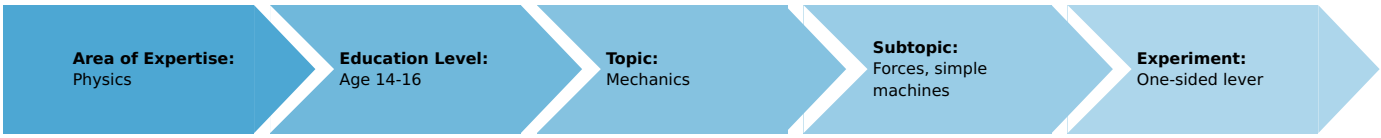
One-sided lever (Item No.: P1000700)

Curricular Relevance



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

Additional Requirements:

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional Information

In Experiment Double-sided lever (P1000600) the students became familiar with the law of the lever and its representation in the form “Sum of all moments of rotation equals zero”. In this experiment they should investigate the one-sided lever in the same way and establish its principles.

In a supplementary problem the representation of the law in the moment of the rotation form is again required.

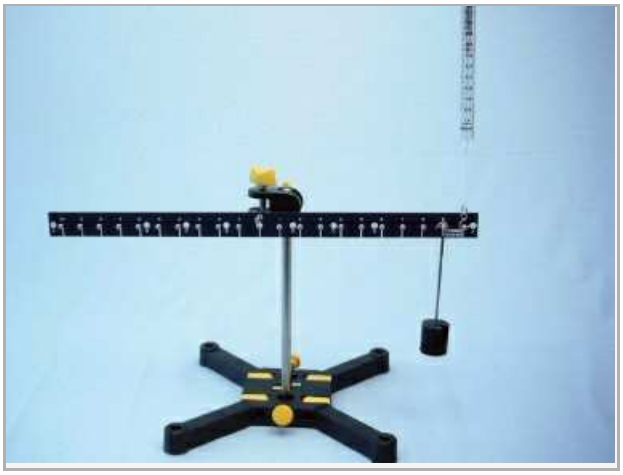
One-sided lever (Item No.: P1000700)

Task and equipment

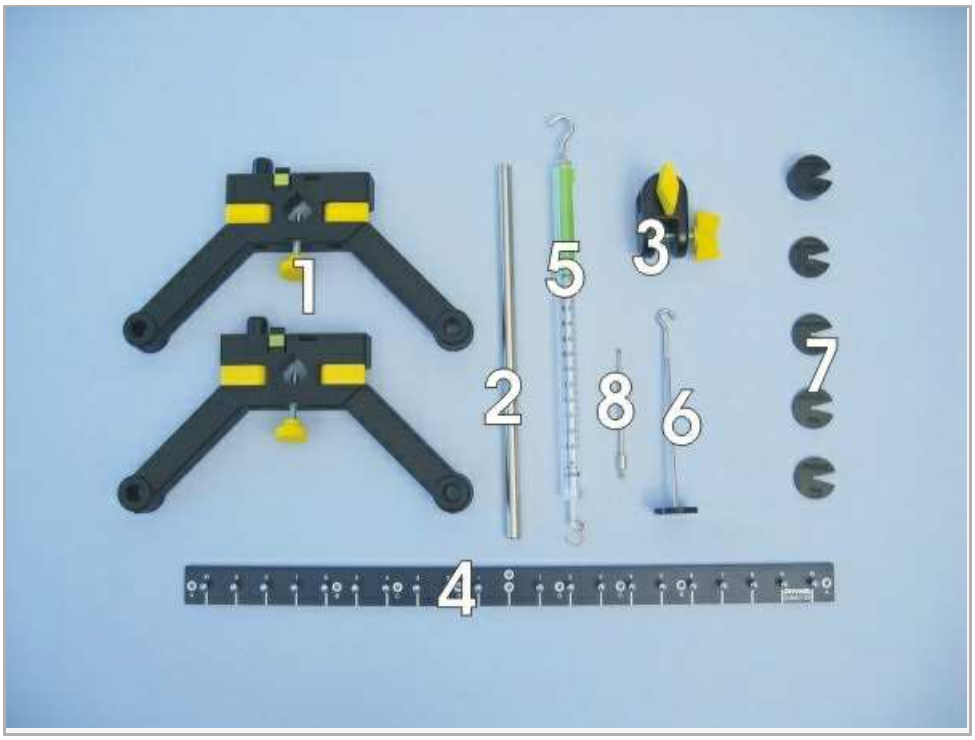
Task

How do force and load relate on a one-sided (class 3) lever?

Load one side of the lever with a mass which acts on different points and bring it with a spring balance which acts on the outer end of the same side in a horizontal position. Measure at each position the occuring forces and lengths.
Load one side of the lever with a mass. With a spring balance which acts on different points on the same side bring the lever into a horizontal position. Perform again measurements of the lengths and masses involved.



Equipment



Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
3	Boss head	02043-00	1
4	Lever	03960-00	1
5	Spring balance,transparent, 2 N	03065-03	1
6	Weight holder for slotted weights	02204-00	2
7	Slotted weight, black, 10 g	02205-01	4
7	Slotted weight, black, 50 g	02206-01	1
8	Holding pin	03949-00	1

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Set-up and procedure

Set-up

Set up a stand with the support base and the support rod (Fig. 1 and Fig. 2).

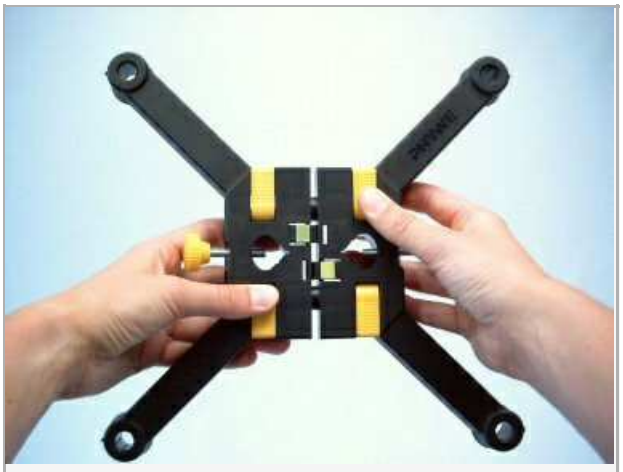

Fig. 1

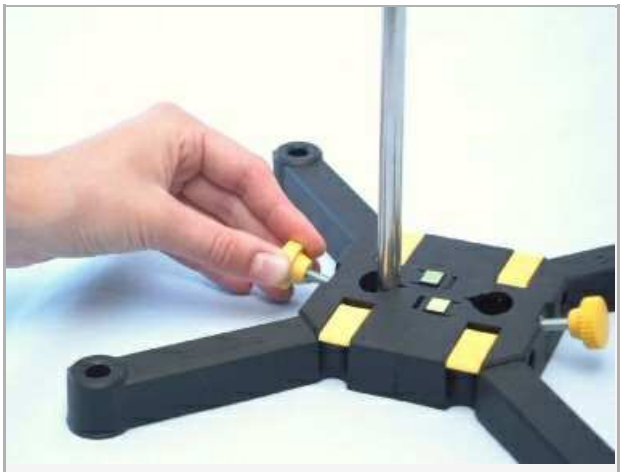

Fig. 2

Attach the bosshead to the support rod. Clamp the lever with the holding pin, so that the holding pin is exactly in the lever's centre. After that, insert the holding pin into the bosshead (Fig. 3). Adjust the spring balance by using the screw (Fig. 4).

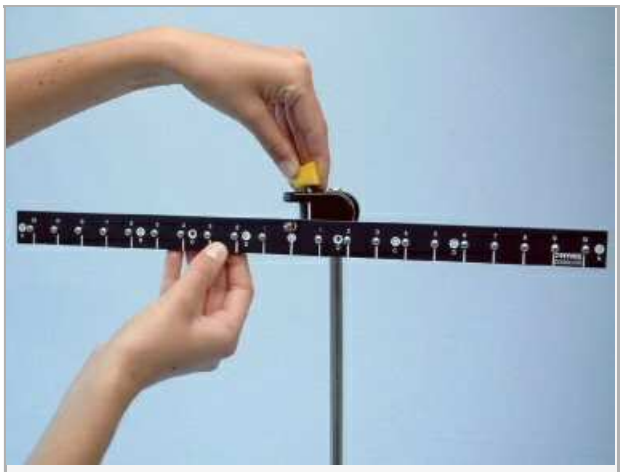

Fig. 3

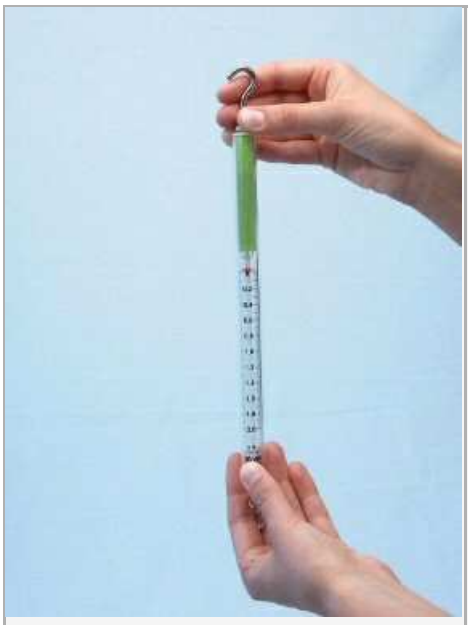

Fig. 4

Procedure

- Hang the weight holder with a mass of $m_{tot.}$ = 100 g at mark 9 on the right side of the lever. For hanging the slotted weight up the weight holder, slip the slotted weight over the top of the weight holder (Fig. 5).

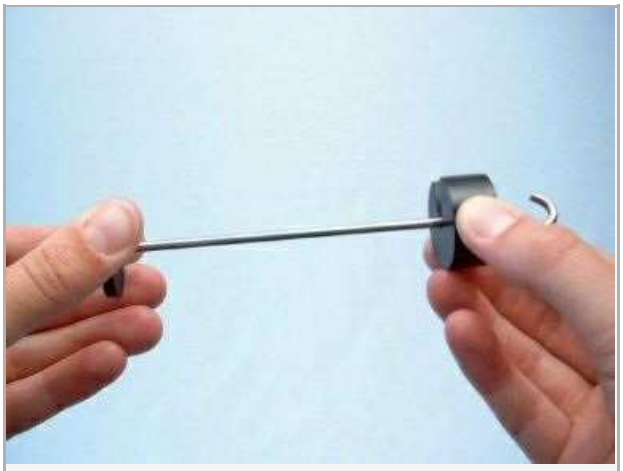

Fig. 5

- Move the lever with the spring balance which is at the 10 mark on the right side into a horizontal position by pulling upwards (Fig. 6).
- Hang the mass successively on the 7, 5, 3 and 1 marks on the right side (Fig. 7) and read the measured value *F* for each position. Record all the measured values in Table 1 in the report.

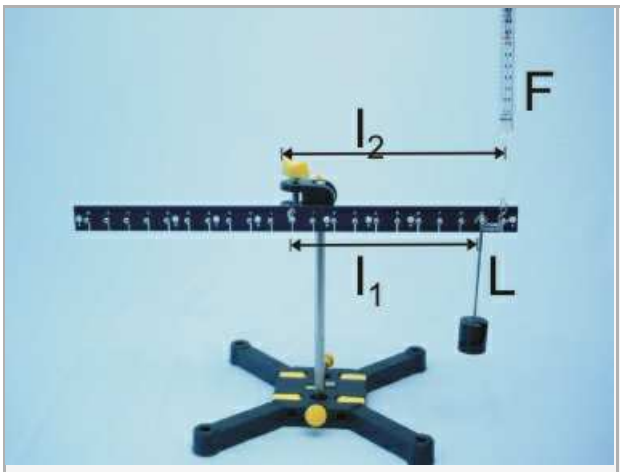

Fig. 6

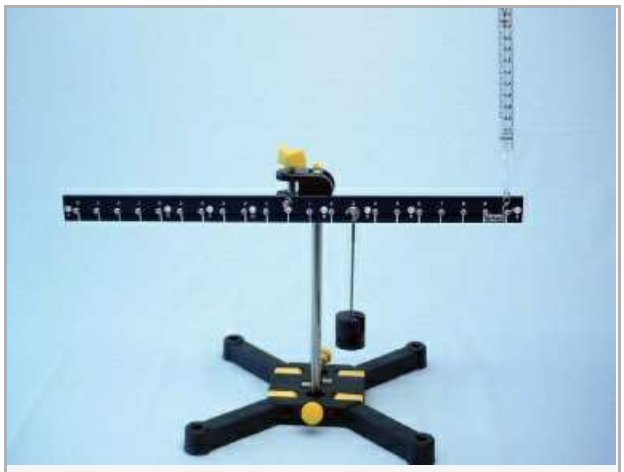

Fig. 7

- Hang the weight holder with a mass of $m_{tot.}$ = 40 g at mark 5 on the right side of the lever (Fig. 8).
- Move the lever with the spring balance which is at the 10 mark on the right side pulling upwards into a horizontal position. Record this values in Table 2 in the report.
- Move the spring balance successively to the 8, 6, 4 and 2 marks on the right side and measure the force *F* for each position of the spring balance (Fig. 9). Record all the values in Table 2 in the report.

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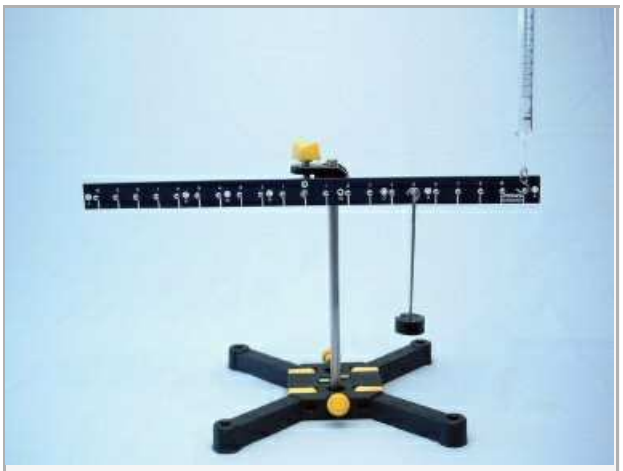

Fig. 8

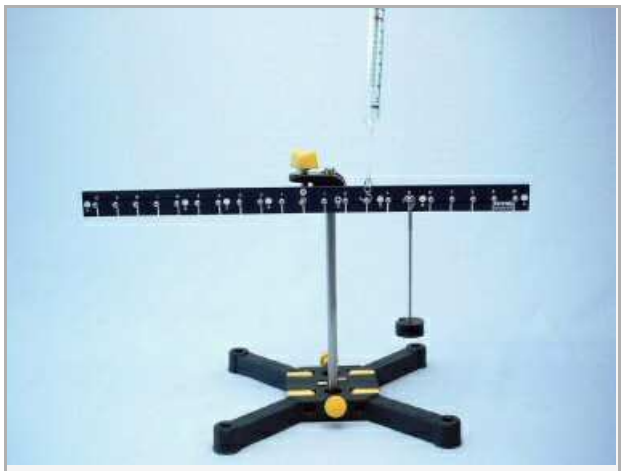

Fig. 9

In order to disassemble the support base you should press the yellow buttons (Fig. 10).

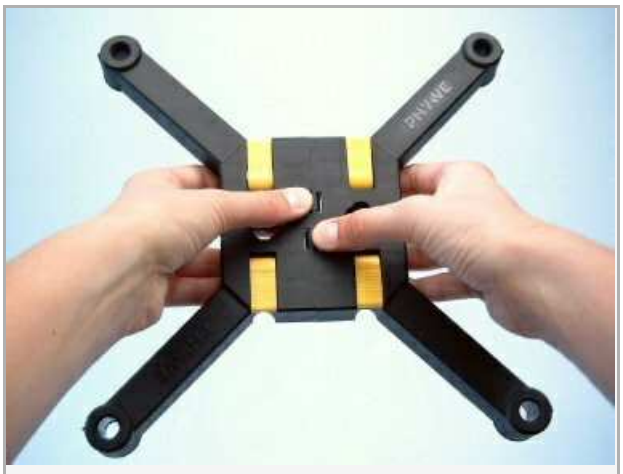

Fig. 10

Report: One-sided lever

Results – Question 1

Part 1:

Calculate the weight (forces) from the masses $m_{tot.}$ and record them as load L in the tables in the report.

$m_{tot.}$ = 100 g, L = ... N

Results – Table 1

Enter measured value in the Table 1.

From the distance between the marks used (2 cm each), calculate the length of the load arm l_1 and the force arm l_2 in cm (see Fig. 6 on the procedure page) and add these values to the table.

Calculate the products $L \cdot l_1$ and $F \cdot l_2$ and record these values in the table, too.

Mark No.		F in N	l_1 in cm	$L \cdot l_1$ in Ncm	l_2 cm	$F \cdot l_2$ in Ncm
mass	spring balance					
9	10	0,88 0	0	0	0	0
7	10	0,68 0	0	0	0	0
5	10	0,49 0	0	0	0	0
3	10	0,29 0	0	0	0	0
1	10	0,1 0	0	0	0	0

Results – Question 2

Part 2:

Calculate the weight (forces) from the masses $m_{tot.}$ and record them as load L in the tables in the report.

m_{tot} = 40 g, L = ... N

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Results – Table 2

Enter measured value in the Table 2.

From the distance between the marks used (2 cm each), calculate the length of the load arm l_1 and the force arm l_2 in cm (see Fig. 6 on the procedure page) and add these values to the table.

Calculate the products $L \cdot l_1$ and $F \cdot l_2$ and record these values in the table, too.

Mark No.		F in N	l_1 in cm	$L \cdot l_1$ in Ncm	l_2 in cm	$F \cdot l_2$ in Ncm
mass	spring balance					
5	10	0,2 0	0	0	0	0
5	8	0,24 0	0	0	0	0
5	6	0,32 0	0	0	0	0
5	4	0,48 0	0	0	0	0
5	2	1,0 0	0	0	0	0

Evaluation – Question 1

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

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Evaluation – Question 2

Express the observed facts in words and as a formula:

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Evaluation – Table 3

Examine the following Table 3:
How does the force change under the given conditions? Does it become larger or smaller? Complete the table.

Load L	Load arm l_1	Force arm l_2	Force F
constant	smaller	constant	1
constant	constant	smaller	1
smaller	constant	constant	1

Evaluation – Question 3

Load the lever at the 6 mark on the right side with 30 g. Hang the spring balance also at this mark and bring the lever into a horizontal position. How large is the force indicated?

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Evaluation – Additional Task 1

Load the right side of the lever with several masses L_1, L_2, ... on the Load arm l_{11}, l_{12}, ... How large is the force F which holds the lever in a horizontal position on the same side on the force arm l_2?

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Evaluation – Additional Task 2

The product "force · lever arm" is called the moment of rotation. State the conditions necessary for the lever to remain in a horizontal position. While doing this consider the lever's direction of rotation.

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