CHAPTER 12

Skills Practice Lab Speed of Sound

OBJECTIVES

- **Measure** the speed of sound in air using a resonance apparatus.

MATERIALS LIST

- 4 tuning forks of different frequencies
- Erlenmeyer flask, 1000 mL
- resonance apparatus with clamp
- thermometer
- tuning-fork hammer
- water

The speed of sound can be determined using a tuning fork to produce resonance in a tube that is closed at the bottom but open on top. The wavelength of the sound may be calculated from the resonant length of the tube. In this experiment, you will use a resonance apparatus to measure the speed of sound.

SAFETY

- **Put on goggles.**
- **Never put broken glass or ceramics in a regular waste container. Use a dustpan, brush, and heavy gloves to carefully pick up broken pieces and dispose of them in a container specifically provided for this purpose.**
- **If a thermometer breaks, notify the teacher immediately.**

PROCEDURE

Preparation

1. Read the entire lab, and plan what steps you will take.
2. If you are not using a datasheet provided by your teacher, prepare a data table in your lab notebook with four columns and five rows. In the first row, label the first through fourth columns *Trial, Length of Tube (m), Frequency (Hz),* and *Temperature (°C).* In the first column, label the second through fifth rows *1, 2, 3,* and *4.*

Finding the Speed of Sound

3. Set up the resonance apparatus as shown in **Figure 1.**
4. Raise the reservoir so that the top is level with the top of the tube. Fill the reservoir with water until the level in the tube is at the 5 cm mark.
5. Measure and record the temperature of the air inside the tube. Select a tuning fork, and record the frequency of the fork in your data table.
6. Securely clamp the tuning fork in place as shown in the figure, with the lower tine about 1 cm above the end of the tube. Strike the tuning fork sharply, but not too hard, with the tuning-fork hammer to create a vibration. A few practice strikes may be helpful to distinguish the tonal sound of the tuning fork from the unwanted metallic “ringing” sound that may result from striking the fork too hard. ***Do not strike the fork with anything other than a hard rubber mallet.***

7. While the tuning fork is vibrating directly above the tube, slowly lower the reservoir about 20 cm or until you locate the position of the reservoir where the resonance is loudest. (Note: To locate the exact position of the resonance, you may need to strike the tuning fork again while the water level is falling.) Raise the reservoir to about 2 cm above the approximate level where you think the resonance is loudest. Strike the tuning fork with the tuning fork hammer and carefully lower the reservoir about 5 cm until you find the exact position of resonance.
8. Using the scale marked on the tube, record the level of the water in the tube when the resonance is loudest. Record this level to the nearest millimeter in your data table.
9. Repeat the procedure for several trials, using tuning forks of different frequencies.
10. Clean up your work area. Put equipment away safely so that it is ready to be used again. Recycle or dispose of used materials as directed by your teacher.

Figure 1
Step 7: From the position of greatest resonance, move the reservoir up 2 cm and down again until you find the exact position.

ANALYSIS

1. **Organizing Data** For each trial, calculate the wavelength of the sound by using the equation for the fundamental wavelength, $\lambda = 4L$, where L is the length of the tube.
2. **Organizing Data** For each trial, find the speed of sound. Use the equation $v = f\lambda$, where f is the frequency of the tuning fork.

CONCLUSIONS

3. **Evaluating Results** Find the accepted value for the speed of sound in air at room temperature (see **Appendix F**). Find the average of your results for the speed of sound, and use the average as the experimental value.
   a. Compute the absolute error using the following equation:
   $$\text{absolute error} = |\text{experimental} - \text{accepted}|$$
   b. Compute the relative error using the following equation:
   $$\text{relative error} = \frac{(\text{experimental} - \text{accepted})}{\text{accepted}}$$
4. **Analyzing Results** Based on your results, is the speed of sound in air at a given temperature the same for all sounds, or do some sounds move more quickly or more slowly than other sounds? Explain.
5. **Applying Ideas** How could you find the speed of sound in air at different temperatures?