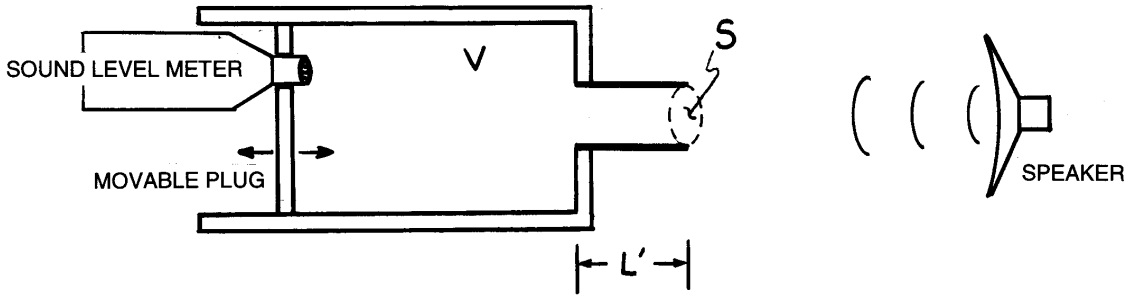
ME458 Noise Control
Laboratory #9

# Helmholtz Resonator

**Objectives:**

1. Investigate the behavior of a lumped acoustic element - a Helmholtz resonator.
2. Compare theory with measured results.
3. Determine the resonant frequency of an acoustic system using a swept sine input.

**Background:** In this experiment, you will study the dynamics of a Helmholtz resonator. This is an example of a lumped acoustic element (1-D), commonly used in automobile mufflers. They are excellent band-stop acoustic filters. You have probably played with this device many times. Whenever you blow across the top of an open bottle, you are demonstrating a Helmholtz resonator. The resonator consists of a rigid cavity of volume **V**, neck of area **A** and length **L** as shown in the figure below.




The resonance frequency of a Helmholtz resonator (assuming that the physical dimensions are smaller than a wavelength) can be calculated by:

$$f_n = \frac{c}{2\pi}\sqrt{\frac{S}{L'V}}$$

L' = effective length of the neck

**Procedure:**

Use a loudspeaker driven by a sine wave generator and audio amplifier as the signal source. The source is placed a measured distance from the resonator. A microphone (or sound level meter) is placed in the resonator cavity to measure

the response. For four different resonator combinations of neck length and volume, do the following:

1. Set the length of the resonator neck (by choosing a tube) and set the position of the movable plug (set the volume). Carefully measure the dimensions of the resonator.
2. Find the resonant frequency of the resonator by adjusting the sine wave frequency until the maximum response amplitude is found.
3. Measure the SPL as the frequency of the sine wave is slowly varied in steps around resonance. Record the frequency and SPL at several frequencies.
4. Plot the SPL as a function of frequency. Compare to the theoretical graph.
5. Compare the measured resonant frequencies to the theoretical calculation

**Reporting Requirements:** Thoroughly document your test procedure, instrumentation, calculations, results, observations and conclusions in a full-length, professional quality report.

**In your report:**

- Thoroughly document the test procedure, instrumentation, results and your observations.
- List all sources of error in your experiment.
- Comment on the validity of the theoretical model of the Helmholtz resonator. Did your results agree with theory? Why or why not?
- What limits the frequency range of application of the model?