Reactive forces for a loaded beam (Item No.: P1000100)

Curricular Relevance

Area of Expertise: Physik
Education Level: Klasse 7-10
Topic: Mechanik
Subtopic: Kräfte, einfache Maschinen
Experiment: Auflagekräfte am belasteten Balken

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

Additional Requirements:

- Scissors

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional Information

Having completed their measurements on an unloaded beam (P1000000), the students should now determine the effect of a load on the loading pressure in dependence on the point of application of the load to the beam.
In the evaluation the influence of a load on one end of the force’s characteristic curves should be worked out. This should be done with regard to the experiments on the laws of levers which follow later.

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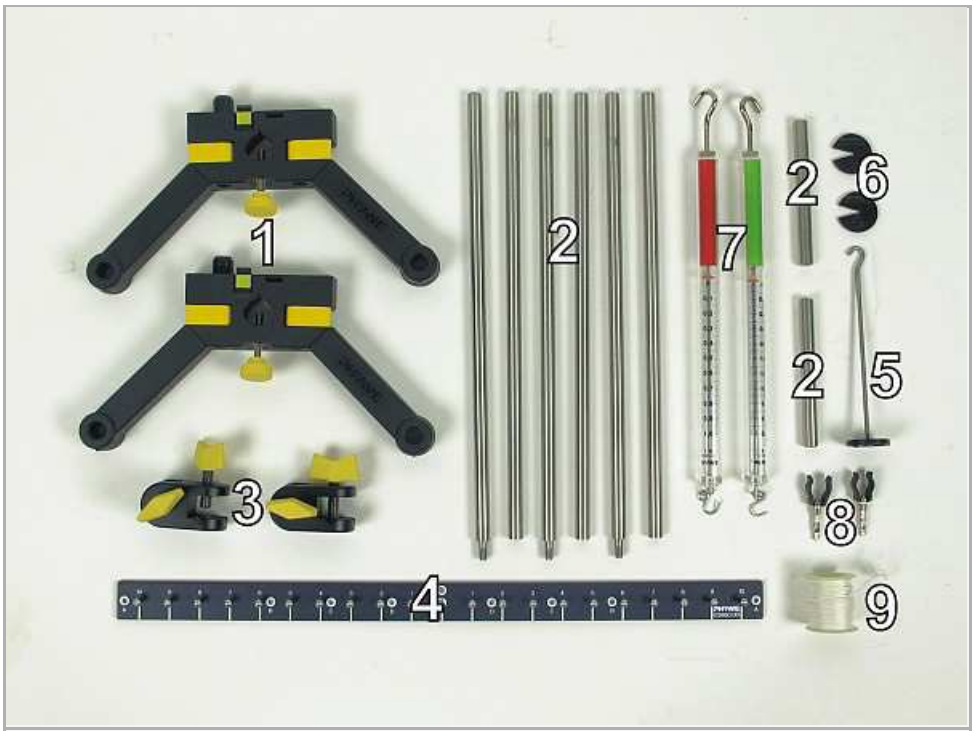
Task and equipment

Task

What is the effect of a load on the loading pressure of a beam?

Load a horizontally suspended beam with an additional weight, which you move progressively from right to left. Read the corresponding loading pressures F_1 and F_2

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	2
2	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	3
3	Boss head	02043-00	2
4	Lever	03960-00	1
5	Weight holder for slotted weights	02204-00	1
6	Slotted weight, black, 10 g	02205-01	2
7	Spring balance,transparent, 1 N	03065-02	1
7	Spring balance,transparent, 2 N	03065-03	1
8	Spring balance holder	03065-20	2
9	Fishing line, l. 20m	02089-00	1
Additional material			
	Scissors		1

Set-up and procedure

Set-up

First screw the splitt support rods together (Fig. 1). Connect the two halves of the support base with the 60 cm support rod and tighten the locking levers (Fig. 2). Set the two 60 cm support rods into the support base halves, tighten them with the locking screws (Fig. 3).

Fig. 1

Fig. 2

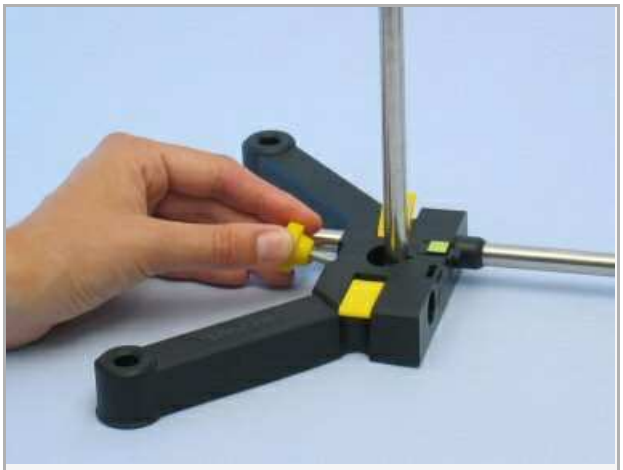


Fig. 3

Insert the spring balance holders into the short rods (Fig. 4). Fix the bosshead at the 60 cm support rod and clamp the short support rod in the bosshead. Clamp the two spring balances into place and adjust them to zero by using the adjustment screw (Fig. 5).

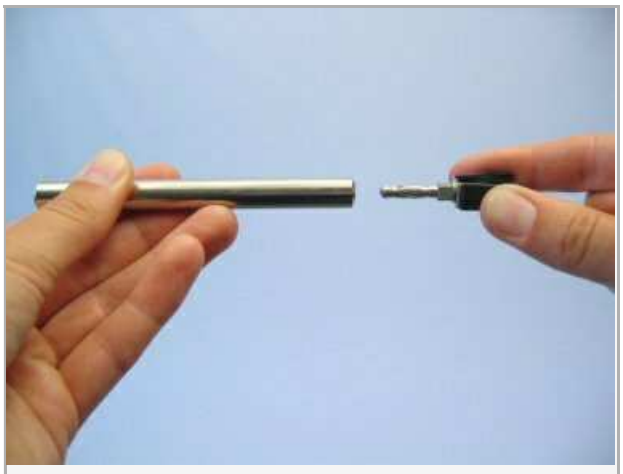


Fig. 4

Fig. 5

Procedure

Attach two loops (thread length of each = 10 cm) in the two outer holes on the beam (Fig. 6). Hang the beam on the spring balances with the loops and adjust the heights of the spring balances so that the beam is horizontal (Fig. 7).

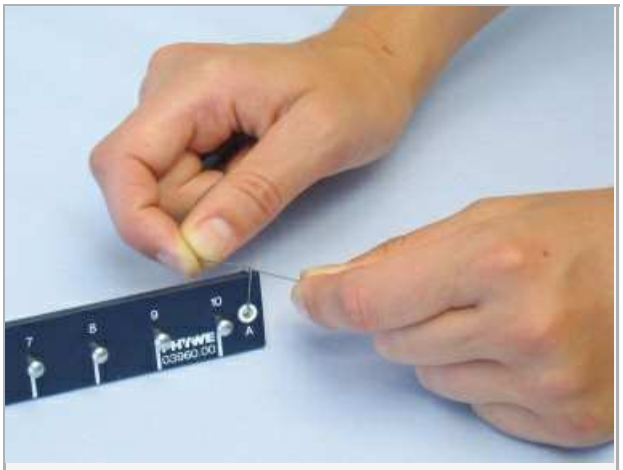


Fig. 6

Fig. 7

- Read the forces F_1 and F_2 without additional load and note the measured values.
- Hang the weight holder with two 10 g mass pieces (m = 30 g) on the right 9 mark.
- Read the forces F_1 and F_2 and note them in table 1.
- Hang the mass successively on the 7, 5, 3, 1 marks beginning at the right and continue further to the left on the 1, 3, 5, 7, 9 marks.
- Record the respective values for F_1 and F_2 in table 1.

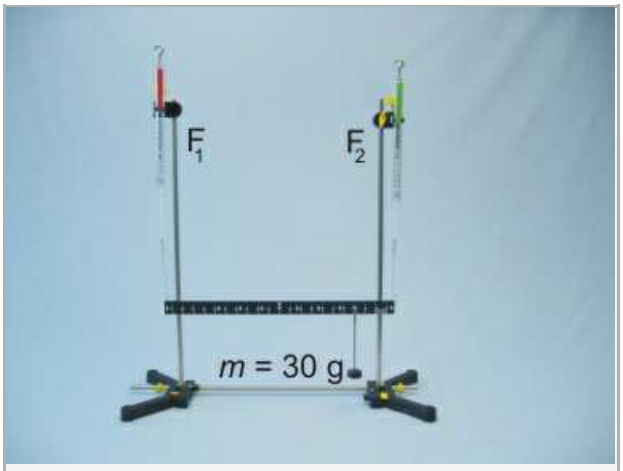


Fig. 8

Determine the beam's weight (force) F_B and record its value above table 1.

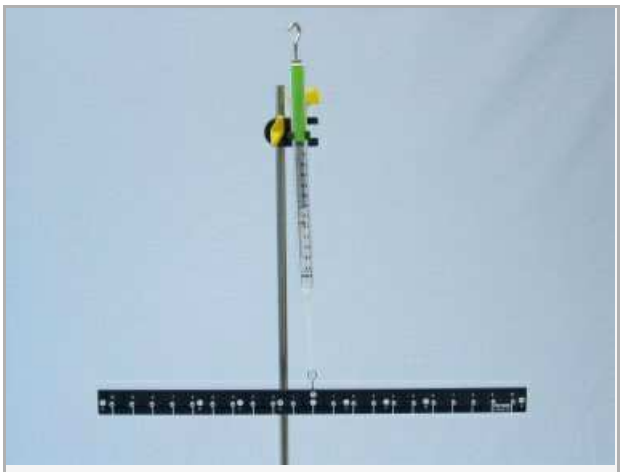


Abb. 9

Report: Reactive forces for a loaded beam

Result - Observations 1

Enter the weight (force) of the beam: F_B = ... N and the weight (force) of the mass m: F_g = ... N.

Using the measured values calculate the sum of the loading pressures, $F_{tot.} = F_1 + F_2$.

F_1 = ... N

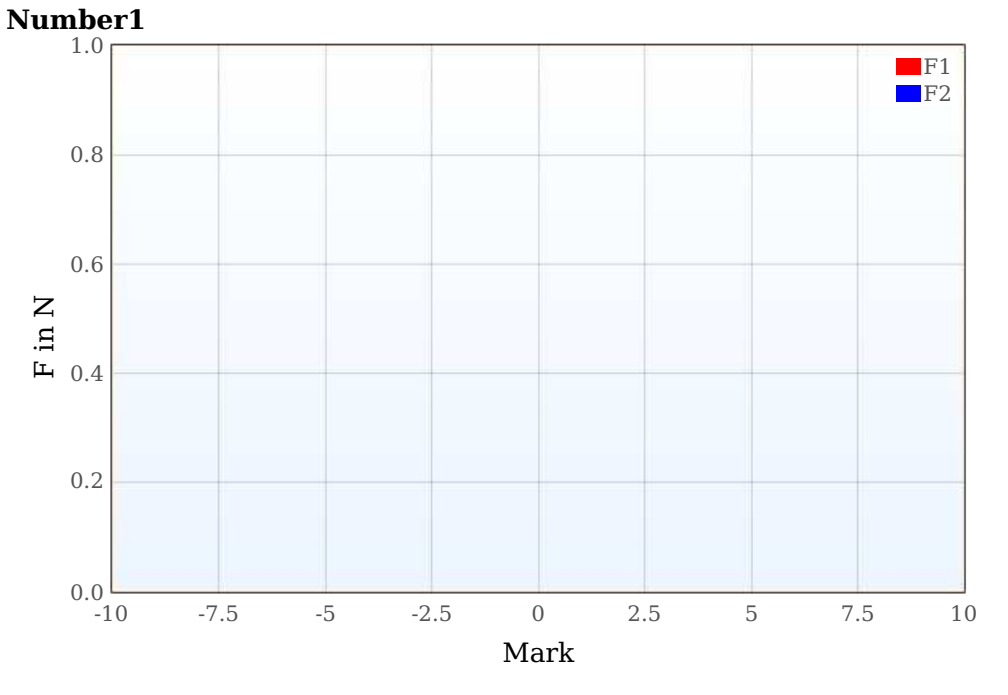
F_2 = ... N

$F_{tot.}$ = ... N

Results – Table 1

Record all the measured values in Table 1. Calculate the sum of the loading pressures, $F_{tot.} = F_1 + F_2$

Mark No.	F_1 in N	F_2 in N	$F_{tot.}$ in N
-9	1 ±0	1 ±0	1 ±0
-7	1 ±0	1 ±0	1 ±0
-5	1 ±0	1 ±0	1 ±0
-3	1 ±0	1 ±0	1 ±0
-1	1 ±0	1 ±0	1 ±0
1	1 ±0	1 ±0	1 ±0
3	1 ±0	1 ±0	1 ±0
5	1 ±0	1 ±0	1 ±0
7	1 ±0	1 ±0	1 ±0
9	1 ±0	1 ±0	1 ±0



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Evaluation – Question 1

Compare $F_{tot.}$ with the weight (forces) F_B and F_g. What is the result of your comparison?

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Evaluation – Question 2

How can you explain the correlation between the determined loading pressures and the point of impact of the mass? What is the role of the beam's center of gravity in this correlation?

Watch the chart on the Results page. The chart is the graph of the measured values of F_1 and F_2 as a function over the position of the mass.

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Evaluation – Question 3

Complete the following statements:

When the mass m is moved from the right to the left, the force F_2 becomes increasingly ..... and the force F_1 increasingly ..... .

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Evaluation – Question 4

How would the force F_{10} (without load) be changed by an additional load which was applied directly to the right suspension point of the beam?

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Evaluation – Question 5

Where do the lines for F_1 and F_2 intersect?

At the mark number ....., or in ..... of the beam.

Evaluation – Question 6

a) What is the significance of this intersection point?

b) Is there a difference in the effect of a mass on the forces F_1 and F_2 when the mass is applied to the left or the right of this intersection?

c) How do the forces act at the intersection?

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Evaluation – Question 7

How would an increase in the load (mass m) affect the curve of F_1 in the chart on the Results page in a repetition of the series of measurements?

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Evaluation – Question 8

What would the effect on F_2 be?

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