Name ____ # _____ Date ___________

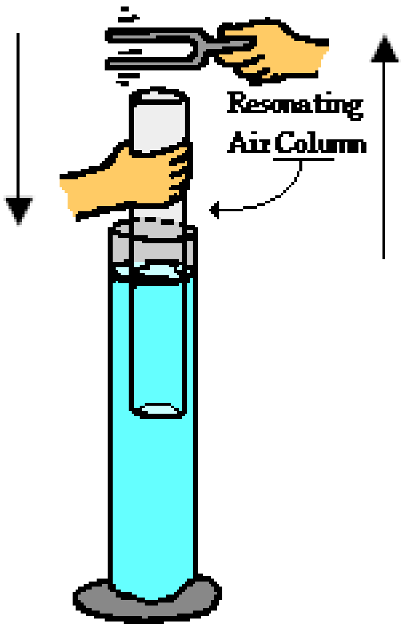
Section _____________

Standing Waves in a Closed Tube Lab

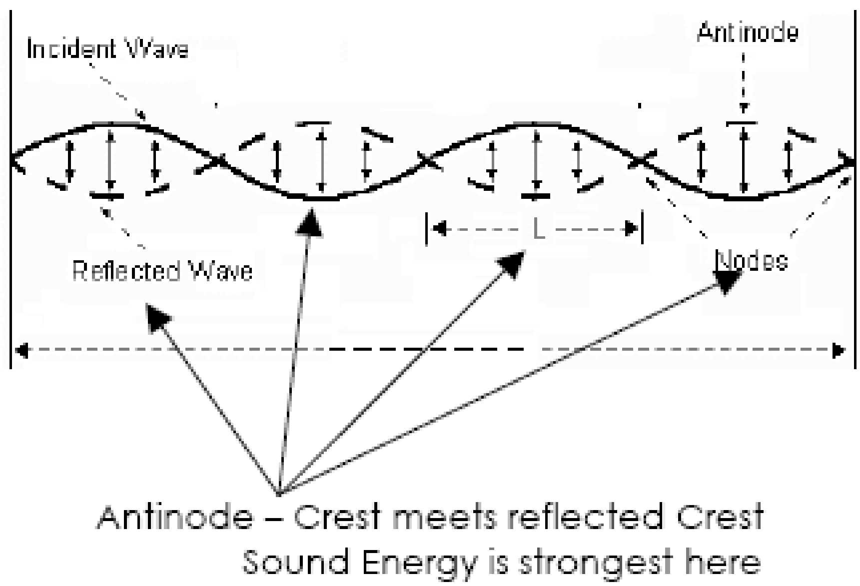
Introduction:

A standing wave is created when the sound wave from a tuning fork is sent into a closed tube. The standing wave comes about when the tuning fork's wave overlaps the reflected wave from the opposite end of the tube. At specific column lengths, the reflected wave is in phase with the wave leaving the tuning fork, and the two waves will reinforce each other. Specific points on the standing wave build up the sound wave's energy. These points are called **ANTINODES**. The buildup of energy at the antinode creates a higher-intensity sound at that point.

The reflection of the tuning fork's wave creates a standing wave.



Tuning fork forcing air coumn into resonance



Purpose: To find the wavelength of various sound frequencies and the frequency of an unknown tuning fork.

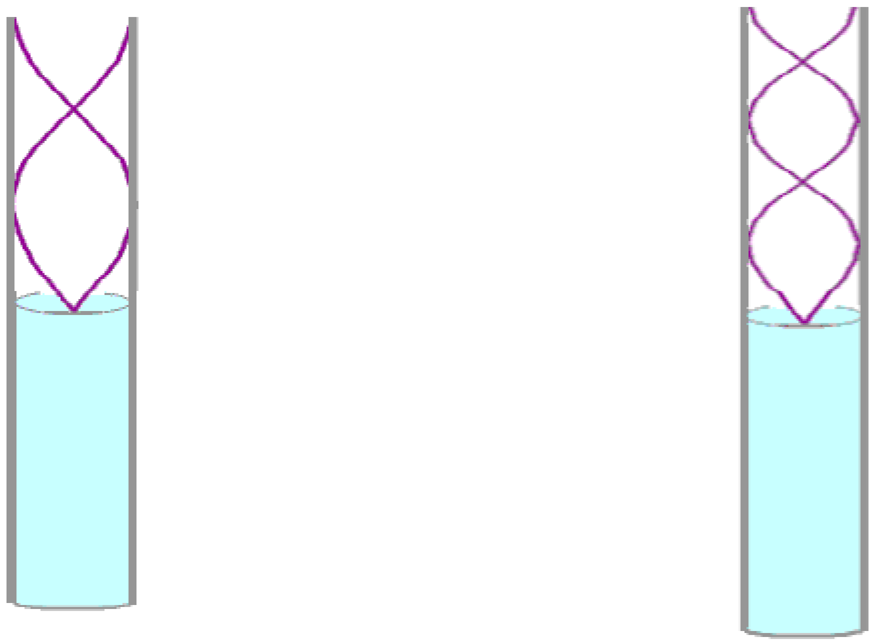
Materials: 1 white PVC Pipe (1-inch diameter) – 1.3-meter length, 1 clear acetate tube (1 ½ inch diameter) – 1.3-meter length, 1 ring stand, water, 2 clamps, assorted tuning forks

Procedure:

1. Firmly secure the rubber stopper at the end of the tube
2. Fill the tube 2/3 full of water
3. Place the stoppered end of the tube on the floor.
4. Clamp the tube into the ring stand
5. Submerge the PVC tube into the water
6. Gently strike the tuning fork and hold it just above the PVC tube (vertically as shown above)
7. Adjust the height of the PVC tube until a higher intensity sound is achieved (resonance is reached). Record the length between the water surface and the top of the tube.

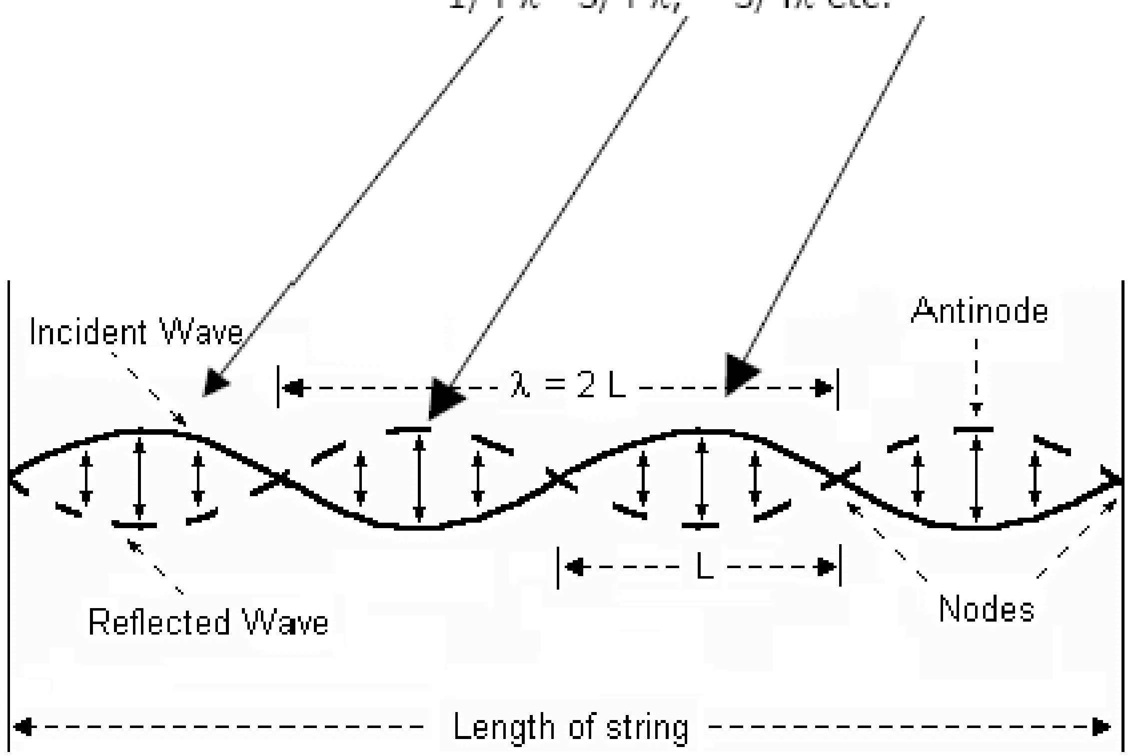
Resonance Occurs Only at Specific PVC tube Lengths:

2^{nd} resonance 3^{rd} resonance



Resonance is achieved only when the tube has a length that is

1/4 λ 3/4 λ, 5/4λ etc.



Questions

1. Take the 1024 Hz tuning fork and find three column lengths that will produce resonance.***
Important – length is measured from the water to the top of the small PVC tube.

Smallest length ________ **(2 pts)** Next Smallest ________ **(2 pts)** Largest _________ **(2 pts)**

2. In the previous step, the smallest length that produced resonance represents ¼ of a wavelength of the sound wave. Use this information to find the wavelength of the sound wave.

3. For each tuning fork, gather data on frequency (written on the tuning fork), smallest resonance length (1/4 l), and wavelength. Record this in the table given.

LEAVE THE LAST COLUMN BLANK FOR NOW (15 points)

Frequency **(Hz)**	Smallest Resonance Length **(m)** (1/4 λ)	Wavelength **(m)**	Speed **(m/s)** (Lookup the equation) **Do THIS AFTER you PLOT**
1024			
512			
480			
256			
320			
Unknown =			
(find the unknown from the plot on the next page)	**(2 pts)** Average Velocity ________________		
(2 pts) Velocity of sound from the reference table ________________			

After you plot the data …

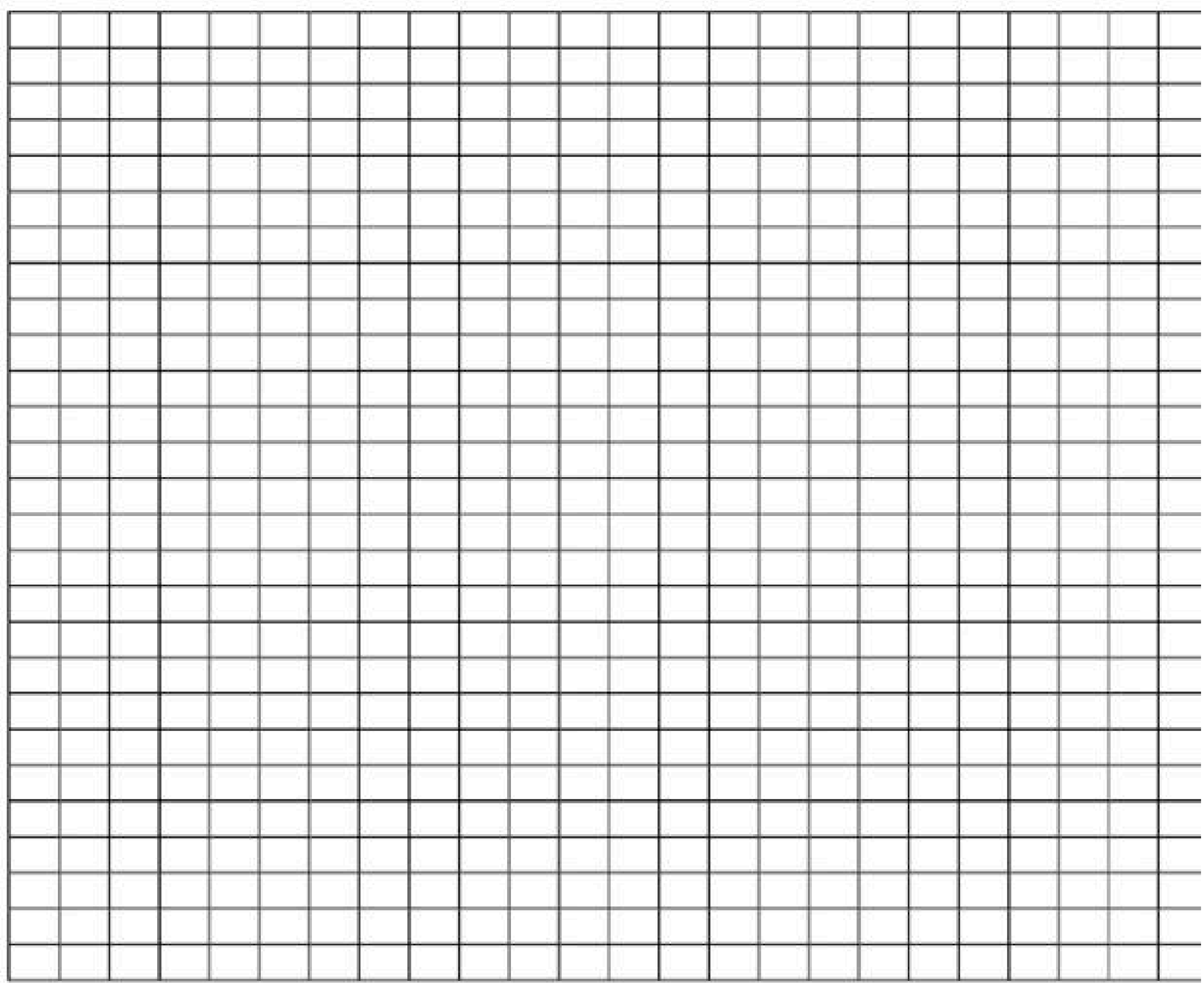
4. Calculate the velocity of the wave created by each tuning fork. Show how you found the velocity for the 1024 Hz and 512 Hz tuning forks. **(4 pts)**

1024 Hz

512 Hz

5. **a)** Plot the wavelength versus frequency **(6 pts)**. Add SMOOTH CURVE /CIRCLE Data Points

b) Add an appropriate title **(3 pts)**. **c)** Label the axis with units **(3 pts)**



Frequency (Hertz)

6. Using the plot above, determine the frequency of your UNKNOWN tuning fork. **(5 pts)**

Also, record your value in the chart on the previous page ____________________

7. The shape of this plot shows that the mathematical relationship between frequency and wavelength is ____________________________ **(6 pts)**

8. Use your data, or the relationship you found, to find the wavelength of a tuning fork with a frequency of 2048 Hz. **(10 pts)** Show how you arrived at your answer.

9. If a standing wave has a wavelength of 2.0 cm, at what length would you

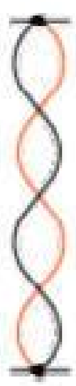
find the first resonance (loud) point? _______ **(5 pts)**

Show ALL Work

10. What determines the speed of any wave? ___________________ **(5 pts)**

11. (a – f) The following questions refer to the standing wave shown on the lower left.

a) Circle all nodes **(5 pts)**



b) How many nodes are in this wave? _______ **(5 pts)**

c) Put an X through the middle of each antinode **(5 pts)**

d) How many antinodes are there in this wave? _______ **(5 pts)**

e) What is the wavelength of this standing wave? _______ cm **(5 pts)**

f) At what length will the first resonance point occur? _____ cm **(5 pts)**