Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period \_\_\_\_\_\_

BOCES Science Laboratory Investigation

THE SPEED OF SOUND

**Introduction**

Sound is something that we don’t often think about, but that is present all around us. We rarely stop to consider that sound takes time to travel from one point to another. This is a function of the fact that we are often usually fairly close to the source of everyday sounds, and that sound does, in the grand scheme of things, travel pretty quickly. The speed of sound, though, is dependent on several factors that you might not have considered before. Whereas there are very few things that can slow down something like light, changing the way sound is transmitted is fairly simple. You can, in fact, try it yourself. Tap your desk and listen to the sound as it travels through the air to your ear. Then, place your ear right on your desk and tap in the same way. You’ll hear that the sound is much louder, because sound travels through solids much better (but not always farther) than in gasses.

Sound is a compression wave. That means that it compresses the medium through which it travels in the direction of travel. Contrast this with a transverse wave like light or a wave in the ocean. In an ocean wave, each individual particle moves up and down as the wave goes by. In that manner, the energy of the wave moves on, but the particles stay in pretty much the same spot.

The speed of sound in 20 °C air is 343.2 m/s, or 1,236 km/h. That’s pretty fast by all estimations, but nowhere near the speed of light, which comes in at just about 300,000 km/s. This is, of course, why you can see distant lightning before you can hear the thunder. Both things happen at the same time, but the thunder just takes longer to reach your ears. Depending on air temperature, humidity and other factors, the speed of sound can be much higher or lower.

Measuring the speed of sound is fairly simple, because we can take into account that light from a distant object will reach an observer almost instantaneously, while sound, over a sufficient distance, will be slightly delayed. So, if we can find the difference in time between when we *see* an event and when we *hear* it, we’ll be able to accurately determine the speed of sound.

**Purpose**

The purpose of this investigation is to acquaint you with proper measurement procedures as well as with the percent deviation formula. You’ll also see how small errors in measurement can be magnified if you’re not careful, and how important it is to have a clear idea of many vital phenomena in the natural world.

**Materials**

Crash Cymbals Stopwatches

Clipboards Measuring Tape

PENCIL

**Procedures**

1. Designate one student to remain at the starting spot indicated by your teacher. This student will be the crash cymbal crasher. This student should anchor the measuring tape and have one walkie talkie for ease of communication.

2. The rest of the class should move at least 300 m away from the crash cymbal crasher.

3. At the proper distance, indicate to the crasher to crash the cymbals.

4. When you *SEE* the cymbals come together, start the stopwatch.

5. When you *HEAR* the cymbals crash, stop your stop watch. You have just measured the time that it took the sound to travel from the crasher to your ears.

6. Repeat 10 times and record each of your measurements in table 1.

7. Measure the air temperature outside. Be sure that the thermometer is not near your body or affected by you in any way. Record the temperature in table 1. Note that the air temperature will probably not change between trials, so indicate that accordingly.

8. Enter your data into the computer so that it can be aggregated with the data from the other classes.

|  |  |  |
| --- | --- | --- |
| **Trial Number** | **Time Difference (s)** | **Air Temperature (°C)** |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |
| 7 |  |  |
| 8 |  |  |
| 9 |  |  |
| 10 |  |  |

Table 1. Time differences and air temperatures for speed of sound trials.

**Analysis**

QUESTION 1: What was the average time difference that you found after aggregating all the data from all classes on the computer, in seconds? Be as accurate as possible with your decimal places.

QUESTION 2: How far away, in meters, were you from the cymbal crasher?

QUESTION 3: Using the information from questions 1 and 2, calculate your experimentally-determined speed of sound in meters per second.

QUESTION 4: Use the interwebs to determine the speed of sound in air at your particular recorded temperature.

QUESTION 5: Use the percent deviation formula to figure out how far off you were from the actual speed of sound for the air temperature that you recorded.

QUESTION 6: What are some possible sources of error in this investigation?

QUESTION 7: What are two things that you would change about this lab if you could?