# Speed of Sound Lab -- Catch a Wave!

"Collect quantitative data and use patterns to analyze and interpret the data with the goal of mathematically computing the speed of sound in a column of air." NGSS HS-PS4-1

**The idea:** It's possible to measure the speed of sound directly if you have a loud noise, plenty of space, and good timing equipment. In this experiment, you can measure the speed of sound in a more subtle, indirect way, by making a trap to catch a wave. You'll change the length of a column of air until you hear it resonating with a tuning fork of known frequency; then you'll know you have trapped the wave. With only a little effort you can measure the wavelength and calculate the speed.

**What you'll need:** tall plastic graduated cylinder, hollow pipe with centimeter markings, several tuning forks, a large rubber stopper (or the heel of your shoe), and a thermometer.

**What you'll do:** Fill the cylinder nearly full with water and slip the hollow pipe into it with the zero-centimeter end out of the water. One team member will then hold the pipe so that most of it is in the water. That same team member will then solidly bonk a tuning fork against a rubber stopper or heel and hold the fork close over the open end of the pipe with the tips of its tines above one another. Smoothly but not too slowly, move the pipe out of the water, bringing the tuning fork up along with it, until the sound you hear suddenly becomes louder. That's when the air in the column is singing along with the tuning fork! Hold the pipe at the level, bonk the fork again, hold it over the pipe again, and move the pipe up and down just a little to try to find the spot where the sound in the pipe is the loudest. Carefully and as accurately as you can, read the scale on the pipe to measure the air column in it. Divide by 100 to convert that length to meters and record it in a data table, like the one on the next page. Also record the frequency of the tuning fork, which is engraved on one of its tines.

Now since the air column in the pipe is open on one end but closed by the water on the bottom, it should hold one-quarter of a wave, so you would multiply its length by four to find the wavelength.

Multiply the frequency column times the wavelength column to get your estimate of the speed of sound for this trial with this tuning fork. **Round off your answer to the nearest whole number** and be sure to include measuring units with each column.

Repeat the process four or five more times with different tuning forks. You can save yourself some time by thinking about what *should* happen; if the frequency of the next fork you use is higher, the air column that sings with it should be *shorter*, right? Or with a lower frequency fork, the column should be longer. Average your results for the speed of sound.

Sometime during the lab, use a thermometer to measure the temperature of the air inside the pipe; it may not be the same as the air in the room, since the water below it may be a different temperature than the room air. (*Subtract 1 degree Celsius if you are given the room temp.*)
**For each degree Celsius, add 0.6 m/s to 331 m/s** to find the expected speed of sound for your lab group. v = 331m/s + [0.60m/s * (Temp. in Celsius)]

Find the percent error in your experiment; **divide the difference** between your result and the expected **by the expected, times 100.**

Here is a sample table that you could use for your lab:

Name:_______________________________________________________________________

| Frequency<br>f | Length of air column<br>L | Wavelength<br>λ | Speed of sound<br>v |
|---|---|---|---|
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| | | | |
| | | | |
| | | | |
| | | Average speed of sound (m/s) → | |
| Air temperature in tube (ºC) → | | Expected speed of sound (m/s) → | |
| | | Percent error → | |