Force reduction and direction change of force with Cobra SMARTsense

The students observe the force to be applied when lifting a mass with the help of a fixed and a loose roller. They notice that both advantages of the previous experiments with one roller each are combined in one device.

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/63a397e1ca290600038947c6

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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 and a loose roller.

They find that here both advantages of the last experiments with one roller each are combined in one unit.

From this, they conclude that there is an immediate saving in force with this procedure and, in addition, the deflection of the direction of force in certain applications makes it even easier to transport the load.

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Other teacher information (1/2)

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Prior knowledge

- Students can distinguish between "weight" 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

Students experiment independently with the force gauge on the loose and fixed pulley assembly.

In doing so, they investigate the reduction of the necessary force by means of attached masses and measurement with the force gauge if the path over which the force acts is extended, as well as the possibility of changing the direction of the force by means of the fixed roller.

Other teacher information (2/2)

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Learning objective

- The force to be applied decreases the longer the distance over which the force acts, but the work remains (at least) the same in all cases.
- A fixed roller allows variation of the direction of force

Tasks

- Students hang weights on the weight plate and attach it to the loose pulley
- The students measure the force on the thread behind the fixed pulley.
- You compare the result with the measurement from the previous test (without pulley).

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
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info@phywe.de
www.phywe.de

Safety instructions

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- Students should be instructed to be mindful when using the Cobra SMARTsense force gauge.
- 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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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Motivation

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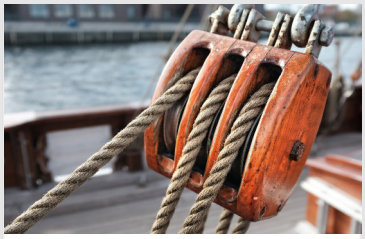
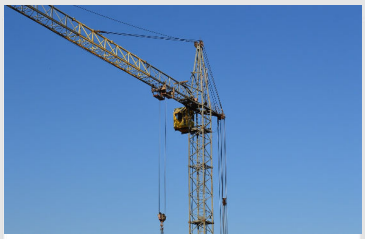


Wire rope hoist



Building crane

In the last experiment, you already learned about the advantages of a loose pulley in many areas of everyday life, for example, with rope hoists on sailing ships or construction cranes.

In the experiment, however, you had to pull up on the rope to move the mass upwards.

For many applications, however, it is advantageous if you can determine the direction in which you have to pull yourself and you need even less force. For this purpose, you can combine the loose pulley with a fixed pulley and this is exactly the set-up we want to examine more closely in this experiment.

Tasks

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What can be achieved by using a fixed roller in addition to the loose roller?

- A greater saving of power.
- A redirection of the force.

Moving masses via a loose and a fixed roller

- Put 8 weights on the weight holder and hang it on the hook of the loose roll
- Now attach the dynamometer to the end of the thread behind the pulley and measure the weight force.
- Measure how much the weight holder moves upwards when you pull the dynamometer down a certain distance.
- Compare your results with those of the last experiment.

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Robert-Bosch-Breite 10
37079 Göttingen

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www.phywe.de

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	Rod for pulley	02263-00	1
9	Pulley,movable,dia.65mm,w.hook	02262-00	1
10	Pulley,movable,dia.40mm,w.hook	03970-00	1
11	Support base, variable	02001-00	1

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Robert-Bosch-Breite 10
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info@phywe.de
www.phywe.de

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.

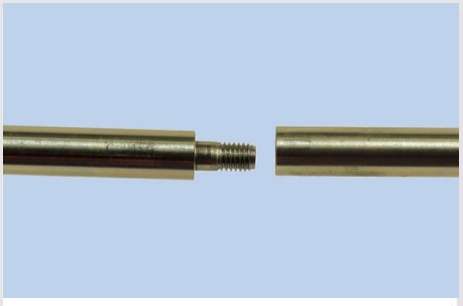

Fig. 1

Fig. 2

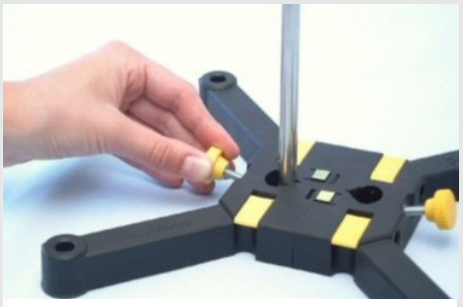

Fig. 3

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
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Set-up (3/3)

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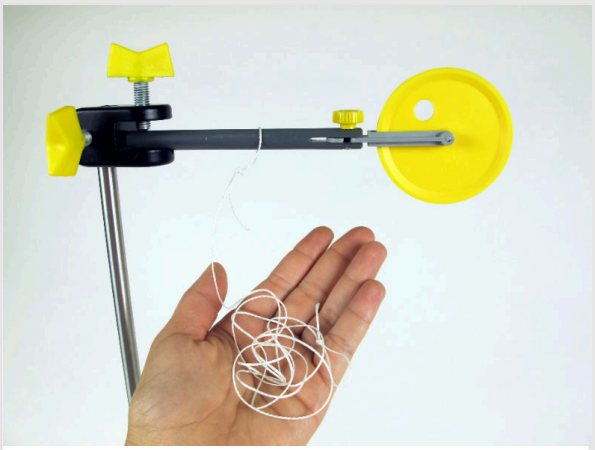

Fig. 4

Attach the boss head to the very top of the support rod.

Place the large roll in the handle.

Take a piece of string about 110 cm long. Tie a small loop to one end and a slightly larger loop to the other end to fit around the handle for the reel.

Hang the line with the larger loop around the handle and screw the handle with the rear end into the boss head. The pulley is far away from the boss head and the line hangs on the stem as in Fig. 4.

Procedure (1/2)

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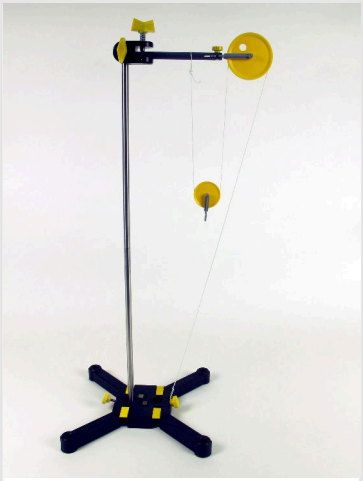

Fig. 5

Hold the force gauge with the hook pointing upwards and select "Set to zero".

Switch off "Measurement on key pressure" and go to the diagram window.

Now feed the string first through the small pulley and then through the large pulley, as in Fig. 5.

Place 8 slotted weights on the weight holder.

Hang the weight holder on the hook of the small pulley.

Hang the dynamometer in the loop of the cord and pull it down slightly until the small pulley and weight holder are hanging slightly in the air.

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Robert-Bosch-Breite 10
37079 Göttingen

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info@phywe.de
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Procedure (2/2)

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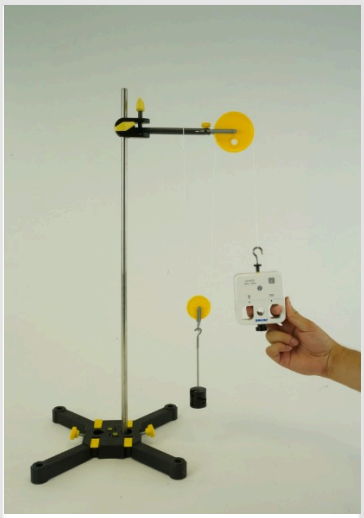

Fig. 6

Make sure that the line is on both pulleys. It is best to do this in pairs. One holds the dynamometer, the other carefully places the small pulley on the string and then puts the string over the large pulley. After that, the set-up should look like in Fig. 6.

Start the measurement.

Now slowly pull the force gauge down.

Stop the measurement when the weight plate reaches the top of the roller or when you touch the table with the dynamometer.

Observe the force measured when pulling.

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Report

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Task 1

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The mass moves up by the ... distance upwards as you moved the dynamometer.

- same
- double
- half

Task 2

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Summarise what you have learned in this experiment.

In this experiment, a loose and a fixed roller were combined. The _____ roller ensures that less force is needed to move the attached mass. The _____ roller ensures that the direction of the _____ changes. Since the mass only moves upwards by _____ the distance you pull, the _____ done remains the same.
So heavy loads can be lifted from the ground, for example with a _____.

- fixed
- pulling force
- bottle hoist
- half
- work
- loose

Check

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

Slide	Score / Total
Slide 8: Initial question	0/1
Slide 16: Force measurement on loose and fixed roller	0/4
Slide 17: Loose and fixed roll	0/6

Total 0 / 11

Solutions Repeat

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Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de