5.4 Damping

Task

Do oscillations stop?

A spring pendulum oscillates in air - first only with a mass - then a cardboard disk is added. Measure the deflection after different times and compare them with the original deflection. Immerse the pendulum mass in water and investigate the deflection after different times.

Use the space below for your own notes.

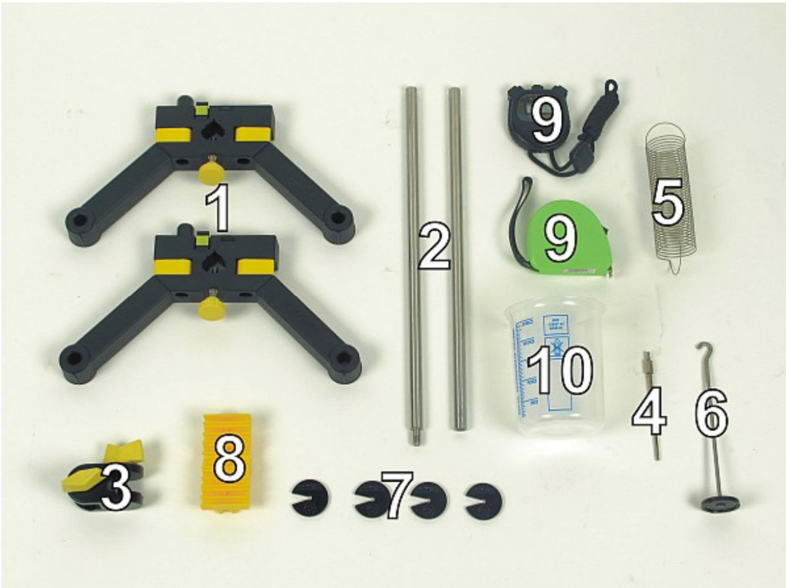
Material

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, split in 2 rods, *l* = 600 mm	02035-00	1
3	Bosshead	02043-00	1
4	Holding pin	03949-00	1

5	Helical spring 3 N/m	02220-00	1
6	Weight holder for slotted weights, 10 g	02204-00	1
7	Slotted weight, black coloured, 10 g	02205-01	4
8	Glass tube holder with tape measure clamp	05961-00	1
9	Stop watch, digital, 24h, 1/100 s and 1 s	24025-00	1
9	Measuring tape, *l* = 2 m	09936-00	1
10	Beaker, plastic, short form, 250 ml	36013-01	1
Additional Material			
	Drawing cardbord (approx. DIN A4)		1

Material required for the experiment



Setup

First screw the split support rod together (Fig. 1). Set up a stand with the support base (Fig. 2), put the support rod in the support base and tight it with the screw (Fig. 3).

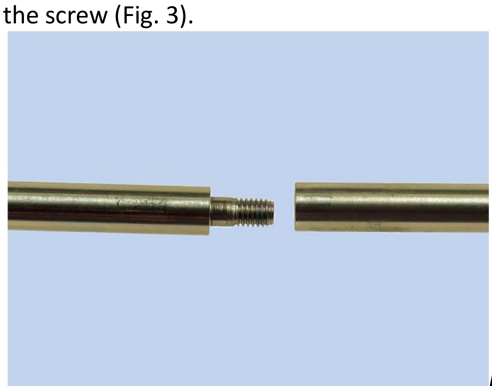


Fig. 1

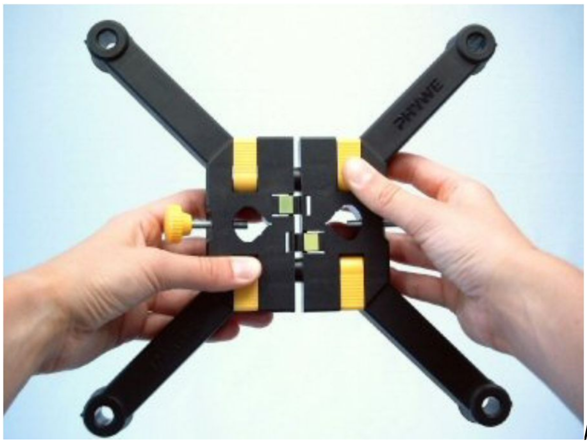


Fig. 2

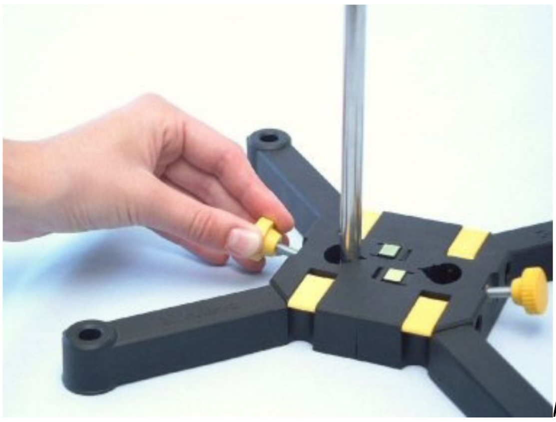


Fig. 3

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

Clamp the extended measuring tape in the glass tube holder and clamp both on the base of the support rod (Fig. 5).


Fig. 5

Prepare a cardboard disk with a diameter of 7.5 cm; make a hole in its center and a radial slit.

Action

- Load the helical spring with a weight of *m* = 50 g including the weight holder (Fig. 6) and deflect it by Δl_0 = 10 cm.
- Determine the pendulum's maximum deflections Δl_1 between 0.5 min and 3 min in 0.5 min steps. Record the deflection values in Table 1 on the Results page.

Fig. 6

- Place the cardboard disk on the weight holder under the slotted weights (Fig. 7).
- Deflect the spring pendulum with the disk again by Δl_0 = 10 cm (Fig. 8) and determine the deflections Δl_2 at the above mentioned times. Add the values to Table 1.

Fig. 7

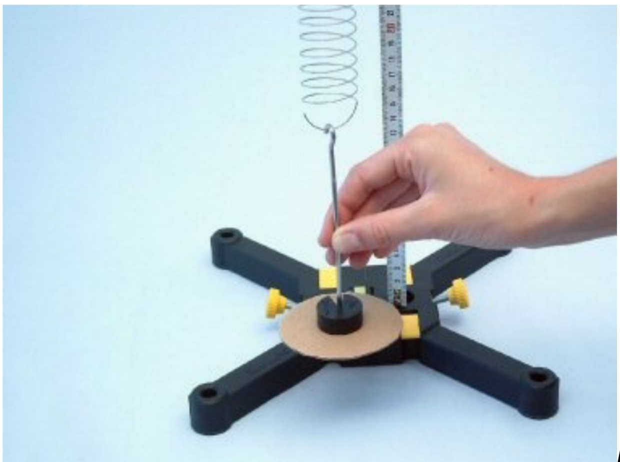


Fig. 8

- Fill the beaker completely with water and immerse the weight holder with a 50 g mass about 4 cm into the water (Fig. 9).
- Deflect the spring pendulum by Δl_0 = 4 cm down to the bottom of the beaker (Fig. 10) and measure the deflection Δl_3 after 5 s. Record the measured value under Chart 1 on the Results page.


Fig. 9


Fig. 10

In order to disassemble the support base you should press the yellow buttons (Fig. 11).

Fig. 11

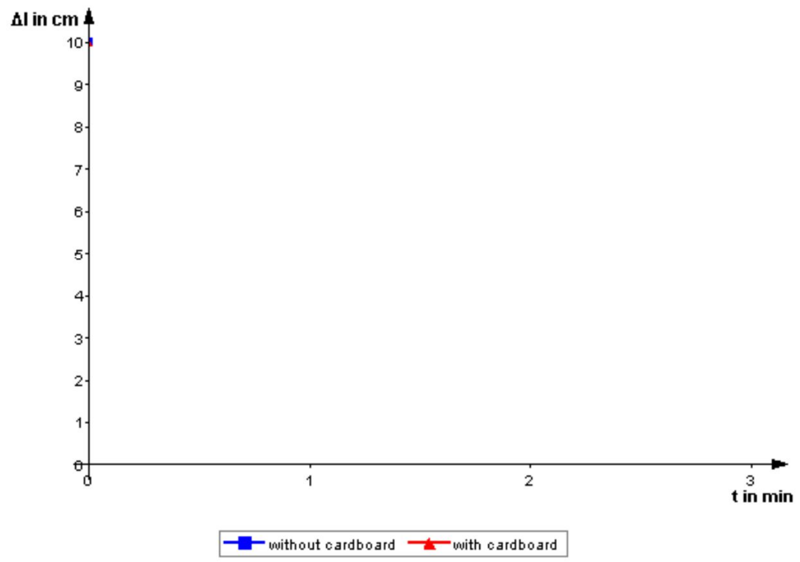
Results

Table 1

In the air

t in min	with cardboard disk Δl_1 in cm	without cardboard disk Δl_2 in cm
0	**10**	**10**
0.5		
1		
1.5		
2		
2.5		
3		

Chart 1



In water
$\Delta l_0 = 4$ cm, $t = 5$ s,

$\Delta l_3 =$ ______ cm

Evaluation

The decrease in oscillation amplitude is called damping.

Question 1.1:

Calculate the amount the amplitude (the deflection) Δl_1 has decreased after 3 minutes in cm and in percent.

Question 1.2:

Calculate the decrease in amplitude for Δl_2 (in cm and in %) after 3 min, too.

Question 1.3:

Compare the two results with each other. What do you see?

Question 1.4:
Which arrangement has the larger damping?

Question 1.5:
Can you explain this?

Question 1.6:
What can you conclude from the course of the curves for the longer times *t*? Does the amplitude reach a limit?

Question 1.7:
What does the limit 0 mean for the oscillation?

Question 2.1:
Calculate the decrease in amplitude for Δl_3 in cm and in %.

Question 2.2:
Compare the decrease in amplitude for the pendulum oscillations in air (with and without the disk) with those of the pendulum immersed in water. In which case is the damping (decrease in amplitude) the least, in which the largest?

Question 2.3:

How can you explain this?

Question 2.4:

Why is it nearly impossible to record a curve in water similar to that in air?