Frequency determination by beat

Physics | Acoustics | Wave Motion

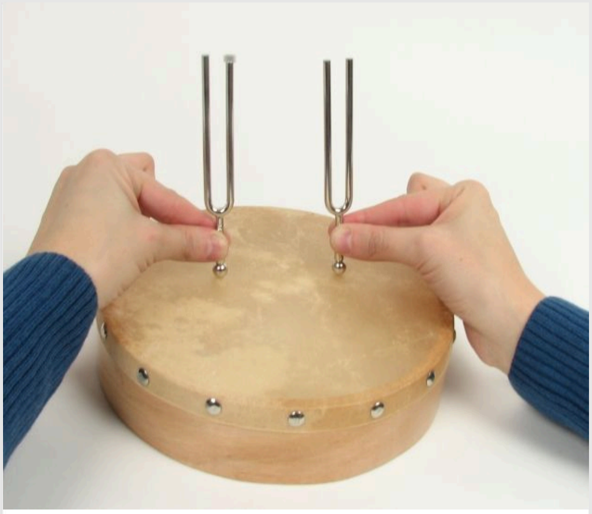
Difficulty level	Group size	Preparation time	Execution time
easy	1	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/61668adfe473310003365cde

Teacher 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 use beat to determine the frequency of oscillation.

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Other teacher information (1/2)

Previous knowledge

Before performing the experiment, students should be familiar with the concept of beat and the operation of measure Acoustics.

Scientific principle

In this experiment, students will create many different beats and investigate how to determine the frequencies of the vibrations from the beat.

Other teacher information (2/2)

Learning objective

In this experiment, students learn how to use beat to make statements about vibrational frequencies.

Tasks

In this experiment, students determine the frequency of an out-of-tune 440 Hz tuning fork.

1. They measure the beat frequency and calculate possible frequencies of the detuned tuning fork.
2. You determine whether the frequency of the detuned tuning fork is greater or less than the frequency of the untuned tuning fork and thus determine the frequency of the detuned tuning fork.

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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 blues band

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.

If you now know one of the frequencies, you can determine the remaining frequencies.

Tasks

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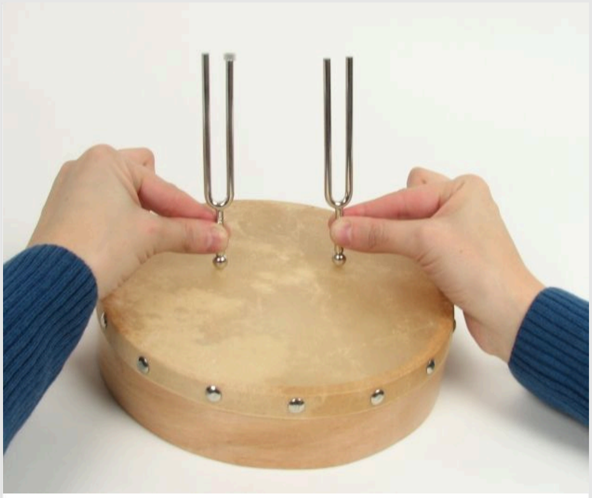

The experimental setup

In this experiment, determine the frequency of a detuned 440 Hz tuning fork.

1. Measure the beat frequency and calculate possible frequencies of the detuned tuning fork.
2. Determines whether the frequency of the detuned tuning fork is greater or less than the frequency of the untuned tuning fork, and thus determines the frequency of the detuned tuning fork.

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Equipment

Position	Material	Item No.	Quantity
1	Software "Measure Acoustics", single user license	14441-61	1
2	Tuning fork 440 Hz	03424-00	2
3	Impact hammer, rubber	03429-00	1
4	Frame drum, d = 20 cm	13289-11	1
5	Silicone tubing, inner diameter 3 mm	39292-00	1
6	Digital stopwatch, 24 h, 1/100 s and 1 s	24025-00	1

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Set-up

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Fig. 1

First, find an experimental partner.

Part 1: Measurement of beat frequency

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

Part 2: Measurement of the unknown frequency with the PC

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

Implementation (1/4)

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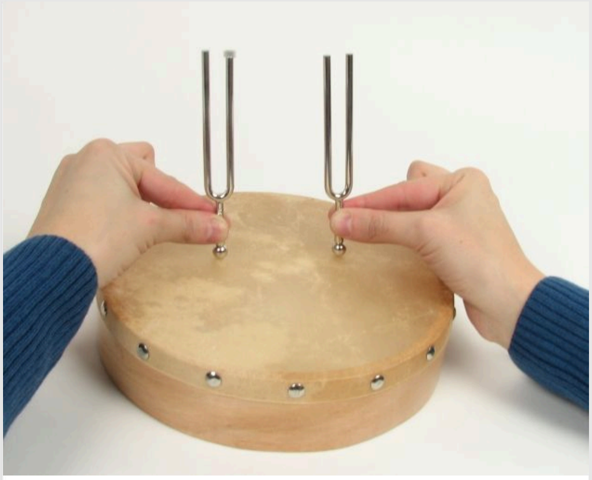

Figure 2

Part 1: Measurement of beat frequency

1. Student 1: Take the stopwatch and get it ready to go.
2. Student 2: Strike both tuning forks and place them with their feet on the frame drum (Fig. 2).
3. Student 2: Count 30 beat maxima; Student 1: Time the time it takes Student 2 to count 30 beat maxima.
4. Note your result.

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Implementation (2/4)

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Figure 3

Part 2: Measurement of the unknown frequency with the PC

1. Now measure whether the frequency of the detuned tuning fork is greater or less than the frequency of the untuned tuning fork.

Using the results from Part 1, the value of the frequency of the detuned tuning fork can then be determined.

2.Student 1: Strike the tuning fork detuned with the piece of tubing and hold it in front of the microphone (Fig. 3).

Implementation (3/4)

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3. Student 2: Freeze the graph by selecting "Enable/Freeze Graph" in the Audio Input (Microphone) Spectrum window.

4. Enlarge the range of maximum amplitude, read the frequency of the detuned tuning fork with the crosshairs and note your result.

Enlarge the appropriate section of the diagram as follows: Hold down the left mouse button and drag a rectangle from the upper left corner to the lower right corner.

Then select the crosshairs with "Mark", hold the crosshairs at the position of the amplitude maximum and read off the x-value (frequency in Hertz) at the bottom left of the diagram window.

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Procedure (4/4)

5.Restores the default graph section and activates the graph. Select "Standard Section" and "Activate/Freeze Graph" in the "Spectrum..." window. (Microphone)" window, select "Standard Section" and "Activate/Freeze Diagram".

6.Repeat the experiment from part 2 at least 10 times, noting the value of the frequency each time.

Report

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Task 1

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When does a beat occur?

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

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.

- envelope
- amplitudes
- quantities

Check

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Task 3

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Mark the correct word in the parenthesis

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

Task 4

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What is the beat frequency as a function of the two original frequencies?

- To determine the beat frequency, the quotient of the two frequencies is formed.
- The beat frequency is equal to the difference of the two frequencies.
- The beat frequency is calculated from the product of the two frequencies.
- The beat frequency can be determined from the sum of the two frequencies.

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Slide	Score / Total
Slide 16: Appearance of a beat	0/1
Slide 17: The envelope	0/3
Slide 18: Suspension properties	0/3
Slide 19: beat frequency	0/1

Total 0/8

Solutions Repeat

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