Relationship between work and speed 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/60f936d8690ba70004c45039

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Teacher information

Application

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Helicopter

The physical quantities energy and work are closely related. If work is done by or on a body, its energy changes. The following applies in general:

The work done by or on a body is equal to the change in its energy.

In this experiment, you will learn about the mathematical relationship between mechanical work and velocity.

Example: A helicopter lifts a container to a certain height. In the process, lifting work is performed. The potential energy of the container increases.

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Other teacher information (1/2)

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Previous

Principle

This experiment requires the concept of kinetic energy as well as physical work.

Kinetic energy:

kinetic energy E_{kin}: Energy increase v_1 at v_2:

$E_{kin} = \frac{1}{2} \cdot m \cdot v^2$ $\quad\quad$ $\triangle E_{kin,1->2} = E_{kin,2} - E_{kin,1}$

Work:

Work done (W\) on a route s by that measure F:

$W = F \cdot s$

Other teacher information (2/2)

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Learning

Task

In this experiment, students learn about the mathematical relationship between mechanical work and speed.

1. Accelerate the DigiCart several times at constant mass by applying different forces on a defined distance and analyse the relationship between mechanical work done and speed.
2. Accelerate the DigiCart by applying a constant force over defined distances of varying lengths and analyse the relationship between mechanical work done and speed.

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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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Helicopter

The physical quantities energy and work are closely related. If work is done by or on a body, its energy changes. The following applies in general:

The work done by or on a body is equal to the change in its energy.

In this experiment, you will learn about the mathematical relationship between mechanical work and velocity.

Example: A helicopter lifts a container to a certain height. In the process, lifting work is performed. The potential energy of the container increases.

Tasks

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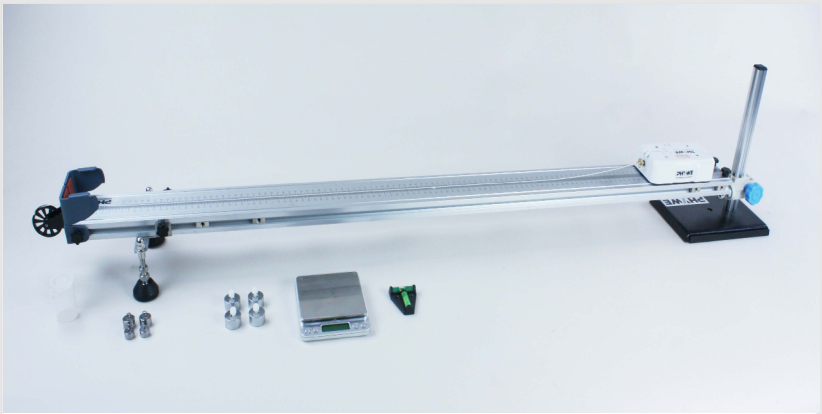

Overview of experimental setup

1. Accelerate the DigiCart several times at constant mass by applying different forces on a defined distance and analyse the relationship between mechanical work done and speed.
2. Accelerate the DigiCart by applying a constant force over defined distances of varying lengths and analyse the relationship between mechanical work done and speed.

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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 (1/3)

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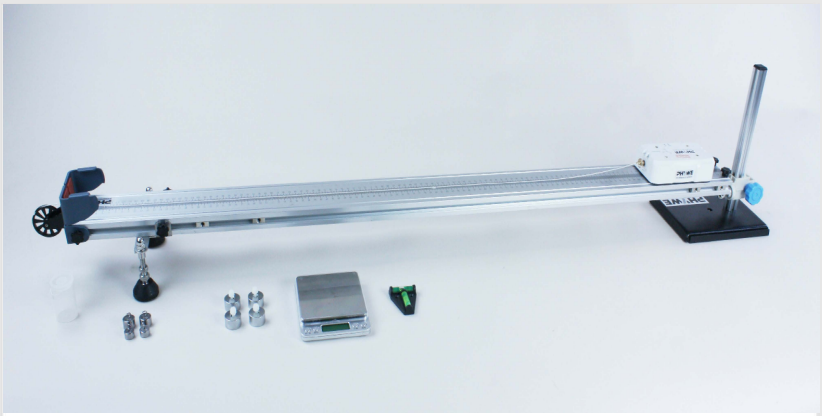

Figure 1: Overview of the experimental setup.

- Fix the four 50 gram additional weights on the DigiCart using the plastic screws.
- Use the scale to weigh the weight of the DigiCart. Make sure that you also weigh the brass screw on the force sensor.
- The track must be placed so that the wheel protrudes over the edge of the table. The table should have a height of about 1 m.

Set-up (2/3)

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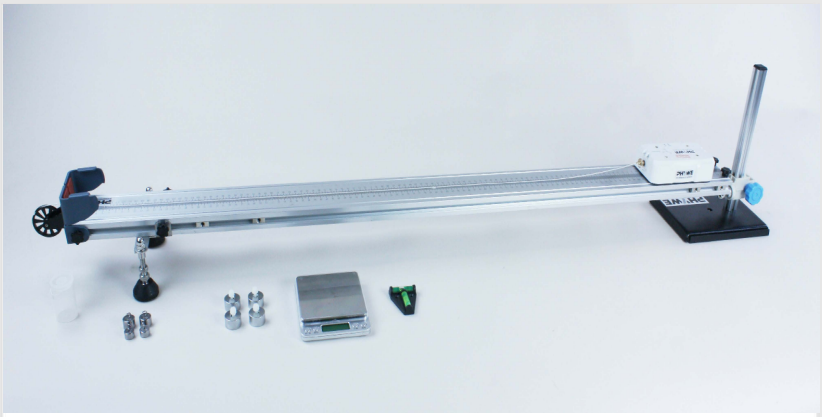

Figure 1: Overview of the experimental setup.

- Bring the track into a horizontal position and place the DigiCart on it.
- Place a 10 gram weight in the film canister and close it with the lid. Attach the string of the film canister to the DigiCart's force sensor using the brass screw and pass the string over the wheel at the end of the track.
- Place the film canister on the edge of the table first.
- Launch the DigiCart app.

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Set-up (3/3)

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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.).

Implementation Part 1 (1/4)

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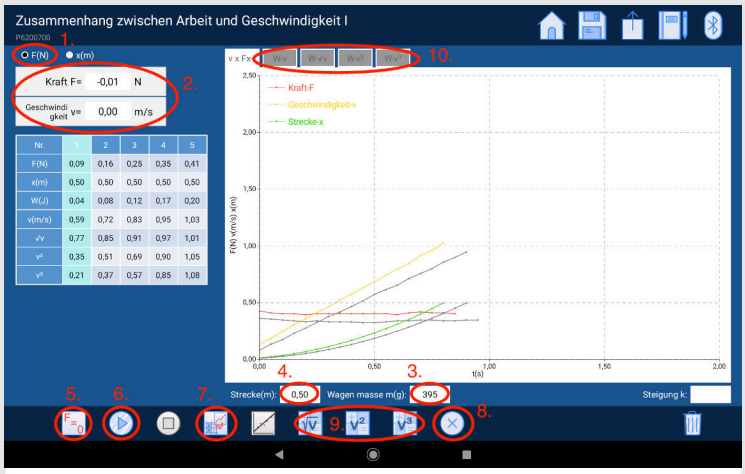

Measurement procedure - Part 1

- The figure on the left shows the steps for the measurement process.
- Click in the lower left part of the window on the button "F(N)". (1.).
- In the force and speed display (2.) the instantaneous force and the instantaneous speed are displayed.
- Enter the mass of the DigiCart in the Cart mass field (3.).

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Implementation Part 1 (2/4)

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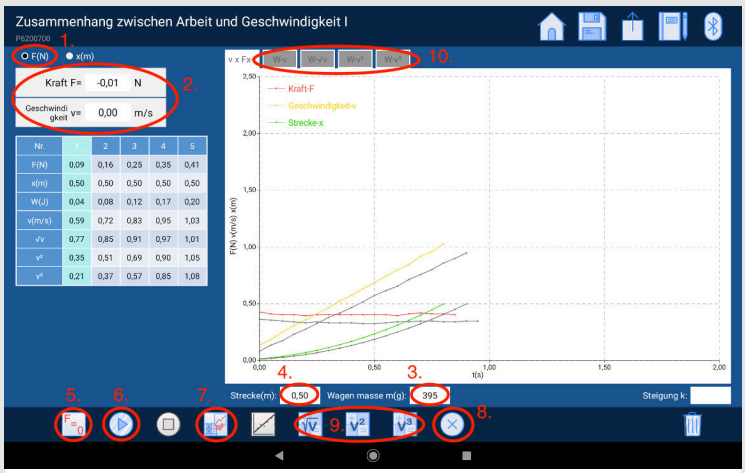

Measurement procedure - Part 1

- The value 0.5 meters is entered in the field "Strecke" (4.) the value 0.5 meter is entered. This is the distance over which we want to measure the mechanical work.
- The force at the sensor is now set to zero via the "Calibration" button (5.). button (5.) to zero. It must be ensured that the thread is not tensioned and that no force is acting on the sensor.
- The DigiCart is placed and held at the height-adjustable end.

Implementation Part 1 (3/4)

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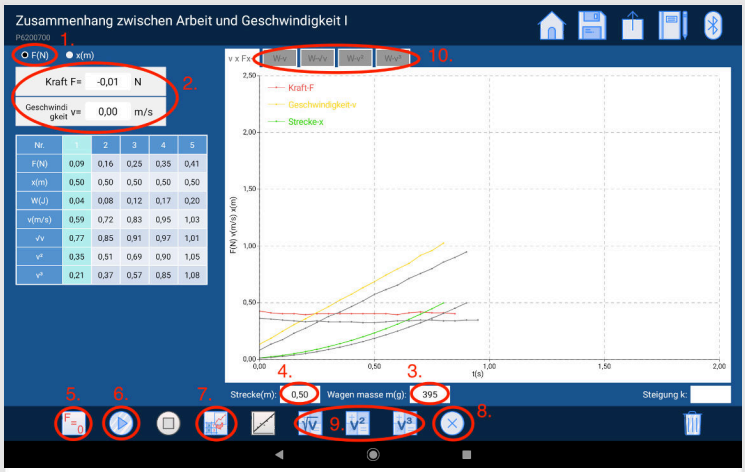

Measurement procedure - Part 1

- The film canister 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". (6.).
- Release the DigiCart. The falling weight causes the DigiCart to move. The measurement ends automatically when the distance covered is 0.5 meters.
- Click on the button "Save" (7.). The measured values are transferred to the table.

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Implementation Part 1 (4/4)

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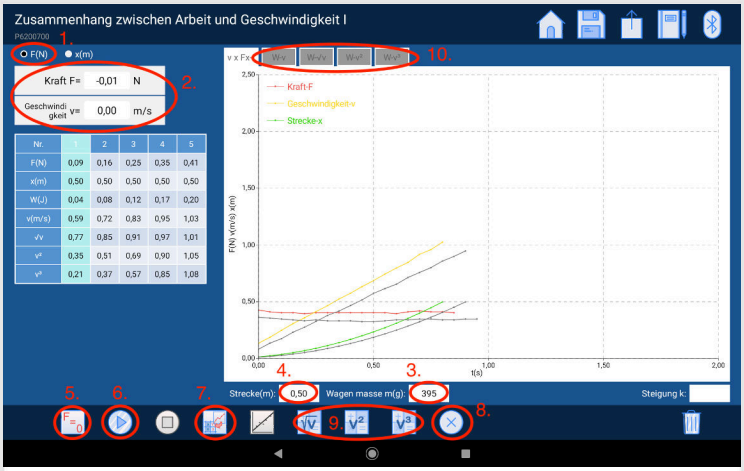

Measurement procedure - Part 1

- Increase the weight of the film canister by 10 grams. Then repeat the last 6 steps. Repeat the measurement until you have taken five measurements. After each measurement, increase the weight by another 10 grams.
- To delete a column from the table, tap on it and then click on the "Delete" button (8.). button (8.). By another measurement the column can be filled with new values.
- Continue reading in the Evaluation Part 1 section.

Implementation Part 2 (1/3)

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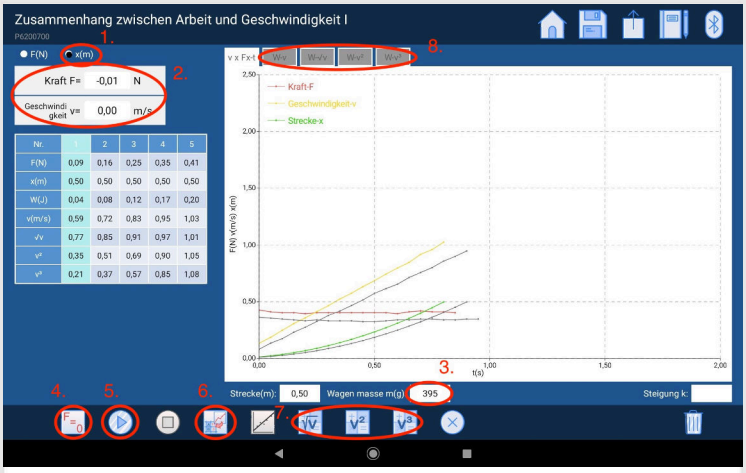

Measurement procedure - Part 2

- The figure on the left shows the steps for the measurement process.
- Click on the button "x(m)" in the lower left part. (1.).
- In the force and speed display (2.) the instantaneous force and the instantaneous speed are displayed.
- Enter the mass of the DigiCart in the field (3.).
- The film canister is filled with 20 grams of weight and placed closed on the table.

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Implementation Part 2 (2/3)

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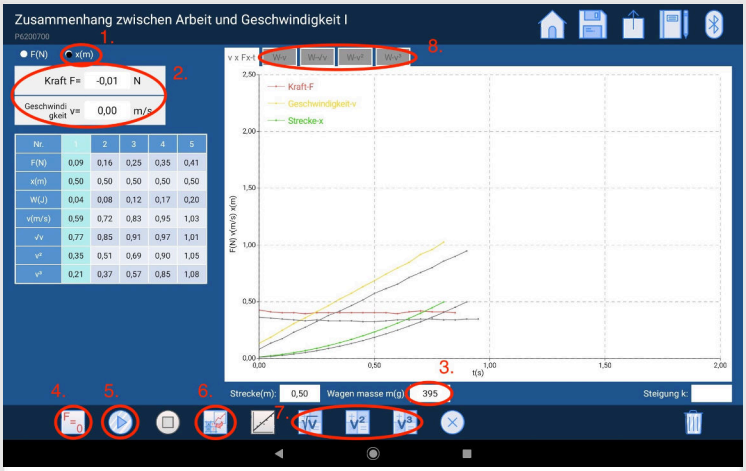

Measurement procedure - Part 2

- The force at the sensor is now set to zero via the "Calibration" button (4.). button (4.) to zero. It must be ensured that the thread is not tensioned and that no force is acting on the sensor.
- The DigiCart is placed and held at the height-adjustable end.
- The film canister 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". (5.).

Implementation Part 2 (3/3)

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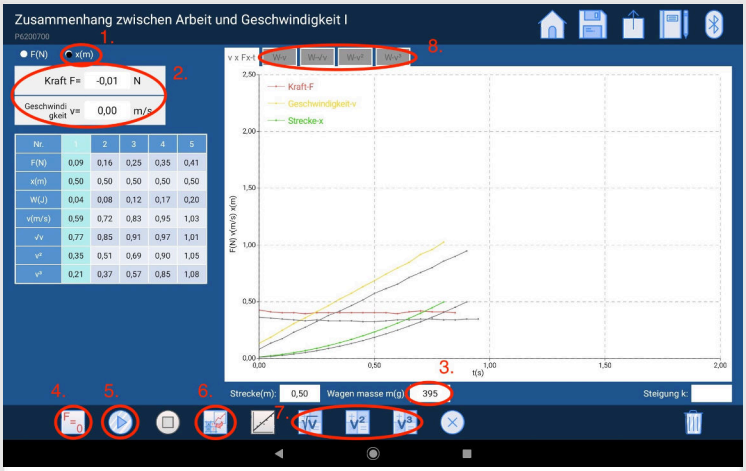

Measurement procedure - Part 2

- Release the DigiCart. The falling weight causes the DigiCart to move.
- The measurement ends automatically after the distance covered is 0.7 meters.
- Click on the button "Save". (6.). The measured values are transferred to the table.

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Report

Evaluation part 1 (1/2)

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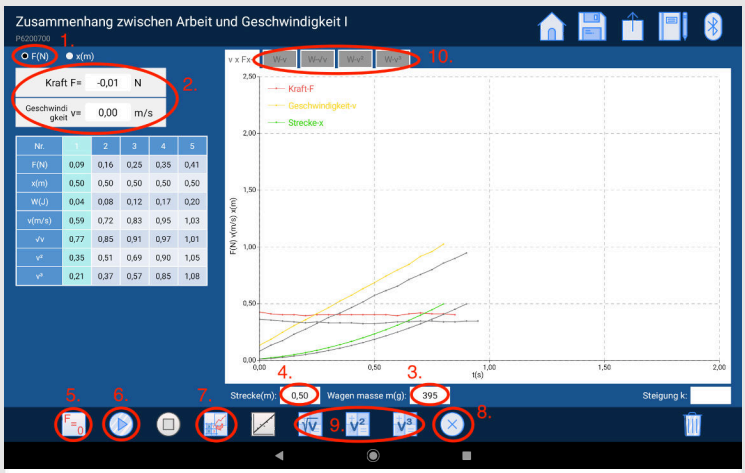

Evaluation procedure - Part 1

- The figure shows the steps for the evaluation.
- Click on the buttons "" one after the other. "$\sqrt{v}$", "$\sqrt{v^2}$" and "$\sqrt{v^3}$" (9.) to calculate the corresponding values from the velocity and have them entered in the table.
- Now click on a tab (10.) above the diagram.

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Evaluation part 1 (2/2)

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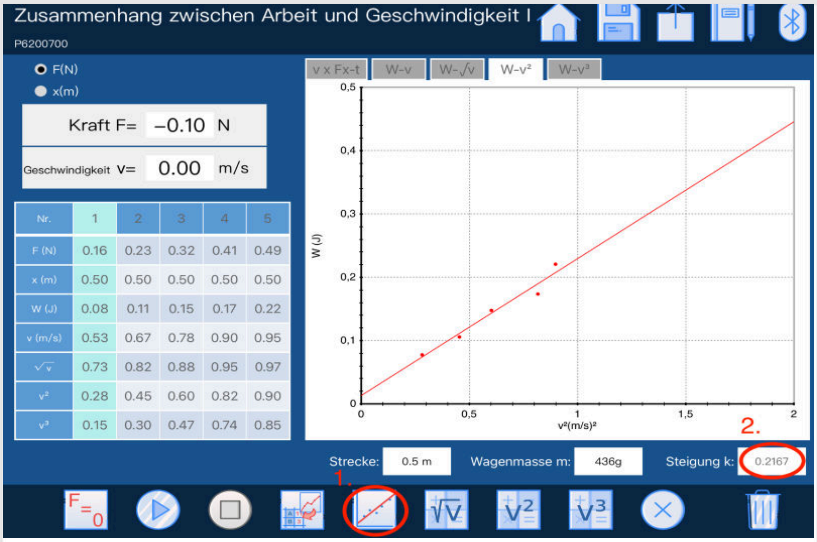

Evaluation procedure - Part 1

- The corresponding points from the table can already be seen in the diagram. Select "Draw straight line" (1.) to draw a straight line through the points.
- Proceed in this way with all tabs above the diagram.
- In the field "Slope" (2.) the gradient of the calculated straight line is displayed.

Task 1

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Drag the correct words into the gaps!

The mechanical work was done by the falling weight, it is _____. In this part of the experiment, by varying the effective force F the work performed varies (x remained constant at 0.5 meters). The work done was converted into kinetic energy, i.e.

$W =$ _____ $=$ _____.

$W = F \cdot x$

$\frac{1}{2} \cdot m \cdot v^2$

E_{kin}

Check

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Task 2

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If you look at the drawn straight lines, you will see that only under the tab "".$W - v^2$"

- the points approximately follow the straight line.
- the points lie far above the straight line.
- the points do not follow the straight line.

Evaluation(1/2) - Part 2

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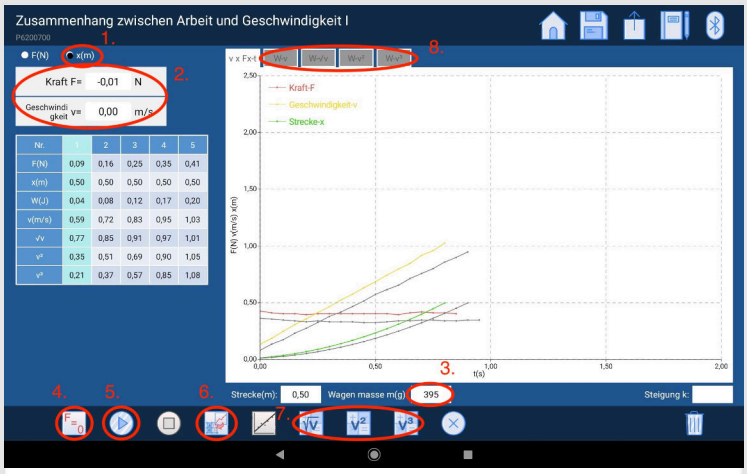

Evaluation procedure - Part 2

- The figure shows the steps for the evaluation.
- Click on the buttons "" one after the other. $\sqrt{v}$", "$\sqrt{v^2}$" and "$\sqrt{v^3}$" (7.) to calculate the corresponding values from the velocity and have them entered in the table.
- Now click on a tab above the diagram (8.).

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Evaluation part 2 (2/2)

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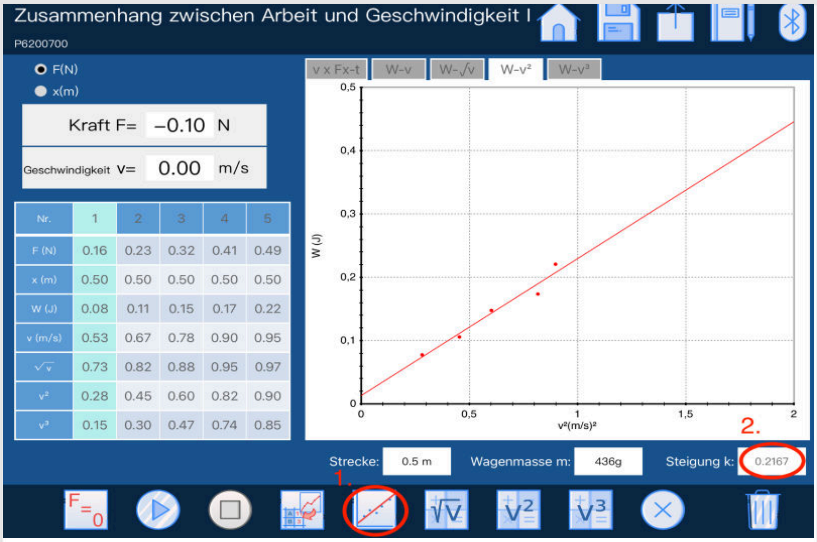

Evaluation procedure - Part 2

- The corresponding points from the table can already be seen in the diagram. Select "Draw straight line" (1.) to draw a straight line through the points.
- Proceed in this way with all tabs above the diagram.
- In the field "Slope" (2.) the gradient of the calculated straight line is displayed.

Task 3

PHYWE

Drag the correct words into the gaps!

As in Part 1, the mechanical work was done by the falling weight:

_____, and the work done is converted into kinetic energy:

_____. In this part of the experiment, by varying the

_____ the work performed varies (here

_____ remained constant).

$W = E_{kin} = \frac{1}{2} \cdot m \cdot v^2$ | force is F | $W = F \cdot x$ | distance x

Check

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Task 4

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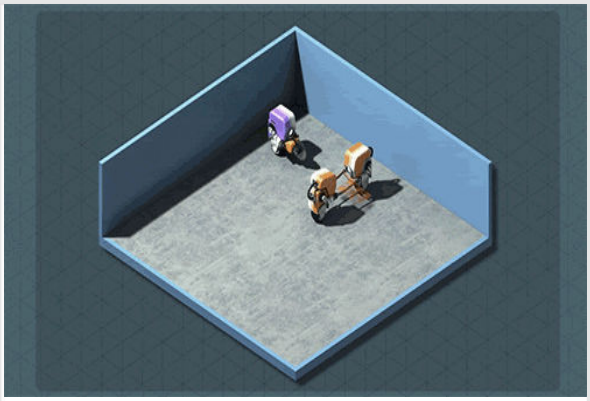
What work is done over a distance of 1 meter if the acting force points along the path and is 10 N?

$W = 10Nm$

$W = 0,1Nm$

$W = 1Nm$



https://giphy.com/gifs

Slide	Score / Total
Slide 23: Mechanical work and kinetic energy	**0/3**
Slide 24: Lines and points	**0/3**
Slide 27: Mechanical work and kinetic energy part 2	**0/4**
Slide 28: Principles Energy forms	**0/3**

Total Score **0 / 13**

Show solutions Retry

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