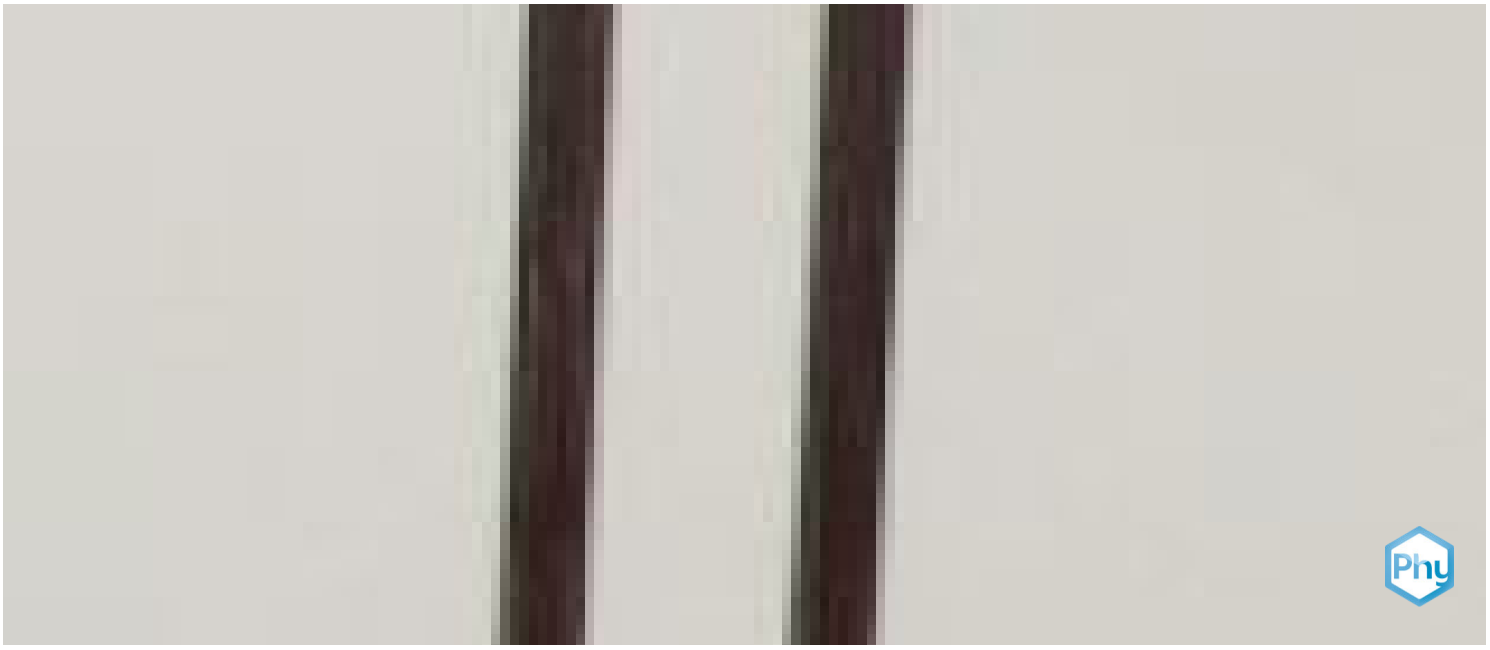
Suspended animation



Physics | Acoustics | Sound generation & propagation

Difficulty level	Group size	Preparation time	Execution time
easy	1	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/61641648374f4f00038cbae9

PHYWE

General information

Application

Experiment setup

Beating is a physical phenomenon in which two waves with slightly different frequencies additively superimpose, producing the characteristic periodic rising and falling amplitudes.

The varying amplitude itself can be understood as an oscillation and described with the so-called envelope.

In this experiment, students will observe this physical effect and learn the relevant principles associated with levitation.

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Application

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Other teacher information (1/3)

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Previous knowledge

Before performing the experiment, the students should be familiar with the operation of the measure Acoustics software.

Scientific principle

In this experiment, a beat is created by aggravating one tip of a tuning fork, causing the tuning fork to produce two sound waves with slightly different frequencies when struck.

These are then digitally recorded and visualized, allowing students to observe levitation and learn about its laws.

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Other teacher information (2/3)

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Learning objective

In this experiment, students learn how a beat occurs and how the frequency of the beat of two tones is related to the frequencies of the tones.

Tasks

In this experiment, students find out what actually happens during a levitation.

1. They investigate how the superposition of two tuning forks of the same frequency sounds, one of which is slightly detuned with a small piece of silicone tubing.
2. They use the PC to analyze how such a superposition changes with the frequency difference of the individual signals.

Other teacher information (3/3)

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Notes on structure and implementation

When using headphones, always check the playback volume before putting on the headphones.

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Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

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Student Information

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Motivation

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A string orchestra

When several sound signals reach our ears at the same time, these signals are superimposed to form a resulting signal.

If the individual signals all have the same frequency, then the resulting signal can also be heard at this frequency, but the volume changes.

However, when two sound signals with different frequencies are perceived, an effect called beating occurs. Beats are used, for example, to tune musical instruments.

In this experiment, we take a closer look at levitation.

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Equipment

Position	Material	Item No.	Quantity
1	Tuning fork 440 Hz	03424-00	2
2	Impact hammer, rubber	03429-00	1
3	Frame drum, d = 20 cm	13289-11	1
4	Silicone tubing, inner diameter 3 mm	39292-00	1
5	Software "Measure Acoustics", single user license	14441-61	1

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Set-up

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Fig. 1

Part 1: Beat of two tuning forks

- Cut a 3 mm wide piece of tubing and slide it a few millimeters onto the tine of one of the two tuning forks (Fig. 1).

Part 2: Beating of two sine tones on the PC

- Connect the headphones to the computer correctly.
- Put on your headphones and set the output volume in the audio settings of your PC to a level that you are comfortable with.
- Start the measure Acoustics software.
- Open experiment "2.3 Schwebung".

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Implementation (1/4)

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Part 1: Beat of two tuning forks

1. Strike the tuning fork without the tube piece and place it with its foot on the membrane of the frame drum.
2. Strike the tuning fork with tube piece with the striking hammer and hold its foot on the membrane.
3. Then strike both tuning forks and hold them simultaneously with their foot on the membrane of the frame drum.
4. Record your observations for frequency and loudness (relative amplitude) of the audible sound in your experimental protocol when you hear the second tuning fork at the same time as the first tuning fork.

Implementation (2/4)

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Part 2: Beating of two sine tones on the PC

1. Open the experiment overview (menu item "File" → "Open experiment" or select "Open experiment" from the menu bar). Select the experiment "2.3 Beating" from the folder "2 Physical principles: Vibrations and waves".

2. In the diagram "Spectrum of the signal at the audio output (loudspeaker or headphones)" two tones are already preset. In the menu "Tone generator" you can view the settings for frequency and relative amplitude for both tones.

3.Right-click on the diagram in the "Spectrum ..." window. (Loudspeaker or Headphone)" and select "Sound generator".

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Implementation (3/4)

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4. In the further course of the experiment, the first tone should remain unchanged and the second tone should only be adjusted in its frequency.

Activate the playback of the two tones and listen to how they sound together.

5. In the graph window, select "Spectrum ... (speakers or headphones)" "Start".

6. Then look at the diagram "Time function of the signal at the audio output (loudspeaker or headphones)". The curve resembles a sine wave (enlarge the curve if necessary), but its relative amplitude is not constant, but varies regularly over time.

7.Use the crosshairs to measure over time how much time lies between two points of time of the smallest relative amplitude. This time is called the beat duration. Write down the value of the beat duration together with the frequencies of the two tones.

Procedure (4/4)

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8.In the diagram window at the top of the gray bar, use the crosshairs "Mark" to determine the x-value (here: frequency in Hz) and the y-value (here: relative amplitude of the sound pressure in %) at the location of the crosshairs by reading both values at the bottom of the screen in the status bar.

9. Repeat your observations and measurements for different frequencies of the second tone: 1050 Hz, 1020 Hz and 1000 Hz. Change the frequency of the second tone in each case.

10. Click in the diagram window "Spectrum of the signal ... (loudspeaker or headphones)" and select "Tone generator" from the menu that appears. In the tone generator, enter the desired frequency in the line of tone 2 under Frequency and select "Apply" at the bottom right.

11. Also note the difference in the auditory impression for 1010 Hz and 1001 Hz.

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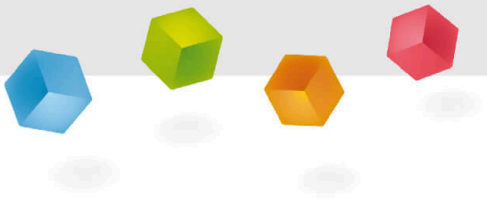

Report

Task 1

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When does a beat occur?

- A beat occurs when oscillations or waves with strongly different frequencies overlap.
- A beat occurs when two waves are perfectly additive.
- A beat occurs when several oscillations or waves with similar but not the same frequency are additively superimposed.
- A beat occurs when oscillations or waves interfere exactly destructively with each other and thus cancel each other out.

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Task 2

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Drag the words into the correct gaps

The _____ is a sinusoid which wraps itself around a beat like an envelope. It can be used to describe how exactly the _____ change periodically.
There are also the beat amplitude, beat frequency and beat period.
These _____ are at the same time the vibration-describing quantities of the envelope.

amplitudes
envelope
quantities

Check

Task 3

PHYWE

Mark the correct word in the brackets in this text

Note that the beat frequency and the (amplitude / period) of the beat, as with all other oscillations, are tightly bound to each other via the reciprocal.

Now, the closer the two (frequencies / amplitudes) of the original oscillations are to each other, the greater the beat period.

If the two original oscillations had unequal amplitudes, the resulting beat is also called a (pure / impure) beat.

Check

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