Determining the Speed of Sound with a Tuning Fork

Materials:
1. Tuning Fork
2. Glass Tube
3. Glass Cylinder
4. Water

The speed of sound can easily be determined using a toning fork of a known frequency, a glass tube 2 cm to 4 cm in diameter and at least 40 cm long, a tall cylinder and a meter stick.

Fill the cylinder with water to about 2 inches from the top. Submerge the glass tube into the water. Holding the tuning fork by its shank, cause it to vibrate by striking it with a tuning hammer or on a large rubber stopper. Hold the tuning fork over the open end of the submerged tube as shown in the illustration. While maintaining the tuning fork-tube orientation, slowly raise the glass tube out of the water. Locate the position where the sound becomes louder.

This increase in sound is called *resonance.*

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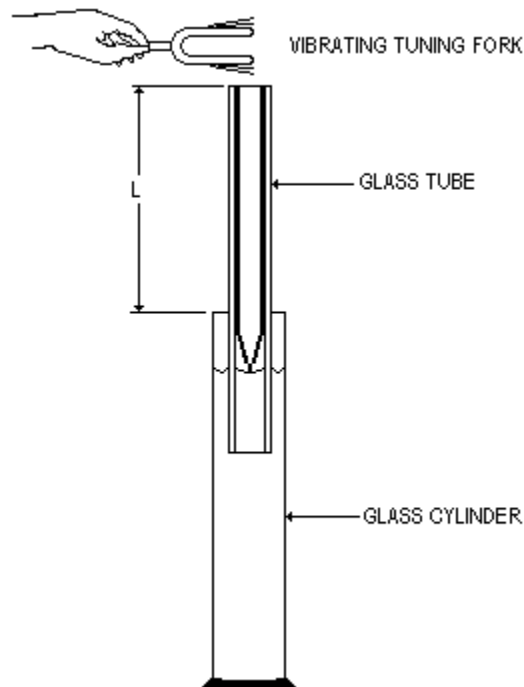
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Accurately measure the length of the tube above the water's surface. Substitute this distance plus the known frequency of the tuning fork into the equation below to determine the speed of sound (S).

$$S = f \times 4 (L + 0.4d)$$

- f = Known frequency
- L = Length of tube above the water's surface
- d = Inside diameter of the glass tube

The equation contains a correction factor that takes into consideration the inside diameter of the tube. The length of the tube, L, above the water's surface must be the shortest length at which the resonance occurs. The loudness of the sound will increase at tube lengths of 2L, 3L and 4L etc, above the water's surface. Suppose L = 32.2cm, d = 2.5cm and f = 256 vibrations per second; by substituting these factors into the above equation, you would get a value for the speed of sound as:

S = 256 vib/ sec. X 4 (32.2cm + 0.4 X 2.5 cm)
S = 256 vib/ sec. X 4 (33.2 cm)
S = 256 vib/ sec. X 132.8 cm
S = 33996.8 cm/sec or 340 m/sec

The value of the speed of sound varies with temperature. Thus, to obtain an accurate comparison of this experimental value with accepted values derived from more sophisticated techniques; you must record the temperature at the time of the experiment.