Force and counterforce (Item No.: P6103200)

Curricular Relevance

Area of Expertise: Natural Sciences
Education Level: Age 11-14
Topic: Nature and technology
Subtopic: Mechanical devices in daily use
Experiment: Force and counterforce

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

Additional Requirements:

- Digital measurement data recording with a tablet PC and Cobra4 sensor

Experiment Variations:

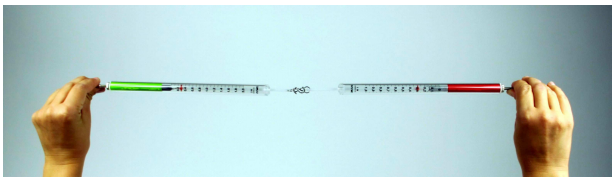
Keywords:

Counteracting force, Principle of action and reaction, Newton's third law, Actio, Reactio

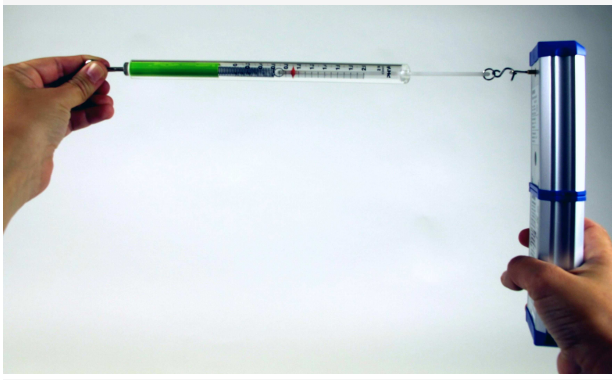
Information for the teacher

Educational objective and competences

During this experiment, the students observe the effects of the principle of action and reaction. They find out that two connected dynamometers always indicate the same force, leading to the conclusion that when one body exerts a force on a second body, the second body simultaneously exerts a force equal in magnitude on the first body in order to maintain the system at equilibrium.



Standard experiment set-up



Experiment set-up for measurements with a tablet PC

Competences

Process-related competences:

K: Knowledge gain
C: Communication
A: Assessment

The students can...

K 01 – name aspects which may have an influence and distinguish between significant and insignificant ones.
K02 – develop problem-related questions and formulate hypotheses.
K03 – describe relationships with sentences of the type "The more/less..., the more/less..." or "The greater/higher/smaller/lower..., the greater/higher/smaller/lower...".
K06 – execute simple experiments independently based on written instructions.
K08 – recognise technical concepts in examples from everyday life.
K09 – plan, execute and document simple experiments by themselves.
K12 – make assumptions about connections and causes.

C02 – describe the technical connections and relationships in everyday language.
C03 – acquire measurement data and extract them from age-appropriate representations.
C05 – present their results with the aid of specified media.
C06 – express and accept criticism.
C07 – work in groups on their own initiative.
C09 – read age-appropriate, relevant texts and relay the content thereof.

A01 – appraise their own results based on a comparison with other groups.
A02 – recognise the role of scientific phenomena in their everyday life.
A03 – evaluate arguments, take up a position and substantiate their point of view.
A06 – explain the areas of application in which scientific knowledge is of importance.
A08 – distinguish between the desired and undesired characteristics for the application of scientific effects.

Content-related competences:

The students can...

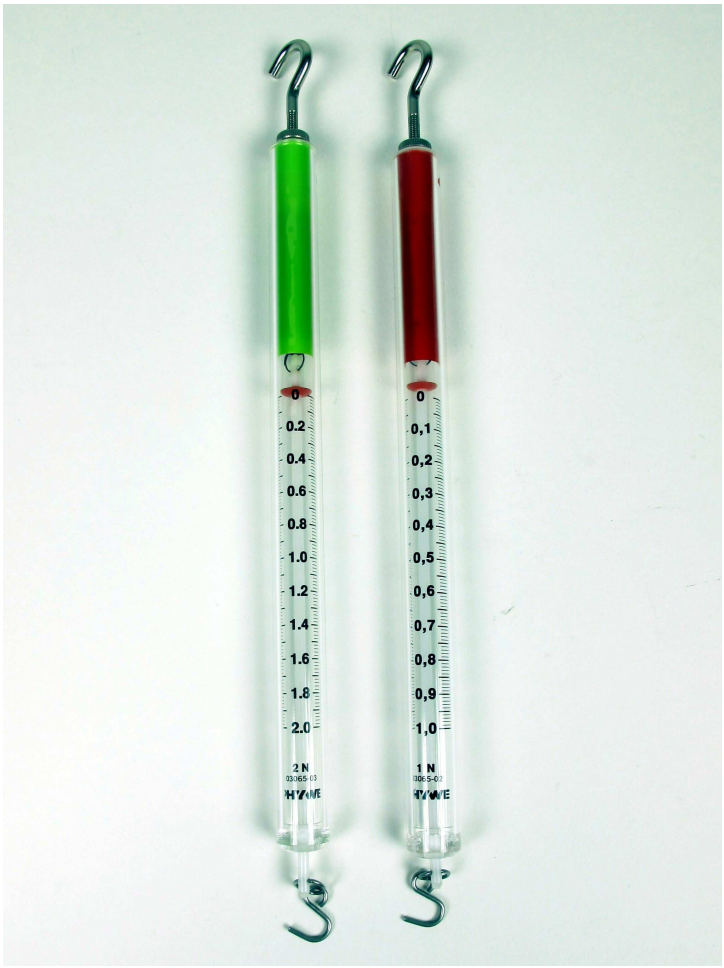
S: Specialised knowledge

S14 – use the unit of force (1 N).

Material

Standard procedure

Position No.	Material	Order No.	Quantity
1	Spring balance,transparent, 1 N	03065-02	1
2	Spring balance,transparent, 2 N	03065-03	1

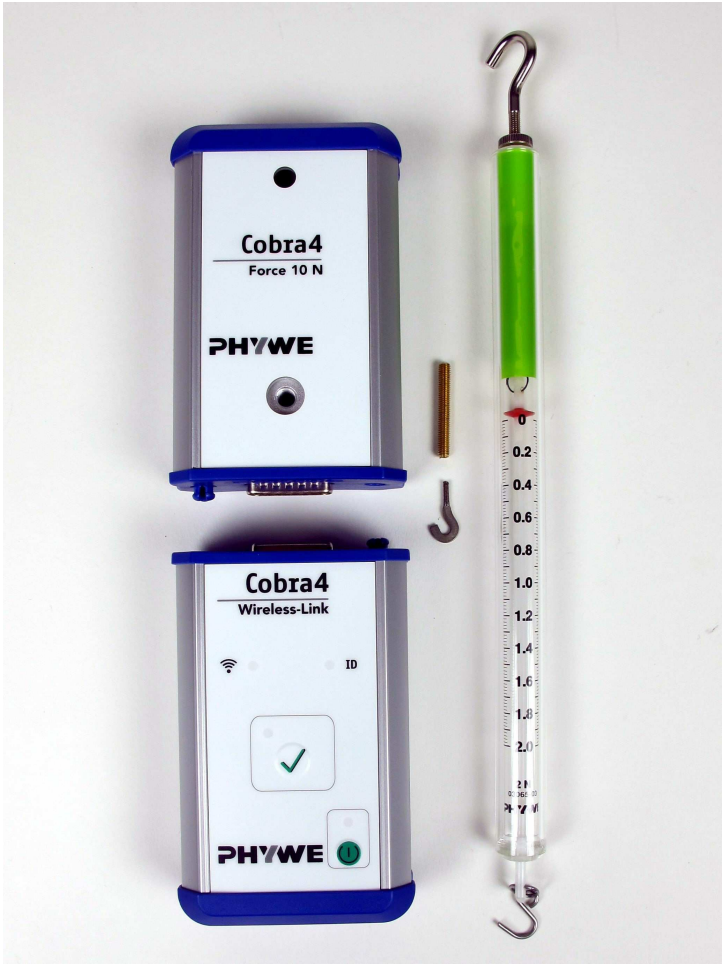


Measurement with a tablet

In order to perform the experiment with digital measurement data recording, the following additional material is required.

Position No.	Material	Order No.	Quantity
1	Spring balance, transparent, 2 N	03065-03	1
2	Cobra4 Wireless/USB-Link	12601-09	1
3	Cobra4 Sensor-Unit Force, 10 N	12646-00	1
4	Apple iPad		1
5	PHYWE measure App		1

Download on the App Store



Saefty information

- For this experiment, the general notes and instructions concerning safe experimentation in science classes apply.
- Prior to performing the experiment, you should warn the students that a loaded spring dynamometer may rebound when it is unloaded.

Didactic notes

Procedure

The students pull away from one another via two dynamometers (either two spring dynamometers or a spring dynamometer and a force sensor). They learn that the forces are the same, but that their readability depends on the scale that is used. Since different measuring ranges are used, they should also ensure that the values of the measuring range of the smaller dynamometer are not exceeded during pulling.

Tablet PC option

In addition to the classic variant, you can also let the students perform the experiment with the Cobra4 equipment and tablet PCs. The digital measurement data recording method enables the students to quickly acquire the measurement data, understand them more readily and to evaluate them in a particularly comfortable way.

- Remove one of the spring dynamometers from the set-up and replace it with the Sensor-Unit "Force" connected to the Cobra4 Wireless/USB-Link. The students perform the same measurements with the Sensor-Unit and observe the measured force on an analogue scale. If the students save their series of measurements, they can view the development of the force in the form of a diagram based on the saved measurement values.

Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

Force and counterforce (Item No.: P6103200)

Experiment (standard)

Introduction

Surely, you have all engaged in tug of war (or rope pulling) in physical education or in the school yard. Two teams pull on opposite ends of a rope. The team that succeeds in pulling the other team over to its side is the winner of this contest. Both teams pull on the rope with a certain force.

Tug of war (or rope pulling)

Application

Vehicle parked on a slope: The vehicle remains stationary because different forces act on it: the weight tries to pull it downwards and the braking force keeps it in place.

Glass on a table: When you hold a glass up in the air and release it, it falls down on the floor. If you place it on a table, it remains on the table.

Rocket: A rocket burns propellant and flies up into the sky.

Task

During this experiment, you will examine the force that is indicated by two dynamometers when you hook the dynamometers together and pull on the opposite ends.

Experiment set-up

Assumption

Where does the force act?

Initial question

Before you perform the experiment, think about what will probably happen.
If you use a dynamometer to pull on another dynamometer, which of the dynamometers will indicate a force greater than zero?

- [ ] Only the stationary dynamometer
- [ ] Only the pulling dynamometer
- [ ] Both dynamometers

Material and procedure

Position No.	Material	Order No.	Quantity
1	Spring balance,transparent, 1 N	03065-02	1
2	Spring balance,transparent, 2 N	03065-03	1

Procedure

The experiment works best when you work together with a partner. Each of you holds a dynamometer in your hand.

Hold your dynamometers horizontally and set them to zero. Then, hook both dynamometers together as shown in Fig. 1.

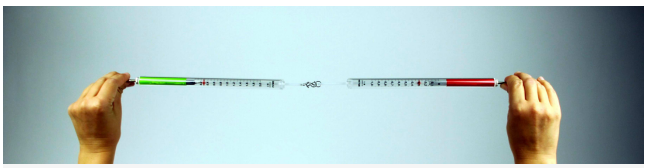


Fig. 1

Hold the dynamometers so that they form a straight line. Both dynamometers indicate a force of 0 N (0 Newton).

1. Ask your partner to simply hold their dynamometer.

   Then, pull your dynamometer carefully a little towards you and hold it in this position.

   Observe the force that is indicated by the two dynamometers. What does the dynamometer on which you are pulling indicate and what does the dynamometer which is held by your partner indicate?

2. Then, hold your dynamometer completely still and ask your partner to pull carefully on their dynamometer.

   Once again, observe the force that is indicated by the two dynamometers.

3. Then, both of you pull on your respective dynamometer.

   Try to pull on your dynamometer so that it indicates a force of 1 N. Compare this force to the force that is indicated by the dynamometer of your partner.

Evalution

During the experiment, you have explored how the value indicated by the dynamometer changes when you use it to pull on another dynamometer that is stationary. In addition, you also have observed the force that is indicated by the stationary dynamometer.

Go to the experiment report and answer the questions about the experiment.

Robert-Bosch-Breite 10
D - 37079 Göttingen

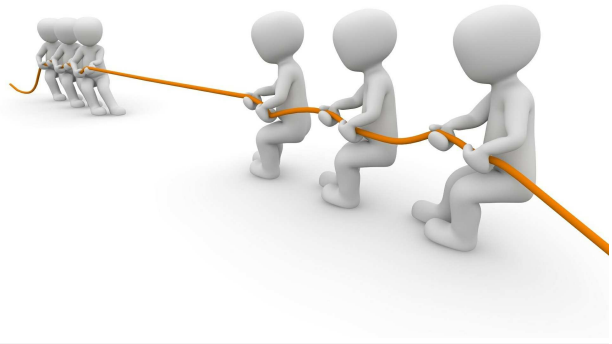
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com

Experiment (with a tablet PC)

Introduction

Surely, you have all engaged in tug of war (or rope pulling) in physical education or in the school yard. Two teams pull on opposite ends of a rope. The team that succeeds in pulling the other team over to its side is the winner of this contest. Both teams pull on the rope with a certain force.



Tug of war (or rope pulling)

Application

Vehicle parked on a slope: The vehicle remains stationary because different forces act on it: the weight tries to pull it downwards and the braking force keeps it in place.

Glass on a table: When you hold a glass up in the air and release it, it falls down on the floor. If you place it on a table, it remains on the table.

Rocket: A rocket burns propellant and flies up into the sky.

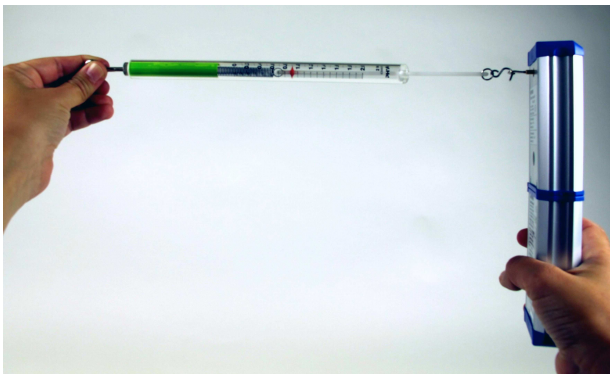
Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com

Task

During this experiment, you will examine the force that is indicated by two dynamometers when you hook the dynamometers together and pull on the opposite ends.



Experiment set-up

Assumption

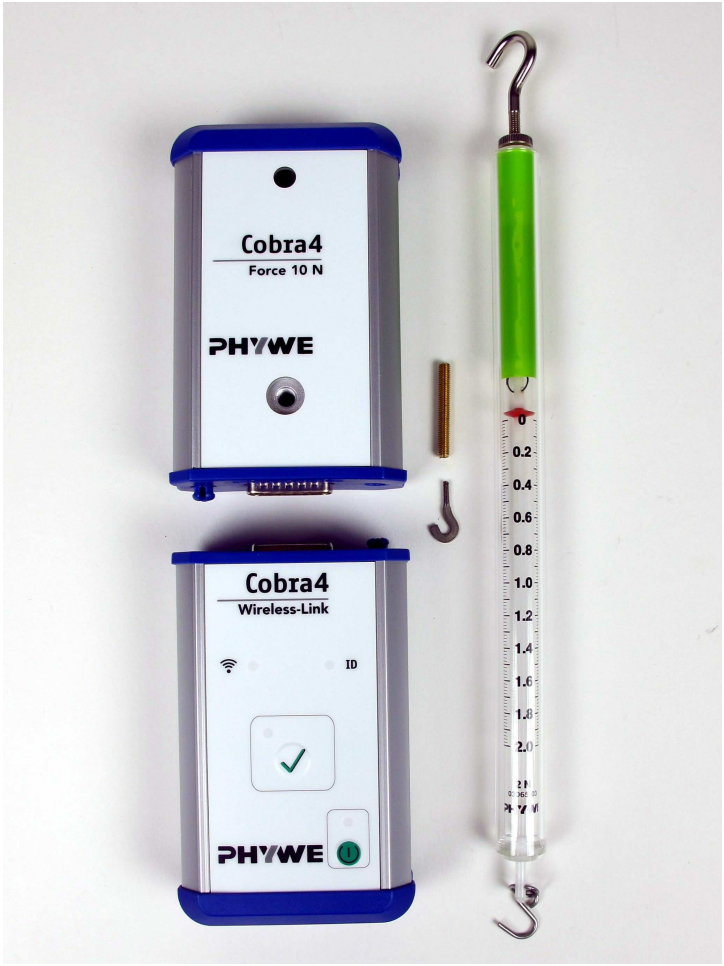
Where does the force act?

Initial question

Before you perform the experiment, think about what will probably happen.
If you use a dynamometer to pull on another dynamometer, which of the dynamometers will indicate a force greater than zero?

- ☐ Only the stationary dynamometer
- ☐ Only the pulling dynamometer
- ☐ Both dynamometers

Material and procedure



Position No.	Material	Order No.	Quantity
1	Kraftmesser, transparent, 2 N	03065-03	1
2	Cobra4 Wireless/USB-Link	12601-09	1
3	Cobra4 Sensor-Unit Force, Kraft 10 N	12646-00	1
4	Apple iPad		1
5	PHYWE measure App		1

Procedure

Connect the ''Wireless/USB-Link" and the sensor and switch the device on.

Connect your tablet PC with the "Wireless/USB-Link" and open the "measure" app .

Select the connected sensor.

Open the window with the analogue display

The experiment works best when you work together with a partner. One of you holds a traditional spring dynamometer and the other one the "Sensor-Unit" connected to the app.

Hold your dynamometers horizontally and set them to zero. Then, hook both dynamometers together as shown in Fig. 1.

Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com

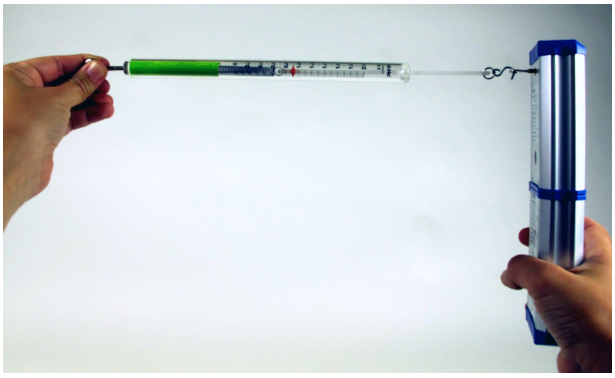


Abb. 1

Hold the dynamometers so that they form a straight line. Both dynamometers indicate a force of 0 N (0 Newton).

1. Ask your partner to simply hold their dynamometer.

   Then, pull your dynamometer carefully a little towards you and hold it in this position.

   Observe the force that is indicated by the two dynamometers. What does the dynamometer on which you are pulling indicate and what does the dynamometer which is held by your partner indicate?

2. Then, hold your dynamometer completely still and ask your partner to pull carefully on their dynamometer.

   Once again, observe the force that is indicated by the two dynamometers.

3. Then, both of you pull on your respective dynamometer.

   Try to pull on your dynamometer so that it indicates a force of 1 N. Compare this force to the force that is indicated by the dynamometer of your partner.

Evalution

During the experiment, you have explored how the value indicated by the dynamometer changes when you use it to pull on another dynamometer that is stationary. In addition, you also have observed the force that is indicated by the stationary dynamometer.

Go to the experiment report and answer the questions about the experiment.

Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com

Report: Force and counterforce

Observation - Question 1 (1 point)

You use your dynamometer to pull on the dynamometer of your partner so that your dynamometer indicates a force of 0.5 N.
How many Newtons does the dynamometer of your partner indicate?

Observation - Question 2 (1 point)

How does the force, which is indicated by your dynamometer, change when your partner pulls on it by way of their dynamometer?

.....

.....

.....

.....

Observation - Question 3 (1 point)

In the third part, both of you have pulled on your respective dynamometer at the same time.
Which force in Newton does the dynamometer of your partner indicate when you pull on your dynamometer so that it indicates 1 N?

Evaluation - Question 1 (2 points)

If an object pulls on another object with a certain force, the ..... force also acts on the object itself.

The force acts in the ..... direction.

Initial question (repeated) (1 point)

Before you perform the experiment, think about what will probably happen.

If you use a dynamometer to pull on another dynamometer, which of the dynamometers will indicate a force greater than zero?

- [ ] Only the stationary dynamometer
- [ ] Only the pulling dynamometer
- [ ] Both dynamometers

Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com