5.1 Helical spring pendulum

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 and D.

Use the space below for your own notes.

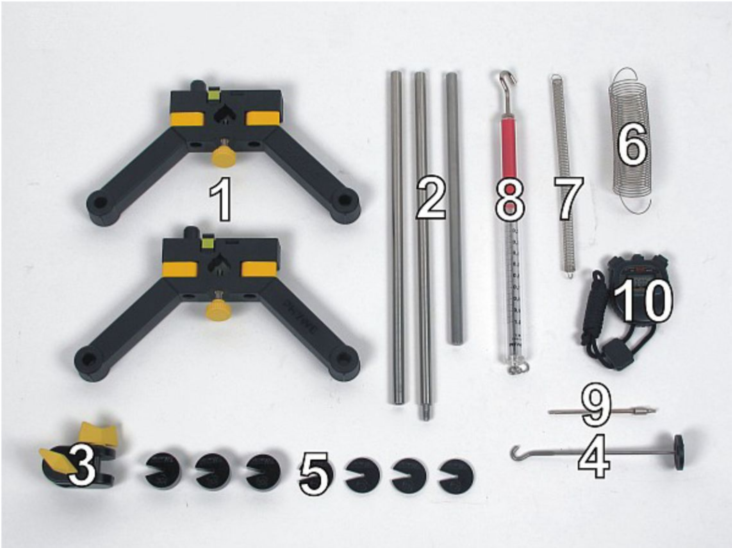
Material

Material from "TESS advanced Physics Set Mechanics 1, ME-1" (Order No. 15271-88)

Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel 18/8, l = 250 mm d = 10 mm	02031-00	1
2	Support rod, split in 2 rods, l = 600 mm	02035-00	1
3	Bosshead	02043-00	1
4	Weight holder for slotted weights, 10 g	02204-00	1
5	Slotted weight, black coloured, 10 g	02205-01	4

5	Slotted weight, black coloured, 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, digital, 24h, 1/100 s and 1 s	24025-00	1

Material required for the experiment



Setup

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

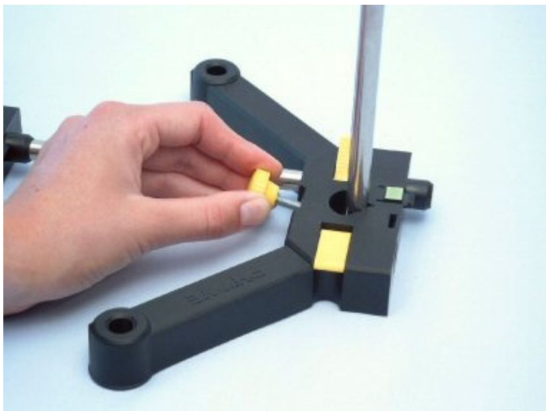


Fig. 3

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


Fig. 4

Action

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

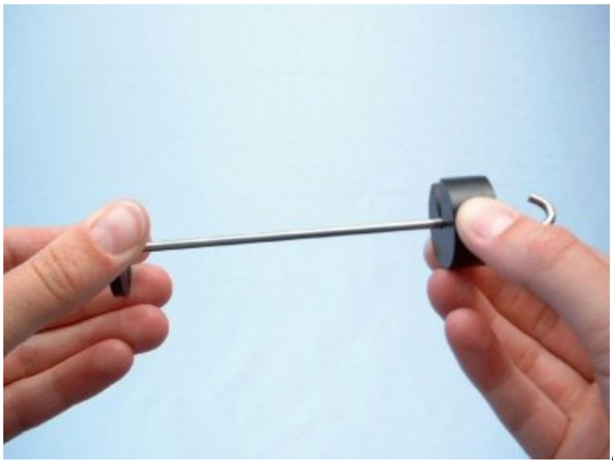


Fig. 6

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 on the Results page.

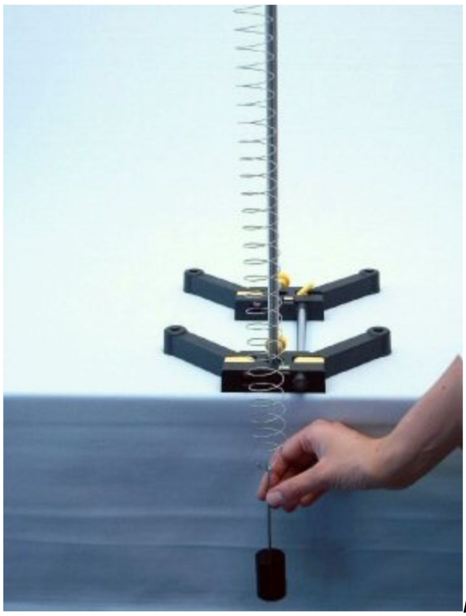


Fig. 7

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 on the Results page.


Fig. 8

Results

Table 1

***m* in g**	**spring 3 N⁄m**		**spring 20 N⁄m**	
	***t* in s**	***T* in s**	***t* in s**	***T* in s**
20				
40				
60				
80				
100				
120				
140				

Chart 1

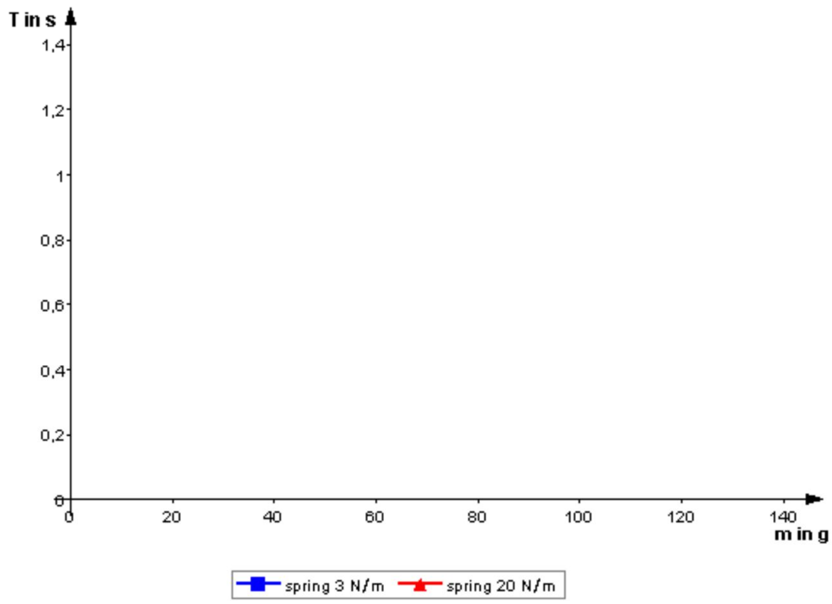


Table 2

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

Evaluation

Question 1:

Using the value t for 10 oscillations, calculate the oscillation period T for one oscillation and record this value in Table 1 on the Results page.

Question 2:

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

Question 3:

Watch Chart 1 on the Results page, 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?

Question 4a:

Watch Chart 2 on the Results page, 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*?

Question 4b:

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

Question 5:

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

$T^2 \sim$ ______

Additional Tasks

Question 1:

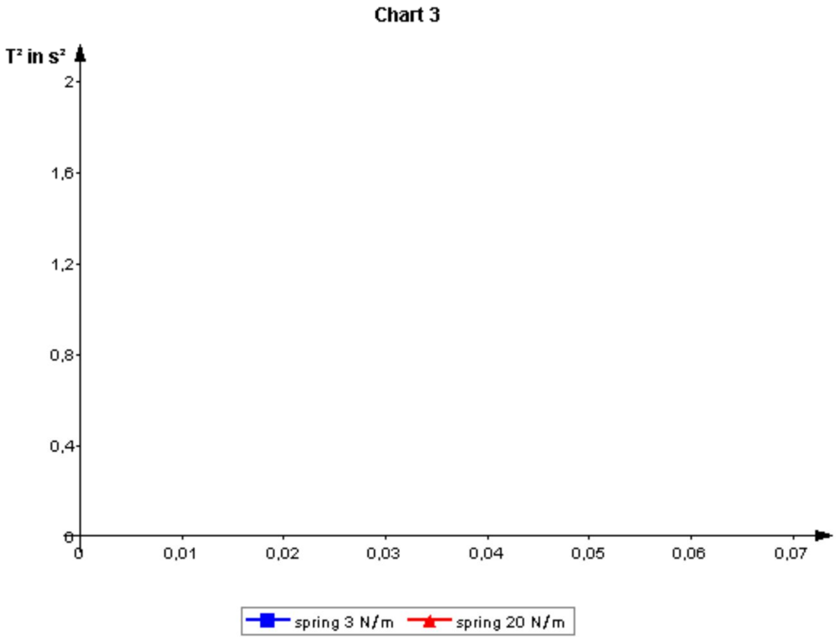
Do the curves in chart 1 and chart 2 go through the origin? Can you imagine what the reason for this might be? Suggestion: Have you included all factors which enter into the measuring results? Consider the springs again!

Question 2:

Determine the masses m_F of the two springs with the spring balance and correct the effective masses in both experiments according to $m_k = m + 1/3\ m_F$. Record the calculated values in Table 3.

Table 3

m in g	spring 3 N/m m_F = ☐ g			spring 20 N/m m_F = ☐ g		
	m_k in g	T^2 in s^2	m_k/D in kg m/N	m_k in g	T^2 in s^2	m_k/D in kg m/N
20						
40						
60						
80						
100						
120						
140						



Question 3:

Transcribe T^2 from Table 2 into Table 3, calculate m_k/D; the chart shows a diagram with the corrected values: $T^2 = f\,(m_k/D)$.
Express the correlations as a proportionality.

$T^2 \sim$ ☐

Question 4:

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

K = ☐ Dimension: ☐

Question 5a:

Calculate $4\pi^2$ and compare the numerical value with the proportionality factor *K*. Are they identical?

Question 5b:

Using the correlations determined, write down the oscillation equation for a spring pendulum:

T^2 =