **(1)**?

2. Speed of sound in CO_2

Using the above experience, try to obtain a close value of this.

➢**Speed of sound in air (reference value)**

Room temperature $T=\left(\frac{5}{9}\right)\left(^{\circ}F-32\right)$_____$\left(^{\circ}C\right)$

Wave velocity in CO_2 $v=(258.0+0.47\cdot T)$ _____$\left(m/s\right)$← **(4)**

Frequency of a tuning fork, *f*:_____ (Hz)

Distances of water levels for intensity maxima, L = the lengths between a node and the next node:

(m)	(m)	(m)
(m)	(m)	(m)

The average length between nodes: L:_____(m)

Wavelength $\lambda=2L$:_____ (m)

Wave velocity $v_{CO_2}=f\lambda$:_____(m/s) ← **(5)**

♣Did you obtain the close results in **(5)** to the reference value **(4)**?

Lab Procedure for Standing Waves in an Air Column

Please treat the glass tube and bottle carefully because they are fragile.

1. Speed of sound in air (with 2 different frequencies)

- **Fill up the bottle with water.**
  If you have any trouble with attaching it to the glass tube, please ask the TA.

- **Pick up two different-frequency tuning forks.**
  The frequencies are labeled on tuning the forks.

- **Put 5 or 6 rubber bands around the glass tube.**
  Those will be the marks for the nodes of standing waves.

- **Lift up the bottle to fill the tube with water.**
  You should use two hands to do this because the bottle is slippery.

- **Strike a tuning fork, and look for the water levels so that you can hear a louder sound; then, mark the level with rubber bands.**

- **Calculate the average wavelength and the speed of sound in air.**
  To make sure the experimental results are suitable, calculate the speed of sound by using the room temperature.

✵ **For this second part, first calculate the theoretical L, which is the length between nodes. Then, referring to it, find the experimental L. But you will use the different frequency from the previous one.**

2. Speed of sound in CO_2 (with one frequency)

- **Perform exactly the same procedure as you did in part 1, using small pieces of dry ice for this part.**
  Please be careful about dealing with dry ice. For this, you will pick out only one tuning fork.

- **From the results, calculate the speed of sound in CO_2.**
  You can also find it with the formula, which is a function of temperature.

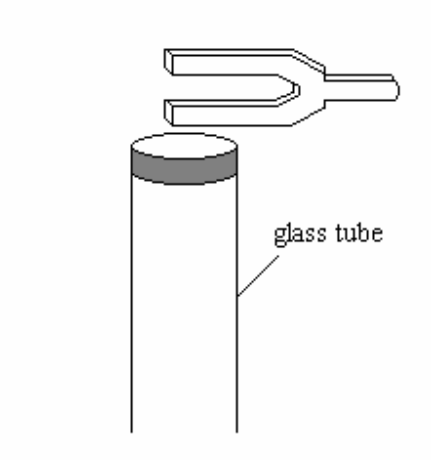
3. Lab Report

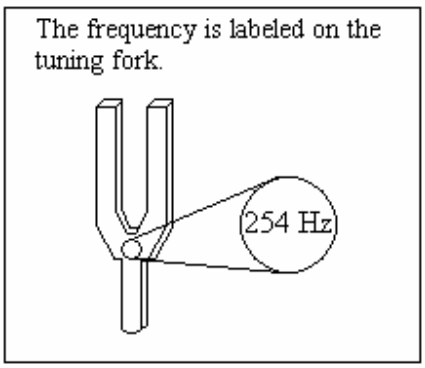
- **If you got a very different result, please discuss the causes of error.**
- **If you have an application related to your study field, please write it in your report.**

Note for dealing with a tuning fork

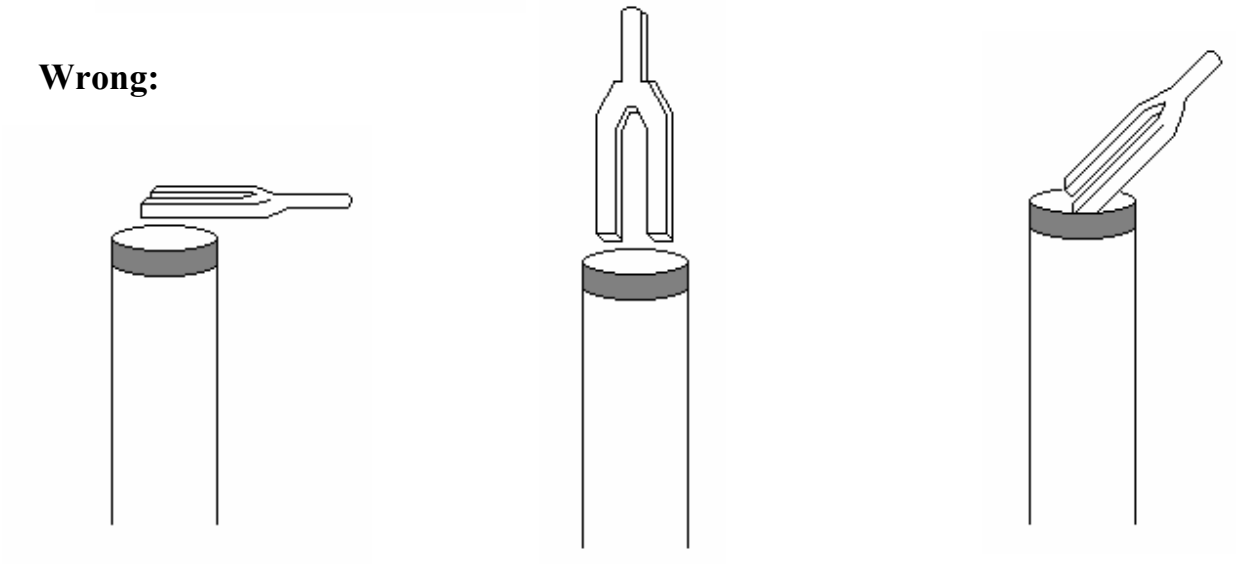
- The air column is made of glass, so a tuning fork might break the tube when it is touched to the tube. The following suggestion is also useful to obtain the appropriate results.

Correct:



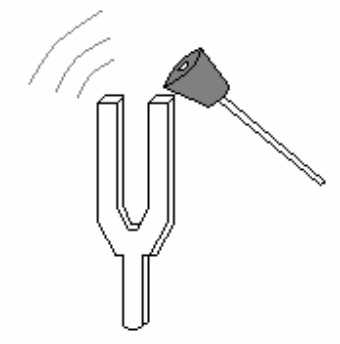


Wrong:

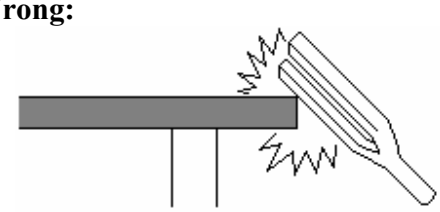


How to tap the tuning forks

Correct:



Wrong:



Never strike the tuning fork on a hard object (e.g. a table). This may damage the fork and cause a change in its chracteristic frequency.