Hooke's law with Cobra SMARTsense

In this experiment, the pupils should learn that deformation is a characteristic property of every spring. They should also learn to understand relationships through Hooke's law. Application and measurement on two coil springs.

Physics > Mechanics > Forces, work, power & energy

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/618d1b98f20c940003879e5b

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Teacher information

Application

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Spring scale

Test setup

Hooke's law

Hooke's law can be applied to determine the mass of a body.

If you hang a body on a spring, you can determine the weight of the body by means of the deflection resulting from the load exerted by the body and the spring constant.

By means of the connection $m = \frac{F_G}{g}$ then the mass of the body can be determined.

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Teacher information (1/2)

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Previous

Students should be made aware of the context $F_g = m \cdot g$ be known.

Principle

Hooke's law: The elastic deformation is proportional to the applied load.

Teacher information (2/2)

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Learning

In this experiment, students will learn that deformation is a characteristic property of any spring that can be used to observe a fundamental law (Hooke's law). The students should understand the statement of Hooke's law, i.e. the proportionality between force and deflection within the elastic range of an elastic body, by making measurements on two coil springs with different spring constants.

Task

Students:

1. Measure the force on the spring with increasing load and determine the respective deflection.
2. Check whether there is a correlation between load and deflection for two different springs.

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Safety instructions

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

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Motivation

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Spring scale

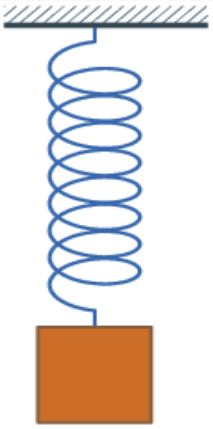
Hooke's law

Can forces deform bodies?

Hooke's law can be applied to determine the mass of a body.

If you hang a body on a spring, you can determine the weight of the body by means of the deflection resulting from the load exerted by the body and the spring constant.

By means of the connection $m = \frac{F_G}{g}$ the mass of the body can be determined.



Task

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Test setup

1. Measure the power F on a spring under increasing load and determine the respective deflection.

2. Check whether there is a correlation between load and deflection for two different springs.

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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	Boss head	02043-00	1
5	Weight holder, 10 g	02204-00	1
6	Slotted weight, black, 10 g	02205-01	4
7	Slotted weight, black, 50 g	02206-01	3
8	Helical spring, 3 N/m	02220-00	1
9	Helical spring, 20 N/m	02222-00	1
10	Holding pin	03949-00	1
11	Glass tube holder with tape measure clamp	05961-00	1
12	Measuring tape, l = 2 m	09936-00	1
13	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Set-up (1/3)

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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

Set-up (2/3)

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- Rotate the two-part tripod rod together.
- Put the tripod base and the tripod rod together like this to form a tripod.
- Clamp the tape measure into the glass tube holder.
- Then clamp the glass tube holder to the bottom of the tripod rod.

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Set-up (3/3)

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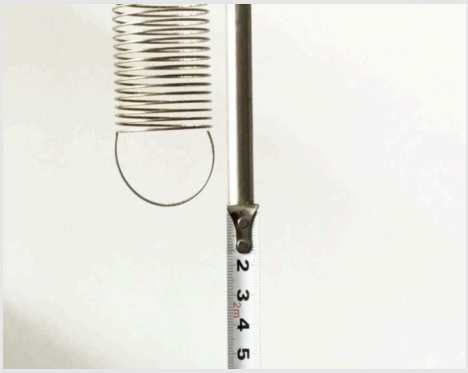
- Fasten the force sensor in the double socket.
- Hang coil spring 1 (larger diameter) on it.
- Adjust the tape measure so that its zero mark coincides with the end of the coil spring.



Procedure (1/8)

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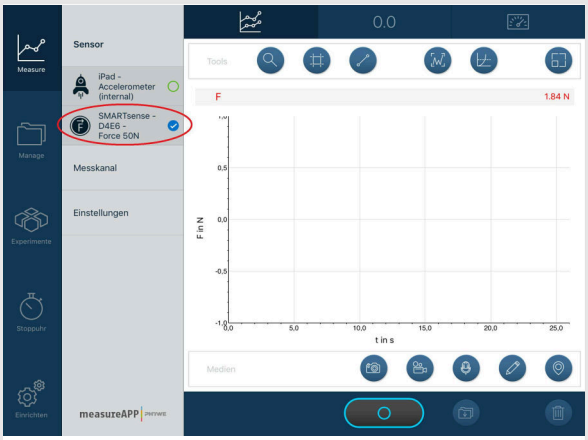
Switch on



Select sensor in measureAPP

- Turn on the force sensor by pressing the power button for several seconds.
- After successful switching on you will see a flashing LED (left picture).
- Start the measureAPP. Tap on the tab "Sensor" and select the force sensor (right figure).

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Procedure (2/8)

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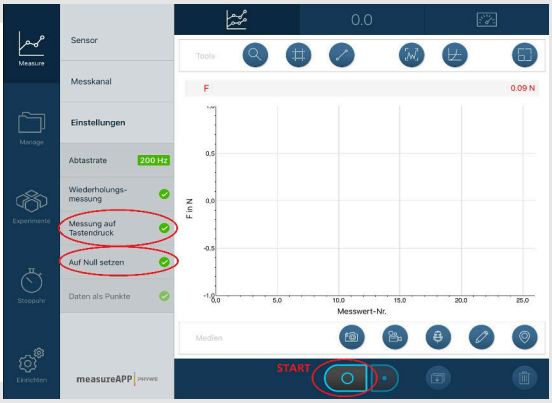
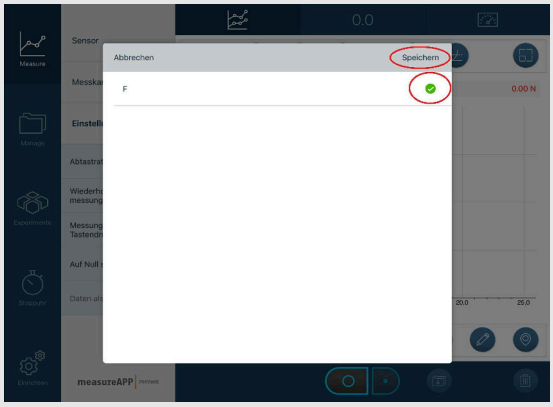
- Tap on the tab "Configuration" and select "Measurement on keystroke" (left figure). In the same tab, tap on "Set to zero" and select the force sensor in the following window.
- Exit the window by clicking on save (right image).





Procedure (3/8)

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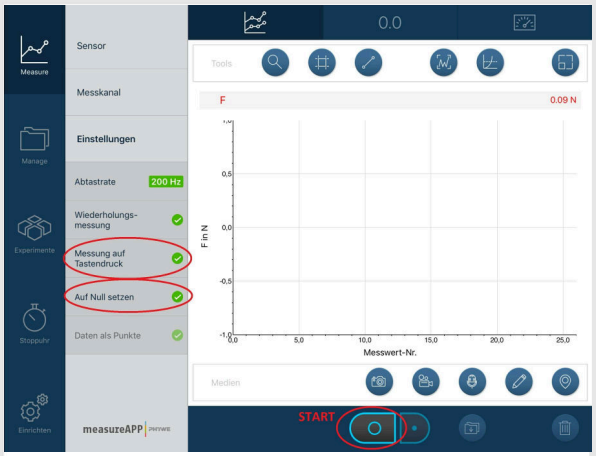

Execution - Start measurement

- Hang the weight plate (mass = 10g) on the eyelet of the coil spring.
- The spring should be completely at rest and not vibrate. Therefore, if necessary, steady the system with your hand.
- Start the measurement (figure). The first measured value is immediately displayed in the diagram.

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Implementation (4/8)

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Execution - Measurement

- Increase the weight by 10 grams, take another reading and again read the deflection on the tape measure.
- Repeat the last step until a weight of 50 grams is reached.
- Stop the measurement.
- Use the auto-zoom function.

Procedure (5/8)

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Execution - Straight through the points

- Lay a straight line through the data points that describes the measurement points as well as possible.
- Save the measurement.

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Procedure (6/8)

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Feedthrough - slotted weight

NoteTo attach the slotted weight to the weight plate, slide it over the top of the weight plate (Figure).

- Now hang the coil spring 2 on the force sensor and set the zero mark of the measuring tape to its end.
- Set the force sensor back to zero in the same way as before.
- Hang the weight plate with a mass piece 10 g (total 20 g) on the eyelet of the coil spring. Again, make sure that the spring does not vibrate.
- Start the measurement, read the deflection on the tape measure and record it in the log.

Procedure (7/8)

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Execution - Measurement

- Increase the mass by 20 g each time (up to a total of 200 g) and measure the force on the spring. Determine the deflection of the spring for each measurement and note it down.
- Stop the measurement.
- Use the auto-zoom function.
- Lay a straight line through the data points that describes the measurement points as well as possible.
- Save the measurement.

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Procedure (8/8)

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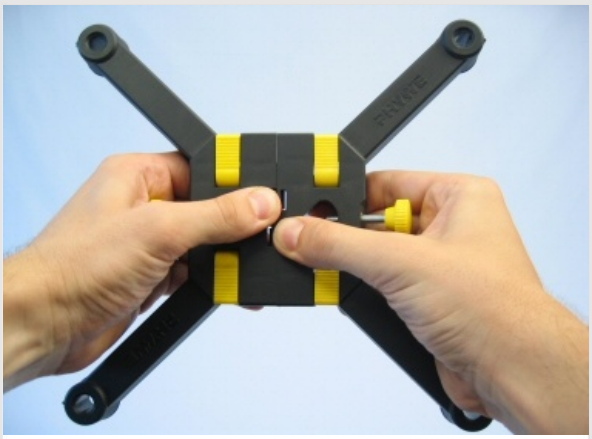

Feedthrough - Tripod base

- To disassemble the tripod base, press the buttons in the middle and pull both halves apart.

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Report

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Table 1

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Enter the deflections for spring 1 in the table.

Mass m in [g]	10	20	30	40	50
Deflection der spring 1 in [cm]					

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Enter the deflections for spring 1 in the table.

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Table 2

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Enter the deflections for spring 2 in the table.

Mass m in [g]	20	40	60	80	100
Deflection der spring 2 in [cm]					

Mass m in [g]	120	140	160	180	200
Deflection der spring 2 in [cm]					

Task 1

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For the measurement with spring 1, the weight was increased in 10 g steps. How does the measured extension of the spring change with each new weight added?

- [ ] With each new additional weight it changes the length in the same measure.
- [ ] The change in length is not constant.
- [ ] The change in length is constant.

Check

What follows from this in terms of deflection and mass?

- Deflection and mass are not in any relation to each other.
- The deflection is quadratic to the attached mass.
- The deflection is proportional to the attached mass.

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Task 2

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It can be seen that the force F acting on the spring is proportional to the attached mass m. What is the relationship between the force and the deflection of the spring.

Since the force is [ ] to the mass, and the mass in turn is [ ] to the deflection, the force is also [ ] to the defl

Check

What is the difference between the two springs?

[ ] can be stretched further than [ ] under the same load. This can be seen from the [ ] in Table 1&2. The [ ] is a measure of this property.

Spring 1 | Spring 2 | deflections | spring constant

Check

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