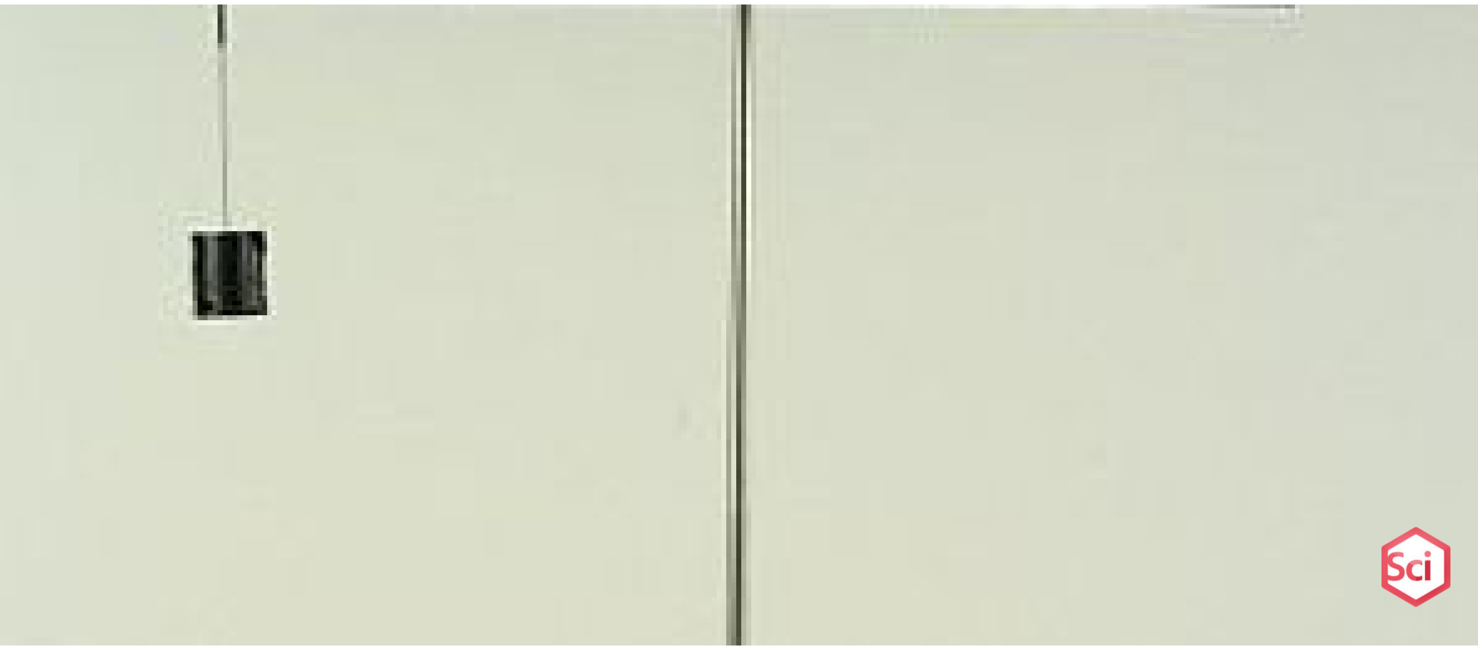
Force reduction with a one-sided lever with Cobra SMARTsense



In this experiment, the students observe the relationship between the weight force and the length of the lever arm of a one-sided lever.

Nature & technology | Devices & machines in everyday use

Difficulty level	Group size	Preparation time	Execution time
medium	-	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/63a36daeca29060003894701

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Teacher information

Application

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Experimental

In this experiment, the students observe the relationship between the weight force and the length of the lever arm of a one-sided lever.

In doing so, they discover that the point of application of different masses influences the amount of force needed to keep the lever in equilibrium, and how the force to be applied also changes depending on the point of application of the force gauge.

From this they conclude that force can be saved by positioning the mass and force gauge appropriately using the one-sided lever.

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Other teacher information (1/2)

Prior knowledge

Students can distinguish between "weight force" and "mass".

You can apply the unit of measurement of force "1 N".

Students can independently set up simple devices and experimentally show that they can reduce the forces needed.

Principle

The students experiment independently on the one-sided lever and, by varying the suspension point of the mass and force gauge, investigate the reduction in the force required when the distance over which the force acts is lengthened.

Hint: You should discuss with the students the "disadvantage" that the work to be done cannot be reduced by this.

Other teacher information (2/2)

Learning objective

The force to be applied decreases the longer the distance over which the force acts.

However, the work remains (at least) the same in all cases.

Tasks

- The students hang different numbers of mass pieces on the lever and measure the force with the Cobra SMARTsense force gauge.
- The students compare the force required with different weights, as well as positions of the lever and the dynamometer.
- You consider the relationship between the position of the mass and the force gauge and the force required.

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Safety instructions

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- Students should be instructed to use the Cobra SMARTsense force gauge with care.
- Point out to the students that a tall tripod set-up can easily tip over if they pull too far up on it
- For this experiment, the general instructions for safe experimentation in science lessons apply

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Student information

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Motivation

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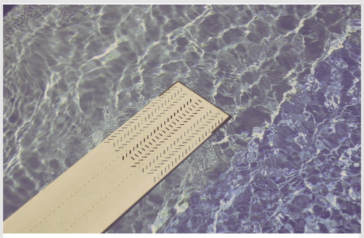

Springboard

Nutcracker

You have probably seen a diving board in a swimming pool that bends when you stand on it. You have probably noticed that the board bends more the further forward you step. For heavier people it bends even more. Your mass and your position on the board determine how much it bends.

This is the principle of one-sided leverage and there are other examples of this in everyday life. For example, you need much less strength to crack a nut if you do it with a nutcracker instead of your bare hand. Or the wheelbarrow, which is easier to lift the longer the handle.

So the further away the point of application of the force is from the suspension of the lever, the less force is needed to move it.

Tasks

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If you hang the weight closer to the suspension point of the lever and pull it, it will ....

- be easier for you to move the lever.
- be equally difficult for you to move the lever.
- be harder for you to move the lever.

What does the required force on the one-sided lever depend on?

- Hang all the weights on the lever and measure the force with the force gauge. Change the position of the weights and observe how the required force changes.
- Take less weight and now investigate how the force behaves when you only attach the force gauge in a different position each time.
- Think about what your measurements have shown and answer the questions in the report.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense Force & Acceleration - Sensor for measuring force and acceleration ±50 N / ±16 g (Bluetooth + USB)	12943-00	1
2	Weight holder, 10 g	02204-01	1
3	Slotted weight, silver bronze, 10 g	02205-03	9
4	Support base, variable	02001-00	1
5	Support rod, l = 600 mm, d = 10 mm, split in 2 rods with screw threads	02035-00	1
6	Boss head	02043-00	1
7	Lever	03960-00	1
8	Holding pin	03949-00	1
9	Fishing line, l. 5m	02089-01	1

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Set-up (1/3)

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For measurement with the **Cobra SMARTsense sensors** the **PHYWE measureAPP** is required. The app can be downloaded free of charge from the relevant app store (see below for QR codes). Before starting the app, please check that on your device (smartphone, tablet, desktop PC) **Bluetooth** is **activated**.

iOS

Android

Windows

Set-up (2/3)

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First screw the support rod together (Fig. 1).

Set up a support with the support base and the support rod as shown in Fig. 2 and Fig. 3.

Fig. 1

Fig. 2

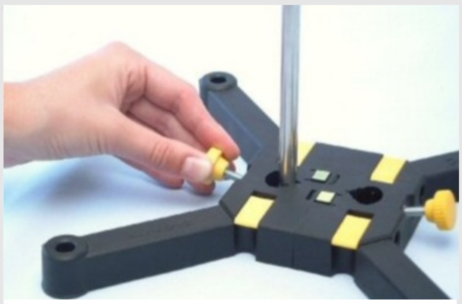

Fig. 3

Set-up (3/3)

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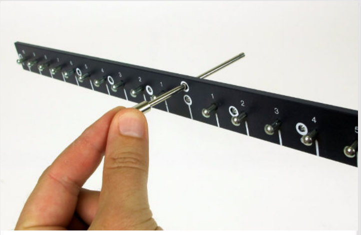

Fig. 4

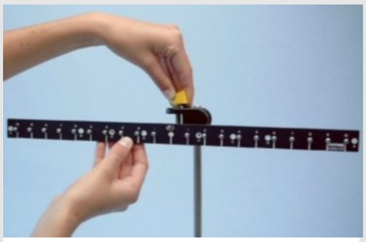

Fig. 5

Attach the boss head to the support rod.

Push the holding pin through the upper hole in the middle of the lever and then fix the holding pin in the boss head (Fig. 4 and Fig. 5).

Turn on the Cobra SMARTsense Force. Hold it with the hook down and open the measure app. Select the sensor and connect it if it has not already done so automatically.

If it shows a value other than "0 N" afterwards, go into the settings and set it to zero while holding the tick down.

Procedure (1/2)

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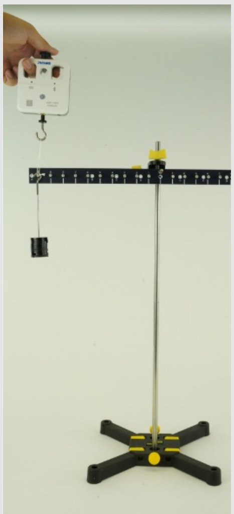

Fig. 6

In the "measure App", go to the diagram window and set "measure at the touch of a button". Attach the force gauge to the lever with a loop.

Task 1

Place all 9 slotted weights on the weight holder. The mass is now 100 g.

Hang the weight holder on the lever at position "10". Hook the Cobra force gauge in the same position and pull it up until the lever is horizontal as in Fig. 6. Now record a measuring point in the "measure App".

Now hang the weight holder at different points on the lever and take a measurement with the force gauge at position "10" each time. Observe how the force changes. Then stop the measurement and save it.

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Procedure (2/2)

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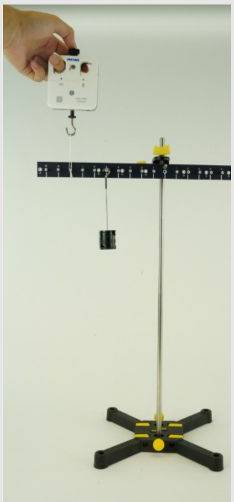

Fig. 7

Task 2

Now place only 3 weights on the weight plate. The mass is now 40 g.

Always hang the weight plate in the same place for this part of the experiment, for example at position "5".

Now measure the force acting on the lever with the force gauge at different positions when you hold the lever horizontally in equilibrium, as in Fig. 7. Record a measuring point each time.

Again, observe how the power changes.

Then stop the measurement and save it.

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Report

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Task 1

What are examples of the one-sided lever? Two answers are correct!

- [ ] Pipe wrench
- [ ] Nutcracker
- [ ] Springboard
- [ ] Barrier

Check

Task 2

If you leave the weight plate hanging at the same position on the lever and always measure at different points with the force gauge, does the indicated force change?

- No
- Yes

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Task 3

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On the one-sided lever, the force required increases when .... ? Two answers are correct!

- [ ] pulls far out on the lever.
- [ ] the mass hangs far outwards.
- [ ] pulls close to the suspension of the lever.
- [ ] the mass hangs close to the centre.

Check

Task 4

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Summarise what you have learned in this experiment.

The ______ lever offers the possibility of saving force if one grasps further ______ on the lever or suspends the ______ further inward on the lever. This reduces the ______ to move a mass, but the ______ required to do so increases.

Therefore, the ______ that has to be done in total remains the same.

- distance
- mass
- force
- work
- outward
- one-sided

Check

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Slide	Score / Total
Slide 8: Suspension point of a lever	0/1
Slide 16: Examples of the unilateral lever	0/2
Slide 17: Force effect on the lever	0/4
Slide 18: Save energy - multiple choice	0/2
Slide 19: Summary Lever, force and work	0/6

Total 0 / 15

Solutions Repeat

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