Relationship between work and Speed II (Item No.: P6200800)

Curricular Relevance
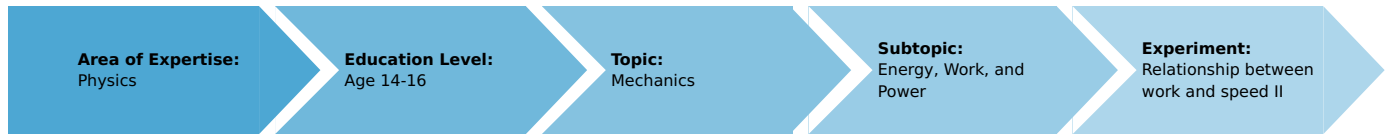
| Area of Expertise: Physics | Education Level: Age 14-16 | Topic: Mechanics | Subtopic: Energy, Work, and Power | Experiment: Relationship between work and speed II |

Difficulty	**Preparation Time**	**Execution Time**	**Recommended Group Size**
Intermediate	10 Minutes	20 Minutes	2 Students

Additional Requirements:	**Experiment Variations:**
• Tablet PC with DigiCart App	

Keywords:

Kinetic energy, Work, Energy conversion

Information for teachers

Introduction

Overview experimental setup.

Educational objective

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

Task

Provide the DigiCart with varying velocities and analyze the relationship between mechanical work performed and velocity.

Prior knowledge

This experiment requires the concept of kinetic energy and physical work.

Principle

For the kinetic energy E_{kin} of a body of mass m and velocity v the following equation applies

$$E_{\mathrm{kin}} = \tfrac{1}{2} \cdot m \cdot v^2 \, .$$

If the body accelerates from the velocity v_1 to the velocity v_2, the energy increase is as follows:

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

Equipment

Position No.	Material	Order No.	Quantity
1	DigiCart white		1
2	1.2 m track		1
3	Height adjustable holder		1
4	DigiCartAPP		1
5	Magnetic starter		1
6	Magnetic starter contact disc		1
7	Rubber bands		1
8	Scale		1
9	Spirit level		1

Safety information

For this experiment, the general instructions for safe experimentation in science teaching apply.

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Robert-Bosch-Breite 10
D - 37079 Göttingen

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

info@phywe.de
www.phywe.com

Introduction

Application and task

Application
In this experiment you will learn something about the mathematical connection between mechanical work and velocity.

Task
Provide the DigiCart with different velocities and analyze the relationship between mechanical work performed and velocity.

Equipment

Position No.	Material	Order No.	Quantity
1	DigiCart white		1
2	1.2 m track		1
3	Height adjustable holder		1
4	DigiCartAPP		1
5	Magnetic starter		1
6	Magnetic starter contact disc		1
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Set-up and procedure

Set-up

Figure 1: Overview of experimental setup.

- Mount the magnetic starter at the height-adjustable end of the track.

- 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.

- Attach the contact disk for the magnetic starter to the DigiCart and place the DigiCart on the track.

- Use the scale to weigh the weight of the DigiCart.

- Place the DigiCart on the track so that the contact disc points in the direction of the rubber band.

- Start the DigiCart App.

- Select experiment 8 from the overview. The measurement window opens.

- Connect the DigiCart to the app (see Figure 2). Two steps are required. First, press the ON switch 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, one taps the DigiCart from the list once and establishes the connection via the connect button (3.). You can now hide the window again by pressing the close button (4.).

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info@phywe.de
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Figure 2: Connecting to the DigiCart.

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Robert-Bosch-Breite 10
D - 37079 Göttingen

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

info@phywe.de
www.phywe.com

Procedure

- Figure 3 shows the steps for the measurement process.

- The velocity display (1.) shows the instantaneous velocity.

- Enter the mass of the DigiCart in the car mass field (2.).

- Activate the magnetic starter via the ON button and dock with the DigiCart to it. The rubber band is tensioned.

- Start the measurement by clicking on start measurement (3.).

- Now release the DigiCart from the magnetic starter by pressing the ON button again.

- End the measurement by clicking on end measurement (4.) as soon as the DigiCart reaches the end of the track.

- Click on the save button (5.). The measured velocity value is transferred to the table.

- Install one additional rubber band.

- Return the DigiCart to its original position and fix it with the magnetic starter.

- Repeat the measurement process until you have made five measurements. Each time you make a measurement, increase the number of rubber bands you have tensioned by one.

- To delete a column from the table, touch it and then click the delete button (6.). By a further measurement the column can be filled with new values.
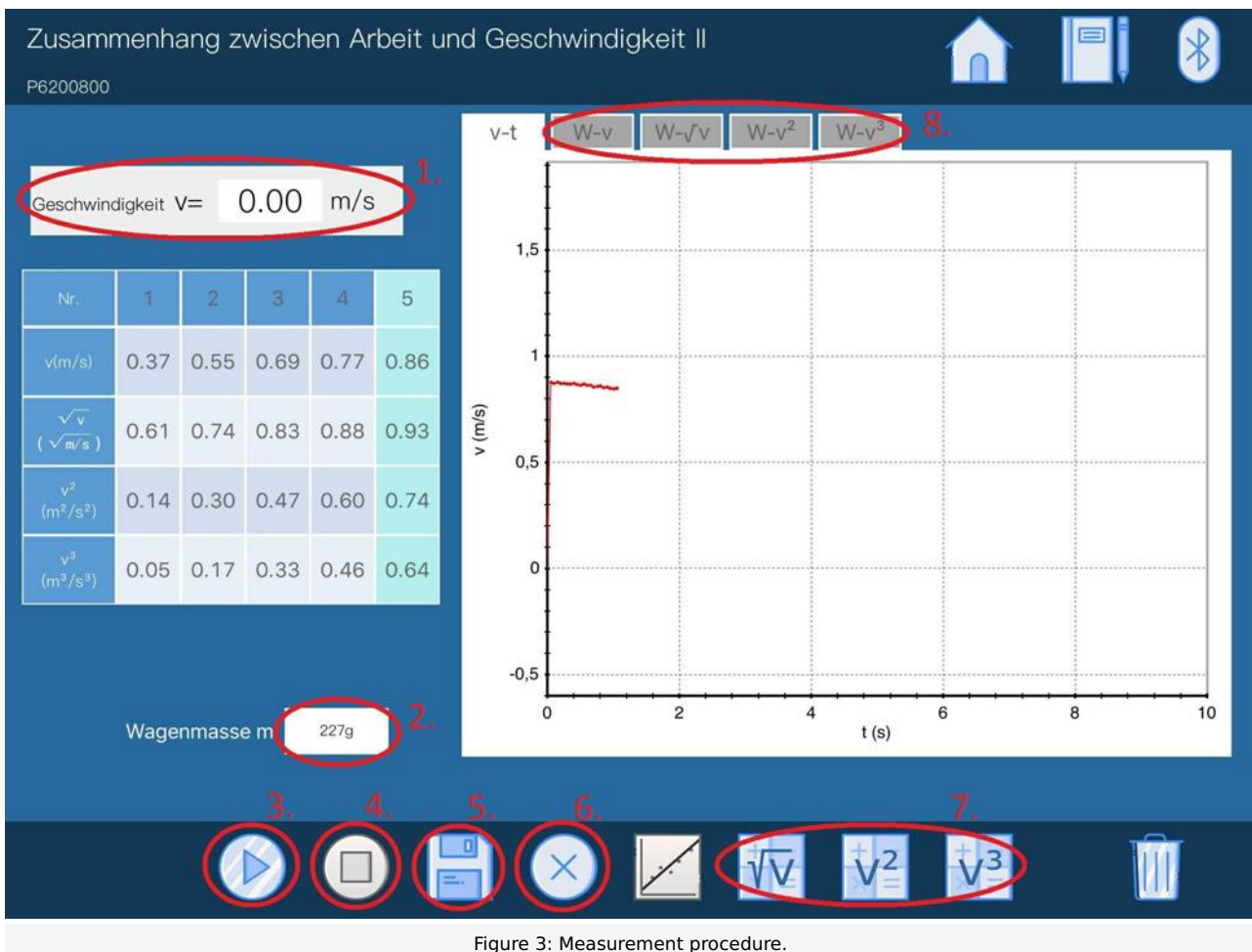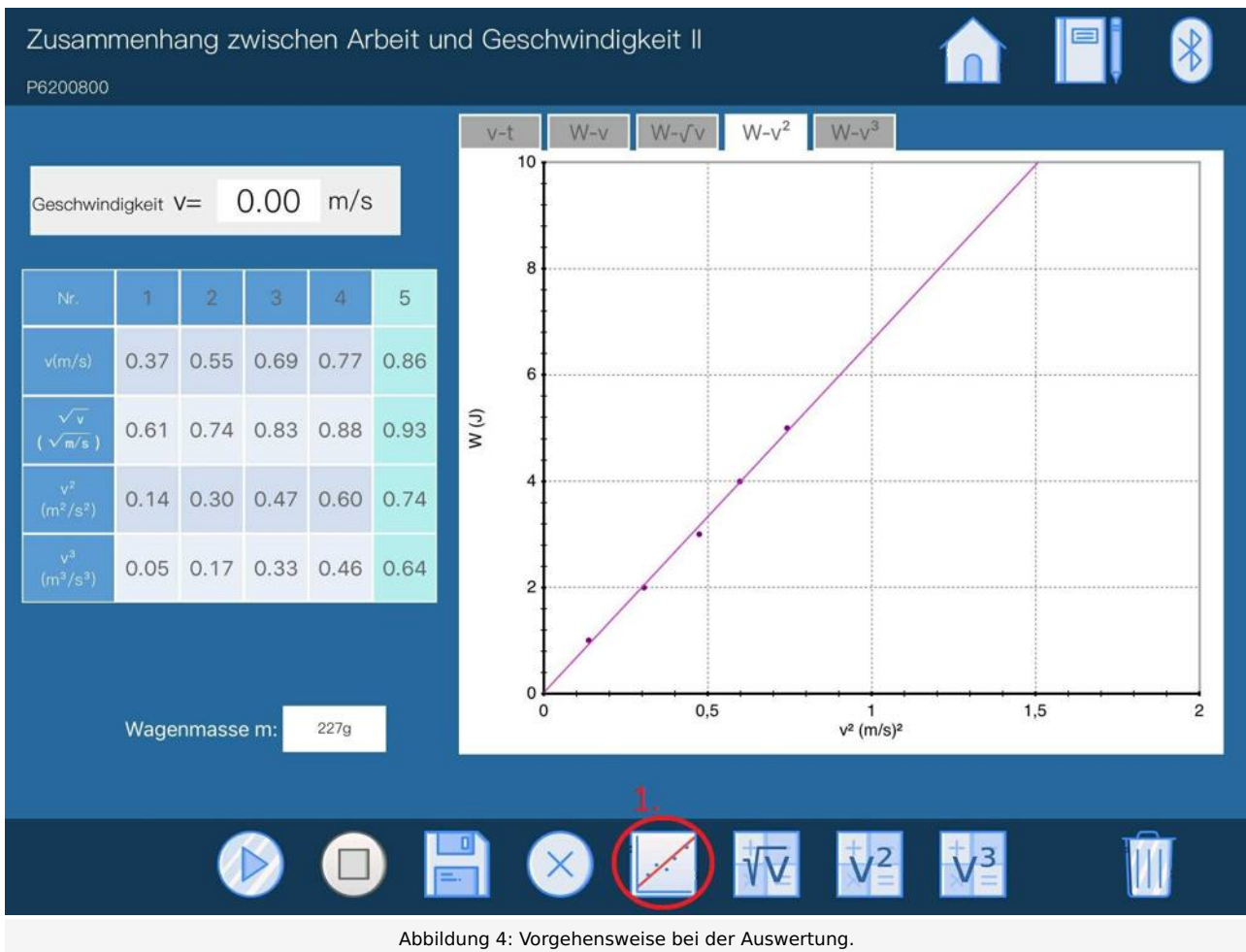

Figure 3: Measurement procedure.

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Fax: +49 551 604 - 107

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Evaluation

- Figure 3 shows the steps for the evaluation.

- Click on the buttons "$\sqrt{v}$", "v^2" and "v^3" (7.) in order to calculate the corresponding values from the velocity and enter them in the table.

- Now click on a tab above the diagram (8.).

- Figure 4 shows the further steps for the evaluation.

- The corresponding points from the table can already be seen in the diagram. Select straight line (1.) to pass a straight line through the point.

- Proceed in this way with all tabs above the diagram.

If you look at the drawn lines, you can see that only under the tab "$W - v^2$" the points follow the line approximately. All other straight lines deviate strongly from the points. This confirms the physical statement that the kinetic energy is proportional to the square of the velocity, $E_{kin} = 0.5 \cdot m \cdot v^2$.

Abbildung 4: Vorgehensweise bei der Auswertung.

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D - 37079 Göttingen

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Relationship between work and speed II

Results - Evaluation 1 (1 point)

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

Score is granted based on the occurrence of the following keywords:

- Tension energy.

Scoring Mode: Automatic Scoring with Keywords on Finding ONE

Results - Evaluation 2 (1 point)

Which forms of energy are converted into each other in this experiment?

Score is granted based on the occurrence of the following keywords:

- The tension energy of the rubber bands is converted into kinetic energy of the DigiCart.

Scoring Mode: Automatic Scoring with Keywords on Finding ONE

Results - Evaluation 3 (1 point)

Which formula can be used to calculate the kinetic energy?

Score is granted based on the occurrence of the following keywords:

- $0.5*m*v^2$, where m is the mass of the body and v its velocity.

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