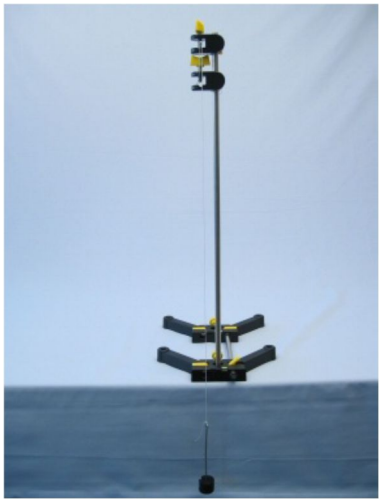
1.2 Measurement of time

Task

How rapidly does a pendulum oscillate?

Count the oscillations of a pendulum while timing them with the aid of a stopwatch. To determine the dependence of the oscillation period on the pendulum's length the length is shortened by 50 % in the second part of the experiment.



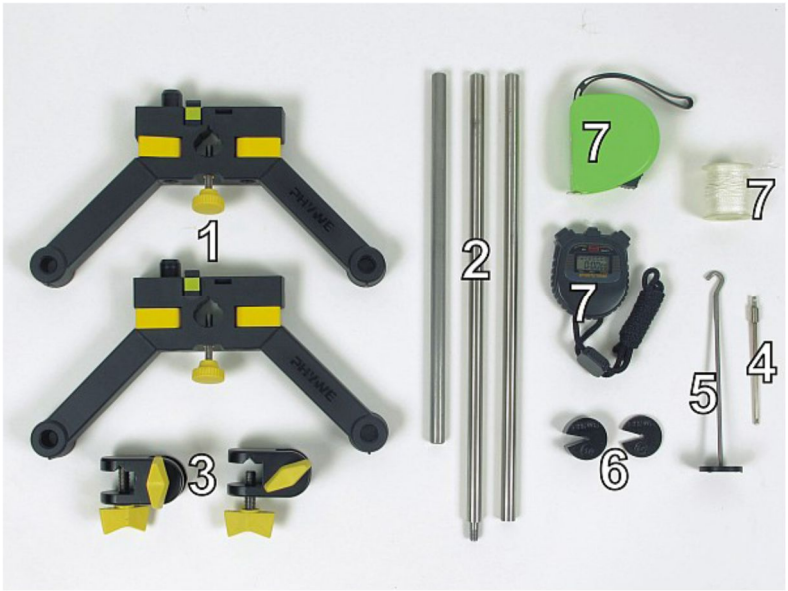
Use the space below for your own notes.

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
2	Support rod stainless steel 18/8, *l* = 250 mm, *d* = 10 mm	02031-00	1
3	Bosshead	02043-00	2
4	Holding pin	03949-00	1
5	Weight holder for slotted weights, 10 g	02204-00	1
6	Slotted weight, black coloured, 10 g	02205-01	1
6	Slotted weight, black coloured, 50 g	02206-01	1
7	Fish line, in reel, *d* = 0.7 mm, 20 m	02089-00	1.5 m
7	Stop watch, digital, 24h, 1/100 s and 1 s	24025-00	1
7	Measuring tape, *l* = 2 m	09936-00	1
Additional Material			
	Scissors		1

Material required for the experiment



Setup

Set up a stand for the pendulum. First screw the two rods together (Fig.1). To fix the rod pull the yellow lever (Fig. 2 and Fig. 3).

Fig. 1

Fig. 2

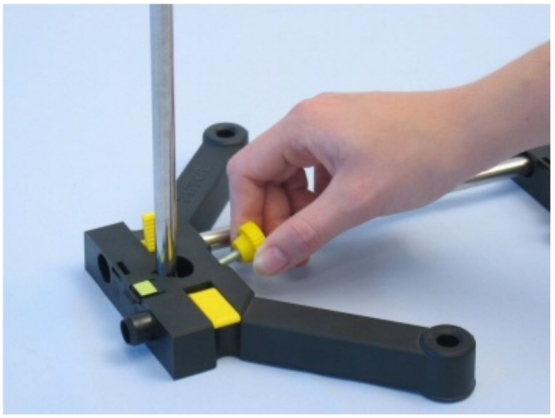


Fig. 3

Secure the holding pin with the upper bosshead so that the hole at its end is horizontal (Fig. 4).

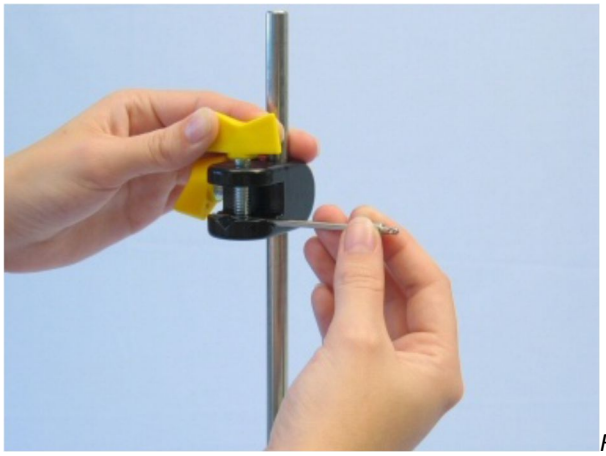


Fig. 4

Tie a piece of fish line (approx. 1.1 m) to the hook of the weight holder (Fig. 5) and thread it through the hole in the holding pin (Fig. 6).

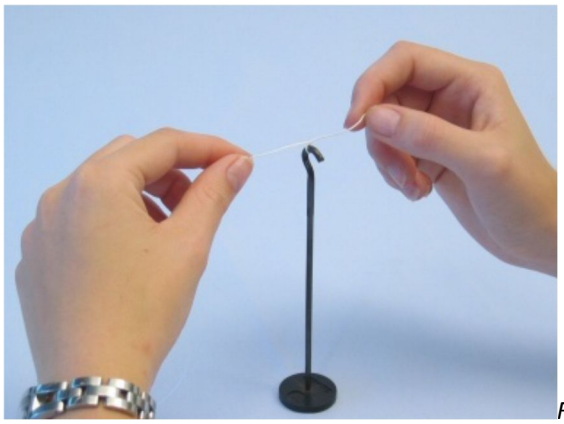


Fig. 5

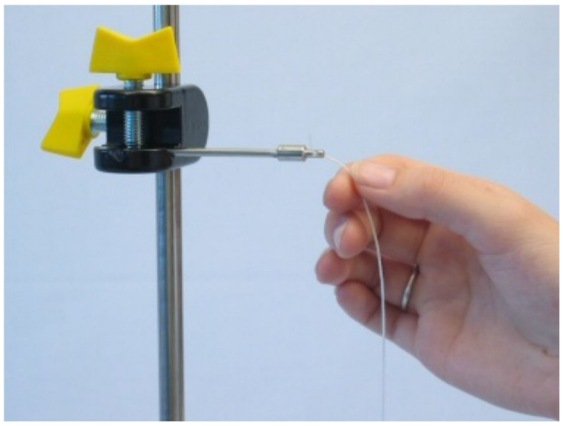


Fig. 6

Tie the fish line to the second bosshead (Fig. 7). Place the weight on the weight holder so that the total weight is 70 g. Fig. 8 shows how to hang the slottet weight into the weight holder.

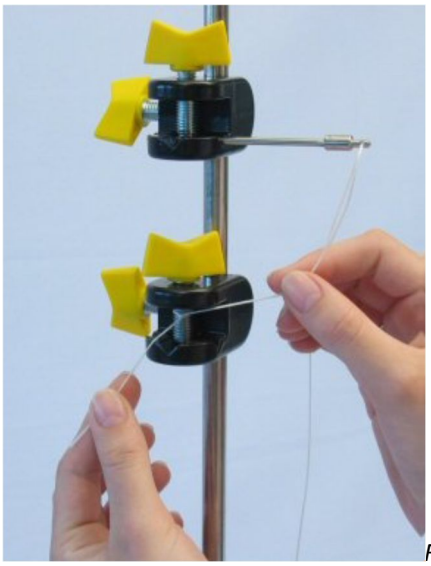


Fig. 7

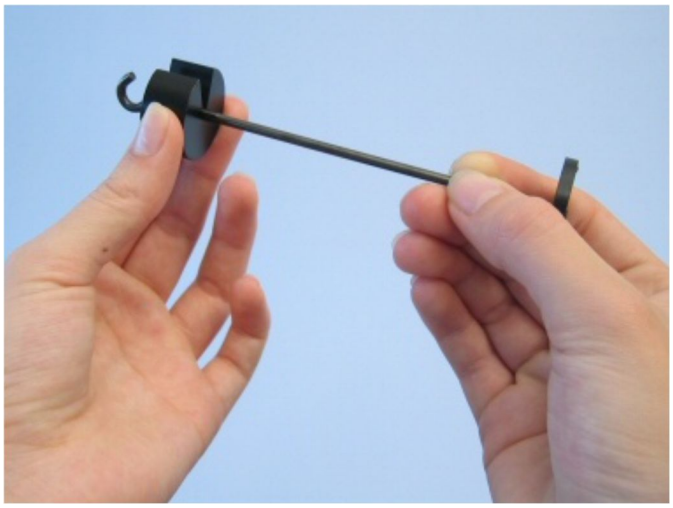


Fig. 8

Adjust the height of the lower bosshead so that the total length from the upper anchor point to the middle of the weights is as close to 99.4 cm as possible. (Fig. 9)

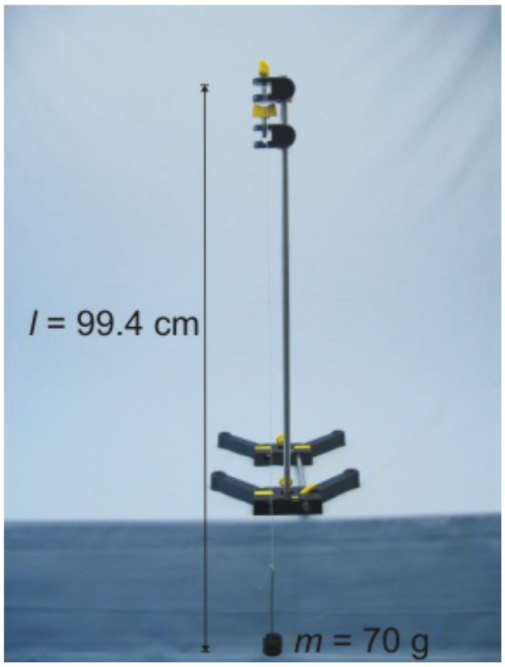


Fig. 9

Action

Let the pendulum oscillate parallel to the edge of the table, correct the swing if necessary.

- Move the end of the pendulum about 20 cm laterally (Fig. 10) and release it carefully. On releasing the pendulum, start the stop watch.

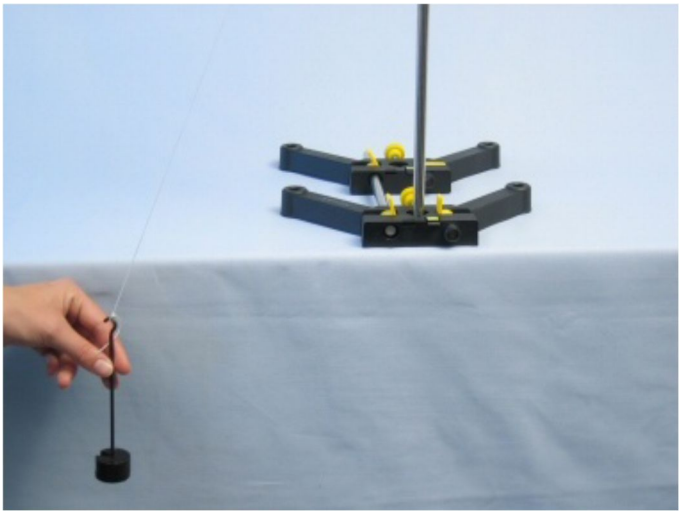


Fig. 10

- Stop the watch when the pendulum has completed an entire oscillation and read the time from the watch. Enter the value obtained under t_1 in Table 1 on the Results page.
- Repeat the trial by counting 20 oscillations. Stop the watch after 20 oscillations and read the elapsed time; enter the value under t_{20}.
- Repeat both trials 4 more times.
- Shorten the length of the pendulum to exactly 49.7 cm (Fig. 11) by moving the lower bosshead downward and if necessary by winding the fish line around it. Measure the time required for one and for 20 oscillations 5 times each and enter these values in Table 2 on the Results page.

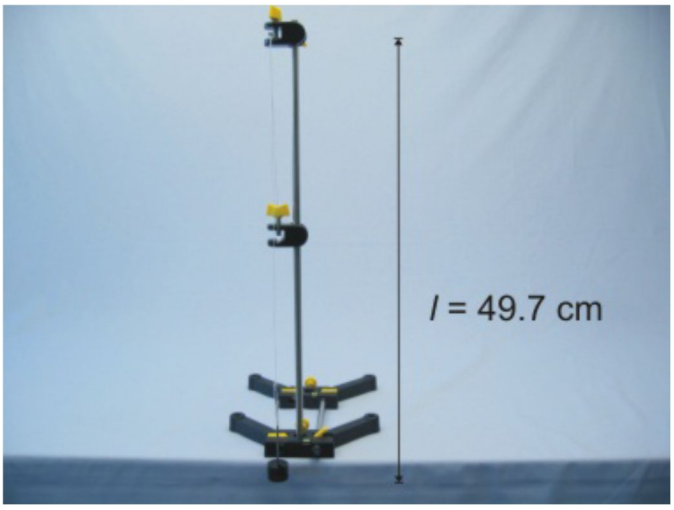


Fig. 11

Results

Table 1

Pendulum length *l* = 99.4 cm

Measurement No.	t_1 in s	t_{20} in s
1		
2		
3		
4		
5		
Average		

T =	s
$t_{0.5}$ =	s

Table 2

Pendulum length *l* = 49.7 cm

Measurement No.	t_1 in s	t_{20} in s
1		
2		
3		
4		
5		
Average		

T =	s
$t_{0.5}$ =	s

Evaluation

Question 1:

Calculate the average value of the time for 1 oscillation (t_1) and of the time for 20 oscillations (t_{20}). Now calculate the average oscillation time (T) dividing the average of t_{20} by 20. Enter the obtained value T in Table 1 and Table 2 on the Results page.

Question 2:

Compare the thus-determined value of T with the average for one oscillation (t_1).

Question 3:

Which result is probably more exact?

Question 4:

How much do the different measurements diverge from the average value?

Question 5:

How does shortening the pendulum's length affect its oscillation period?

Question 6:

Calculate the period for half an oscillation $t_{0.5}$ from the oscillation period T. Write the values in Table 1 and Table 2 on the Results page.

Question 7:

Can you explain, why a pendulum with a length of l = 99.4 cm is called a "second-pendulum"?

Additional Tasks

Question 1:

Determine the ratio of the oscillation periods of the 2 pendulums of different length. How large is it?

- $\sqrt{2}$
- $3/2$
- 2

Question 2:

Which proportionality is right?

- $T \sim \sqrt{l}$
- $\sqrt{T} \sim l$
- $T \sim l$