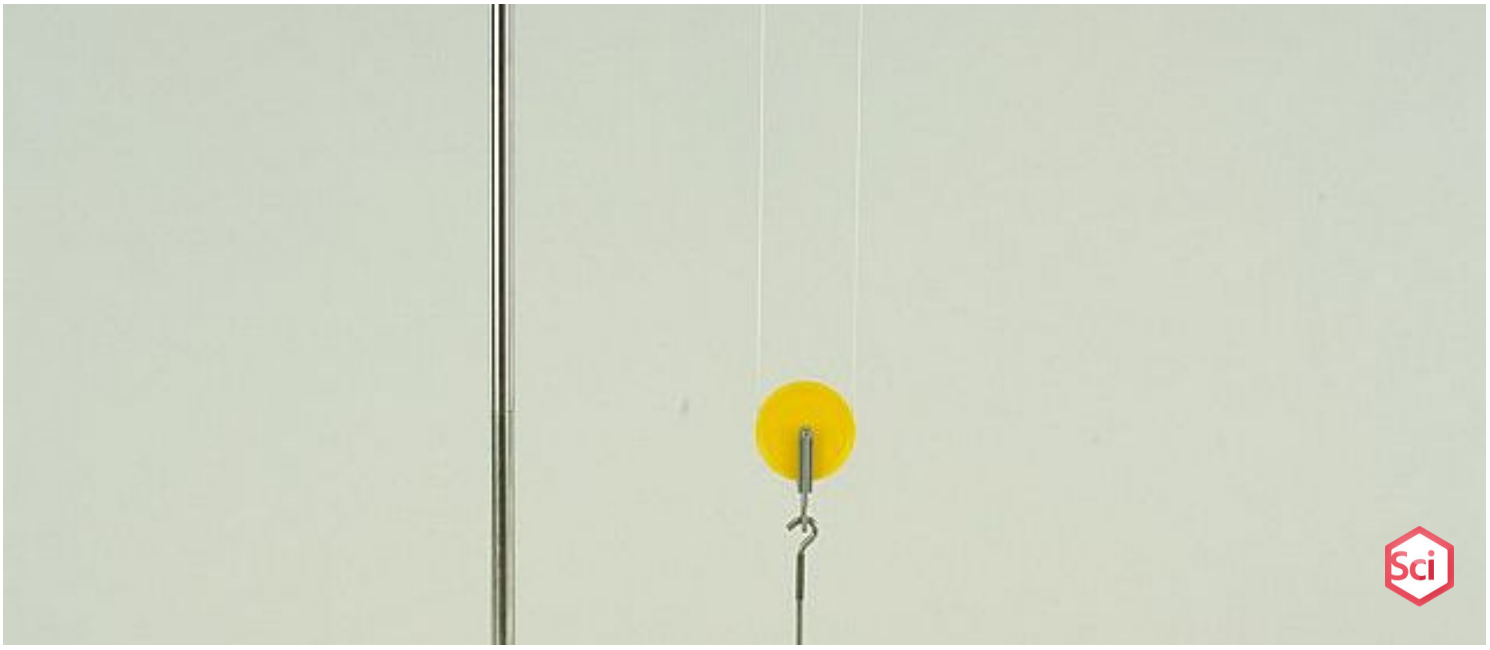
# Force reduction with Cobra SMARTsense



The students observe the force to be applied when lifting a mass with the help of a loose pulley. They observe that the force is less when lifting with a light loose pulley than when lifting the mass freely.

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/63a38de8ca290600038947bb

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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 loose roller.

They find that the force is less when lifting with a light loose pulley than when lifting the mass freely.

From this they conclude that there is an immediate saving of force with this procedure if the roller used is not heavier than the load to be transported, but the force has to be applied over a longer distance.



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# Other teacher information (1/2)

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## 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 with the force gauge on the loose pulley and investigate the reduction of the necessary force by varying the attached mass and measuring with the force gauge if the distance over which the force acts is extended.

**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)

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## Learning objective

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

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

## Tasks

- Students hang weights on the weight holder and measure the force with the Cobra SMARTsense force gauge.
- Students attach the weight holder to the loose pulley and measure the force this time on the deflected thread
- They measure the distance you have to move the force gauge to lift the weight a certain distance



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

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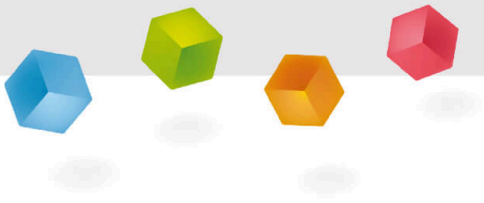

# Student information



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# Motivation

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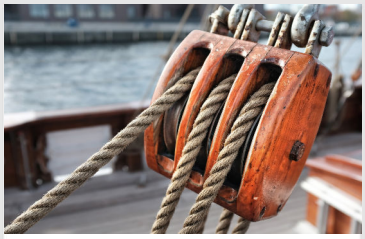

Wire rope hoist

Rope team

There are sometimes situations in which you want to move particularly heavy objects. Your own strength is not always sufficient for this. You have already learned about one way to save strength: the lever. But a lever cannot be used everywhere.

Maybe you've been climbing and had to belay someone, or on a sailing ship where you move heavy masts and sails with ropes.

This makes use of a so-called "loose pulley" to safely lower a heavy person or hoist a heavy sail, for example.

In this experiment, we want to investigate how exactly this works.

# Tasks

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In this experiment you pull the mass upwards over a roller. How does this affect the force required?

- The power does not change.
- You need more strength now, because the roll has a weight of its own.
- The roller saves power.

**Moving masses over a loose roller**

- Place 8 weights on the weight holder and measure the weight force when you hang it directly on the dynamometer.
- Now attach the weight holder to the loose roller over which you pass the thread and measure the weight at the end of the thread.
- Measure how much the weight plate moves upwards when you pull the force gauge upwards a certain distance.



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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 | 8 |
| 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 | Holding pin | 03949-00 | 1 |
| 9 | Pulley,movable,dia.65mm,w.hook | 02262-00 | 1 |
| 10 | Support base, variable | 02001-00 | 1 |



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## Set-up (1/3)

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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 split 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.

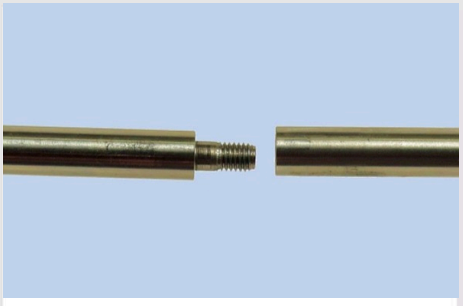

Fig. 1

Fig. 2

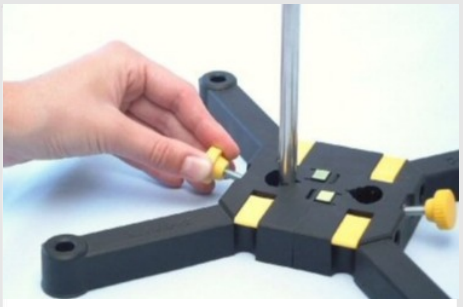

Fig. 3



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## Set-up (3/3)

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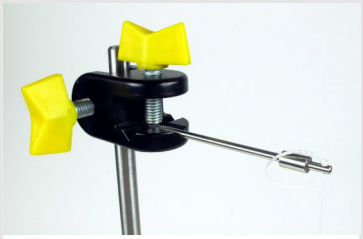

Fig. 4a

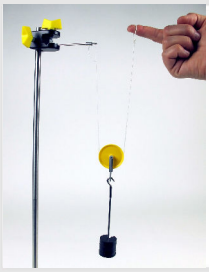

Fig. 4b

Take a piece of string about 60 cm long and knot a small loop at one end.

Thread the other end through the eyelet and tie a tight knot as shown in Fig. 4a.

Screw the retaining bolt into the boss head on the support rod (Fig. 4b).

Hold the force gauge with the hook down and set it to zero. Then switch off "Measurement on key pressure" and go to the window with the analogue display.

## Procedure (1/2)

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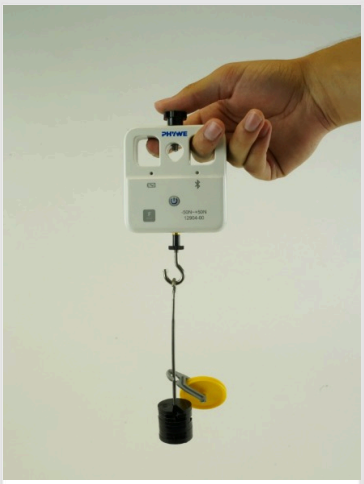

Fig. 6

The thread can easily slip off the roll, make sure it is always correctly positioned in the guide!

**Task 1**

Place 8 slotted weights on the weight holder. The mass is now 90 g.

Hang the small pulley to the weights on the handle of the weight plate as in Fig. 6.

Measure the weight of the entire attached mass with the dynamometer and write it down on a piece of paper.



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# Procedure (2/2)

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Fig. 7

**Task 2**

Now hang the weight holder with the 8 slotted weights on the hook of the reel. Run the string along the bottom of the pulley (between the pulley and the hook) and hold the other end of the string upwards. Hang the loop of the string on the dynamometer. Hold the dynamometer so that the pulley with the weight plate hangs over the table as in Fig. 7.

Go to the diagram window and start the measurement. Slowly pull the dynamometer upwards until you have lifted the load about 10 cm. Observe the force on the dynamometer and the distance you had to move the dynamometer and note both distances.

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# Report



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## Task 1

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**The distance by which the mass moves upwards is ...**

- equal in size to the distance drawn.
- twice as large as the drawn distance.
- half the size of the drawn distance.

## Task 2

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**Summarise what you have learned in this experiment.**

A loose pulley can save _____ when lifting masses. This is because the mass suspended from the pulley only travels _____ the distance you pull on the rope. This makes it _____ to lift the mass, but the _____ you have to do remains _____ because of the longer distance.
This principle is useful when you want to lift heavy masses but cannot use a _____, for example when climbing a rope.

easier
lever
power
work
the same
half

Check



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| Slide | Score / Total |
|---|---|
| Slide 8: Power saving | 0/1 |
| Slide 16: Force measurement on the loose roller | 0/3 |
| Slide 17: Save energy | 0/6 |

**Total** 0 / 10

Solutions Repeat



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