Helical spring pendulum (Item No.: P1002700)

Curricular Relevance

Area of Expertise:	Education Level:	Topic:	Subtopic:	Experiment:
Physik	Klasse 7-10	Mechanik	Schwingungen und Wellen	Schraubenfederpendel

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

Additional Requirements:

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional Information

The students have determined the spring constant of springs in experiment P0999100 (Hooke's Law) and had their first experience with an oscillating system in experiment P0998200. In this experiment with a spring pendulum they should discover the factors on which the oscillation period of a helical spring depends and how the correlations can be expressed as a proportionality. Under the Additional Tasks tab, the students should make the necessary corrections for the spring's mass and then set up the helical spring's oscillation equation by determining the slope and the proportionality constant K from the straight lines determined when plotting T^2 against m/D. Through comparison the numerical value of K can also be found.

Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

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Task and equipment

Task

What factors influence the oscillation period of a spring pendulum?

1. Determine the oscillation period *T* of a spring pendulum for various masses *m* on two springs with different spring constants *D*.
2. Set up a proportionality between the three factors *T*, *m* und *D*.

Equipment

Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
2	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	1
3	Boss head	02043-00	1
4	Weight holder for slotted weights	02204-00	1
5	Slotted weight, black, 10 g	02205-01	4
5	Slotted weight, black, 50 g	02206-01	3
6	Helical spring, 3 N/m	02220-00	1
7	Helical spring, 20 N/m	02222-00	1
8	Spring balance,transparent, 1 N	03065-02	1
9	Holding pin	03949-00	1
10	Stop watch 4	03078-00	1

Set-up and procedure

Set-up

Connect the two halves of the support base with the 25 cm support rod and tighten the locking levers (Fig. 1).
Screw the two rods together to get a long one (Fig. 2). Set this long support rod into the support base, tighten it with the locking screw (Fig. 3).

Fig. 1

Fig. 2

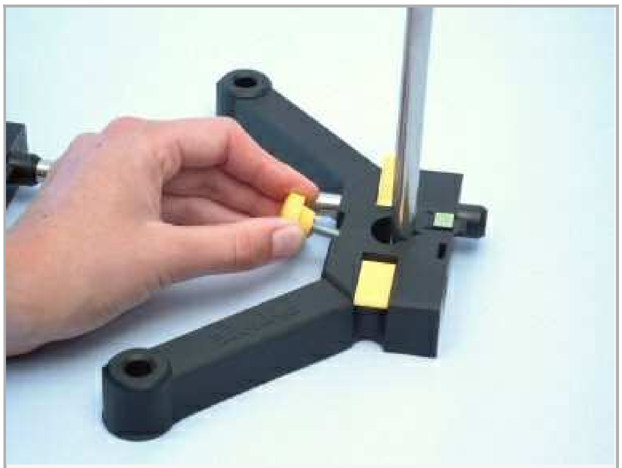


Fig. 3

Attach the bosshead to the support rod, fix the holding pin in the bosshead and hang the helical spring (3 N/m) in it (Fig. 4).

Fig. 4

Procedure

Load the spring with masses *m* = 20, 40, 60 ... up to 140 g including the weight holder (10 g) (Fig. 5). For hanging the slotted weight up the weight holder, you should slip the slotted weight over the top of the weight holder (Fig. 6).

Fig. 5

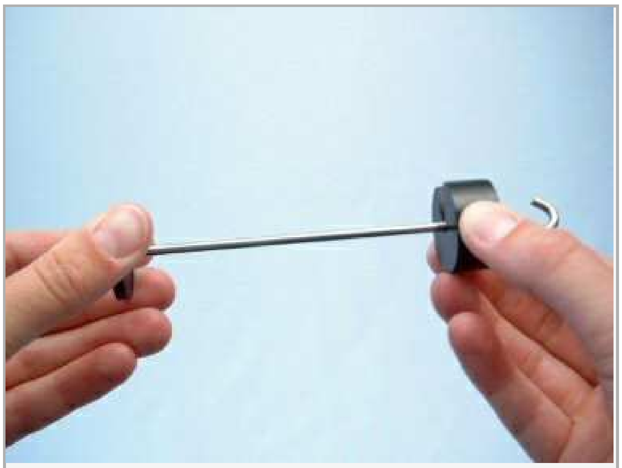


Fig. 6

Deflect the helical spring and let it begin to oscillate (Fig. 7). For each mass determine the time *t* required for 10 oscillations. Record all the measured values in Table 1 in the report.

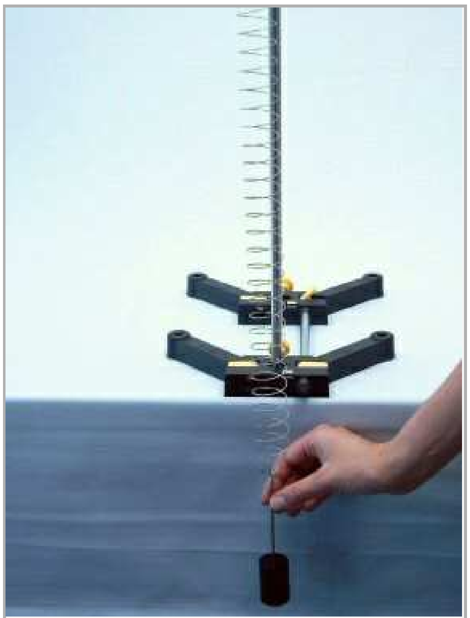


Fig. 7

Now use the 20 N/m helical spring and repeat the measurements described in above (Fig. 8). However, use masses of only 40, 60 ... up to 140 g. Record the measured values obtained in Table 1 in the report.

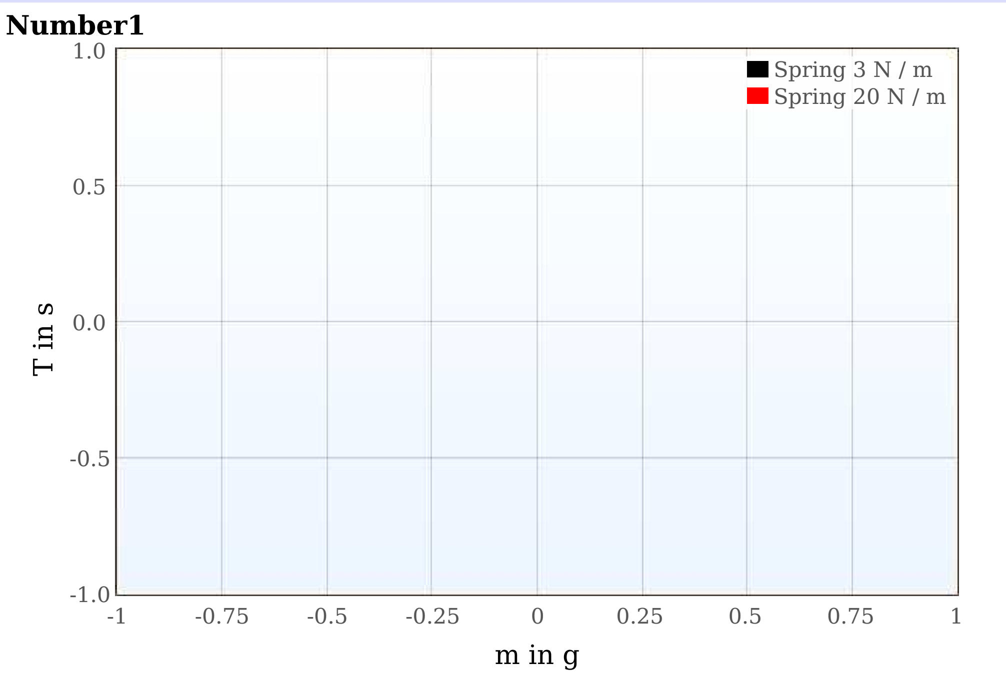
Fig. 8

Report: Helical spring pendulum

Results – Table 1

Record all the measured values in the table 1. Using the value *t* for 10 oscillations, calculate the oscillation period *T* for one oscillation and record this value in the table.

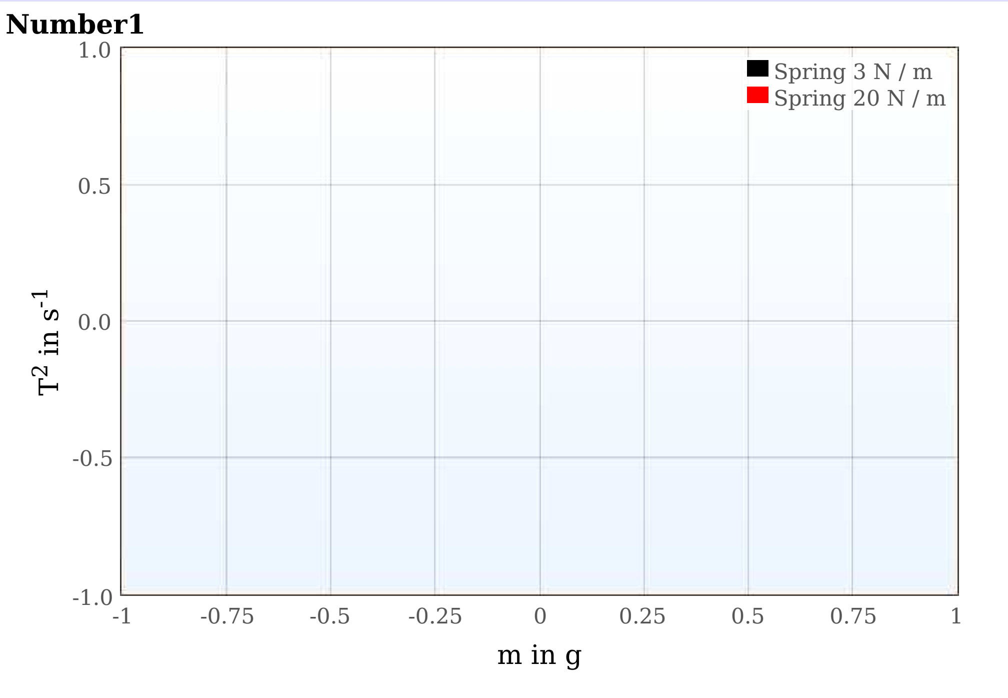
m in g	Spring 3 N/m		Spring 20 N/m	
	t in s	*T* in s	*t* in s	*T* in s
20	1	1		
40	1	1	1	1
60	1	1	1	1
80	1	1	1	1
100	1	1	1	1
120	1	1	1	1
140	1	1	1	1



Results – Table 2

Square T and record the value for T^2 in Table 2.

m in g	Spring 3 N/m	Spring 20 N/m
	T^2 in s^2	T^2 in s^2
20	1	
40	1	1
60	1	1
80	1	1
100	1	1
120	1	1
140	1	1



Evaluation – Question 1

Watch Chart 1, which shows *T* as a function of the mass *m*, with the spring constant *D*. What can you say about the influence of *m* and *D* on the oscillation period?

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Evaluation – Question 2

Watch chart 2, which shows T^2 plotted as a function of the mass *m* with *D* as a parameter.
What can be said about T^2 and *m*?

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Evaluation – Question 3

What is the influence of *D* on *T*?

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Evaluation – Question 4

Set up a proportionality including the three factors T^2, *m* and *D*.

T^2 ~ ....

Evaluation – Additional Task 1

Do the curves in chart 1 and chart 2 go through the origin? Can you imagine what the reason for this might be?
Suggestion: Have you included all factors which enter into the measuring results? Consider the springs again!

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Evaluation – Additional Task 2

Determine the masses m_F of the two springs with the spring balance and record the values:

Spring D = 3 N/m, m_F = ... g

Spring D = 20 N/m, m_F = ... g

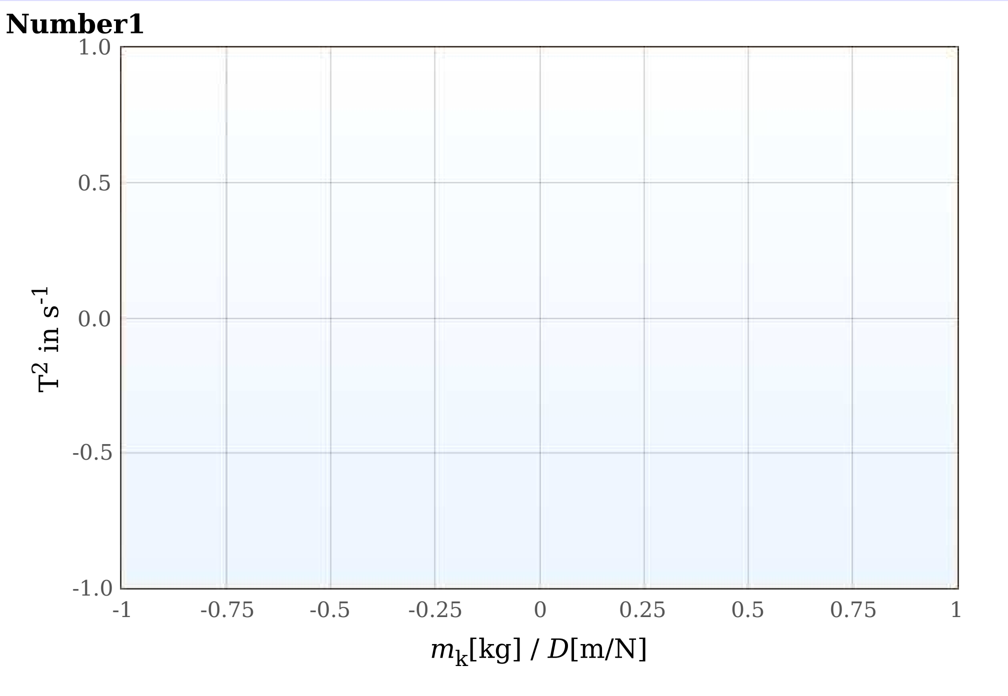
Evaluation – Additional Task 3 - Table 3

Spring D = 3 N/m:

Correct the effective masses in both experiments according to $m_k = m + 1/3\ m_F$. Record the calculated values in Table 3.

Transcribe T^2 from Table 2 into Table 3, calculate m_k/D.

m in g	m_k in g	T^2 in s^2	m_k[kg] / D[m/N]
20	1	1	1
40	1	1	1
60	1	1	1
80	1	1	1
100	1	1	1
120	1	1	1
140	1	1	1



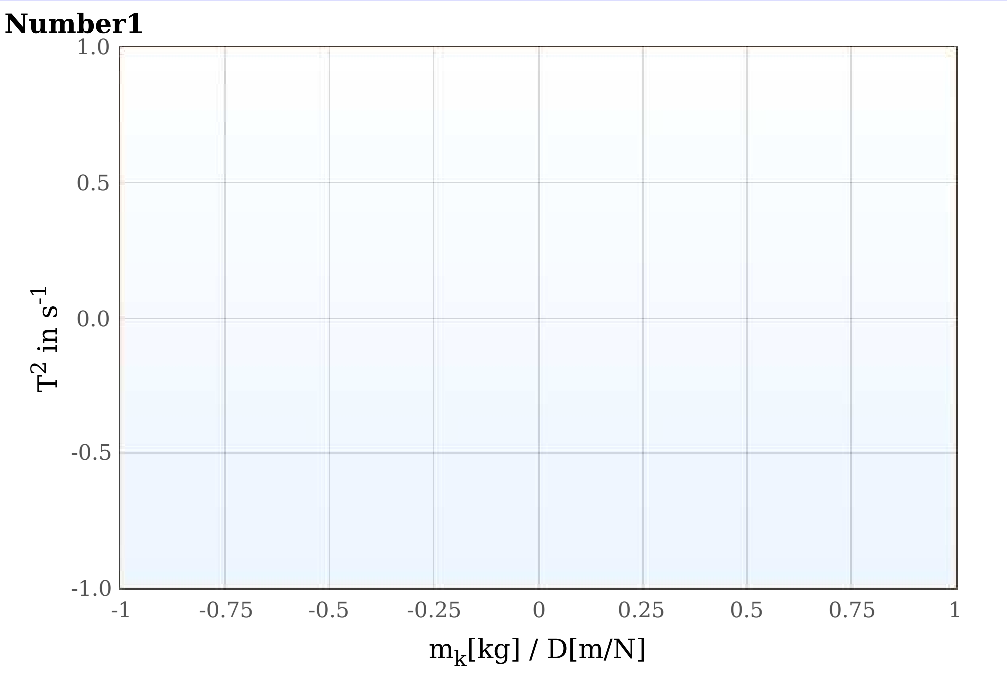
Evaluation – Additional Task 4 - Table 4

Spring D = 20 N/m:

Correct the effective masses in both experiments according to $m_k = m + 1/3\ m_F$. Record the calculated values in Table 4.

Transcribe T^2 from Table 2 into Table 3, calculate m_k/D.

m in g	m_k in g	T^2/s^2	m_k[kg] / D[m/N]
40	1	1	1
60	1	1	1
80	1	1	1
100	1	1	1
120	1	1	1
140	1	1	1



Evaluation – Additional Task 5

The chart shows a diagram with the corected values: T^2 = f (m_K/D). Express the correlations as a proportionality.

T^2 ~ ....

Evaluation – Additional Task 6

Calculate the proportionality factor K from the slope of the curve in chart 3. What is its dimension?

K = ... Dimension: ....

Evaluation – Additional Task 6

Calculate the proportionality factor K from the slope of the curve in chart 3. What is its dimension?

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Evaluation – Additional Task 7

Using the correlations determined, write down the oscillation equation for a spring pendulum: T^2 =

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