Potential energy and elastic energy with SMARTsense

(Item No.: P1001569)

Curricular Relevance

Area of Expertise:	Education Level:	Topic:	Subtopic:	Experiment:
Physik	Klasse 7-10	Mechanik	Arbeit und Leistung	Potentielle Energie und Spannenergie

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

Additional Requirements:

- Tablet with measureApp

Experiment Variations:

Keywords:

Potential energy, Tension energy, Work

Information for teachers

Introduction

Application
Energy conversion is an everyday phenomenon. In hydropower plants, for example, potential energy is converted into kinetic energy. Electrical energy is then generated from kinetic energy. In this experiment, the energy conversion is studied with the help of a spring. Spring tension energy is converted into kinetic and potential energy and vice versa.

Educational objective
In this experiment the students should learn that energy can be converted into different forms. The case of tension energy, kinetic energy and potential energy is used as examples.

Task

1. Observe the force required to lift a mass and the force required to tension a coil spring.
2. Attach a mass to a coil spring and let it fall. Observe the process and describe it using the term energy.
3. Determine the energy contained in a tensioned spring using the energy theorem.

Prior knowledge
Students should be familiar with the terms energy, work and mechanical forms of energy.

Remark
A mass-spring system carries out oscillations. In order to determine the tension energy of the spring at the lower reversal point of the oscillation, it is necessary to choose the height of the mass at the upper reversal point (relaxed spring) such that the mass at the lower reversal point of the oscillation just touches the table (preliminary test 1). To safely adjust this height, first the extension Δl of the spring is determined by a resting mass (Hooke's law) and this distance is then doubled: $h = 2\ \Delta l$.

Equipment

Position No.	Material	Order No.	Quantity
1	Cobra SMARTsense-Force	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	2
7	Helical spring, 3 N/m	02220-00	1
8	Weight holder	02204-00	1
9	Slotted weight, black, 10 g	02205-01	4
10	Slotted weight, black, 50 g	02206-01	3
11	Glass tube holder with tape measure clamp	05961-00	1
12	Plate with scale	03962-00	1
13	Measuring tape, l = 2 m	09936-00	1
Additionally required:			
14	Tablet with measureApp		

Safety information

For this experiment, the general instructions for safe experimentation in science teaching apply.

Introduction

Application and task

Application

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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

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

Fig. 5

Fig. 6

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

Fig. 7

Procedure

- First remove the helical spring from the force sensor.
- Switch on the force sensor by pressing the power button for several seconds. After successfully switching on, you will see a flashing LED (Fig. 8).

Fig. 8

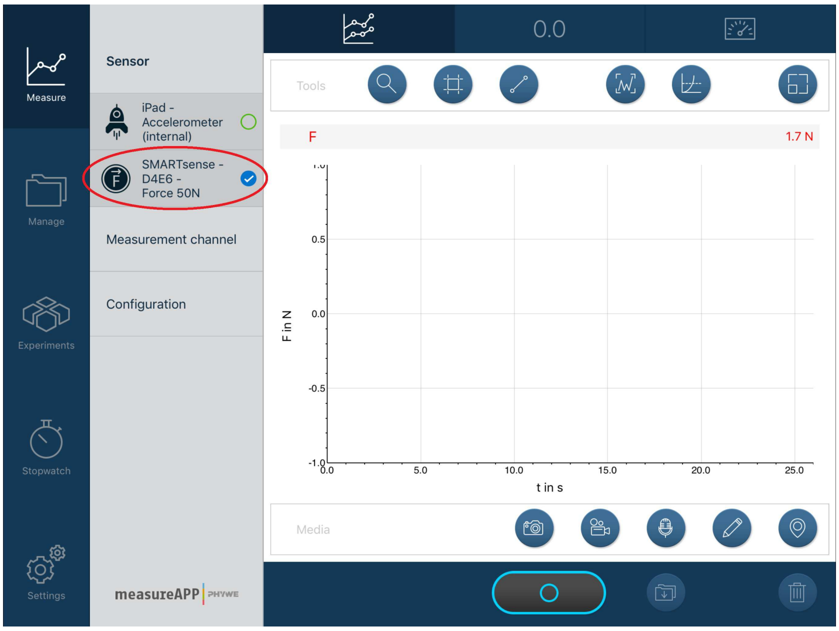

Fig. 9

- 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).

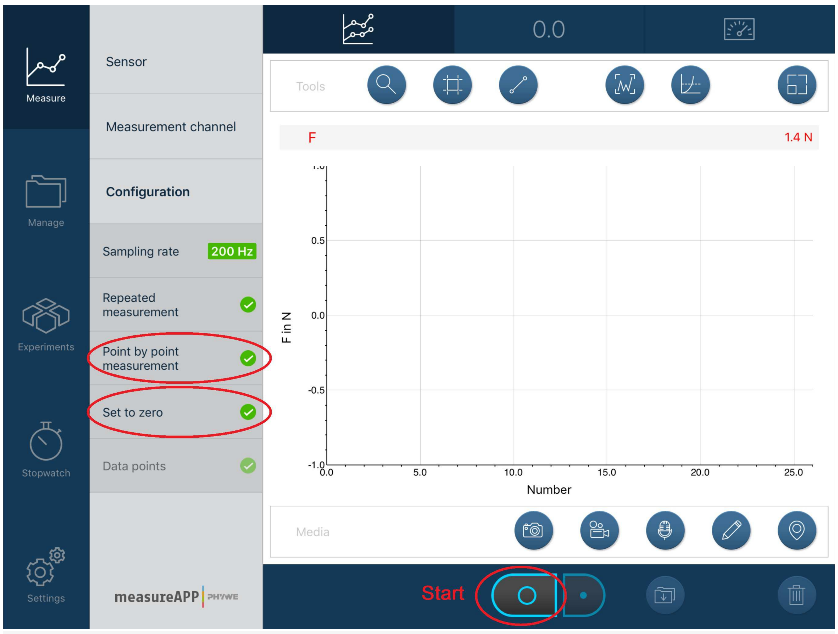

Fig. 10

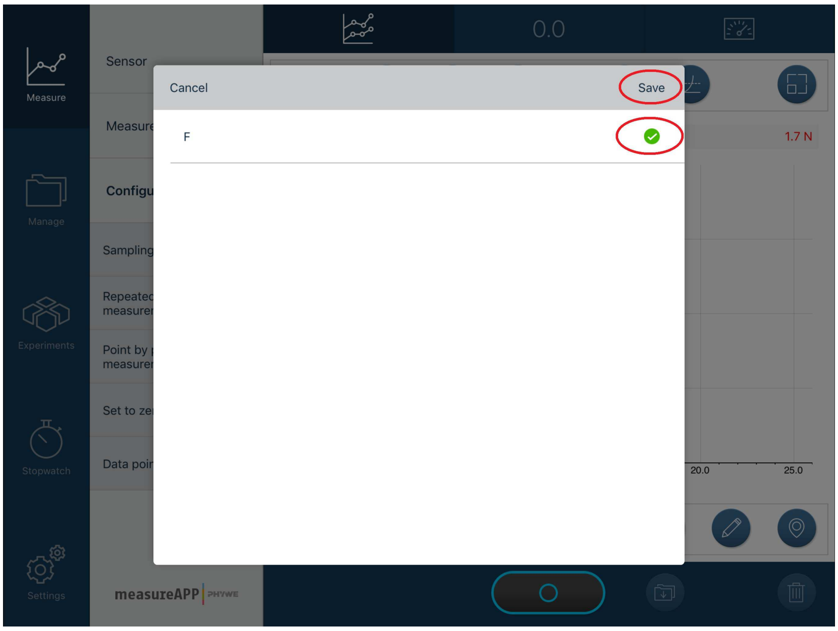

Fig. 11

Preliminary test 1

- Attach a mass of 30 g to the force sensor and observe the instantaneous value of the force in measureApp (Fig. 12).
- Then hang the helical spring on the force sensor again and reset it to zero.
- Attach the force sensor with the helical spring to the tripod rod as high as possible. Pull the helical spring down with your hand and observe the display of the momentary value of the force.

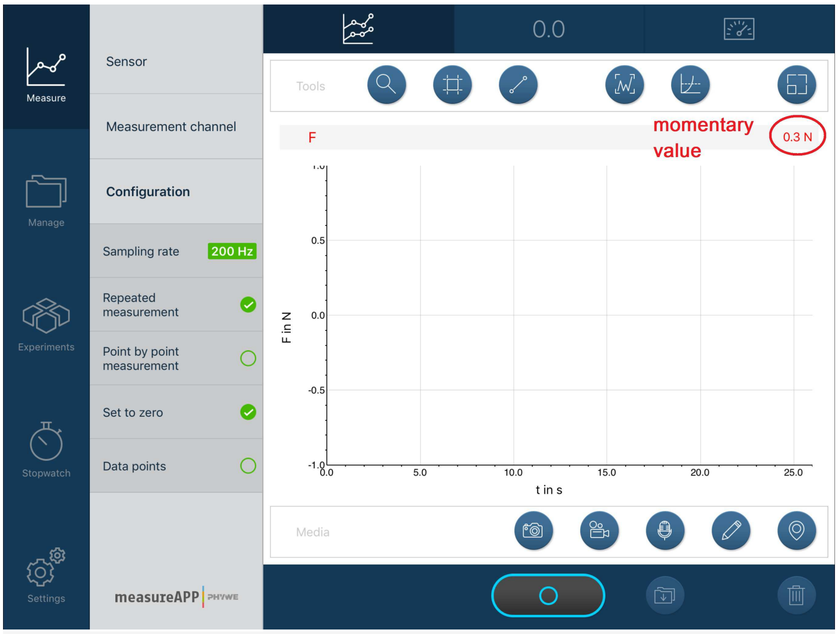

Fig. 12

Preliminary test 2

- Suspend now a mass of 30 g on the helical spring and let it fall. Observe the process.
- Drop the support point such that the mass at the lower reversal point of the oscillation just touches the table.
- Hold the mass when it touches the table surface, let it go again and observe the further course of the experiment.

Main test

- Hang the weight holder (m = 10 g) on the helical spring and determine the extension of the spring.
- Increase the mass by 10 g to max. 40 g each time and for each mass determine the extension Δl (Fig. 13).
- Enter the values for Δl in Table 1 on the protocol.

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- Calculate the height *h* from *h* = 2 Δ*l* and enter these values also in table 1.

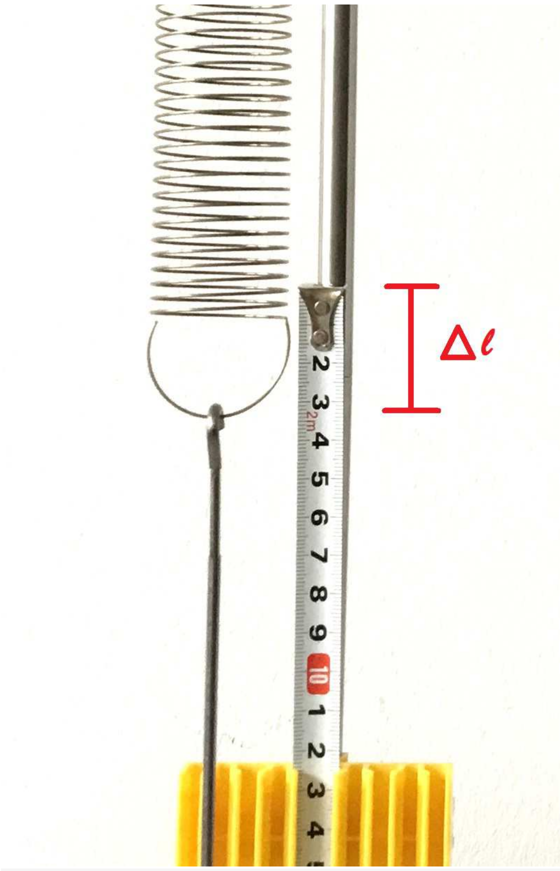


Fig. 13

- Remove the glass tube holder with the measuring tape and attach the second double clamp together with the plate in the lower part of the stand rod (Fig. 14).
- Place the plate on the lower double clamp at the height *h* you determined for *m* = 10 g (Fig. 14).
- Measure the weight force of the mass *m* = 10 g (weight holder) with the force sensor. To do this, you can briefly remove the helical spring again. Remember to zero the sensor first. Then put the weight back on the plate and hang the helical spring back on the force sensor. Enter the result of the weight force in table 1 on the result page.
- Shift the suspension point for the spring so that its lower eyelet is just at the height of the hook on the weight plate (Fig. 14).

Fig. 14

- Remove the plate, attach the weight holder (m = 10 g) to the spring and let it fall. Observe the process.
- Repeat the experiment (2 times) in the same way for the masses m = 20 and 30 g.

To disassemble the tripod base, press the yellow buttons (Fig. 15).


Fig. 15

Protokoll: Potentielle Energie und Spannenergie mit SMARTsense

Ergebnis - Tabelle 1

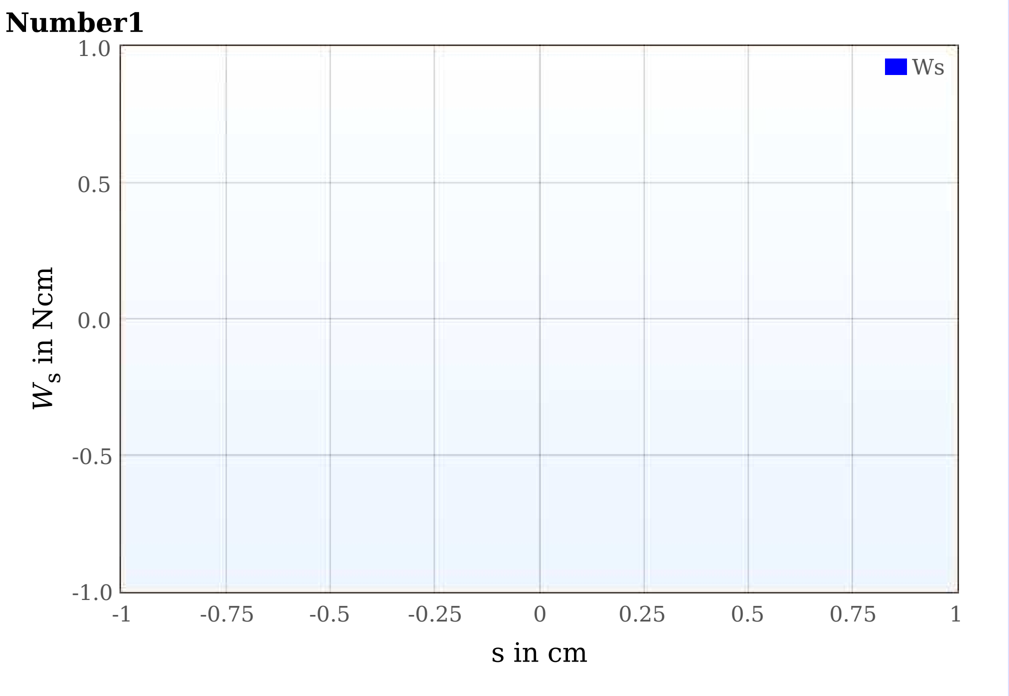
Trage deine Messergebnisse in die Tabelle ein. Berechne aus den Messwerten für h und m bzw. F_g die Hubarbeit W_H und trage die Ergebnisse ebenfalls ein.

m in g	Δl in cm	h in cm	F_g in N	W_H in Ncm
10	1	1	1	1
20	1	1	1	1
30	1	1	1	1
40	1	1	1	1

Ergebnis - Tabelle 2

Trage die Auslenkungen s = h und die Spannenergie W_s = W_h in die Tabelle ein.

m in g	s in cm	W_s in Ncm	C
10	1	1	1
20	1	1	1
30	1	1	1
40	1	1	1



Auswertung - Frage 1

Welche Unterschiede beobachtest du beim Heben einer Masse und beim Dehnen einer Feder an der Kraftmesseranzeige?

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Auswertung - Frage 2

Eine Masse *m* in der Höhe *h* besitzt eine potentielle Energie W_p, die gleich der hinein gesteckten Hubarbeit W_h ist. Wenn du diese Masse an der Feder "fallen" lässt, wird diese potentielle Energie wieder umgewandelt. Wie macht sich diese Tatsache in dem Vorversuch 2 bemerkbar, den du eben durchgeführt hast?

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Auswertung - Frage 3

Wenn du die an der Feder herab fallende Masse in ihrem tiefsten Punkt auf der Tischfläche festhälst, sollte sie die vorher beim Heben hinein gesteckte Hubarbeit wieder abgegeben haben. Was passiert, wenn du die Masse wieder loslässt?

Auswertung - Frage 4

Wie kannst du dir diese Erscheinung erklären?

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Auswertung - Frage 5

Berechne den Faktor *C* aus den Spannenergien, indem du jeweils den höheren Wert durch den Wert für 10 g dividierst, also W_S (20 g)/W_S (10 g) usw. Trage die Werte für *C* in Tabelle 2 ein. Was stellst du beim Betrachten dieser Werte fest?

Auswertung - Frage 6

Erstelle ein Diagramm mit Daten der Tabelle 2. Du siehst die gemessenen Werte für W_S als Funktion von *s*.

Welchen Verlauf hat die Kurve, die du nach Verbinden der Messpunkte erhältst?

Auswertung - Frage 7

Welche Beziehung zwischen s und W_S lässt sich aus den Messungen und Berechnungen ablesen?

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