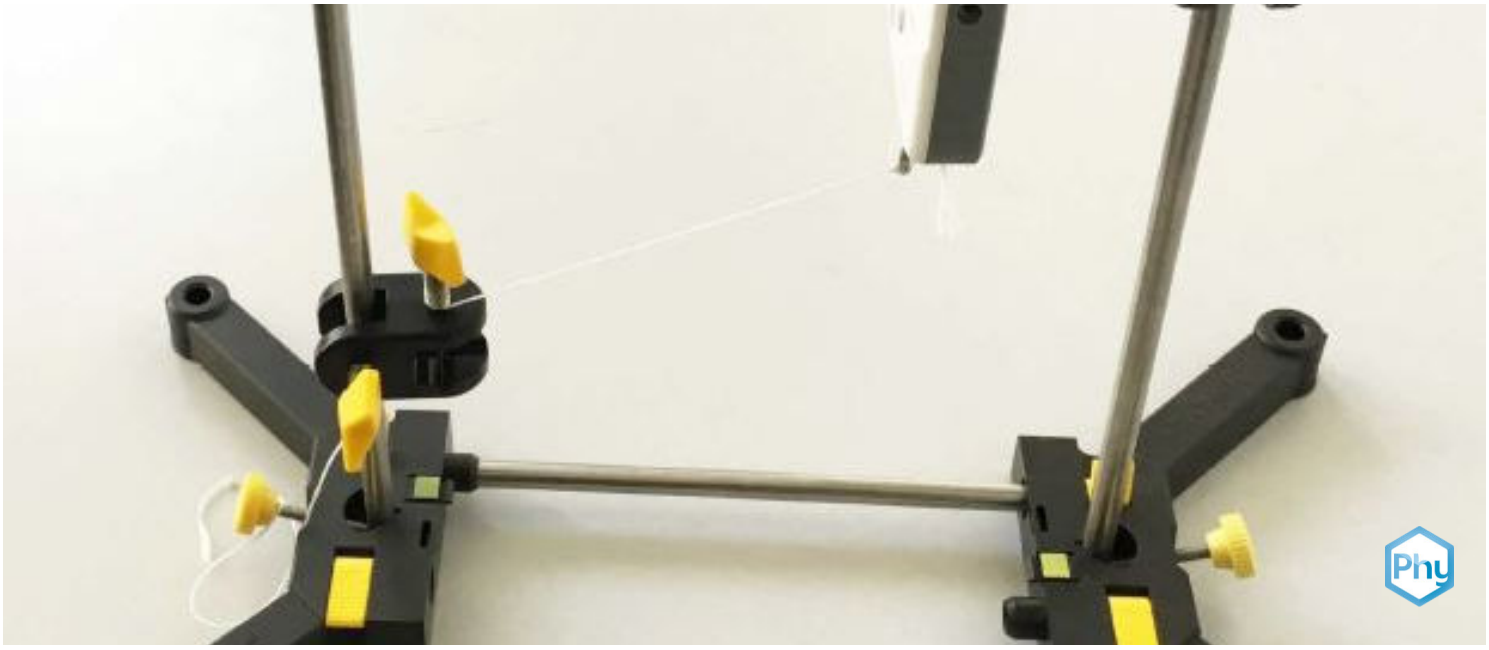
Thread oscillation with Cobra SMARTsense



Physics | Mechanics | Dynamics & Motion

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/5f41c7c9ec7b8f0003d0ea74

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Teacher information

Application

Experiment set-up

Vibrations occur in countless applications of everyday life: When swinging on the playground, playing a musical instrument or clocking electronic devices. Vibrations can be intentional (e.g. oscillating quartz in watches) or unintentional (e.g. vibrations while driving a car) and are primarily described by their amplitude and the period duration or the resulting frequency.

In general, harmonic oscillations can be described with the help of trigonometric functions. In the case of a damped oscillation, the frequency does not change, but the maximum deflection decreases exponentially with time.

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Application

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Other teacher information (1/2)

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Prior knowledge

Students should be familiar with the concept of damped vibration and be able to use the terms period duration, frequency and amplitude.

Scientific principle

By plucking a tensioned thread or rope, vibrations are excited on it. These are acoustically perceptible, similar to a guitar. The vibration varies the force effect at the end of the rope, which is why the vibration can be measured with a force sensor.

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Other teacher information (2/2)

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Learning objective

The students should excite vibrations on a thread themselves and investigate the dependence of the period and frequency on the tension of the thread.

Tasks

1. The pupils stimulate vibrations on the thread with their hands and perceive them acoustically for different rope tensions.
2. They measure the yarn vibration for different rope tensions with the help of the force sensor.

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

Motivation

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Guitar strings

Vibrations occur in countless applications of everyday life: When swinging on the playground, playing a musical instrument or clocking electronic devices.

Vibrations can be intentional (e.g. oscillating quartz in watches) or unintentional (e.g. vibrations while driving a car) and are primarily described by their amplitude and the period duration or the resulting frequency.

In this experiment, you will examine the different natural vibrations of vibration/tones of a thread stretched to different degrees, similar to the different strings of a guitar.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense - Force and Acceleration, ± 50N / ± 16g (Bluetooth + USB)	12943-00	1
2	Support base, variable	02001-00	1
3	Support rod, l = 600 mm, d = 10 mm, split in 2 rods with screw threads	02035-00	1
4	Support rod with hole, stainless steel, 10 cm	02036-01	1
5	Boss head	02043-00	2
6	Fishing line, l. 20m	02089-00	1
7	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Set-up (1/6)

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For measurement with the **Cobra SMARTsense sensors** the **PHYWE measureAPP** is required. The app can be downloaded free of charge from the relevant app store (see below for QR codes). Before starting the app, please check that on your device (smartphone, tablet, desktop PC) **Bluetooth** is **activated**.

iOS

Android

Windows

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Set-up (2/4)

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Connect support bases together

Use the 25 cm long rod to connect the support base together.

Now use the two-part support rod, mount one rod vertically in each of the support base halves and screw it tight.

Set-up (3/4)

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Fasten force sensor

Mount the force sensor over the short stand rod in a boss head and attach it to one of the two stand rods so that the force sensor points inwards.

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Set-up (4/4)

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Experiment set-up

Take the second boss head and attach it to the vertical stand rod opposite the force sensor.

Remove the free screw from the second boss head and feed a piece of thread through the threaded hole. Fix the thread in the thread by screwing the screw back in. Connect the other end of the thread to the force sensor. The thread should now be slightly taut.

Now move the second boss head vertically until the thread is under strong tension and fix the boss head at this point.

Procedure (1/4)

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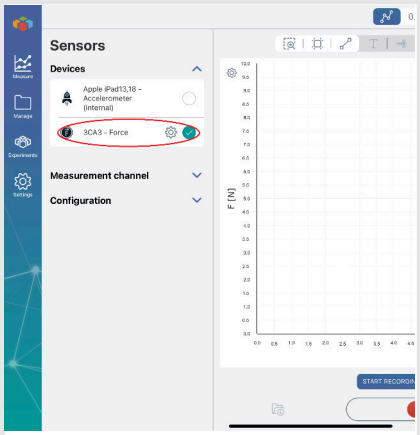
Force sensor

- Switch on the force sensor by pressing the power button for several seconds. After successful switching on you will see a LED flashing.
- Start the measureAPP and select the force sensor under "Devices".
- Pluck the thread with your finger and pay attention to the sound it makes. By moving the second double socket you can vary the tension in the thread. Adjust the tension of the thread, pluck the thread with your finger and pay attention to the pitch.



Select sensor in measureAPP

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Procedure (2/4)

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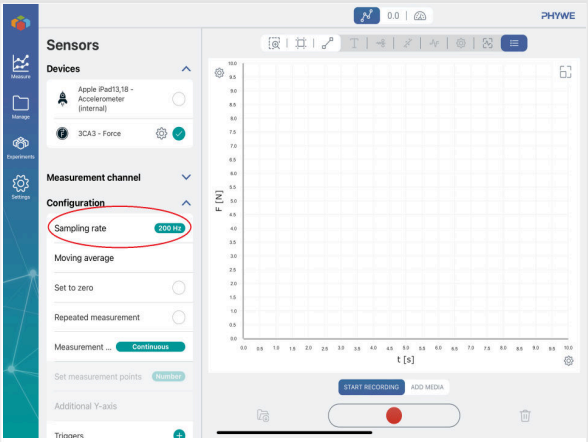

Extract from measureAPP

- Tap on the tab "Settings" and tap on "Sampling rate".
- In the following window, move the selection slider to the far right to the value 1000.
- Leave the window by clicking on "Save".

Procedure (3/4)

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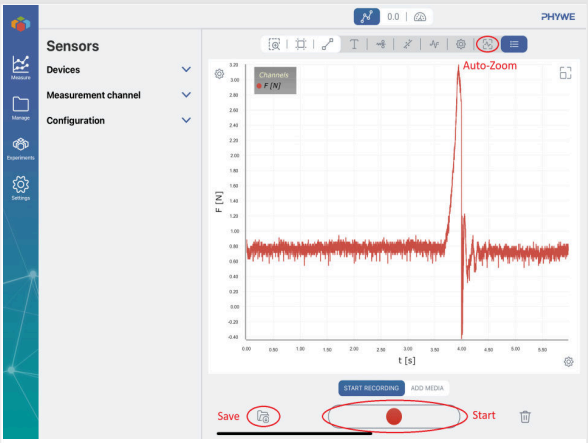

Measurement data in measureAPP

- Now set a moderate thread tension. Start the measurement and then pluck the thread.
- Finish the measurement and use the Auto Zoom function.

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Procedure (4/4)

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Measurement data in measureAPP

- Zoom into the graph with your hand, just behind the peak. Then use the "Measure" function and measure the temporal (horizontal) distance between about 5 periods.
- Calculate the period duration from this value T and the frequency f of the thread oscillation. Enter the value in the table of the Report.
- Repeat this measurement for increasing yarn tension and enter your results in the table.

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Report

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Table 1

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Enter your values for the period duration T and the frequency $f = 1/T$ into the table.

Measurement No.	$T\,[s]$	$f\,[1/s]$
1		
2		
3		
4		
5		

Task 1

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Experiment set-up

What did you notice acoustically when you plucked the rope for different thread tensions?

- ○ The higher the tension, the lower the sound produced.
- ○ There was no acute difference.
- ○ The higher the tension, the higher the sound produced.

Check

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Task 2

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Experiment set-up

Does your observation from question 1 agree with the results in Table 1? Justifications.

- ○ Yes, because the higher the tension and frequency, the higher the sound produced.
- ○ No, because the higher the tension and frequency, the lower the sound produced.

Check

Task 3

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Experiment set-up

Why does the vibration fade away in the series of measurements and what is this effect called?

- ○ The vibration decays due to the gravitational force acting on the thread.
- ○ The vibration decays due to the damping of the system.

Check

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