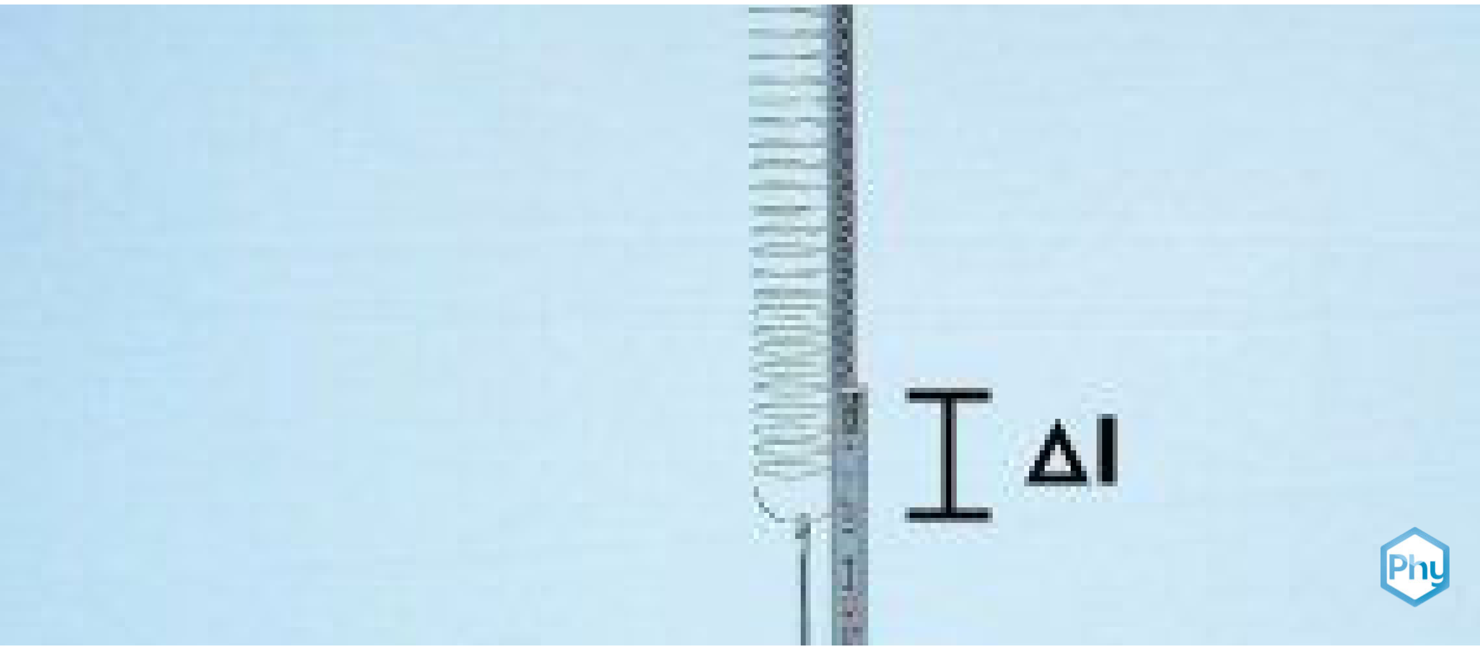
Potential energy and tension energy



Physics | Mechanics | Forces, work, power & energy

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

This content can also be found online at:

http://localhost:1337/c/5fafe482da80e000035c24e6

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Teacher information

Application

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The Power F for apply tension to a spring, according to Hooke's law, is proportional to the deflection x

$$F = D \\ cdotx$$

When loaded with the weight force F_W the spring is in rest position by one length Δl deflected.

$$F = D \\ cdot\,\delta l = m \cdot g = F_W$$

A simple spring-mass-swinging machine has an upper and a lower reversal point with respective swinging amplitude (here Δl) to the rest position. At the upper reversal point, all energy of the system is stored in the potential energy, while at the lower reversal point it is completely converted into tension energy of the spring. The total vibration height h is therefore equal to the maximum deflection Δx of the feather:

$$h = \Delta x = 2 \cdot \Delta l$$

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Other teacher information (1/2)

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Prior

Students should already have developed a basic understanding of how forces work and how to determine them using a force gauge.

Scientific

The total energy of a closed system does not change over time. This fact is based on the law of conservation of energy. Energy can be converted between various forms of energy, but it is never lost. In addition, energy can be brought into or taken out of a closed system.

The SI unit of energy W (or E) is Jewel: $1\,J = 1\,Nm$

The tension energy of a coil spring is $W = \frac{1}{2} \cdot D \cdot x^2 = \frac{1}{2} \cdot F \cdot x$

Other teacher information (2/2)

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Learning

The students should learn that energy is never lost, but merely converted. In addition, they should use the law of conservation of energy to determine the tension energy of a coil spring and find out that it is proportional to the square of the deflection.

Tasks

1. Determine which force is required to lift a mass and which to tension a spring.
2. Load a spring with a mass and let it fall.
3. Determine the energy contained in a tensioned spring.

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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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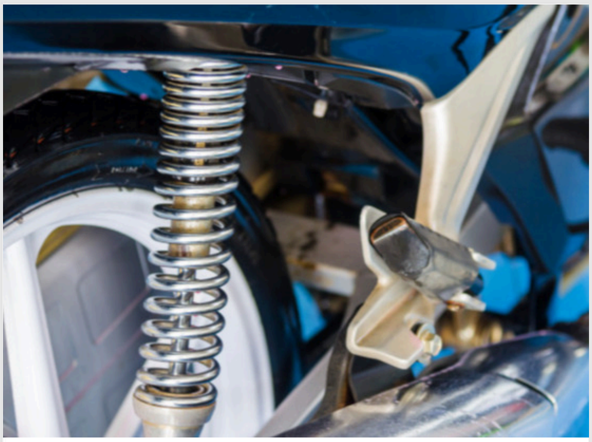

Coil spring as shock absorber on a motorcycle

In a coil spring, energy can be stored in the form of tension energy by compressing or stretching the spring. This principle is also used, for example, in spring shock absorbers on vehicles. Here, a shock caused by a bump, for example, is literally cushioned, whereby the shock has a correspondingly gentle effect on the driver/passenger. The mechanical load on the bodywork is also kept within limits.

In this experiment you will deal with the conversion of simple forms of energy. For this purpose you will learn in which interrelation the stretched energy $W_{stretch}$ and the tension energy W_{tens} of a coil spring to each other.

Tasks

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In this experiment, investigate the so-called law of conservation of energy.

To do this, edit the following points:

- Observe which force is required to lift a mass and which force is required to tension a coil spring.
- Hang a mass on a coil spring and let it "fall" on the spring. Observe the process and interpret it using the concept of energy.
- Determine the energy contained in a spring under tension using the law of conservation of energy.

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Equipment

Position	Material	Item No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	1
3	Boss head	02043-00	2
4	Weight holder, 10 g	02204-00	1
5	Slotted weight, black, 10 g	02205-01	3
6	Helical spring, 3 N/m	02220-00	1
7	Spring balance,transparent, 2 N	03065-03	1
8	Holding pin	03949-00	1
9	Plate with scale	03962-00	1
10	Measuring tape, l = 2 m	09936-00	1
11	Glass tube holder with tape measure clamp	05961-00	1

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Set-up (1/3)

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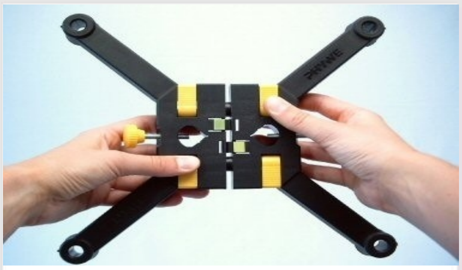
Plug the two halves of the tripod foot together.

Then screw together the divided stand rod to a long one.

Fix the long stand rod vertically in the stand foot.



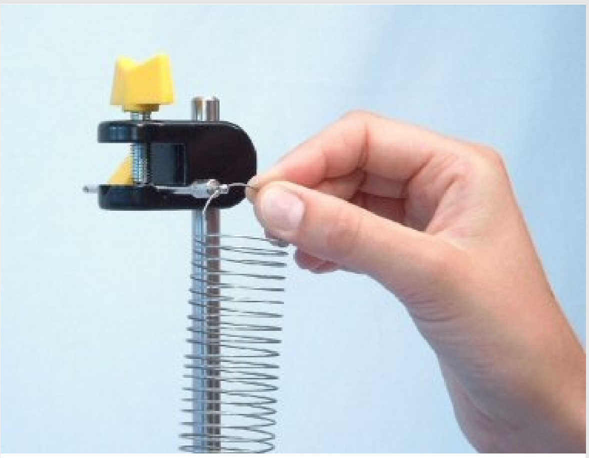
Assembling the tripod base

Screwing the stand rod

Assembling the tripod

Set-up (2/3)

PHYWE



Mounting the double socket on the stand rod

Fasten the double socket at the top of the stand rod.

Then fix the retaining bolt in the double socket.

Hang the coil spring into the hole of the retaining bolt.

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Set-up (3/3)

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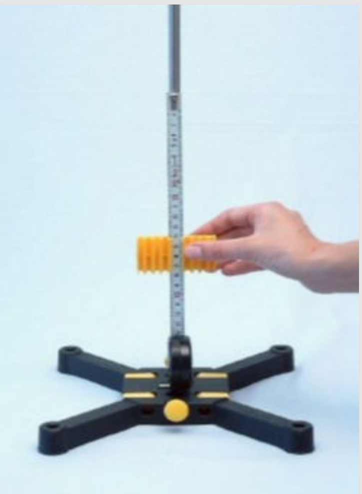
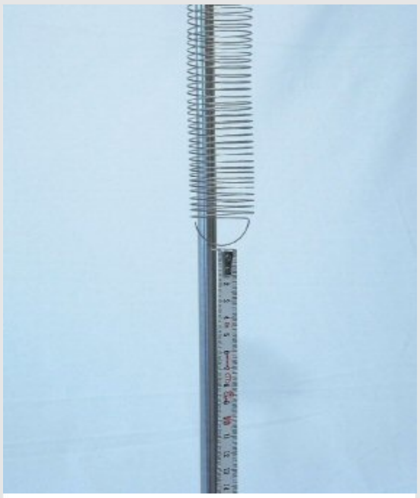


Fasten the measuring tape in the glass tube holder

Clamp the extended measuring tape to the bottom of the stand rod using the glass tube holder.

Adjust the length of the tape measure so that the zero mark is exactly level with the lower end of the coil spring.



Adjusting the measuring tape

Procedure (1/6)

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Loading the force gauge with $m = 40$

- Lift successively the masses of $m = 10\ g, 20\ g, 30\ g, 40\ g$ with the force gauge previously adjusted to zero in the position of use and apply the displayed measured values for the respective weight force F_W into the table in the log.
- Mount the coil spring as high as possible on the stand rod.
- Pull down on the spring with the force gauge and observe the display at different deflections.

Determining the spring force

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Procedure (2/6)

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Mounting the coil spring

- Now hang a mass of 40 g on the coil spring and let it "fall". Observe the process.
- Lower the suspension point so far that the mass at the lower reversal point of the oscillation just touches the table.
- Hold the mass when it touches the table surface, then release it and observe the process again.

Mass at table level

Procedure (3/6)

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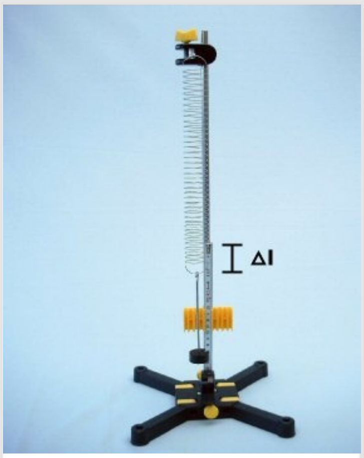

Determining the spring force at different deflections

- Hang the weight plate $(m = 10g)$ to the coil spring and determine the extension of the spring.
- Increase the mass by 10 g to max. 40 g and determine the extension for each mass Δl.
- Enter the values for Δl into the table in the log.
- Calculate the total vibration level according to $h = 2 \cdot \Delta l$ and also enter these values in Table 1.

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Procedure (4/6)

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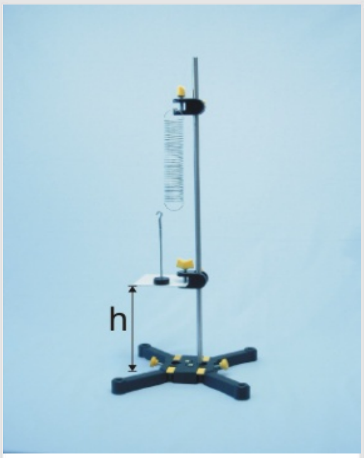

Lift the mass onto the plate

- Mount the plate to the stand using a second double socket in place of the measuring tape.
- Set the plate to the height h that you're using for $m = 10\,g$ you were investigating.
- Place the mass $m = 10\,g$ (weight plate) onto the plate.
- Move the suspension point for the spring so that its lower eyelet is just at the height of the hook on the weight plate.

Procedure (5/6)

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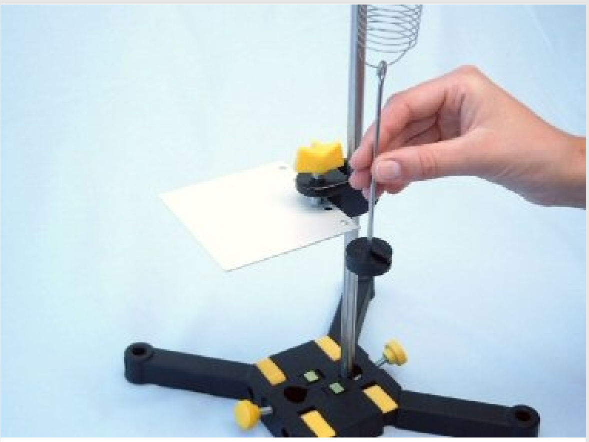

Drop the weight plate hanging from the spring

- Now hang the weight plate $(m = 10\,g)$ to the spring and let it "fall". Observe the process.
- Repeat the experiment (3 times) in the same way for the masses $m = 20\,g,\ 30\,g,\ 40\,g$.
- For each weight, check that the total swing height you have determined is correct, with the mass just about making contact with the table surface (bottom dead center).

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Procedure (6/6)

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Disassembling the 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

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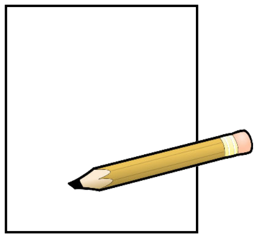
Carry the deflections Δl and the calculated total vibration height $h = 2 \cdot \Delta l$ and the corresponding weight force F_W and the associated stretched energy $W_{stretch} = F_G \cdot h$ into the table.

$m\ [g]$	$\Delta l\ [cm]$	$h\ [cm]$	$F_W\ [N]$	$W_{stretch}\ [Ncm]$
10				
20				
30				
40				

Sketch a diagram on a sheet of paper showing the total deflection h on the X-axis and the energy $W_{stretch} = W_{tens}$ on the Y-axis.



Task 1

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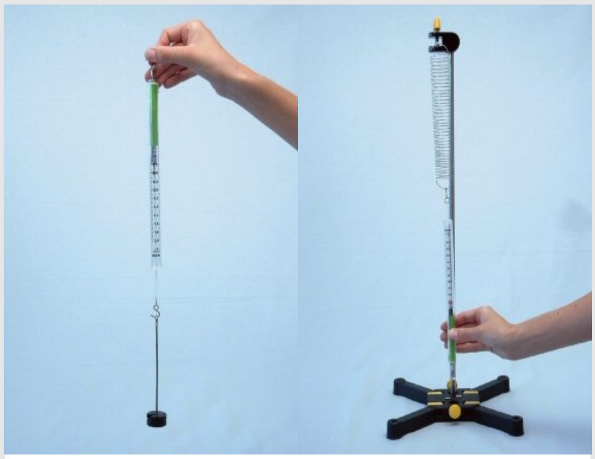
What differences do you observe when lifting a mass and stretching a spring on the force gauge display? Drag the words to the correct position.

The force when ______ a mass is independent of the ______ and ______ for a mass, while when a ______ is deflected, the force ______ with the deflection.

path | increases | spring | lifting | constant

Check



Lifting a mass and stretching a spring, each with the aid of a force gauge

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Task 2

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Ground at top dead center

If you let this mass "fall" on the spring, the potential energy of the mass is converted. How does this fact manifest itself?

- [ ] The potential energy transports the mass back to the bottom dead center.
- [ ] The mass remains in the top dead center.
- [ ] The system oscillates.
- [ ] The tension energy transports the mass back to the rest position.

Check

Task 3

PHYWE

Ground at bottom dead center

When you release this mass on the spring under tension, the tension energy is converted. How does this fact become noticeable?

- [ ] The system oscillates.
- [ ] The mass remains in the bottom dead center.
- [ ] The compressed energy transports the mass back to the rest position.
- [ ] The tension energy transports the mass back to the top dead centre.

Check

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Task 4

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spring deflection

What is the relationship between the deflection and the tension energy of the spring as shown in the diagram you have created?

- ○ The tension energy becomes lower with increasing deflection.
- ○ The tension energy grows linearly with increasing deflection.
- ○ The tension energy grows quadratically with increasing deflection.
- ○ The tension energy does not grow with increasing deflection.

Check

Slide	Score / Total
Slide 21: Lifting a mass vs. stretching a spring	**0/5**
Slide 22: Potential energy	**0/2**
Slide 23: Voltage energy	**0/2**
Slide 24: Deflection and clamping energy	**0/1**

Total amount **0 / 10**

Solutions Repeat Exporting text

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