Linear uniform motion 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/5f499e1cb17715000377a7c3

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Teacher information

Application

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Rocket Launch

Is it possible to determine the distance travelled from the speed curve of a movement?

In this experiment you will learn something about the physical meaning of acceleration.

You will also learn how to obtain the local time diagram from a speed-time diagram.

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Teacher information (1/3)

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Learning objective

In this experiment the students learn about the physical meaning of acceleration. They also learn how to obtain the local time diagram from a velocity-time diagram.

Task

1. Record multiple speed-time diagrams via the app. Select a measuring range and let it calculate the acceleration for the recorded curves.
2. Use the velocity-time diagram to determine the position-time diagram of the movement.

Prior knowledge

This experiment requires the concept of speed and elementary knowledge of integration.

Teacher information (2/3)

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Principle (1/2)

Acceleration

Acceleration is one of the basic concepts of the theory of motion. It indicates how fast an object changes its speed and is measured in the unit $\frac{m}{s^2}$

The concept of acceleration is based on the average acceleration. Designated $\triangle v$ the change in speed during a period of time $\triangle t$.

You can calculate the average acceleration $\bar{a}$.

$$\bar{a} = \frac{\triangle v}{\triangle t}$$

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Teacher information (3/3)

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Principle (2/2)

Momentary speed

Speed is one of the basic concepts of the theory of motion. It indicates how fast an object is moving in space and is measured in the unit meter per second. The concept of instantaneous velocity is based on the average speed. Designated $\triangle x$ the change of the position in a period of time $\triangle t$...so you can talk about:

$$\bar{v} = \frac{\triangle x}{\triangle t}$$

the average speed $\bar{v}$ calculate. If now the time interval $\triangle t$ is made smaller and smaller, it goes over to the infinitesimal object dt and the quotient of the above formula becomes the time derivative of the location. This is the definition of the instantaneous velocity at a point in time t :

$$v(t) = \frac{dx}{dt} = \dot{x}(t)$$

Other teacher information

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From the integral calculus follows now for the points of time between t_1 and t_2 distance traveled x that:

$$x = \int_{t_1}^{t_2} = v(t)dt$$

Since the value of the integral corresponds to the area under the velocity curve, we have the possibility to calculate the distance x to calculate.

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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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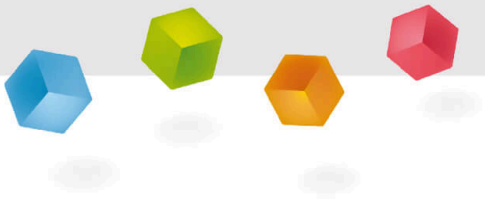

Student Information

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Motivation

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Rocket Launch

Is it possible to determine the distance travelled from the speed curve of a movement?

In this experiment you will learn something about the physical meaning of acceleration.

You will also learn how to obtain the local time diagram from a speed-time diagram.

Tasks

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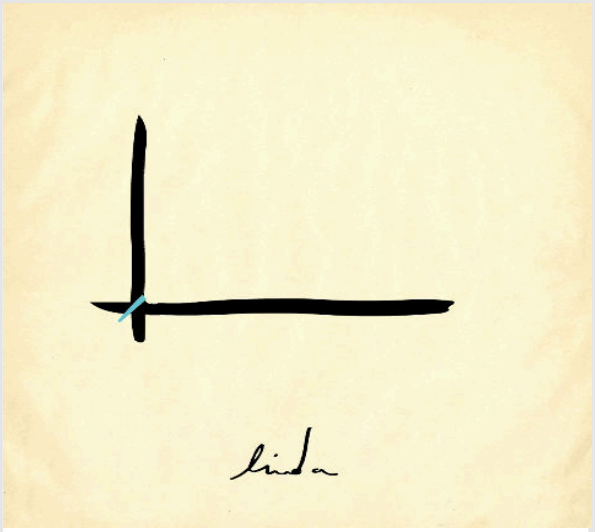

Diagram

1. Record several speed-time diagrams via the app. Select a measuring range and calculate the acceleration for the recorded curves.
2. Use the velocity-time diagram to determine the local-time diagram of the movement.

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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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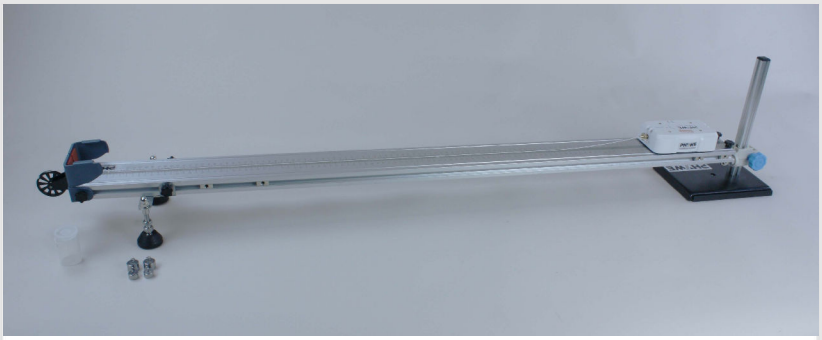

Overview test setup

- The track must be positioned so that the impeller protrudes beyond the edge of the table. The table should have a height of about 1 m.
- Bring the track into a horizontal position. Put a 10 gram weight into the film can and close it with the lid. Attach the film canister's cord to the DigiCart's force sensor with the brass screw and guide the cord over the track's wheel.
- First place the film can on the edge of the table.

Set-up (2/2)

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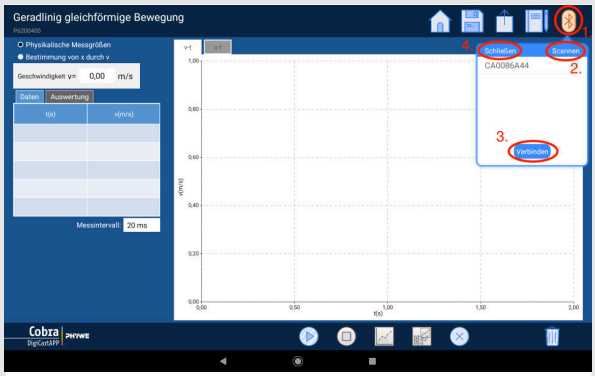

Connection to the DigiCart

- Start the DigiCart App.
- Select experiment 4 from the overview. The measurement window opens.
- Connect the DigiCart to the app.
- Press the ON switch on the DigiCart for at least 3 seconds If the DigiCart is not displayed, you can update the list by clicking on Scan (2.).
- Select the DigiCart from the list and establish the connection with the Connect button (3.). You can hide the window with the close button (4.).

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Procedure (1/8)

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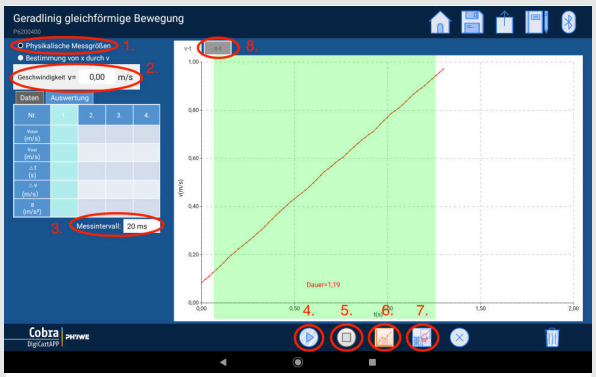

Procedure for the measurement

- The figure shows the steps for the measuring procedure.
- Click on the button "Physical measured quantities" in the upper left part of the window (1.).
- The speed display below (2.) shows the current speed.
- Before each measurement you have the possibility to select the time between two measuring points (3.).
- The DigiCart is placed and held at the height-adjustable end.
- The film can with the weight is taken from the table and hangs freely over the edge of the table.

Procedure (2/8)

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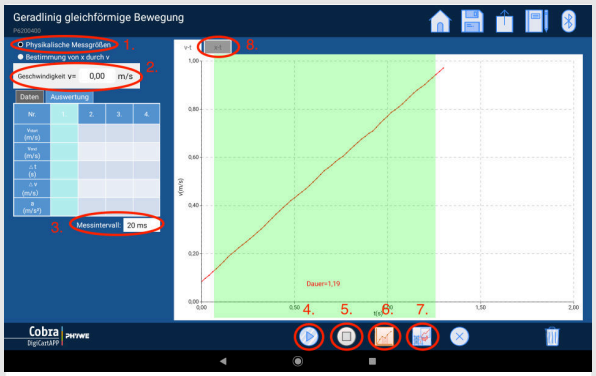

Procedure for the measurement

- Start the measurement - Click on "Start measurement". (4.).
- Release the DigiCart. The DigiCart moves due to the now falling weight.
- Stop the measurement - Click on "Stop measurement". (5.) as soon as the DigiCart reaches the end of the track.
- Select "Select measuring range" (6.), select a measuring range in the velocity-time diagram for which the acceleration is to be calculated.
- The selection is made by sweeping the interval with your finger.

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Procedure (3/8)

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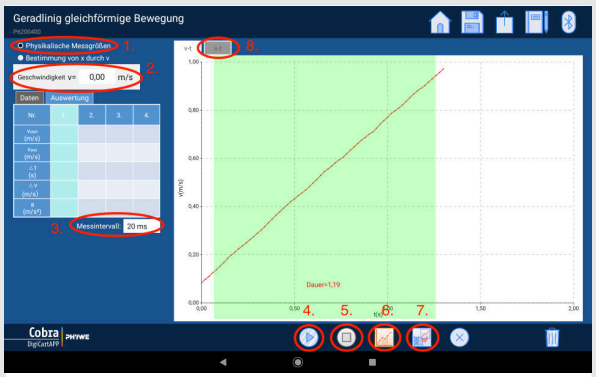

Procedure for the measurement

- Save the measurement by clicking on the "Save" button Button (7.).
- Above the diagram you can click on the tab "x-t" (8.) to switch to the local time diagram to view the time course of the position.
- Return the DigiCart to its original position and increase the weight in the film box by another 10 grams.
- Repeat the last 7 steps until four measurements are made.
- Continue reading in part Evaluation 1.

Procedure (4/8)

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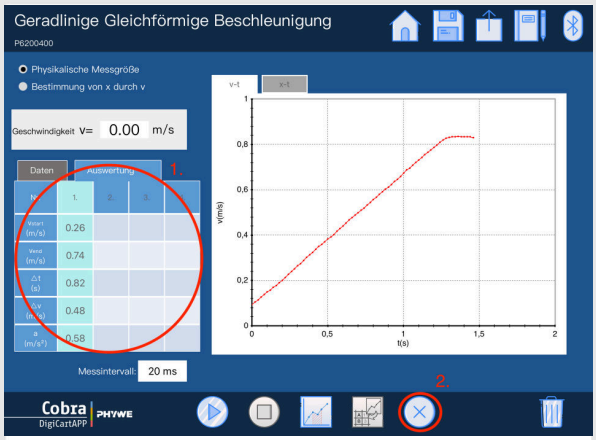

Evaluation steps

- The table on the left side (1.) shows for each of the recorded curves the speed change within the selected measuring range as well as the time interval. From this the acceleration is calculated.
- If a single measurement is to be repeated, first tap on the corresponding column of the table. This column turns green. Now delete the values with the help of the "Delete" button. buttons (2.) and can repeat the measurement.

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Procedure (5/8)

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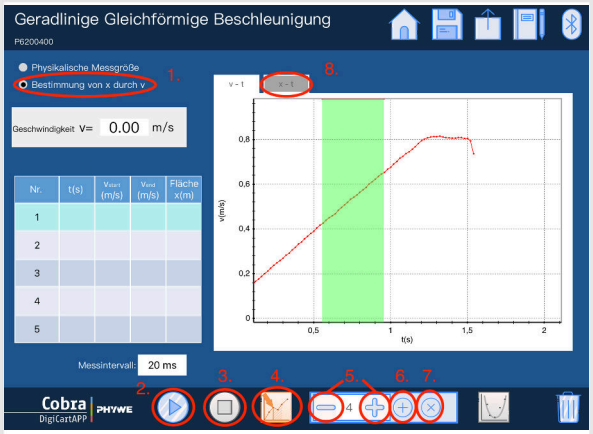

Procedure for the measurement

- This figure shows the steps for the measuring procedure.
- Click on the button "Determine x by v" in the upper left part of the window (1.).
- The DigiCart is placed and held at the height-adjustable end.
- The film canister is filled with a 10 gram weight and removed from the table so that it hangs freely over the edge of the table.
- Start the measurement by clicking on "Start measurement". (2.).

Procedure (6/8)

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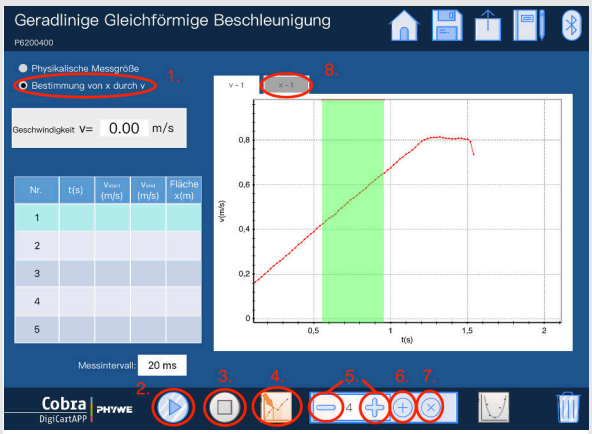

Procedure for the measurement

- Release the DigiCart. The DigiCart moves due to the now falling weight.
- Stop the measurement by clicking on "End measurement". (3.) as soon as the DigiCart reaches the end of the track.
- Select "Select reference point" by clicking on \ (4.) a point in the velocity-time diagram.
- The selection is made by sweeping the interval with your finger.

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Procedure (7/8)

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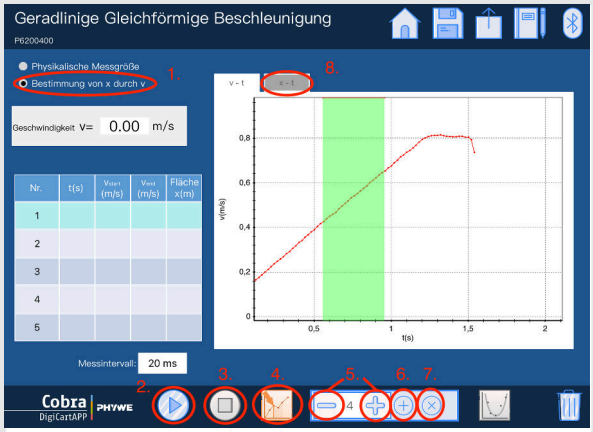

Procedure for the measurement

- By clicking the "-" and "+" buttons (5.) a green-shaded area appears, which increases in size as the number increases. Select the number 1 and then click on the "Add" button (6.).
- Increase the number with the buttons (5.) by the value 1 and click again on add (6.) (until the table is complete).
- To delete a row from the table, tap it once and then click on the "Remove" button Button (7.).
- Now change to the tab "x-t" with a click (8.) above the diagram for the local time diagram.

Procedure (8/8)

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Evaluation steps

- The figure shows the steps for the evaluation.
- The values from the table are already displayed in the local time diagram.
- With one click on "Draw Graph" (1.) a curve is drawn through the points.

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Report

Task 1

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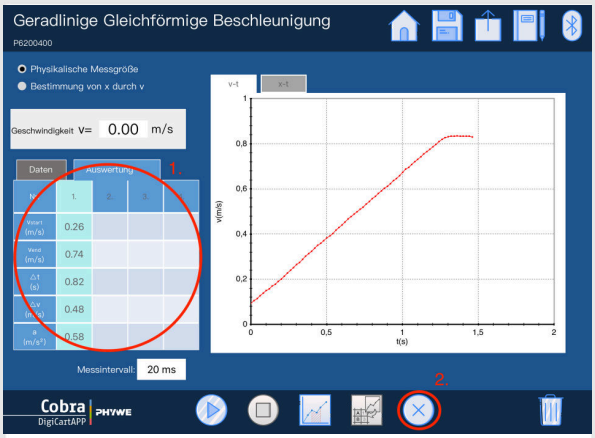

Evaluation steps

Drag the right words into the gaps!

The acceleration is calculated here as _____ over the selected time interval. You can see that it _____ with increasing weight. The _____ the weight of the film canister is, the _____ the DigiCart is accelerated.

more | average acceleration | rises | higher

Check

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Task 2

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Try to complete the right words!

The values calculated in the table for location x correspond to the _____ between the time axis and the speed curve in the speed _____ diagram. This is measured from the selected reference point to the end of the range highlighted in green. The curve drawn in Figure 6 represents the _____. The shape of the curve is already known to us from part 1 of the experiment and thus confirms the correctness of the _____-time curve obtained here from the speed _____ diagram.

Check

Task 3

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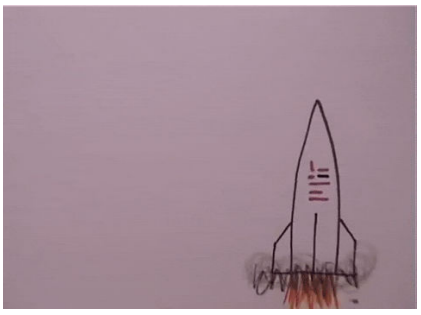
The acceleration indicates how fast an object changes its speed and is expressed in the unit

- $\frac{a}{s^2}$ measured
- $\frac{m}{s}$ measured
- s^2 measured
- $\frac{m}{s^2}$ measured



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Slide	Score / Total
Slide 23: Acceleration	0/4
Slide 24: Location-Time Diagram	0/5
Slide 25: Uniformly accelerated motion	0/4

Total amount 0 / 13

Solutions Repeat

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