

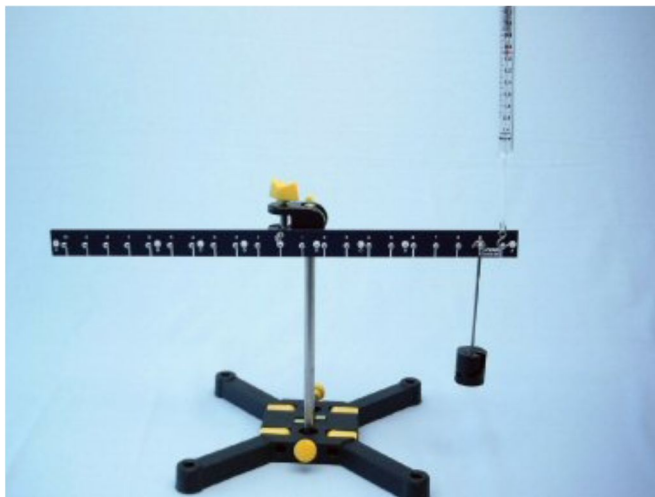
### 3.3 One-sided (class 3) lever

#### 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 occurring 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.



Use the space below for your own notes.

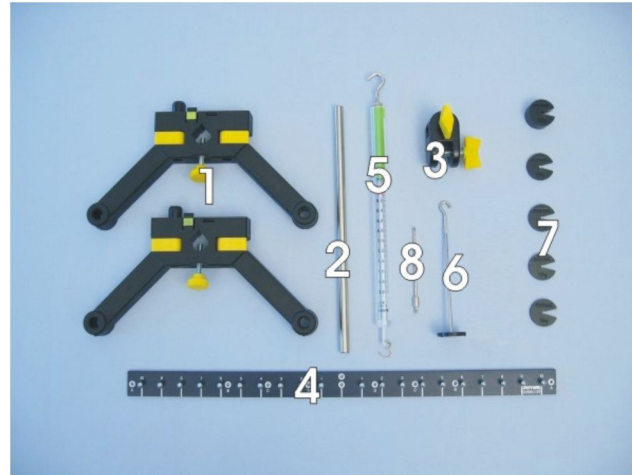
#### Material

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, stainless steel 18/8, $l = 250$ mm, $d = 10$ mm	02031-01	1
3	Bosshead	02043-00	1

4	Lever	03960-00	1
5	Spring balance, transparent, 2 N	03065-03	1
6	Weight holder for slotted weights, 10 g	02204-00	1
6	Slotted weight, black coloured, 10 g	02205-01	4
6	Slotted weight, black coloured, 50 g	02206-01	1
8	Holding pin	03949-00	1

### Material required for the experiment



### Setup

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

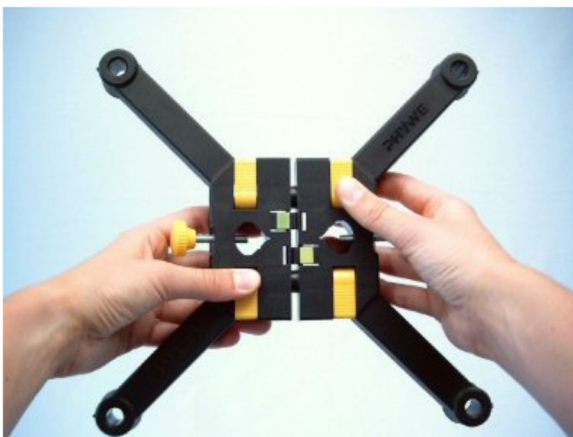


Fig. 1

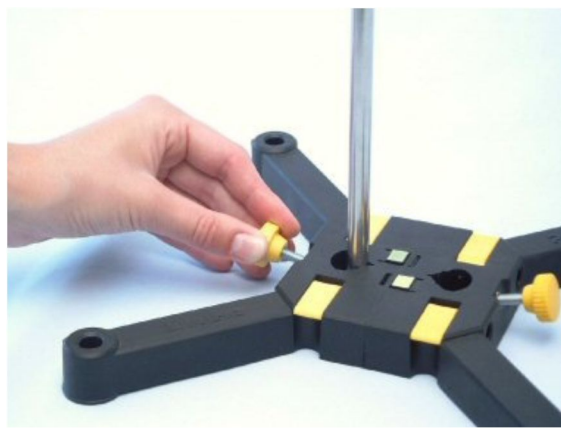


Fig. 2

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).

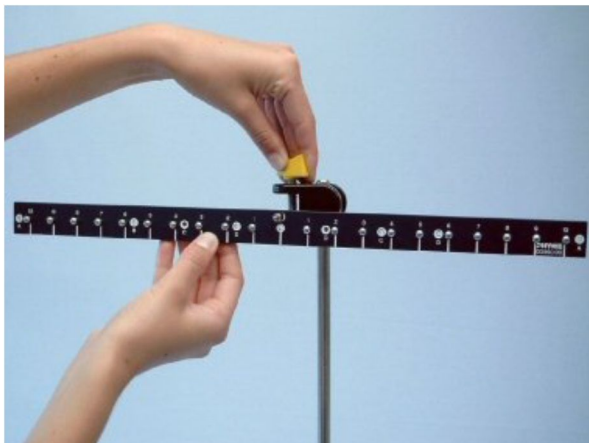


Fig. 3



Fig. 4

### Action

- 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).

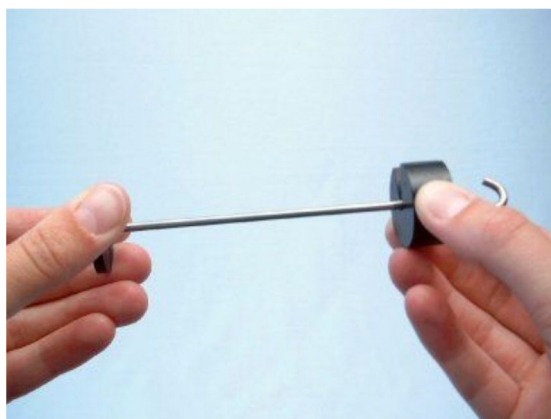


Fig. 5

- 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 on the Results page.

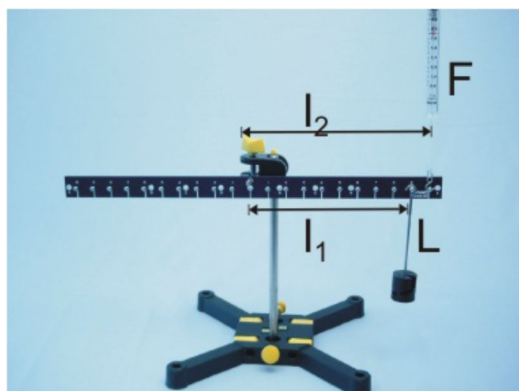


Fig. 6

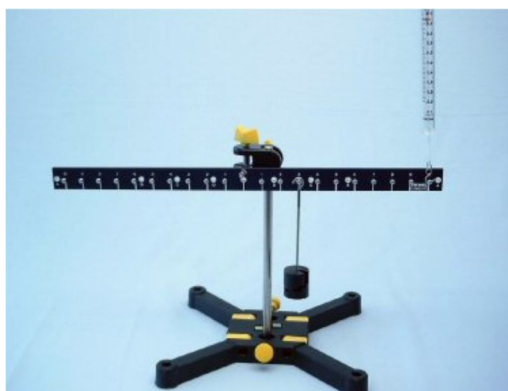


Fig. 7

- 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 on the Results page.
- 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 on the Results page.

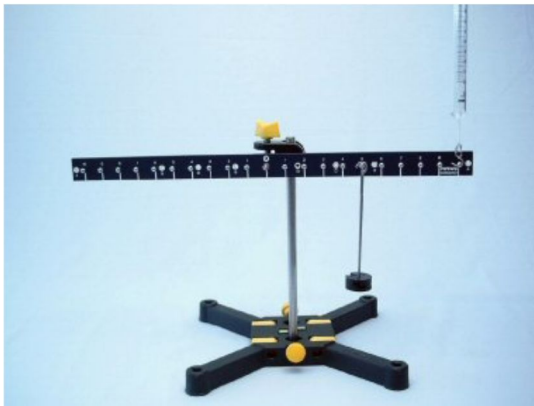


Fig. 8

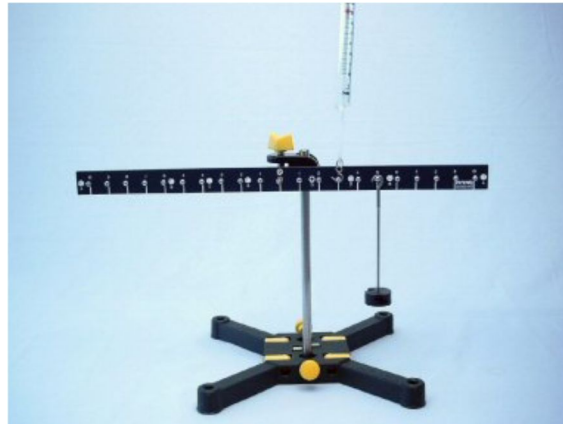


Fig. 9

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

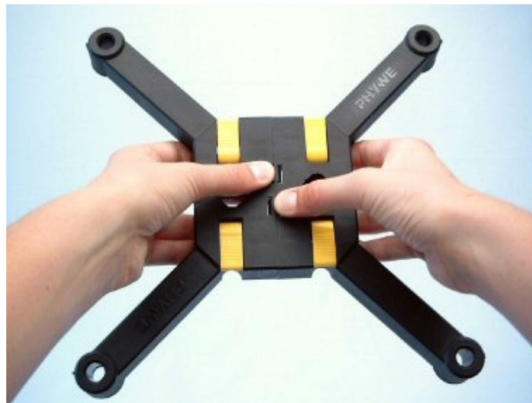


Fig. 10

## Results

Table 1

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

Mark No.		$F$ in N	$l_1$ in cm	$L \times l_1$ in Ncm	$l_2$ in cm	$F \times l_2$ in Ncm
Mass	Spring balance					
9	10					
7	10					
5	10					
3	10					
1	10					



**Table 2**

$m_{tot.} = 40 \text{ g}, L = \boxed{\phantom{00000}} \text{ N}$

Mark No.		F in N	l <sub>1</sub> in cm	L × l <sub>1</sub> in Ncm	l <sub>2</sub> in cm	F × l <sub>2</sub> in Ncm
Mass	Spring balance					
5	10					
5	8					
5	6					
5	4					
5	2					

**Evaluation**

**Question 1:**

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

**Question 2:**

Calculate the length of the load arm  $l_1$  and the force arm  $l_2$  (see Fig. 6 on the Action page) from the distance between the marks (2 cm each) and add the values to the tables on the Results page.

**Question 3:**

Calculate the product  $L \times l_1$  and  $F \times l_2$  and record these values in the tables, too.

**Question 4:**

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

**Question 5:**

Express the observed facts in words and as a formula:

**Question 6:**

Examine the following Table 3:

How does the force change under the given conditions? Does it become larger or smaller?

Complete the table.

**Table 3**

Load $L$	Load arm $l_1$	Force arm $l_2$	Force $F$
Constant	Smaller	Constant	
Constant	Constant	Smaller	
Smaller	Constant	Constant	

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**Question 7:**

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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**Additional Tasks****Question 1:**

Load the right side of the lever with several masses  $L_1, L_2, \dots$  on the Load arm  $l_{11}, l_{12}, \dots$ . 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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**Question 2:**

The product "force  $\times$  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.