Restoring force on a displaced pendulum (Item No.: P1000200)

Curricular Relevance

Area of Expertise: Physik
Education Level: Klasse 7-10
Topic: Mechanik
Subtopic: Kräfte, einfache Maschinen
Experiment: Rückstellkraft am ausgelenkten Pendel

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

Additional Requirements:

- Scissors

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional Information

The students should measure the restoring force F of a deflected pendulum as a function of the deflection x for two different pendulum lengths.
Additionally, they should calculate the ratios x / l and F / Fg and compare them with each other. From the force parallelogram on the deflected pendulum they should conclude that these ratios are nearly equal.

Remark

For best results the laterally-acting counterforce F must act on the center of gravity of the pendulum's mass, i.e. the fish line must be attached between the mass pieces on the weight holder.
In addition, it must be ensured that the force always acts in a direction perpendicular to the pendulum line.

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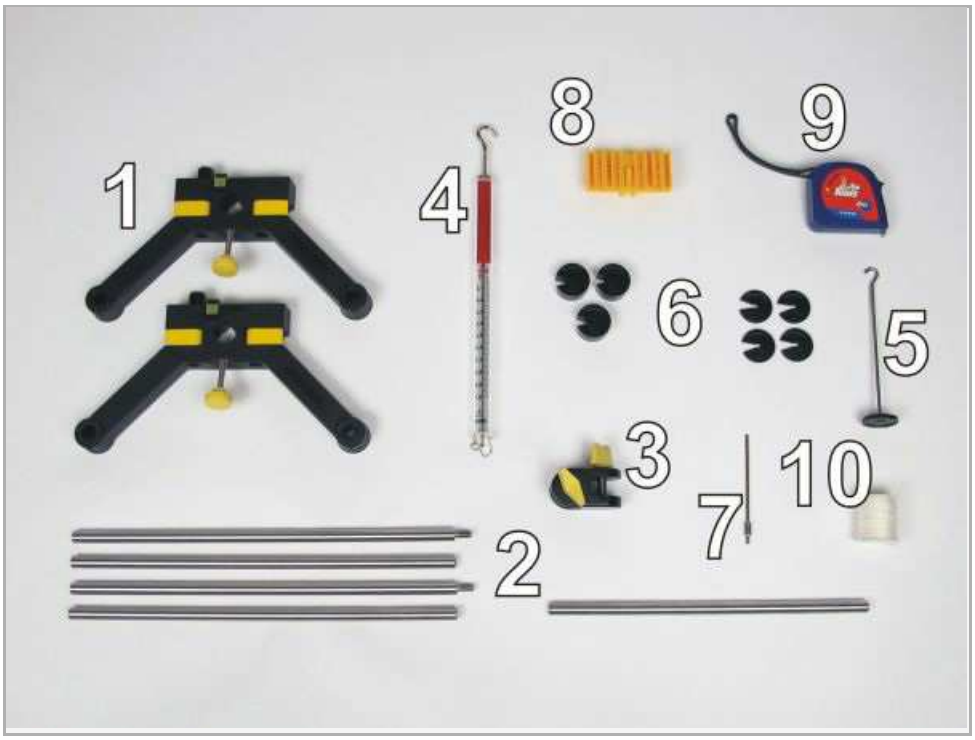
Task and equipment

Task

Which force affects a deflected pendulum?

You will determine the force with which a deflected simple pendulum moves toward its resting point as a function of its deflection.
By shortening the pendulum's length and repeating the measurement, you will verify your results.

Equipment



Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	2
2	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
3	Boss head	02043-00	1
4	Spring balance,transparent, 1 N	03065-02	1
5	Weight holder for slotted weights	02204-00	1
6	Slotted weight, black, 10 g	02205-01	4
6	Slotted weight, black, 50 g	02206-01	3
7	Holding pin	03949-00	1
8	Glass tube holder with tape measure clamp	05961-00	1
9	Measuring tape, l = 2 m	09936-00	1
10	Fishing line, l. 20m	02089-00	1
Additional material			
	Scissors		

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Set-up and procedure

Set-up

First screw the split support rods togehter (Fig. 1). Connect the two halves of the support base with the 60 cm support rod (Fig. 2). By moving the locking lever up, you will be fixing the support rod to the support base.
Set the 60 cm support rods and the 25 cm support rod into the support base halves and tighten them with the locking screws (Fig. 3).

Fig. 1

Fig. 2

Fig. 3

Clamp the bosshead into the 60 cm support rod and fix the holding pin in it (Fig. 4).

Fig. 4

Push the measuring tape into the glass tube holder (Fig. 5) and fix it to the 25 cm support rod (Fig. 6).

Fig. 5

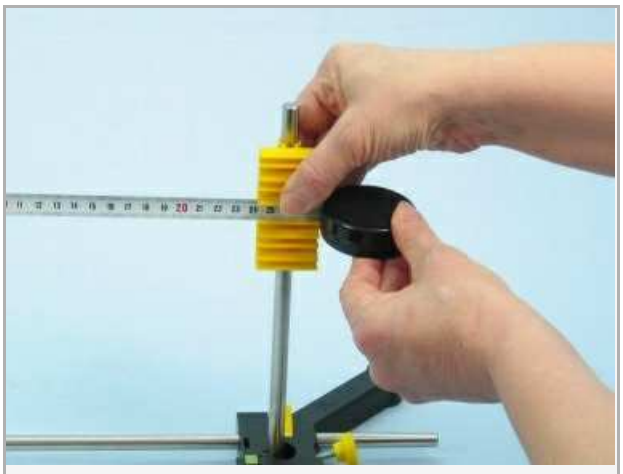

Fig. 6

Tie the ends of a length of fish line in loops, so that the final length is about 30 cm.

Attach one end of the fish line to the holding pin and hang the weight holder onto its other end. Load the weight holder with m_{tot} = 200 g (including the weight holder; Fig. 7).

Using another piece of fish line (Fig. 8), attach the weight holder to the weighing hook of the spring balance.

Make sure that the spring balance acts on the centre of gravity and that its direction is always perpendicular to the thread of the pendulum!

Fig. 7

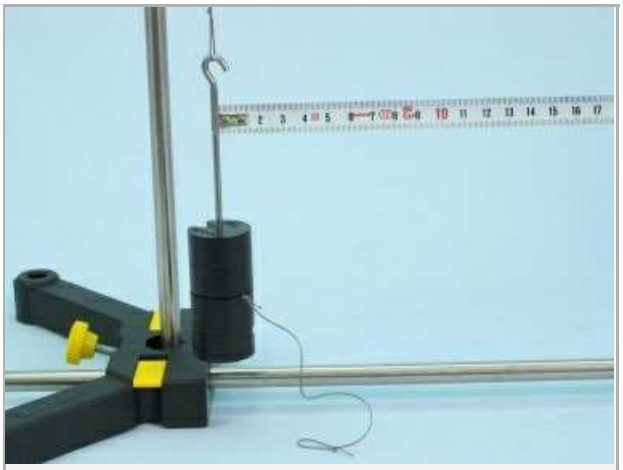

Fig. 8

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Procedure

Measure the length *l* of the pendulum (distance from the suspension point to the centre of gravity of the pendulum; Fig. 9).

Fig. 9

Deflect the pendulum by x = 2, 4, 6, 8, 10 cm; read the spring balance at each deflection distance (with the direction of the spring balance always perpendicular to the line of the pendulum) (Fig. 10, 11), and record the values in Table 1.

Fig. 10

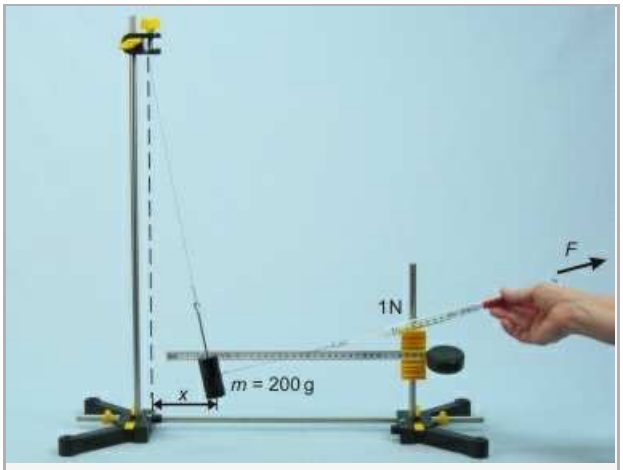

Fig. 11

Now shorten the length of the pendulum by 10 cm and remeasure *l* for each of the different deflection distances. Record the values in Table 2.

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Results – Table 1

Record all the measured values in Table 1 and calculate the ratios x / l and F / F_g.

Enter the results and write down the pendulum lenght in Table 1.

x in cm	F in N	x / l	F / F_g
2	0	0	0
4	0	0	0
6	0	0	0
8	0	0	0
10	0	0	0
Pendulum lenght:	0		

Results – Observation

Weight (force) F_g = ... N

Results – Table 2

Record all the measured values in Table 2 and calculate the ratios x / l and F / F_g.

Enter the results and write down the shortened pendulum lenght in Table 2.

x in cm	F in N	x / l	F / F_g
2	0	0	0
4	0	0	0
6	0	0	0
8	0	0	0
10	0	0	0
Pendulum lenght:	0		

Evaluation – Question 1

Compare the ratios x / l and F / F_g in table 1 and 2. What do you notice?

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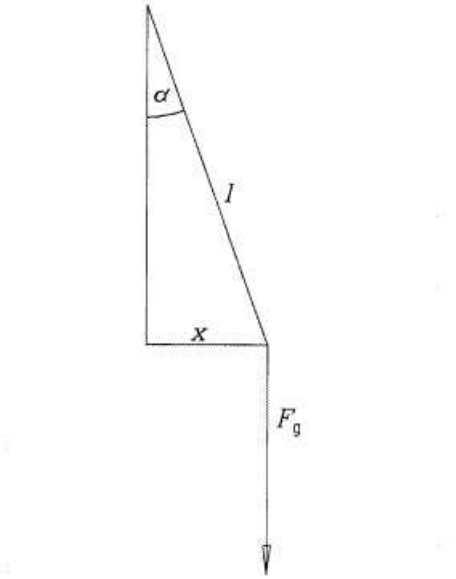
Evaluation – Question 2

Complete the sketch below by adding in the forces which act on the pendulum's mass in the deflected condition, and draw the force parallelogram (using the measured values from Table 1 on the Results page with x = 10 cm).



Evaluation – Question 3

Can you now give reasons for the results of your measurements and calculations?

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