613-0000 (55-050) Resonance Apparatus

Warranty and Parts:
We replace all defective or missing parts free of charge. Additional replacement parts may be ordered toll-free. We accept MasterCard, Visa, checks and School P.O.s. All products warranted to be free from defect for 90 days. Does not apply to accident, misuse or normal wear and tear. Intended for children 13 years of age and up. This item is not a toy. It may contain small parts that can be choking hazards. Adult supervision is required.

Description:
Our 55-050 Resonance Apparatus is used to study resonance columns and to determine the velocity of sound in air.

Curriculum Fit: Speed of Sound, Resonance.

Items needed but not included:
Tuning Forks
C-Clamp
Rubber Hammer
Thermometer
Rubber Bands

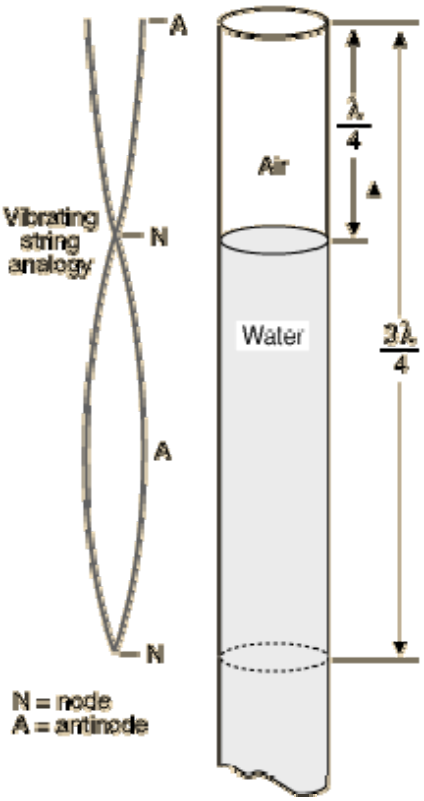
Safety Note: If using on a table, please clamp the base onto your lab table. If the unit falls off of the table, it could cause an injury.

INTRODUCTION

A tuning fork of known frequency is made to vibrate at the mouth of a vertical column of air. The column of air is located in a clear graduated tube that is partially filled with water. The length of the air column is adjusted by regulating the water level in the tube until the column of air resonates with the same frequency as the sounded tuning fork. By locating several resonance positions and measuring their average distance apart, it is possible to compute the wavelength of sound in air, as well as its velocity. The velocity with which sound travels in any medium may be determined if the frequency and the wavelength are known. The relationship between these quantities is:

$v = f\lambda$ where v = velocity of sound propagation
f = frequency
λ = wavelength

Our resonance apparatus consists of a clear cylindrical tube, mounted on a metal base. A water reservoir is clamped on near the top of the cylinder with a flexible tube leading to the bottom of the cylinder. The cylinder has a 90cm scale affixed along its length and marked off in 1cm increments. . The length of the water column may be changed by raising or lowering the water level while the tuning fork is held over the open end of the tube. Resonance is indicated by the sudden increase in the intensity of the sound when the column is adjusted to the proper length. The resonance is a standing wave phenomenon in the air column and occurs when the column length is:



$$\lambda/4,\ 3\lambda/4,\ 5\lambda/4$$

where λ is the sound wavelength.

The water surface constitutes a node of the standing wave since the air is not free to move longitudinally. The open end provides the conditions for an antinode, but the actual antinode has been found to occur outside the tube at a distance of about 0.6 r from the end, where r is the tube radius. This end correction may be added to get a more accurate value if only one resonance can be measured, but it is usually more convenient to eliminate this "end effect" by subtracting the resonance length for λ/4 from those for 3 λ /4, 5λ /4, etc.

PROCEDURE

If not assembled already, mount the resonance tube to the tripod base by inserting it into the two black clamps on the support stand. Next, connect the length of rubber hose between the resonance tube and the water reservoir.

Move the reservoir can to a height just below the top of the resonance tube. Then fill the water reservoir container with water until the level settles about 1cm above the bottom of the container. The water level in the clear tube should be about 20cm from the top of the tube. This level lets the container travel the full length of the scale without overflowing.

Finding the nodes

Safety Note: Never strike the resonance tube with the tuning fork. Never strike the tuning fork with a metal object!

1) Choose a tuning fork and mark its frequency in the table below.
2) Mount the tuning fork with the higher frequency in its clamp so its tines vibrate vertically over the mouth of the resonance tube.
3) Strike the tuning fork with the rubber hammer.

4) **Slowly** lower the reservoir chamber and listen carefully for an increase in the intensity of sound as the resonance chamber is lengthened.
5) Locate the position where the sound is most intense by moving the reservoir chamber up and down and marking the loudest position with a rubber band on the outside of the tube.
6) Next, try to find another position where the sound intensifies. When found, mark this second spot with another rubber band.
7) Lower the water further to find the next resonant length. Continue in this manner as far as the length of the tube will permit.
8) Obtain the lengths $\lambda/4$, $3\lambda/4$, etc. in meters from your measurements. You will need to check to see if your column lengths follow the progression 1, 3, 5, 7, -- since you may have missed a resonance or counted one of the fainter resonances which sometimes occur. Calculate the wavelength and velocity of sound..
9) Measure the distance between the nodes and compute an average value in meters.
10) Repeat the procedure for the other tuning forks you have supplied. The velocity in miles per hour may be found by multiplying the velocity in m/sec by the factor 2.24. Please record the room temperature for reference since the velocity of sound increases with increasing air temperature.
11) Compare to the accepted value of 343m/s at 20°C (68°F).

Frequency of Tuning Fork	$\frac{\lambda}{4}$	$\frac{3\lambda}{4}$	$\frac{5\lambda}{4}$	Calculated Wavelength in meters	Velocity in m/sec	Velocity in miles/hr
	Record only measured resonances; not calculated values.					

Temperature = _____ °C