Hooke's law with SMARTsense (Item No.: P0999169)

Curricular Relevance

Area of Expertise:	Education Level:	Topic:	Subtopic:	Experiment:
Physik	Klasse 7-10	Mechanik	Kräfte, einfache Maschinen	Das Hookesche Gesetz

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	10 Minutes	2 Students

Additional Requirements:

- Tablet with measureApp

Experiment Variations:

Keywords:

Hooke's law, Spring pendulum, Spring constant

Information for teachers

Introduction

Application

Hooke's law can be applied to determine the mass of a body. If a body is suspended from a spring, the extension of the spring, which results from the stress that is applied by the body, and the spring constant can be used to determine the weight of the body (i.e. the force on the body due to gravity). The mass of the object can be determined by way of the relationship $m = \frac{F_w}{g}$.

Spring balance

Experiment set-up

Educational objective

The aim of this experiment is to demonstrate to the students that deformation is a characteristic of all springs based on which a fundamental law (Hooke's law) can be observed. In order to study and comprehend Hooke's law, i.e. the proportionality between force and extension within the elastic range of an elastic body, the students will perform measurements on two helical springs with different spring constants.

Task

1. Increase of the stress on a spring and determination of the resulting extension.
2. Determination of the weight of the objects that apply stress to the spring.
3. Check based on two different springs to see whether there is a relationship between stress and extension.

Prior knowledge
The students should be already familiar with the relationship $F_\mathrm{w} = m \cdot g$.

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

Equipment

Position No.	Material	Order No.	Quantity
1	Cobra SMARTsense - Force, ± 50 N	12904-00	1
2	Support base, variable	02001-00	1
3	Support rod with hole, stainless steel, 10 cm	02036-01	1
4	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
5	Support rod, l = 600 mm, d = 10 mm, split in 2 rods with screw threads	02035-00	1
6	Boss head	02043-00	1
7	Helical spring, 3 N/m	02220-00	1
8	Helical spring, 20 N/m	02222-00	1
9	Weight holder	02204-00	1
10	Slotted weight, black, 10 g	02205-01	4
11	Slotted weight, black, 50 g	02206-01	3
12	Glass tube holder with tape measure clamp	05961-00	1
13	Measuring tape, l = 2 m	09936-00	1
Additional requirements:			
14	Tablet with measureApp		

Safety information

For this experiment, the general notes and instructions concerning safe experimentation in science classes apply.

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Introduction

Application and task

Application

Hooke's law can be applied to determine the mass of a body. If a body is suspended from a spring, the extension of the spring, which results from the stress that is applied by the body, and the spring constant can be used to determine the weight of the body (i.e. the force on the body due to gravity). The mass of the object can be determined by way of the relationship $m = \frac{F_w}{g}$.

Task

1. Increase the stress on a spring and determine the resulting extension.
2. Determine the weight of the objects that apply stress to the spring.
3. Use two different springs in order to check whether there is a relationship between stress and extension.

Equipment

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Set-up and procedure

Set-up

Turn the two-part stand rod together (Fig. 1). Assemble the tripod foot and rod as shown in Figure 2.

Fig. 1

Fig. 2

Clamp the measuring tape into the glass tube holder (Fig. 3) and then clamp the glass tube holder to the bottom of the stand rod (Fig. 4).

Fig. 3

Fig. 4

Fix the force sensor in the double socket (Fig. 5) and hang the helical spring 1 on it (Fig. 6).

Fig. 5

Fig. 6

Adjust the tape measure so that its zero mark coincides with the end of the helical spring (see Fig. 7).

Fig. 7

Procedure

- Switch on the force sensor by pressing the power button for several seconds. After successfully switching on, you will see an LED flashing (Fig. 8).

Fig. 8

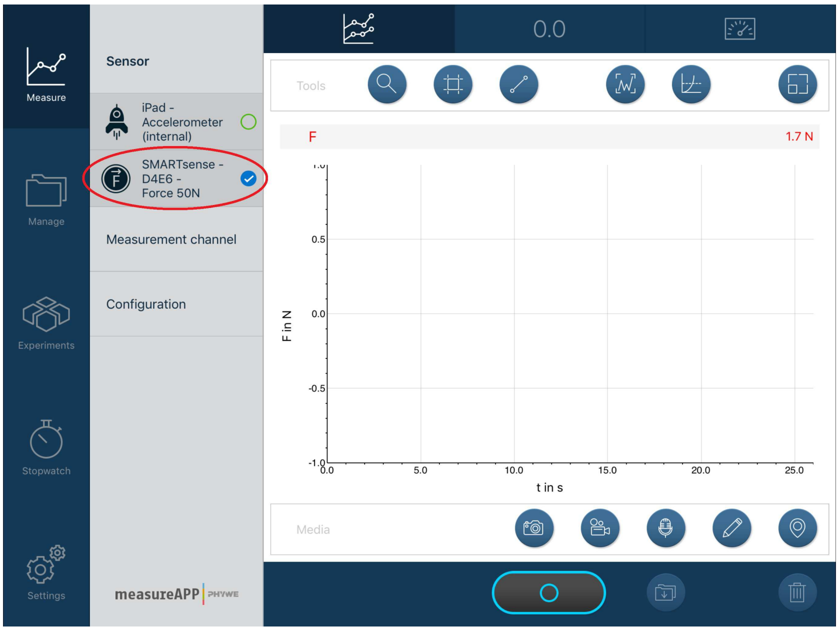

Fig. 9

- Start measureApp. Tap on the "Sensor" tab and select the force sensor (Fig. 9).
- Tap on the "Configuration" tab and select "Point by point measurement" (Fig. 10). Tap on "Set to zero" in the same tab and select the force sensor in the following window. Exit the window by clicking on save (Fig. 11).

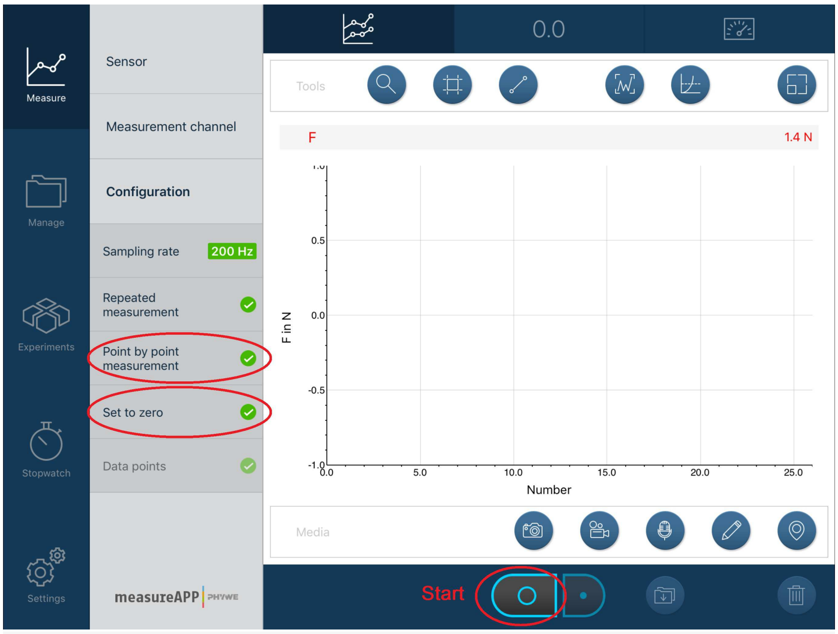

Fig. 10

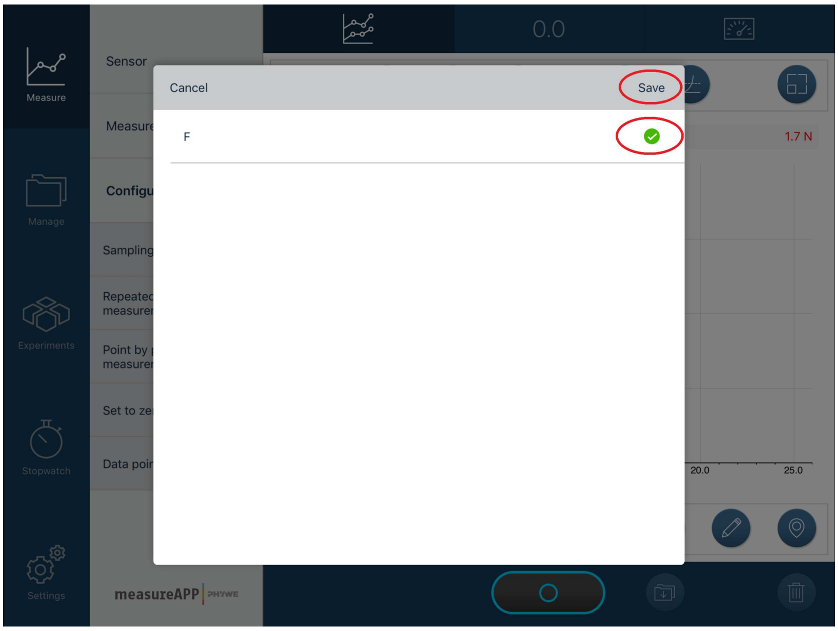

Fig. 11

- Hang the weight holder (mass = 10g) on the eye of the helical spring.
- The spring should be completely at rest and not vibrate. Calm the system down with your hand.
- Start the measurement (Fig. 10). The first measured value is immediately displayed in the diagram.
- Read off the deflection on the measuring tape and write it down.
- Increase the weight by 10 grams, take another reading (Fig. 12) and read the deflection off the tape again.
- Repeat the last step until a weight of 50 gram is reached.
- Finish the measurement (Fig. 12).
- Use the auto-zoom function (Fig. 12).
- Place a straight line through the data points (Fig. 13), which describes the measurement points as well as possible.
- Save the measurement (Fig. 13).

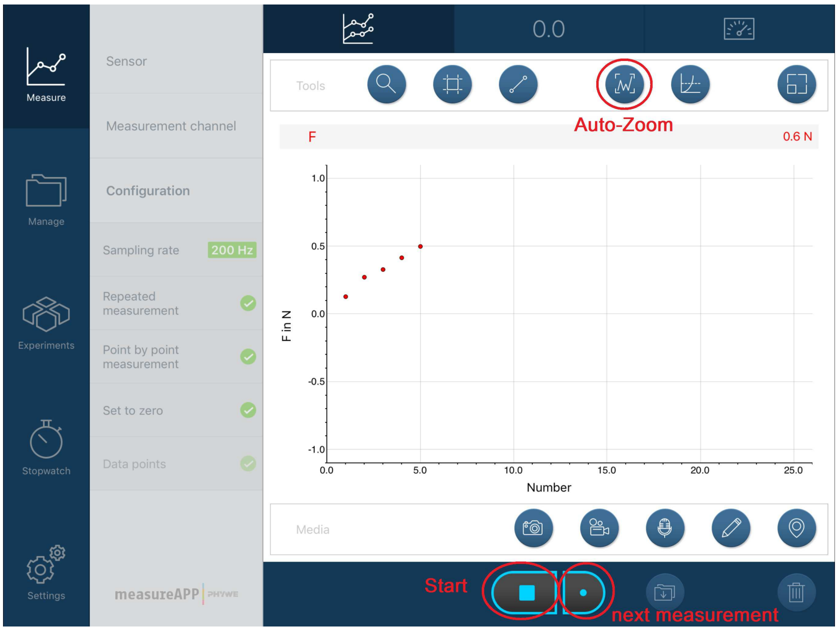

Fig. 12

Fig. 13

Note: To attach the slotted weight to the weight holder, slide it over the upper end of the weight holder (Fig. 14).

Fig. 14

- Now hang the helical spring 2 on the force sensor and set the zero mark of the tape measure to its end.
- Set the force sensor back to zero as above.
- Hang the weight holder on the eye of the helical spring with a piece of 10 g (sum 20 g). Make sure again that the spring does not oscillate.
- Start the measurement, release the deflection on the measuring tape and note it.
- 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 write it down.
- Finish the measurement.
- Use the auto-zoom function.
- Place a straight line through the data points, which describes the measuring points as well as possible.
- Save the measurement.

Note: If you disassemble the tripod base, press the yellow buttons (Fig. 15).

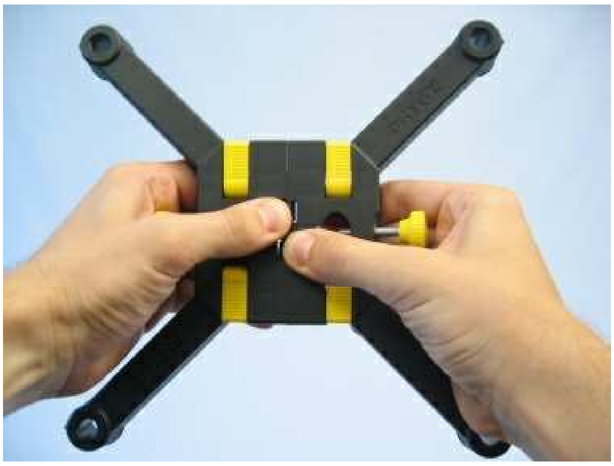

Fig. 15

Report: Hooke's law with SMARTsense

Result - Table 1

Enter the measurement results into the table.

Mass *m* in g	Deflection of spring 1 Δ*l* in cm	Deflection of spring 2 Δ*l* in cm
0	0	0
10	1 ±0	
20	1 ±0	1 ±0
30	1 ±0	
40	1 ±0	1 ±0
50	1 ±0	
60		1 ±0
80		1 ±0
100		1 ±0
120		1 ±0
140		1 ±0
160		1 ±0
180		1 ±0
200		1 ±0

Evaluation - Question 1

For the measurement with spring 1, the weight was increased in 10 g steps. How does the measured expansion of the spring change with each new weight added? Check if your answer is also valid for spring 2.

Evaluation - Question 2

What follows from the result found in question 1?

- [ ] The deflection is proportional to the attached mass.
- [ ] The deflection is square to the attached mass.
- [ ] Deflection and mass are out of proportion to each other.

Evaluation - Question 3

Fig. 13 shows that the force F acting on the spring is proportional to the mass m attached. Use the result from question 2 to clarify the relationship between the force and the deflection of the spring.

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Evaluation – Question 4

What is the difference between the two springs?

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