Changing direction of force with Cobra SMARTsense

The students observe the force to be applied when lifting a mass with the help of a fixed pulley. They notice that the force is the same when deflecting the force via a fixed roller as when lifting the mass freely. They realise that although there is no direct saving in force here, the deflection of the direction of force nevertheless makes it easier to transport the mass, depending on the application.

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/63a389a0ca290600038947a0

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Teacher information

Application

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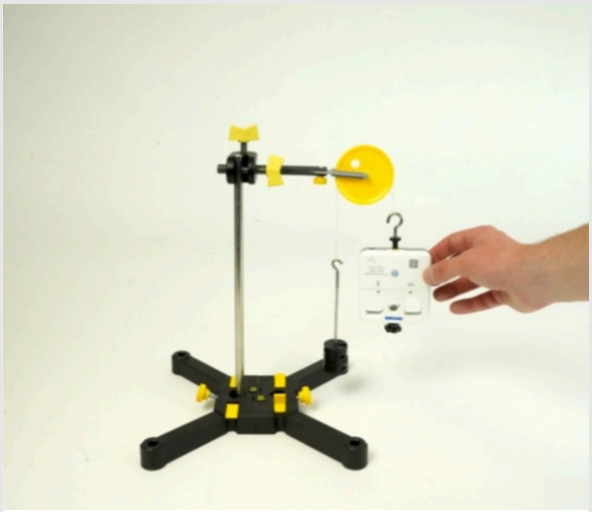

Experimental setup

In this experiment, the students observe the force to be applied when lifting a mass with the help of a fixed pulley. They find that the force is the same when the mass is deflected by a fixed pulley as when it is lifted freely.

You can see that although there is no direct saving in force here, the deflection of the direction of force nevertheless makes it easier to transport the mass, depending on the application.

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Other teacher information (1/2)

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Prior knowledge

- The term "mass" should be known and that it is used in science education instead of "weight".
  - "Mass" is understood here for simplicity's sake as what can be measured in kg or g on the scales.

Principle

- In the first part of the experiment, the students measure the force needed to lift a mass.
- In the second part of the experiment, the students again measure the force needed to lift a mass, but this time after redirecting the force via a fixed roller.

Other teacher information (2/2)

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Learning objective

- In this experiment, the students realise that when lifting a load, the amount of force to be applied remains the same even if the direction of the force is deflected via a fixed roller.
- The students also realise that depending on the application, however, there is a facilitation in the transport of the mass.

Tasks

- Measurement of the force required to pull a mass slowly upwards.
- Measurement of the force required to pull a mass upwards using a fixed pulley.
- Comparison of the two force measurements.

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Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

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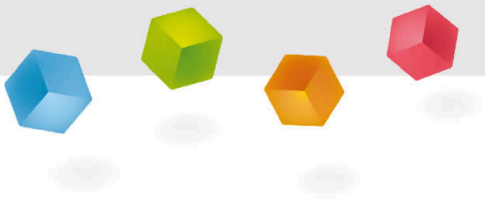

Student information

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Motivation

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Climbing safety

Maybe you've already been to the climbing hall, where you can climb up to the ceiling. But isn't that dangerous?

What can you do to prevent yourself from crashing?

- When climbing, you hang on a safety rope that goes through a hook above you. Then the rope goes further down, where someone is holding it. If you fall, someone can hold you up even though they are pulling down on the rope.

Another example of power redirection is the ski lift.

- The lift takes skiers from the mountain to the valley, but this is often not done in a direct way. If you pull the rope over rollers, you can also move the skiers around the curve.

Tasks (1/2)

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- In this experiment, you will investigate two ways to move a mass from a table to an elevation.
- First you lift the mass directly up, then you pull the rope over a pulley and lift the mass again.
- Compare the force you need to lift the load each time.
- Before you start the experiment, think about what the string could be used for.
- Note down your observations and answer the questions in the report.

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Tasks (2/2)

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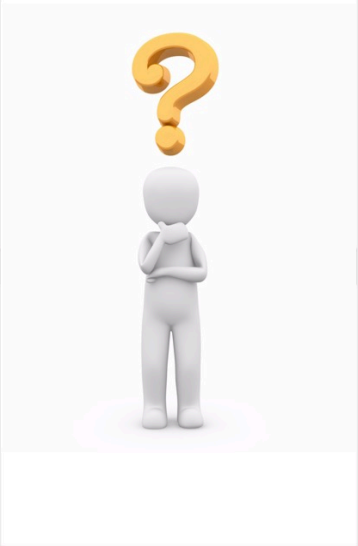

Do you think you need less strength because of the string?

- ○ No, the force gauge shows the same as for direct lifting.
- ○ Yes, you save power.
- ○ No, you need even more strength to lift.

Check

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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	Measuring tape, l = 2 m	09936-00	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	Fishing line, l. 5m	02089-01	1
8	Rod for pulley	02263-00	1
9	Pulley,movable,dia.65mm,w.hook	02262-00	1
10	Support base, variable	02001-00	1

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Set-up (1/4)

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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 (2/4)

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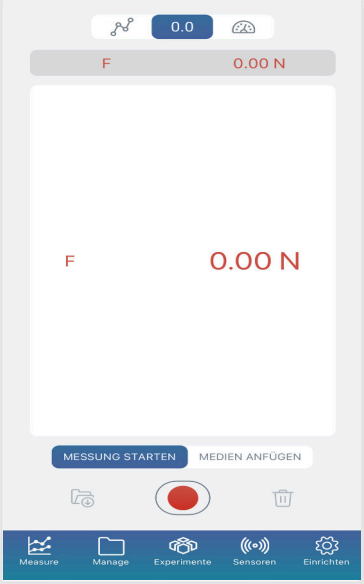

- Switch on your Cobra SMARTsense Force Sensor.
- Open the "measure" app and select the force gauge as the sensor.
- Hold the force gauge with the hook down and select "Set to zero" in the "Sensors" tab.
- Go to the "Live Measurement" mode.
- The current load of the Cobra SMARTsense-Force sensor is shown in N on the display.
- With the red button you can record the measurements.

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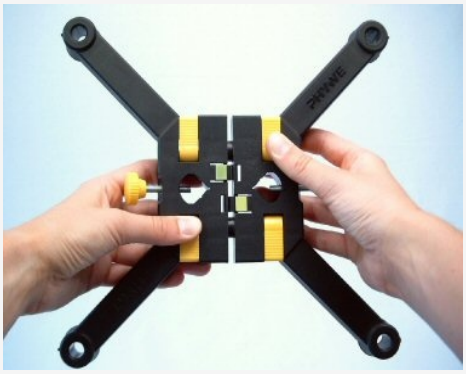
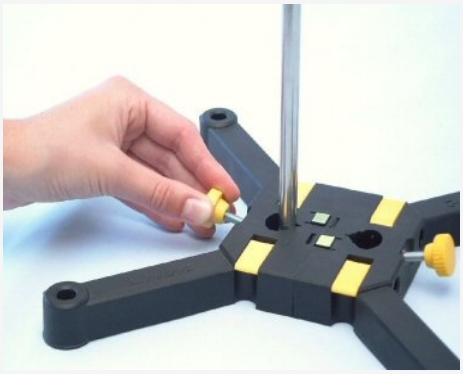
Set-up (3/4)

- First screw the split support rod together.
- Set up a support with the support base and the support rod.





Set-up (4/4)

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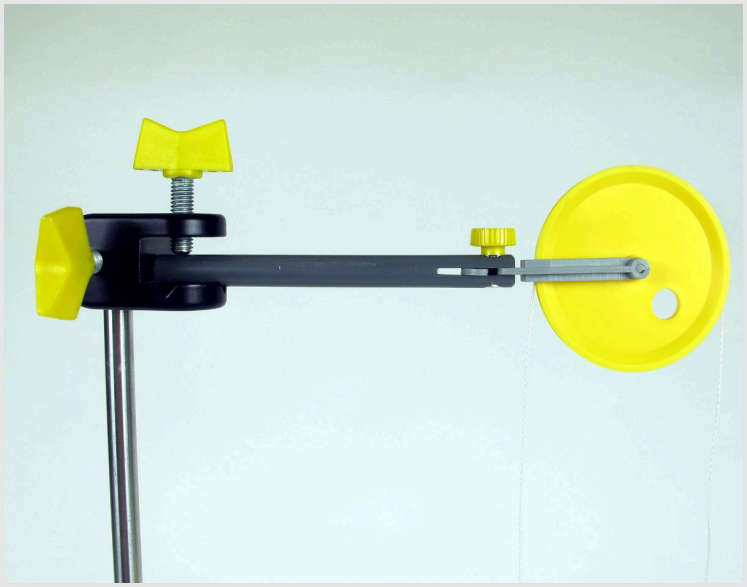

- Attach the boss head to the very top of the support rod.
- Place the large roll in the stem and screw the stem into the boss head.
- Take a piece of string about 70 cm long and knot a small loop at each end.

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Procedure (1/2)

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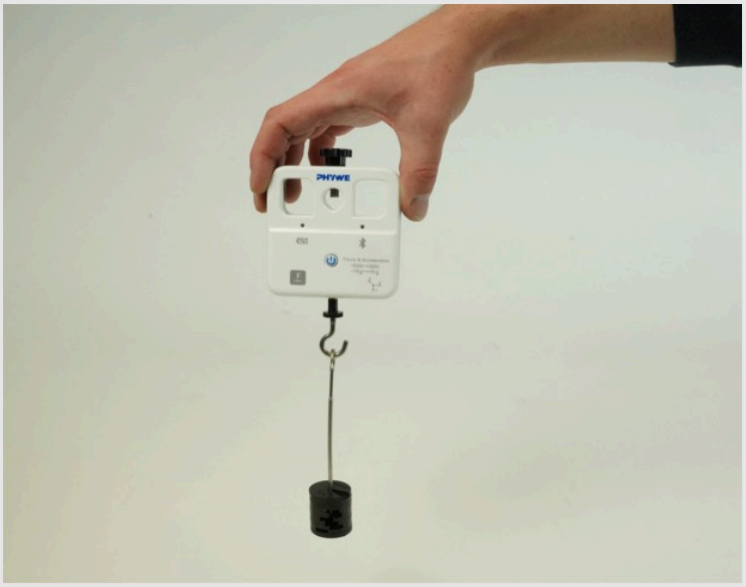

- Place all 9 slot weights on the weight holder.
- Then measure the weight of the weight holder with the dynamometer and write it down in the report.
- Adjust the force gauge to zero before the measurements "over head".

Procedure (2/2)

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- Guide the line over the reel so that it hangs down on both sides of the reel.
- Hang the weight holder (with all the slotted weights) in one loop of the string and in the loop at the other end hang the dynamometer.
- Slowly pull the dynamometer down. Make sure that the string lies on the pulley and that it turns.
- Watch the weight holder while pulling and measure the force on the dynamometer.
- Record the measured force in the report.

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Report

Task 1

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Observations

Note the force measurements for both ways of lifting the weight plate.

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Task 2

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Answer the following questions!

The mass of a body is expressed in...

- Kilograms.
- Joules.

Give the correct formula for the force.

[ ] = [ ] · [ ]

Check

Task 3

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How is the unit Newton defined ?

- [ ] The magnitude of the force that must be applied to give a body of mass 1 kg the acceleration 1 $\frac{m}{s^2}$.
- [ ] The magnitude of the force that must be applied to increase the velocity of a body of mass 1 kg moving in a straight line by 1 $\frac{m}{s}$.
- [ ] The magnitude of the force that must be applied to give a body of mass 1 kg within 1 min the acceleration 1 $\frac{m}{s^2}$.

Check

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Slide	Score / Total
Slide 9: Initial question: What is the purpose of the cord ?	0/1
Slide 19: Multiple tasks	0/8
Slide 20: Definition Newton	0/2

Total 0 / 11

Solutions | Repeat | Export text

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