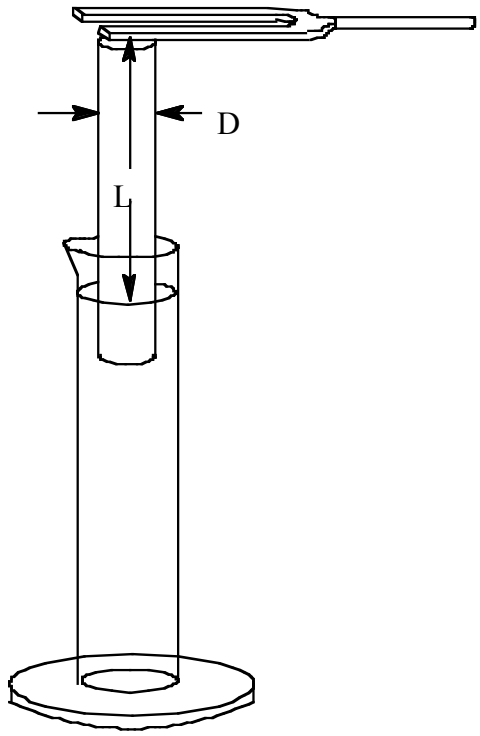
# Measuring the velocity of sound, resonance method.

A classic method of measuring the velocity of sound involves a tuning fork of known frequency, a metal tube and a graduated cylinder full of water. This apparatus is illustrated below:




The fork is held near the top of the metal tube (it is best to hold the fork as illustrated rather than with the tines vertically) and the tube is moved up and down with its bottom end in the water until a loud resonance is heard. A slight moving of the tube up and down will establish the point with the strongest resonance. When maximum resonance is obtained, the distance from the top of the tube to the water surface (L) is measured and the frequency of the tuning fork (F) is recorded. This procedure can be repeated using several different frequency tuning forks. The inside diameter of the metal tube (D) should also be measured.

It is easy to show that the tube will resonate with the tuning fork when the distance from the open end to closed end that the water provides is ¼ the wavelength of the sound produced by the fork. Actually, a more accurate value for the wavelength of the sound produced by a resonating closed tube is: $\lambda = 4(L + 0.4D)$

Using this equation with the correction for the tubes diameter can give a value for the velocity of sound that is sufficiently accurate to determine the temperature of the air in the tube. (The value for the velocity of sound with temperature corrections is generally available.)

Deriving the formula for the diameter correction can be complex and recognizes that the larger the tube, the advancing wave front will travel a greater distance in a larger tube before the average returning sound returns to the top of the tube. A very interesting special project for an interested student would be to repeat this experiment with several different tubes of different diameter to see if an empirical verification of the formula can be developed.