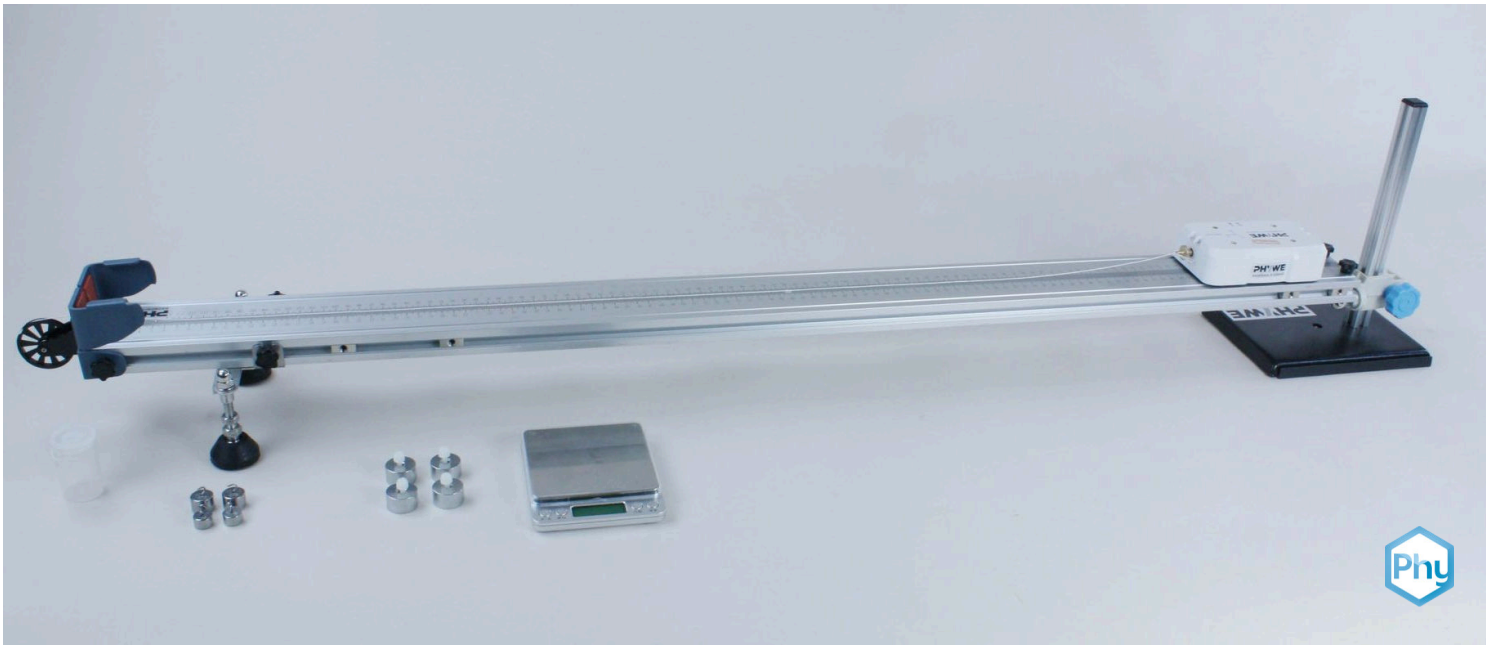
Change of kinetic energy by a constant force with Cobra DigiCart



Physics > Mechanics > Dynamics & Motion

Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/6051db591dbcea0003704bb3

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Teacher information

Application

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Hydroelectric power plant

Kinetic energy by exerting a constant force

Energy conversion plays a role in many areas. In a hydroelectric power plant, for example, potential energy is converted into kinetic energy and then into electrical energy.

In this experiment, students learn about the physical concept of mechanical work. It also teaches how to convert work into other forms of energy, such as kinetic energy.

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Teacher information (1/2)

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Prior knowledge

Students should be familiar with the concept of acceleration and velocity.

Scientific principle

Kinetic energy E_{kin} of a body with the mass m and speed v:

$$E_{kin} = \frac{1}{2} \cdot m \cdot v^2$$

Energy increase of the acceleration from v_1 to v_2:

$$\Delta E_{kin,1\to2} = E_{kin,2} - E_{kin,1}$$

If the force F is exerted onto a body on the route s the work performed is W:

$$W = F \cdot s$$

Teacher information (2/2)

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Learning objective

In this experiment, students will learn about the physical concept of mechanical work. They will also see how work can be converted into other forms of energy, such as kinetic energy.

Task

Using the DigiCart app, record force-time, velocity-time and position-time diagrams for different forces with a constant mass of the DigiCart. Compare the mechanical work performed with the increase in kinetic energy.

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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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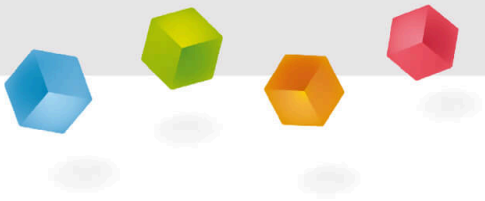

Student Information

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Motivation

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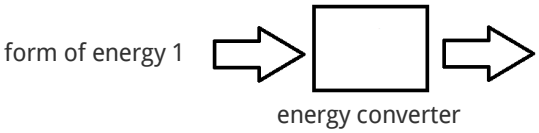
Hydroelectric power plant

Kinetic energy by exerting a constant force

Energy conversion plays a role in many areas. In a hydroelectric power plant, for example, potential energy is converted into kinetic energy and then into electrical energy.

In this experiment you will learn about the physical concept of mechanical work.

You will also see how work can be converted into other forms of energy, such as kinetic energy.



Task

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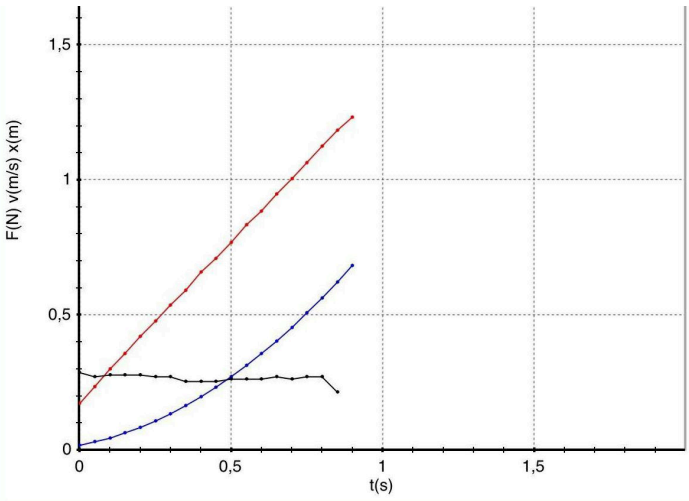
1. Using the DigiCart app, record force-time, velocity-time, and position-time graphs for different forces with a constant mass of the DigiCart.
2. Compare the mechanical work performed $W = F \cdot s$ with the increase in kinetic energy

$E_{kin} = \frac{1}{2} \cdot m \cdot v^2$ with

$\Delta E_{kin,1 \to 2} = E_{kin,2} - E_{kin,1}$.



Force-time diagram - example

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Equipment

Position	Material	Item No.	Quantity
1	Cobra DigiCart Basic Set	12940-77	1
2	Cobra DigiCartAPP	14582-61	1

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Set-up (1/2)

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Overview of the experimental setup

- Measure the weight of the DigiCart using the scale (with brass screw on the force sensor).
- Set up the track so that the wheel protrudes over the edge of the table. Table height approx. 1 m.
- Bring the track into a horizontal position and place the DigiCart on it. Place a 10 gram weight in the film container and close it with the lid. Attach the string of the film container to the DigiCart's force sensor using the brass screw and guide the string over the wheel at the end of the track.
- First, place the film container on the edge of the table.
- Launch the DigiCart app.

Set-up (2/2)

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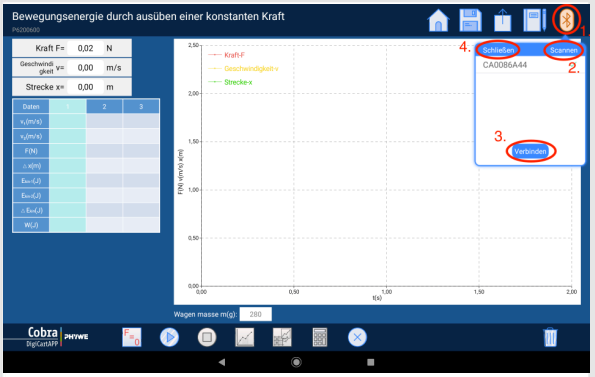

Connection to the DigiCart

- Select test 7 from the overview. The measurement window opens.
- Connect the DigiCart to the app.
- First, press the ON button on the DigiCart for at least 3 seconds. Then open the connection window in the app via the Bluetooth symbol (1.). The DigiCart should now be displayed there. If not, you can update the list by clicking on Scan (2.).
- Now tap the DigiCart from the list once and establish the connection via the Connect button (3.). The window can now be hidden again via the Close button (4.).

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Procedure (1/6)

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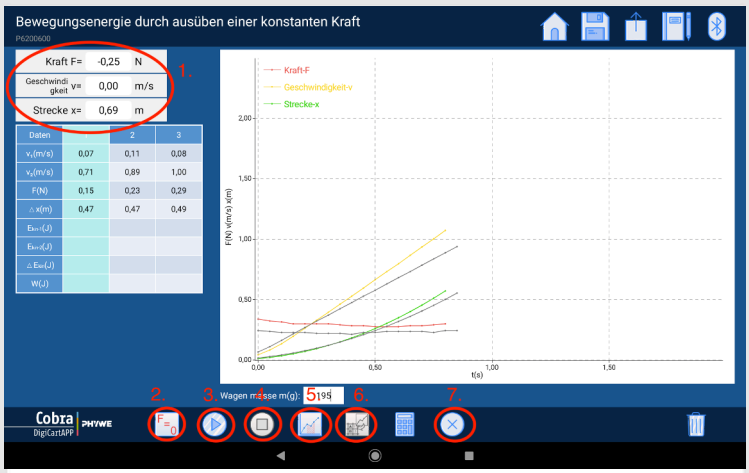

Measurement procedure

- The figure shows the steps for the measurement process.
- In the force, speed and position display (1.) the current readings are shown.
- The force at the sensor is now set to zero via the "Calibration" button (2.).
- Make sure that the thread is not tensioned and that no force is acting on the sensor yet.

Procedure (2/6)

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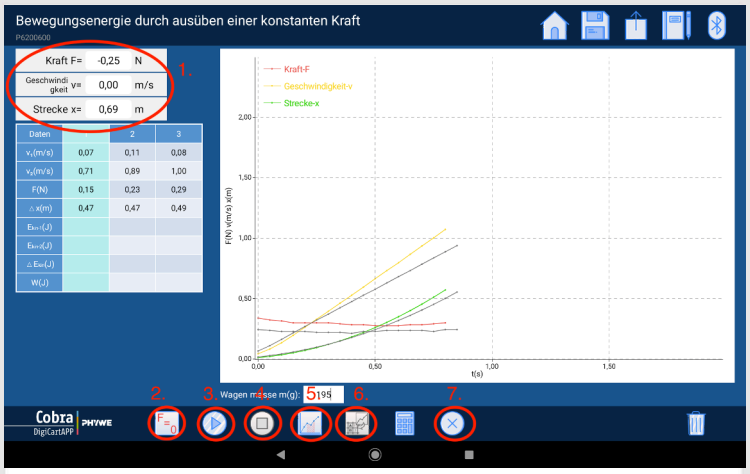

Measurement procedure

- The DigiCart is placed and held at the height-adjustable end.
- The film container with the weight is removed from the table and hangs freely over the edge of the table.
- Start the measurement by clicking on "Start measurement" (3.) and release the DigiCart. The falling weight causes the DigiCart to move.
- Stop the measurement by clicking on "Stop measurement". (4.) as soon as the DigiCart reaches the end of the track.

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Procedure (3/6)

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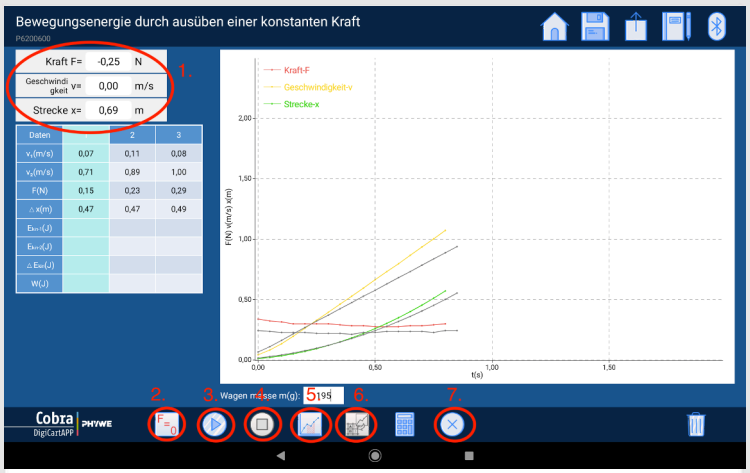

Measurement procedure

- Select a measuring range in the force-time diagram by clicking on "Select measuring range" (5.) for which the average difference of force, distance and velocity is to be calculated.
- the selection is made by swiping your finger over the interval.
- Save the measurement by clicking on the "Save" button (6.).
- The readings are filled in the left table.

Procedure (4/6)

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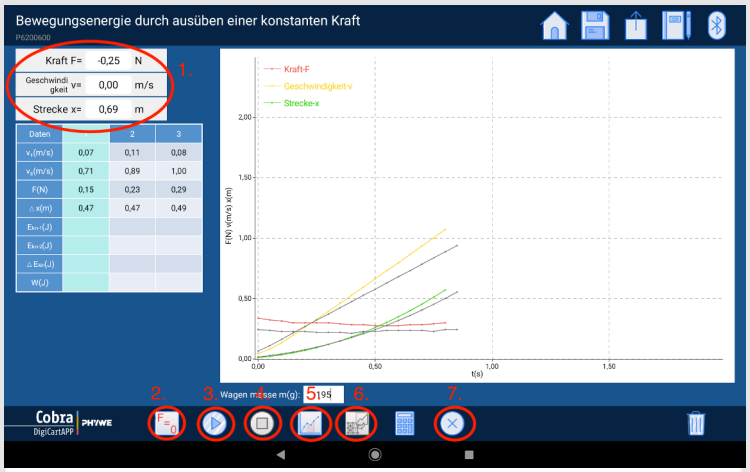

Measurement procedure

- Increase the weight of the film container by 10 grams. Repeat the last 7 steps.
- Then increase the weight of the film canister by another 10 grams and repeat the steps again.
- To delete a column from the table, tap on it and then click on the "Delete" button (7.).
- The column can be filled with new values by another measurement.

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Procedure (5/6)

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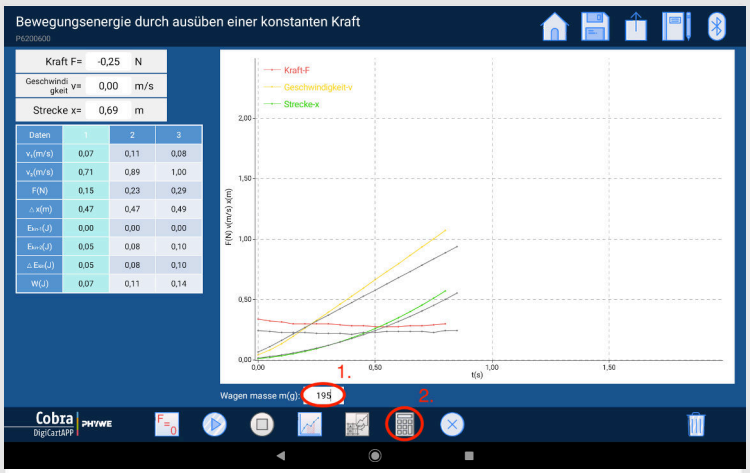

Procedure for the evaluation

- The figure shows the steps for the evaluation.
- Enter the measured mass of the DigiCart in the field Car mass (1.), using the unit gram. The entered mass is taken as the basis for further calculations. Important, do all three measurement series with the same cart mass!
- Click on the "Calculate" button (2.) to complete the table. The kinetic energy at the beginning and the end of the measuring range, the difference between both values and the mechanically performed work are determined.

Procedure (6/6)

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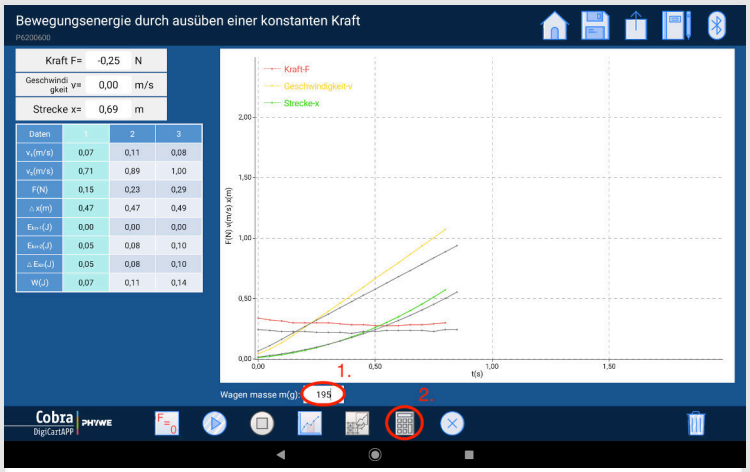

Procedure for the evaluation

The table in the figure shows that the difference between the two kinetic energies equals the performed mechanical work.

The work performed was completely converted into kinetic energy and thus fed to the DigiCart.

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Report

Task 1

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Kinetic energy by exerting a constant force

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How is the mechanical work calculated?

- $W = \frac{F}{s}$
- $W = F \cdot a$
- $W = F \cdot s$
- $W = F \cdot s^2$

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Task 2

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Drag the correct words into the gaps

For the kinetic energy _____ of a body with the mass m and velocity v applies the equation: _____. If the body accelerates from the velocity v_1 to the velocity v_2, the energy gain is: _____. About the work performed $W = F \cdot s$ you can say that work is _____ that is transferred to a body by _____. The important thing is that the force acts along the _____ travelled.

E_{kin} | path | forces | $\Delta E_{kin,1\to2} = E_{kin,2} - E_{kin,1}$ | $E_{kin} = \frac{1}{2} \cdot m \cdot v^2$ | energy

Check

Slide	Score / Total
Slide 19: Calculation mechanical force	0/4
Slide 20: Energy conversion	0/6

Total 0 / 10

Solutions | Repeat

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