Forestville Central School • Physics Name ____________________

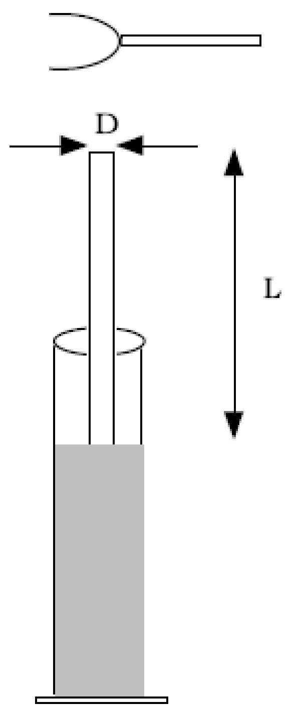
Determining the Speed of Sound in Air lab

For this lab you will be designing a simple experiment to calculate the speed of sound in air utilizing the notion of 1st, 2nd, 3rd etc harmonics. (Hint: think about how standing waves are formed in tubes).

(You can check the accuracy of your work if you know the temperature in the classroom. The speed of sound in air is given by: v sound = 331.5 + 0.6 * Temp in Celsius)

Materials:

- large graduated cylinder (very large for 500 hz fork)
- 250 Hz or 500 Hz tuning forks and rubber hammer
- hollow plastic tube
- measuring tape



Changing the air length (height) of the tube with a tuning fork sounding above it will result in the column of air vibrating at the same frequency as the tuning fork when the air column length is a harmonic length of the frequency.

Hence 4 * L = the wavelength (λ)

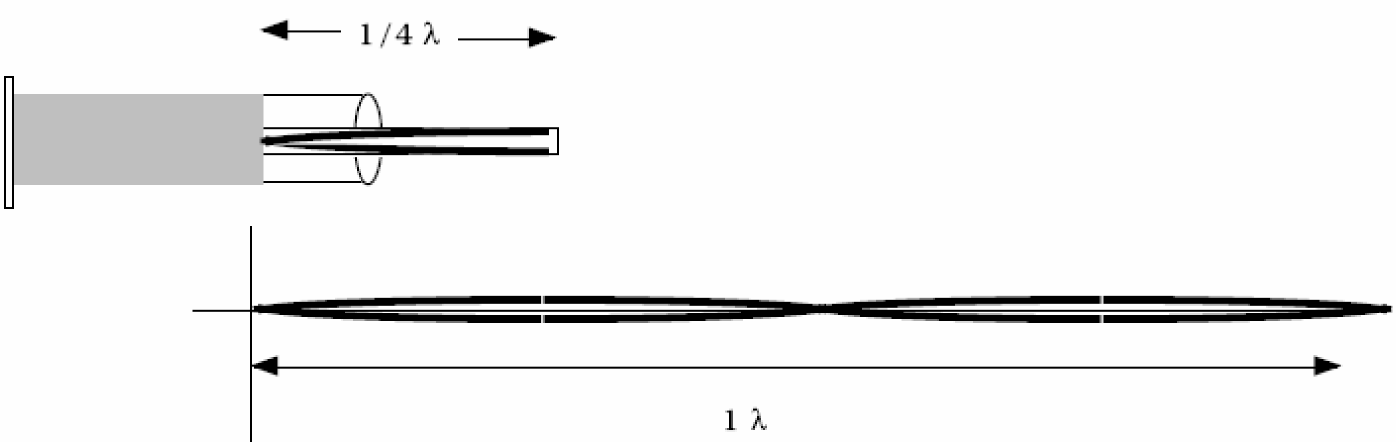
and $v_{sound} = f * \lambda$

$= f * 4 * L$

Since a slight quantity of air vibrates above the plastic pipe, the length (L) of the air column needs to be adjusted slightly.

L' = (0.4 * D) + L where D is the diameter of the plastic pipe.

and $v_{sound} = f * 4 * \mathbf{L'}$



Data Collection

Diameter of plastic tube ______ m

Tuning Fork Frequency	Length of Plastic Tube at Resonance	Velocity of Sound by calculation

Calculations:

Use the formula v = 4f (length of tube x 0.4d) and show your work below

Trial 1

Trial 3

Trial 2

Trial 4

Questions

1. Determine the speed of sound in air using the formula on the first page and our current temperature. Show you work below.

2. Find the average of your trials.

3. Compare your average vs. the theoretical speed of sound in air determined in question 1. Do a percent error calculation.

Name: ____

Chapter 12 Sound Summary Worksheet

Questions 1 and 2 refer to the following:

SHATTERING GLASS

An old television commercial for audio recording tape showed a singer breaking a wine glass with her voice. The question was then asked if this was actually her voice or a recording. The inference is that the tape is of such high quality that the excellent reproduction of the sound is able to break glass.

This is a demonstration of resonance. It is certainly possibly to break a wine glass with an amplified singing voice. If the frequency of the voice is the same as the natural frequency of the glass, and the sound is loud enough, the glass can be set into a resonant vibration whose amplitude is large enough to surpass the elastic limit of the glass. But the inference that high-quality reproduction is necessary is not justified. All that is important is that the frequency is recorded and played back correctly. The wave-form of the sound can be altered as long as the frequency remains the same. Suppose, for example, that the singer sings a perfect sine wave, but the tape records it as a square wave. If the tape player plays the sound back at the right speed, the glass will still receive energy at the resonance frequency and will be set into vibration leading to breakage, even though the tape reproduction was terrible. Thus, this phenomenon does not require high-quality reproduction and, thus, does not demonstrate the quality of the recording tape. What it does demonstrate is the quality of the tape player, in that it played back the tape at an accurate speed!

1) Explain why the glass in the given situation would *not* break if the tape player did *not* play back at an accurate speed.

2) Based on the given situation, list *two* properties that a singer's voice must have in order to shatter a glass.

Questions 3 and 4 refer to the following:

A student plucks a guitar string and the vibrations produce a sound wave with a frequency of 650 hertz.

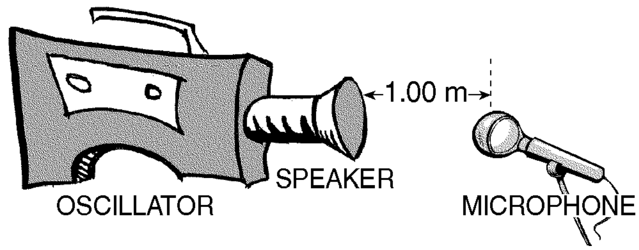
3) The sound wave produced by the situation described can *best* be described as a

A) electromagnetic wave of varying wavelengths
B) mechanical wave of varying frequency
C) longitudinal wave of constant frequency
D) transverse wave of constant amplitude

4) Based on the given information, calculate the wavelength of the sound wave in air at STP. [*Show all work, including the equation and substitution with units.*]

Questions 5 and 6 refer to the following:

A system consists of an oscillator and a speaker that emits a 1,000.-hertz sound wave. A microphone detects the sound wave 1.00 meter from the speaker.



5) What type of wave is emitted by the speaker in the given diagram?

A) electromagnetic B) circular C) longitudinal D) transverse

6) The microphone in the given diagram is moved at constant speed from a position at 0.50-meter back to its original position 1.00 meter from the speaker. Compared to the 1,000.-hertz frequency emitted by the speaker, the frequency detected by the moving microphone is

A) lower B) the same C) higher

7) Which phenomenon occurs when an object absorbs wave energy that matches the object's natural frequency?

A) interference B) reflection C) diffraction D) resonance

8) Rubbing a moistened finger around the rim of a water glass transfers energy to the glass at the natural frequency of the glass. Which wave phenomenon is responsible for this effect?

9) A 512-hertz sound wave travels 100. meters to an observer through air at STP. What is the wavelength of this sound wave?

10) A train sounds a whistle of constant frequency as it leaves the train station. Compared to the sound emitted by the whistle, the sound that the passengers standing on the platform hear has a frequency that is

A) higher, because the sound waves travel faster in the still air above the platform than in the rushing air near the train
B) higher, because the sound-wave fronts reach the platform at a frequency higher than the frequency at which they are produced
C) lower, because the sound-wave fronts reach the platform at a frequency lower than the frequency at which they are produced
D) lower, because the sound waves travel more slowly in the still air above the platform than in the rushing air near the train

11) An opera singer's voice is able to break a thin crystal glass when the singer's voice and the vibrating glass have the same

A) amplitude B) frequency C) wavelength D) speed