SPRING PENDULUM – SPRING CONSTANT

SWD 01.02

Material:

Item Code	Qty	Description
DS600-10	1	Assembly for lab table "NTL"
DS600-6G	1	Board holders, pair, magnetic
DS103-1P	1	Panel, green/white, 900x610mm
DS110-66	1	Magnetic base, d=66 mm, with tube and pin
DS200-04	1	Stand tube, H=40 mm
DM380-6K	1	Ball, D=60 mm, plastics, white, tapped
DM386-1H	1	Pendulum ball with hook, wooden, D=60 mm
P1810-1S	1	Coil spring 5 N/m, D= approx. 16 mm
P1810-2S	1	Coil spring 10 N/m, D=approx. 16 mm
P1810-2B	1	Coil spring 20 N/m, D=12 mm approx.
DE722-1W	1	Stop-watch "inno"
DE722-2W	1	Remote control for laser and stopwatch "inno"

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Goal:

Concept of harmonic oscillation. Dependence of the period of oscillation of a spring pendulum on the attached mass and the spring constant as well as the independence of the amplitude.

Setup:

The table assembly is set up.
The board holders are mounted on the front ends of the footrest profiles.
The panel is stapled to the board holders in landscape format.

The magnetic base will be fixed to the board approximately in the middle, close to the upper edge. The stand tube 40 mm is clamped into the column of this foot, the bearing bolt with clamping insert is then fixed in this column.

The coil spring 10 N is hooked into the bearing bolt.
The KS pendulum ball is suspended from the coil spring.

Experiment 1:

It is to be examined whether the deflection (amplitude) has an effect on the oscillation period of a pendulum.

The pendulum is deflected about 5 cm from the rest position and released.

The time period for 10 oscillations (1 oscillation consists of an up and down movement) is measured. Two measurements are to be made for each deflection quantity. The duration T for 1 oscillation is calculated from the mean value. The results are entered in the table below.

Deflection (in cm)	Period of oscillation 10 T (in seconds)		Period of oscillation (in seconds)
	Measurement 1	Measurement 2	
5			
10			
15			

The deflection is changed as indicated in the table, the times are measured and entered in the table.

Result:

The period of oscillation is almost the same.
The deflection of the pendulum bob therefore has no effect on the period of oscillation.

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Experiment 2:

To investigate whether the mass of the pendulum bob has an effect on the period of oscillation of a pendulum

For this purpose, the masses of the two pendulum spheres are determined with an accurate balance:

Pendulum ball wood: ……… g

Pendulum ball plastic: ……… g

The pendulum ball wood is hung on the coil spring 10 N.
The pendulum is deflected about 5 cm from the rest position and released.

The time period for 10 oscillations (1 oscillation consists of a back and forth movement) is measured. Two measurements are to be made. The duration T for 1 oscillation is calculated from the mean value. The results are entered in the table below.

Pendulum ball	Period of oscillation 10 T (in seconds)		Period of oscillation T (in seconds)
	Messung 1	Messung 2	
Wood			
Plastic			

The results with the plastic ball can be taken over from experiment 1.

Result:

The greater the mass of the pendulum ball is, the greater the period of oscillation is.

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Experiment 3:

To investigate whether the "strength of the coil spring" has an effect on the period of oscillation of a pendulum.

The pendulum ball wood is hung on the coil spring 5 N.
The pendulum is deflected about 5 cm from the rest position and released.

The time period for 10 oscillations (1 oscillation consists of a back and forth movement) is measured. Two measurements are to be made. The duration T for 1 oscillation is calculated from the mean value. The results are entered in the table below.

Coil spring	Period of oscillation 10 T (in seconds)		Period of oscillation T (in seconds)
	Measurement 1	Measurement 2	
5 N			
10 N			

The results with the coil spring 10 N can be taken over from test 2.

Result:

With the "softer" coil spring, the period of oscillation is greater.

Conclusion:

The period of oscillation of a helical spring depends on the mass of the pendulum bob and the "strength of the spring" (= spring constants).

Experiment 4:

Comparing the period of oscillation of the pendulum ball plastic on the

coil springs 5 N/m and 20 N/m

you should get twice the period of oscillation.

Coil spring	Period of oscillation 10 T (in seconds)		Period of oscillation T (in seconds)
	Measurement 1	Measurement 2	
5 N			
20 N			

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Experiment 5:

It is to be examined whether the attached force is proportional to the extension of the spring. If this were the case, there would have to be a "spring constant".

Setup:

The pendulum ball KS is suspended from the coil spring 10 N.

The distance from the top edge of the ball to the axis of the bearing pin is measured and entered in the table.

Attached Mass	Spring expansion (in cm)	Elongation difference „dl“ (in cm)
Ball KS		
+ 50 g		
+ 100 g		

Resukt:

You can see that the strain differences are equal. If they are not exactly equal, the average is calculated.

Average elongation difference of the spring:

dl = ... cm = ... m

The spring constant k is calculated using the formula F = k × dl:

$$k = \frac{F}{dl} = \text{..........} \ \mathrm{N/m}$$

Conclusion:

The attached force is proportional to the extension of a helical spring.
Using the formula F = k × dl, the spring constant k can be calculated.

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Experiment 6:

We can also calculate the spring constant from the period of oscillation of the pendulum.

To do this, we put the measurement results from experiments 1 and 2 into the following formula:

From the formula for the period of oscillation $T = 2\pi\sqrt{\frac{m}{k}}$

m Mass
k Spring constant

you get the spring constant $k = \frac{4\,\pi^2 m}{T^2}$

Conclusion:

The period of oscillation of a coil spring depends on the mass of the pendulum bob and the spring constant of the coil spring.

Note:

If the experimental result is higher than the calculated result, we must consider that the spring's own mass also vibrates.
In this case, it is advisable to determine the mass of the coil spring with an accurate balance and to add about 1/3 of this mass to the attached mass.

Attention:

With vibrating strings, the period of vibration is also increased by increasing the mass and decreasing the tension.

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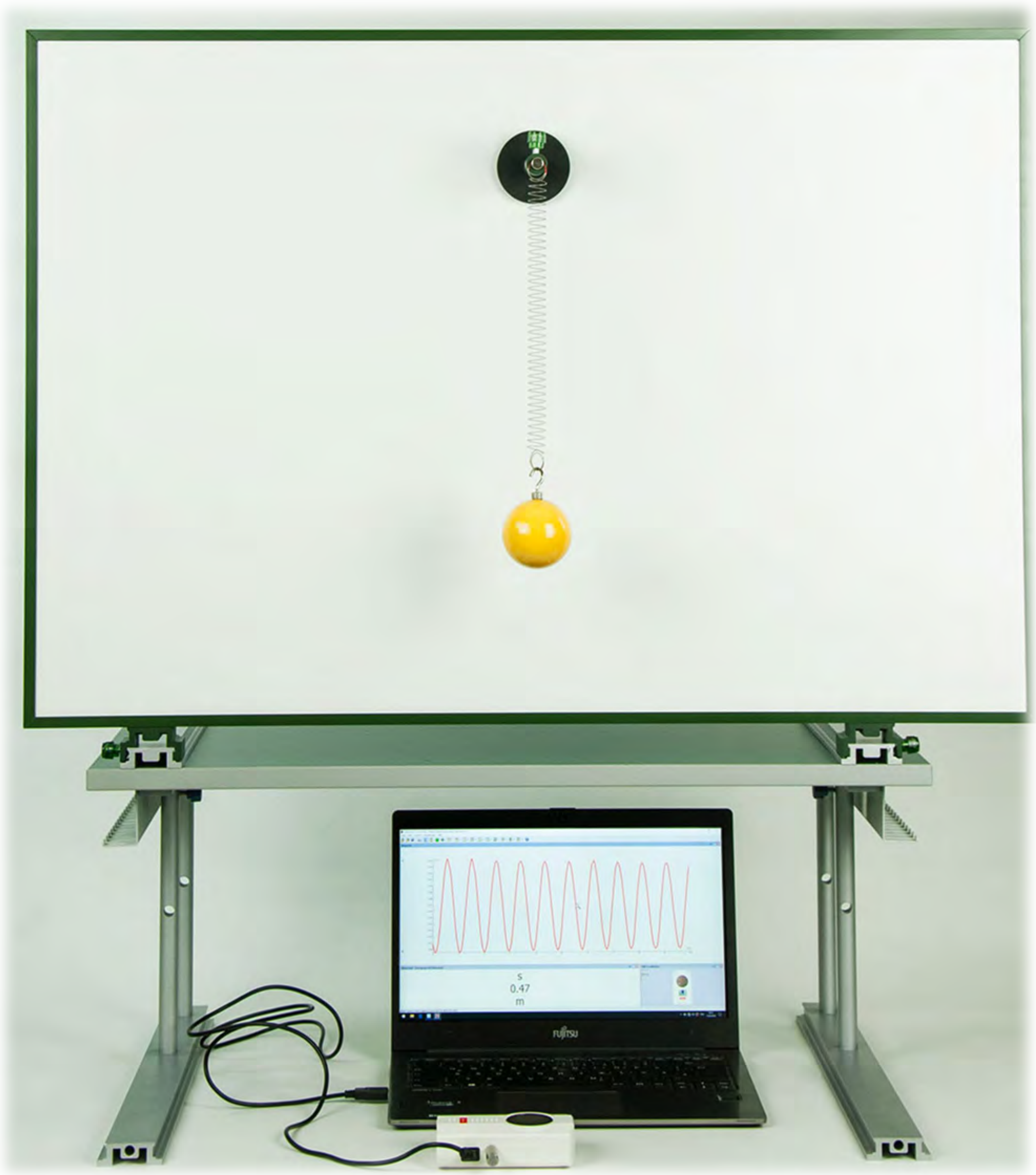
For this experiment, it is recommended to use a distance sensor and measurement software.



Due to the 20 times per second distance measurement, the periodic process of the pendulum swing can be reproduced optically very nicely.

With most software programs, you can determine the duration of each oscillation quite precisely.

If the software allows to superimpose the sinusoidal oscillations of different measurements, the comparison of the oscillation processes is optically self-explanatory.

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