Correlation between work and velocity II with Cobra DigiCart

Physics > Mechanics > Dynamics & Motion

Difficulty level	Group size	Preparation time	Execution time
medium	2	20 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/605333206cb02000034e1432

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Teacher information

Application

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Example - Skateboarder

Relationship between work and velocity

Work W in physics is the energy that is transferred to an object by forces. One says: "Work is done on the object".

The velocity v describes how fast and in which direction an object changes its location in the course of time.

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

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Teacher information (1/2)

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Prior knowledge

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

Scientific principle

Kinetic kinetic energy E_{kin} of an object with the mass m and the velocity v:

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

Energy increase of the acceleration from v_1 to v_2:

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

Teacher information (2/2)

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Learning objective

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

Task

The students give the DigiCart different velocities and analyse the relationship between the mechanical work done and the resulting velocity based on that.

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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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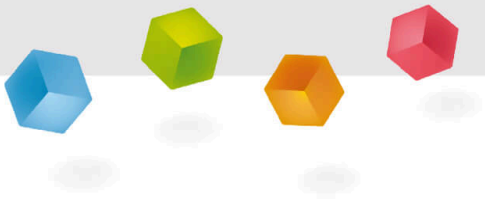

Student Information

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Motivation

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Example - Skateboarder

Relationship between work and velocity

Work W in physics is the energy that is transferred to an object by forces. One says: "Work is done on the object".

The velocity v describes how fast and in which direction an object or a phenomenon changes its location in the course of time.

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

Task

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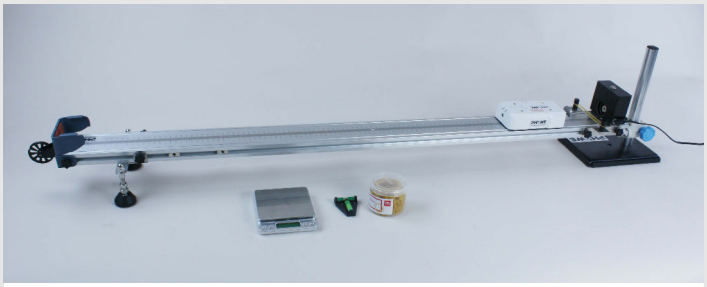
1. Give the DigiCart different velocities
2. Analyze the relationship between mechanical work done and velocity.

Cobra DigiCart



Experimental set-up

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Equipment

Position	Material	Item No.	Quantity
1	Cobra DigiCart Expert Set	12940-88	1
2	Cobra DigiCartAPP	14582-61	1

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Set-up (1/2)

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Overview of experimental setup

- Mount the magnetic starter at the height-adjustable end of the track and bring the track into a horizontal position using the spirit level. Then tighten a rubber band at the end of the track on the black cylinders provided for this purpose.
- Attach the contact disc for the magnetic starter to the DigiCart and place the DigiCart on the track with the contact disc facing the rubber band.
- Measure the weight of the DigiCart with the scale.
- Launch the DigiCart app.

Set-up (2/2)

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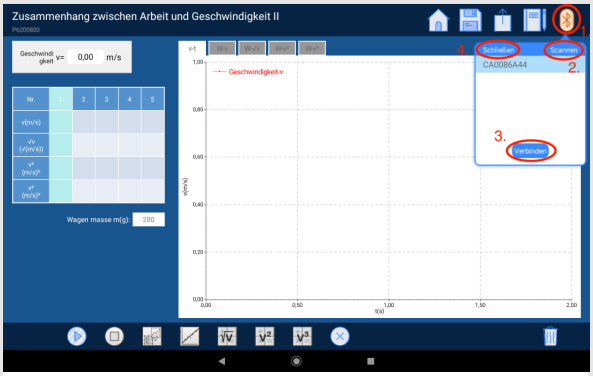

Connection to the DigiCart

- Select test 8 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 (1/5)

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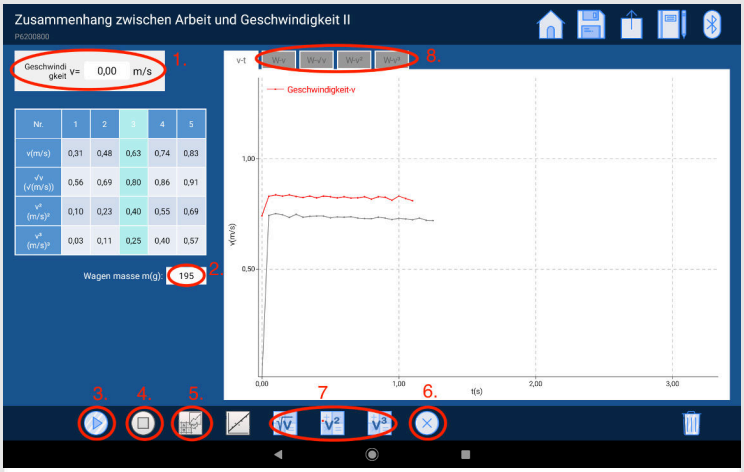

Measurement procedure

- The figure shows the steps for the measurement process.
- The instantaneous velocity is shown in the velocity display (1.).
- Enter the mass of the DigiCart in the Cart mass field (2.).
- Press the ON button to activate the magnetic starter and dock the DigiCart to it. The rubber band will be stretched.

Procedure (2/5)

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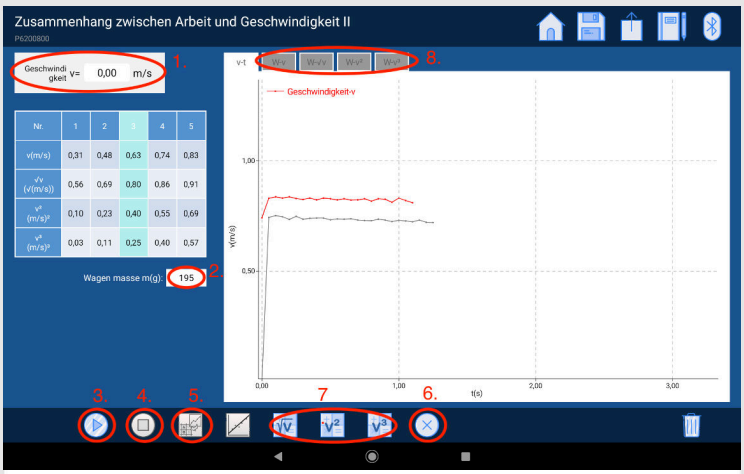

Measurement procedure

- Start the measurement on "Start measurement". (3.).
- Release the DigiCart from the magnetic starter by pressing the ON button again.
- Stop the measurement by clicking on "Stop measurement" (4.) as soon as the DigiCart reaches the end of the track.
- Click on the button "Save" (5.). The measured velocity value is transferred to the table.

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Procedure (3/5)

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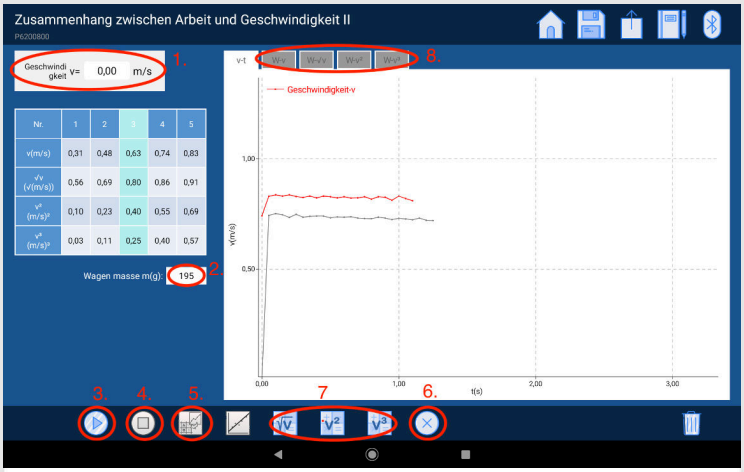

Measurement procedure

- Clamp in another rubber.
- Return the DigiCart to its original position and secure it with the magnetic starter.
- Repeat the measuring process until you have 5 measurements. With each measurement, increase the number of rubbers by 1.
- To delete a column from the table, tap on it and then click on "Delete"(6.). The column can take new values by further measurements.

Procedure (4/5)

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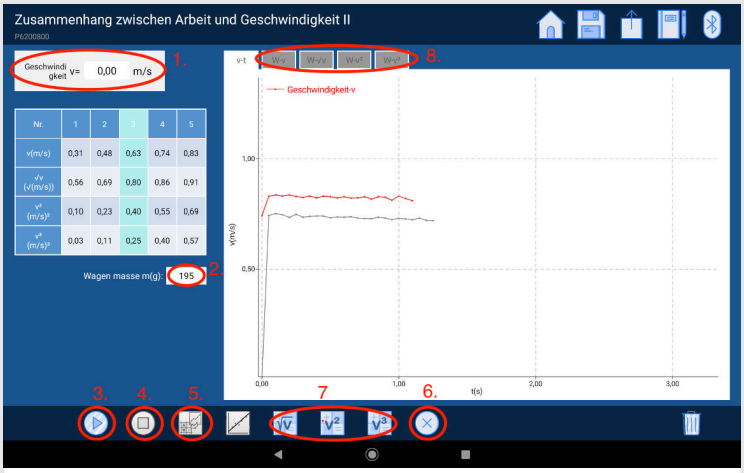

Procedure for the evaluation

- Click on $\sqrt{v}$", "v^2" and "v^3" (7.) one by one to calculate the corresponding values from the velocity and have them entered in the table.
- Now click on a tab above the diagram (8.).
- 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.

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Procedure (5/5)

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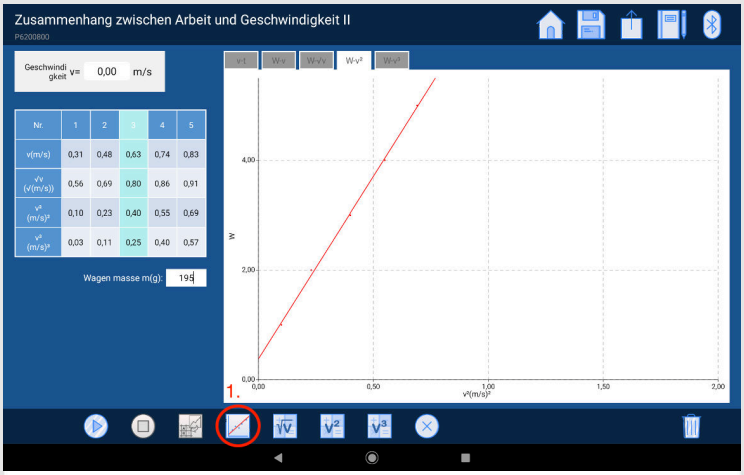

Procedure for the evaluation

If you look at the drawn straight lines, you will notice that only under the tab:

$$"W - v^2"$$

the points approximately follow the straight line.

All other straight lines deviate strongly from the points. This confirms the physical statement that the kinetic energy is proportional to the squared velocity:

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

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Report

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Task 1

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What do you call the form of energy that is in the stretched rubber bands?

- Clamping energy
- Kinetic energy
- Elasticity energy
- Deformation energy

Task 2

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Which of the following statements are correct?

- [ ] The more rubber bands are used, the lower the stored clamping energy.
- [ ] The greater the clamping energy, the lower the resulting velocity.
- [ ] The more rubber bands used, the greater the stored clamping energy.
- [ ] The greater the clamping energy, the greater the resulting velocity.

Check

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Task 3

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Which of the following represent units of energy?

- [ ] J (joules)
- [ ] $N \cdot m$ (Newtonmeter)
- [ ] $kg \cdot m^2/s^2$
- [ ] $W \cdot s$ (watt seconds)

Check

Slide	Score / Total
Slide 18: Energy form of the rubber bands	0/5
Slide 19: Je-Desto Relationships	0/2
Slide 20: Unit for work and energy	0/4

Total 0 / 11

Solutions Repeat

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