Force and displacement on a fixed pulley (Item No.: P1000800)

Curricular Relevance

Area of Expertise: Physik
Education Level: Klasse 7-10
Topic: Mechanik
Subtopic: Kräfte, einfache Maschinen
Experiment: Kräfte und Wege an der festen Rolle

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

Additional Requirements:

- Tape
- Scissors

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional Information

The students should deflect a force with a fixed pulley and determine whether the forces and distances are changed by doing this.
Further, through experiment and calculation they should determine whether the products of load × load distance and force × force distance are equal.

The term “(slotted) weight" is incorrect inasmuch as we are dealing with a mass which becomes a weight (in reality “a weight-force") under the influence of the earth’s gravity. The term “mass piece" used here is better.

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Task and equipment

Task

Which forces and distances occur on a fixed pulley?

On a fixed pulley hold a mass in equilibrium with a spring balance; then move the spring balance a specific distance. Determine the distance that the mass moved.
Determine the correlation between distance and force through calculation and comparison with the measured data.

Equipment

Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod with hole, stainless steel, 10 cm	02036-01	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	2
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	2
6	Pulley,movable,dia.65mm,w.hook	02262-00	1
7	Rod for pulley	02263-00	1
8	Spring balance,transparent, 2 N	03065-03	1
9	Glass tube holder with tape measure clamp	05961-00	1
10	Measuring tape, l = 2 m	09936-00	1
10	Fishing line, l. 20m	02089-00	1
Additional material:			
	Tape		
	Scissors		

Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com

Set-up and procedure

Set-up

Set up a stand with the support base (Fig. 1). Push the 25 cm support rod into the hole of the support base (Fig. 2). Screw the two rods together to get a long one (Fig.3). Put this 60 cm support rod in the support base and fix it with the screw (Fig. 4).

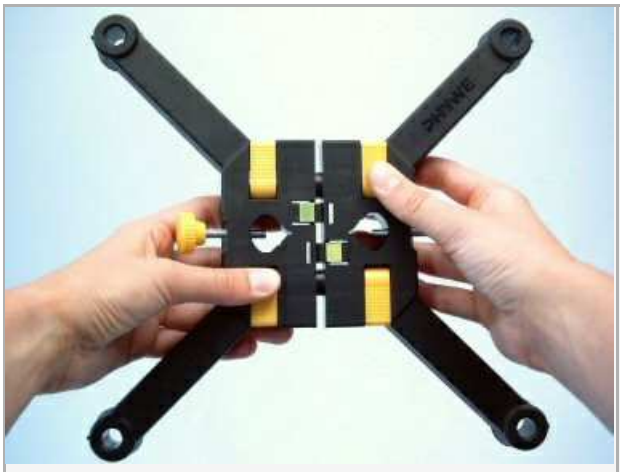

Fig. 1


Fig. 2


Fig. 3


Fig. 4

Fix the pulley to the "rod for pulley" (Fig. 5) and clamp it with the bosshead to the long support rod (Fig. 6).


Fig. 5


Fig. 6

Clamp the measuring tape and the short support rod in the glass tube holder (Fig. 7 and Fig. 8) and clamp the short rod in the second bosshead to the 60 cm support rod (Fig. 9).

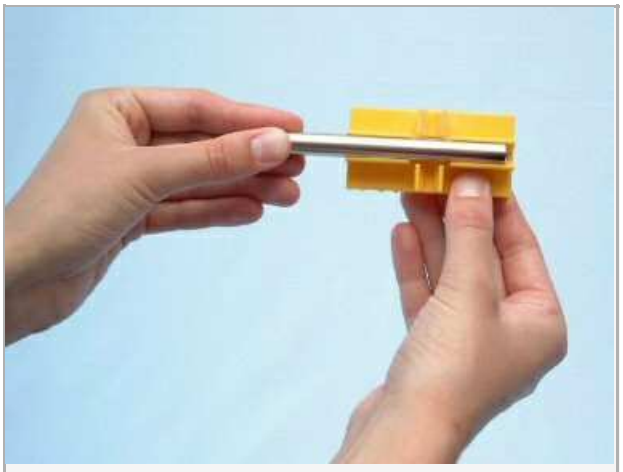
Fig. 7


Fig. 8


Fig. 9

Attach the free end of the measuring tape with a piece of adhesive tape to the table top. Connect the spring balance to the

weight holder through the pulley with a piece of fish line about 70 cm long. Set the upside down spring balance to zero (Fig. 10).

Fig. 10

Procedure

Place four 10 g mass pieces on the weight holder. For hanging the slotted weight up the weight holder, you should slip the slotted weight over the top of the weight holder (Fig. 11).

Fig. 11

- Hold the mass (load) with the spring balance so that it is suspended just above the table top (Fig. 12), i.e. $h_{l0} = 0$.
- Read F_f in N on the spring balance's indicator. Also measure the heights of the lower end of the spring balance h_{f0}.
- Hook the supporting hook of the spring balance onto the support base and read the heights of the lower end of the spring balance h_{f1} and of the mass h_{l1} on the measuring tape (Fig. 13).
- Record the measured values in Table 1 in the report.
- Repeat these measurements, first, with a mass of 100 g and, then, with 150 g. Add the measured values to Table 1.

Fig. 12

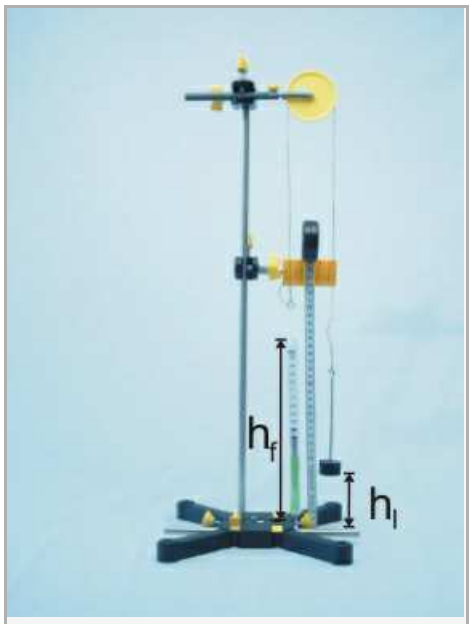

Fig. 13

In order to disassemble the support base you should press the yellow buttons (Fig. 14).

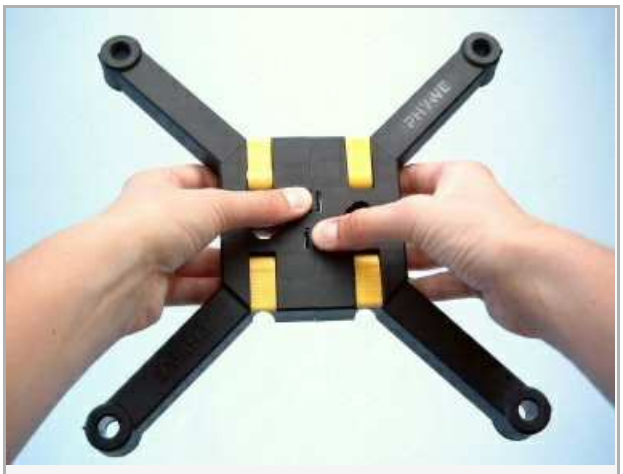

Fig. 14

Report: Force and displacement on a fixed pulley

Results – Table 1

Enter measured value in the Table 1. h_{l0} = 0 cm

From the mass m calculate the weight (force) of the load F_l and record the value obtained in table 1. From the difference h_{l1} - h_{l0} calculate the load distance s_l; from the difference h_{f0} - h_{f1} the force distance s_f. Record the values obtained in the table1.

m in g	F_f in N	h_{f0} in cm	h_{l1} in cm	h_{f1} in cm	F_l in N	s_l in cm	s_f in cm
50	0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
100	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0	0 ±0
150	0 ±0	0 ±0	1 ±0	0 ±0	0 ±0	0 ±0	0 ±0

Evaluation – Question 1

What is the correlation between load distance to force distance on a fixed pulley?

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Results – Table 2

From the force F_f and the force distance s_f calculate the product $F_f \times s_f$ for the three masses and record these values in the table 2.

In the same way, calculate the product $F_l \times s_l$ from the load F_l and the load distance s_l; record these values in the table, too.

m in g	$F_f \cdot s_f$ in Ncm	$F_l \cdot s_l$ in Ncm
50	0 ±0	0 ±0
100	0 ±0	0 ±0
150	0 ±0	0 ±0

Evaluation – Question 2

Compare the results with each other, what do you notice?

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Evaluation – Question 3

Do the distances along the line change when the angle of the acting force is changed?

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Evaluation – Question 4

Does the force change after a deflection of its direction by a fixed pulley?

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D - 37079 Göttingen

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info@phywe.de
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Evaluation – Question 5

What tasks can be performed with a fixed pulley?

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