

Measuring the Seismic and Acoustic Time of Flight – Lessons in Earthquakes and Thunder

When teaching the fundamentals of waves and wave propagation, students must appreciate and understand that different waves travel through different materials at different speeds. We describe a simple experiment to explore acoustic wave propagation through the ground and the air and how to use those observations to locate the source of the waves. The experiment that can be performed with a geophone, a microphone, and an oscilloscope.

For this activity, students will strike a metal plate, equipped with a vibration trigger, with a hammer. The blow triggers an oscilloscope to begin recording data in a “single-shot” mode. The two channels of the oscilloscope record the output of the microphone (measuring the energy of sound waves in the air) and the geophone (measuring the seismic wave energy in the ground). Seismic waves reach the geophone earlier than the sound waves since they travel at approximately ten times the speed. Students can measure the travel time on the oscilloscope, or using data downloaded to a computer. With measurements of the travel time and distance to the hammer, students can calculate the velocity of each wave. Then, the hammer can be used at other distances from the sensors and by measuring the difference in arrival time of the two waves, students can estimate the distance to the source which they check by direct measurement.

This exercise can be directly connected to common observations such as seeing lighting before hearing thunder. The activity also connects directly to concepts related to earthquake location. We describe pedagogical materials, including experiment instructions, videos and data for those who do not have access to the equipment, and simple exercise suggestions for classroom activities.