Sound waves

Teacher Notes

PHYSICS
Sound

Driving Question:
What is sound and what are sound properties?

Applied Technology: Data-logging

Student Level: Middle School Level (11-14)

Duration: 1 lesson period

Recommended Settings: Student Investigations

Learning Objectives

- To learn that sounds are made by vibrations
- To record tuning forks' sound waveforms
- To interpret the recorded sound graphs
- To determine the period and frequency of sound waves from tuning forks
- To measure the amplitude of sound waves from tuning forks
- To understand that the term "loudness" describes how loud sound is and is connected to the amplitude of sound vibrations
- To understand that the term "pitch" describes how high or low sound is and is connected to the frequency of vibrations

Didactical Approach

In this activity students use the sound sensor and record the sound waveforms from tuning forks.

Common student difficulties:

- Sounds can be produced without using any material objects.
- Hitting an object harder changes the pitch of the sound produced.
- Loudness and pitch of sounds are the same things.
- The pitch of a tuning fork will change as it "slows down", (i.e. "runs" out of energy)
- Frequency is connected to loudness for all amplitudes.
- Sound waves are transverse waves (like water and light waves).

Concepts learnt in this activity:

- Sound wave, period, frequency, amplitude, pitch, loudness.

Materials

- Data-logger e.g. CMA €Lab,

– Sound sensor,
– Tuning forks of two different frequencies, for example 440 Hz and 436 Hz.

Procedure

- Let the students answer questions given in the ‘Thinking about the question’.
- Start the activity by asking students: ‘What do you think a sound would look like if we could see it?’ Have student volunteers come up to the board to illustrate.
- Open Coach Activity ‘Sound waves’.
- Divide the class into groups, and let students set up the experiment and record the sound of a tuning fork.
- Discuss the recorded sound waveforms and how sound is produced and how it travels to a sound sensor (and human ear).
- Let students determine the amplitude and period of sound vibrations and let them calculate the frequency of the recorded sound.
- Then let them perform investigations on sound loudness and pitch, and summarize their findings by defining the properties of sound: loudness (defined by sound amplitude), pitch (defined by sound frequency).

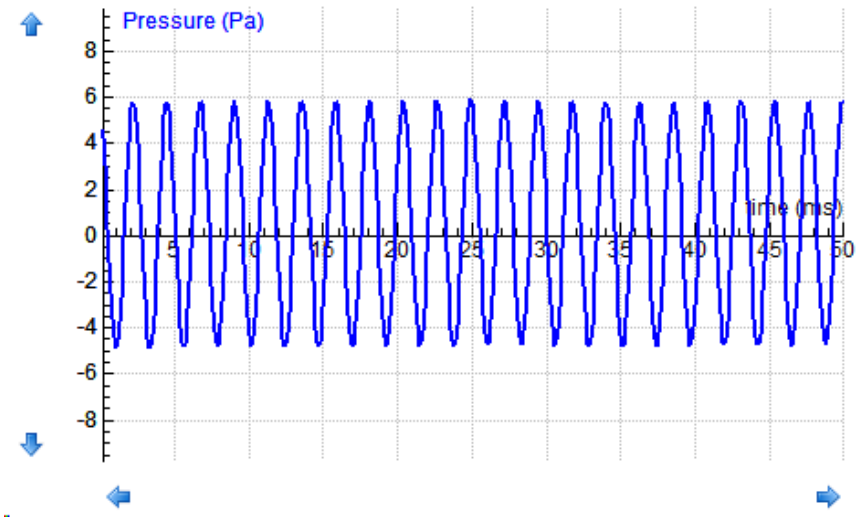
Questions and Assignments

- What is the frequency of vibrations?
- How do you determine the amplitude of the sound waveform?
- How do you determine the period of the sound waveform?
- How do you calculate the amplitude of the sound waveform?
- What determines pitch?
- What determines loudness?
- How do you determine the amplitude of the sound waveform?

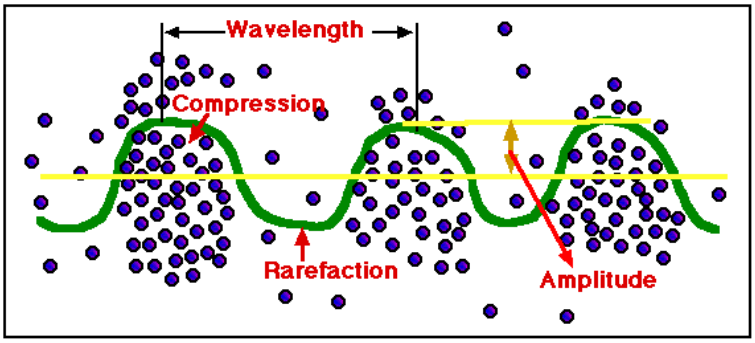
Data Analysis

Students use the sound sensor and record a sound pattern (wave-form) produced by a tuning fork.

The graph shows exemplary data.



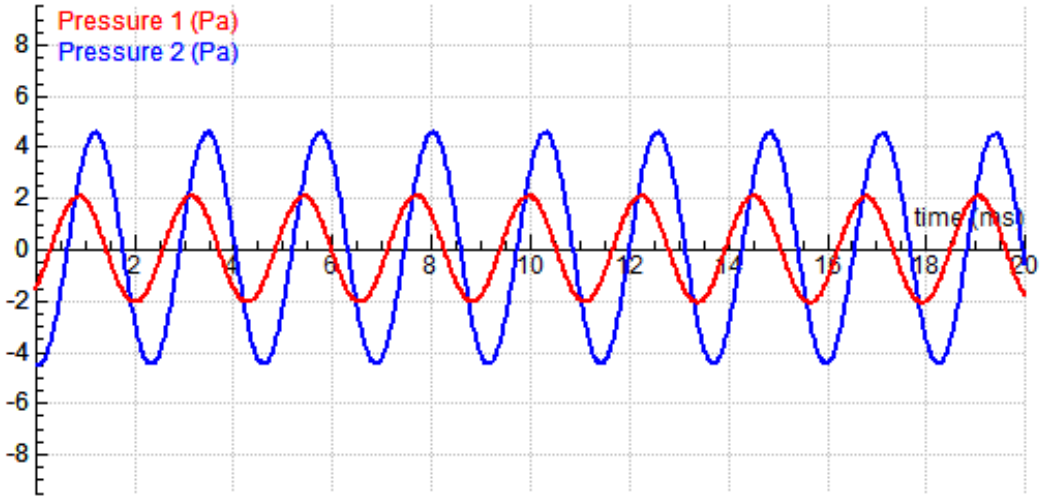
After the explanation/discussion what the sound vibrations are students may draw a sound waveform on the given picture, in the way shown below.



This picture also indicates the wavelength and amplitude of the sound wave. Wavelength is the distance between two consecutive wave compressions (or wave rarefactions). Amplitude is related to the loudness of sound.

During investigations students should discover that:

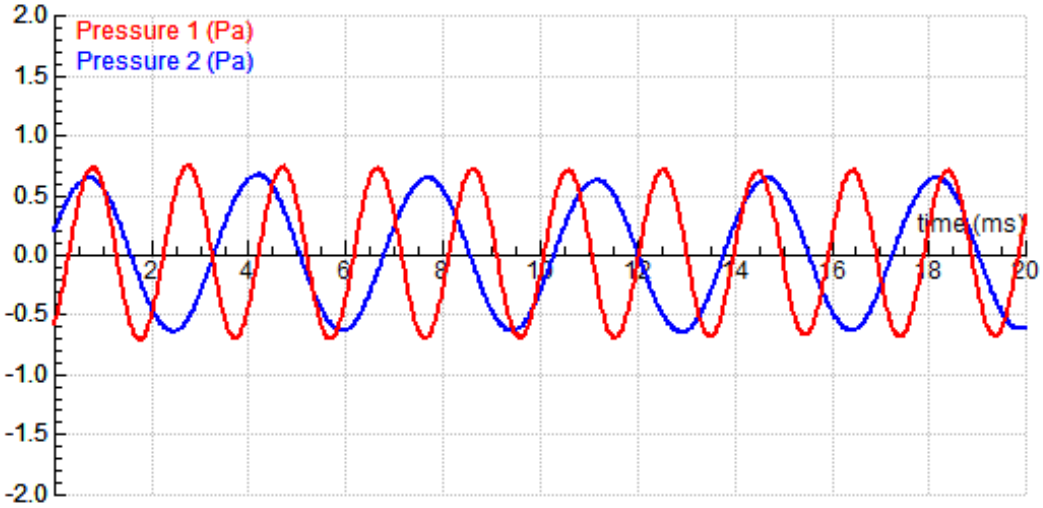
– the sound loudness is related to the height of the sound vibrations or in other words to the amplitude of sound vibrations.



Data examples: Vibrations of a hard struck tuning fork (blue waveform) have higher vibrations (higher amplitude) than vibrations of a soft struck tuning fork (red waveform). The number of vibrations in 20 ms[1] time remains the same.

[1] 1 ms = 0.001 second

– the pitch is determined by the number of vibrations in a time period (sound frequency). Discuss this with students and conclude that sound with a high frequency (many vibrations per second) will make a high-pitched sound, and one with a low frequency (less vibrations per second) will make a low-pitched sound.



Data examples: The tuning fork of a high frequency (high-pitched sound) has more vibrations in the recorded time period (10 vibrations in 20 ms) than the tuning fork of a low frequency (6 vibrations in 20 ms). When the tuning forks are struck with the same force (loudness) the amplitude of the waveforms remain near the same.

Resources

Coach 6 Activity: Sound waves.cma7

Coach 6 Result: Sound waves - tuning fork 384 Hz.cmr7

Sound waves - tuning fork 440 Hz.cmr7

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