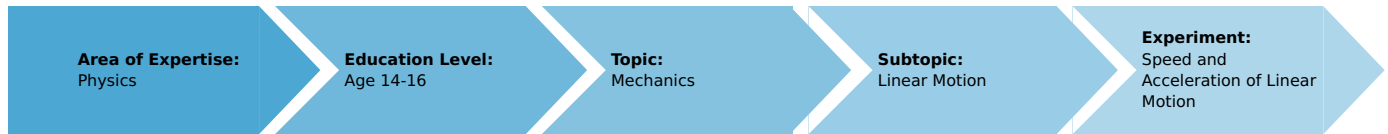


Speed and Acceleration of Linear Motion (Item No.: P6200300)

Curricular Relevance



Difficulty



Intermediate

Preparation Time



10 Minutes

Execution Time



20 Minutes

Recommended Group Size



2 Students

Additional Requirements:

- Tablet PC with DigiCart App

Experiment Variations:

Keywords:

Acceleration, Kinematics, Inclined plane

Information for teachers

Introduction



Overview of experimental setup.

Educational objective

In this experiment, the students learn something about the physical significance of acceleration.

Task

Use the app to record several speed-time diagrams. Select a measuring range and calculate the acceleration for the recorded curves.

Prior knowledge

This experiment requires the concept of velocity.

Principle

Acceleration is one of the basic concepts of kinetics. 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 average acceleration. If Δv denotes the change of velocity in a period of time Δt , you

can use

$$\bar{a} = \frac{\Delta x}{\Delta t}$$

to calculate the average acceleration \bar{a} .

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

Safety information

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

Introduction

Application and task

Application

In an airplane you are pressed into the seat when you take off. Satellites orbit the earth. All this has to do with acceleration.

In this experiment you will learn something about the physical meaning of acceleration. The experiment assumes that you have already dealt with the subject of velocity.

Task

Record multiple speed-time diagrams using the app. Select a measuring range and calculate the acceleration for the recorded curves.

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

Set-up and procedure

Set-up



Figure 1: Overview of experimental setup.

- Bring the track into a horizontal position. Now raise one end of the track by about 3 cm using the height-adjustable holder. The track is now inclined so that the DigiCart can roll down (see Figure 1).
- Start the DigiCart App.
- Select experiment 3 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.).

Geschwindigkeit und Beschleunigung

P6200300

Einzelmessung
 Mehrfachmessung

Geschwindigkeit $v =$ m/s

Daten		Auswertung	
t(s)	v(m/s)		

Intervall:

The screenshot shows the Cobra DigiCartAPP interface. On the left, there are controls for measurement type (Einzelmessung selected), a velocity display (0.00 m/s), a data table with columns for time (t(s)) and velocity (v(m/s)), and an interval setting (20 ms). On the right, a graph plots velocity v(m/s) on the y-axis (0 to 1) against time t(s) on the x-axis (0 to 10). A connection dialog box is open, showing 'cart-8179' and three buttons: 'Schließen' (4), 'Scan' (2), and 'Verbinden' (3). A red circle with the number 1 is around the Bluetooth icon in the top right corner.

Figure 2: Connecting to the DigiCart.

Procedure

- Figure 3 shows the steps for the measurement process.
- Since several measurements are made for this experiment, select multiple measurements (1.) in the top left-hand corner of the window.
- The velocity display below (2.) shows the instantaneous velocity.
- Before each measurement, it is possible to select the time between two measurement points (3.).
- The DigiCart is placed and held in the elevated area of the track.
- Start the measurement by clicking on start measurement (4.).
- Let the DigiCart roll down the track.
- Stop the measurement by clicking on stop measurement (5.) as soon as the DigiCart has arrived at the bottom.
- Lift the one end of the track by another 3 cm using the height-adjustable holder and repeat the last 4 steps.
- In this way, up to four speed-time diagrams can now be recorded.
- Click on select measuring range (6.) to select a point in time in the path-time diagram at which the instantaneous velocity is calculated. The selection is made by sweeping the interval with the finger.
- Stop the measurement by clicking on the save button (7.).

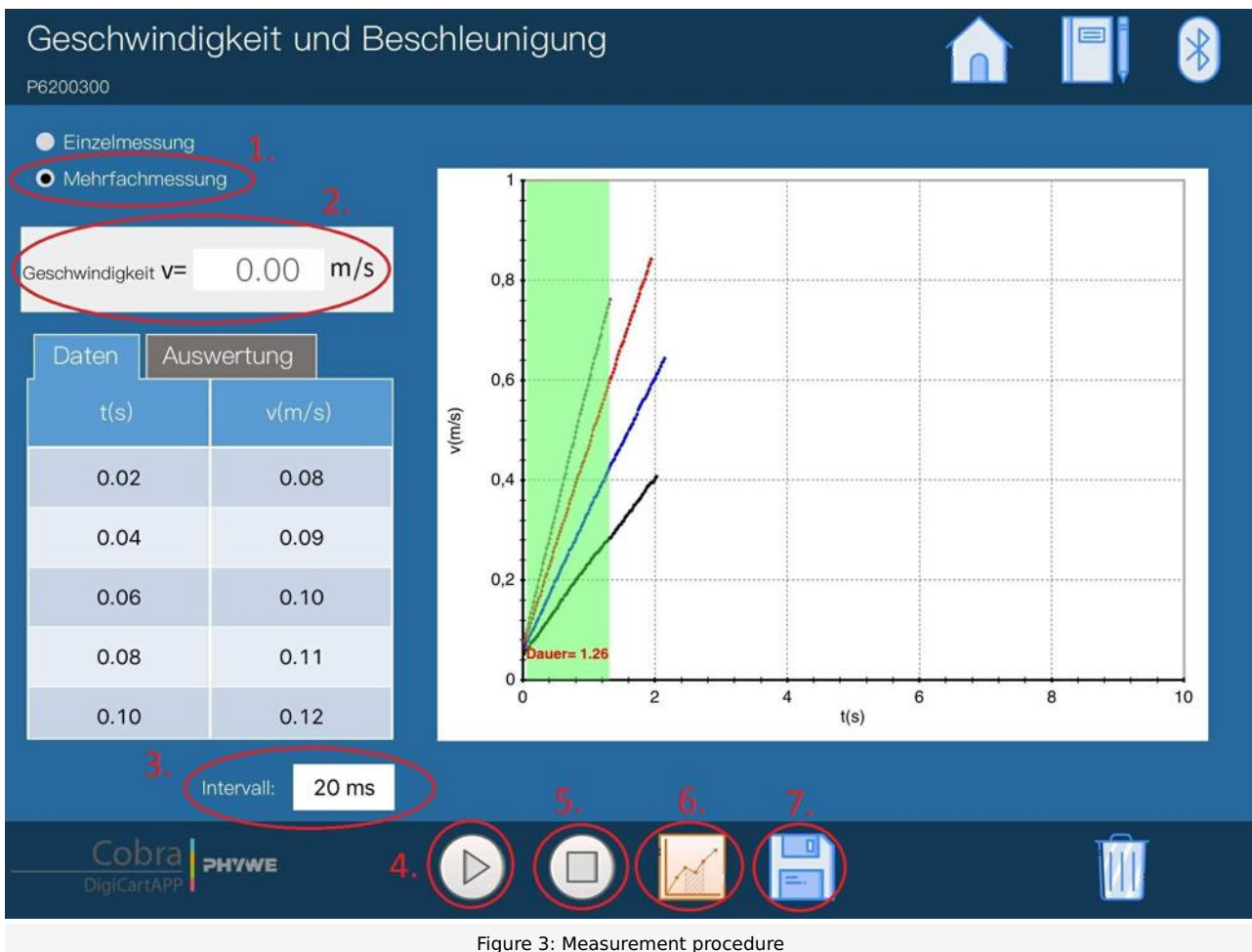


Figure 3: Measurement procedure

Evaluation

- Figure 4 shows the steps for the evaluation.
- The table on the left side (1.) shows for each of the recorded curves the velocity change within the selected measuring range as well as the time interval. The acceleration is calculated from this.
- If the measurement is to be repeated, the data can be deleted using the delete button (2.) and a new measurement series can now be started.

The velocity change in the measuring range increases from case to case because the track has become steeper and steeper. The time interval is the same for all measurements. Since the acceleration is equal to the velocity change per time interval, it increases from case to case.

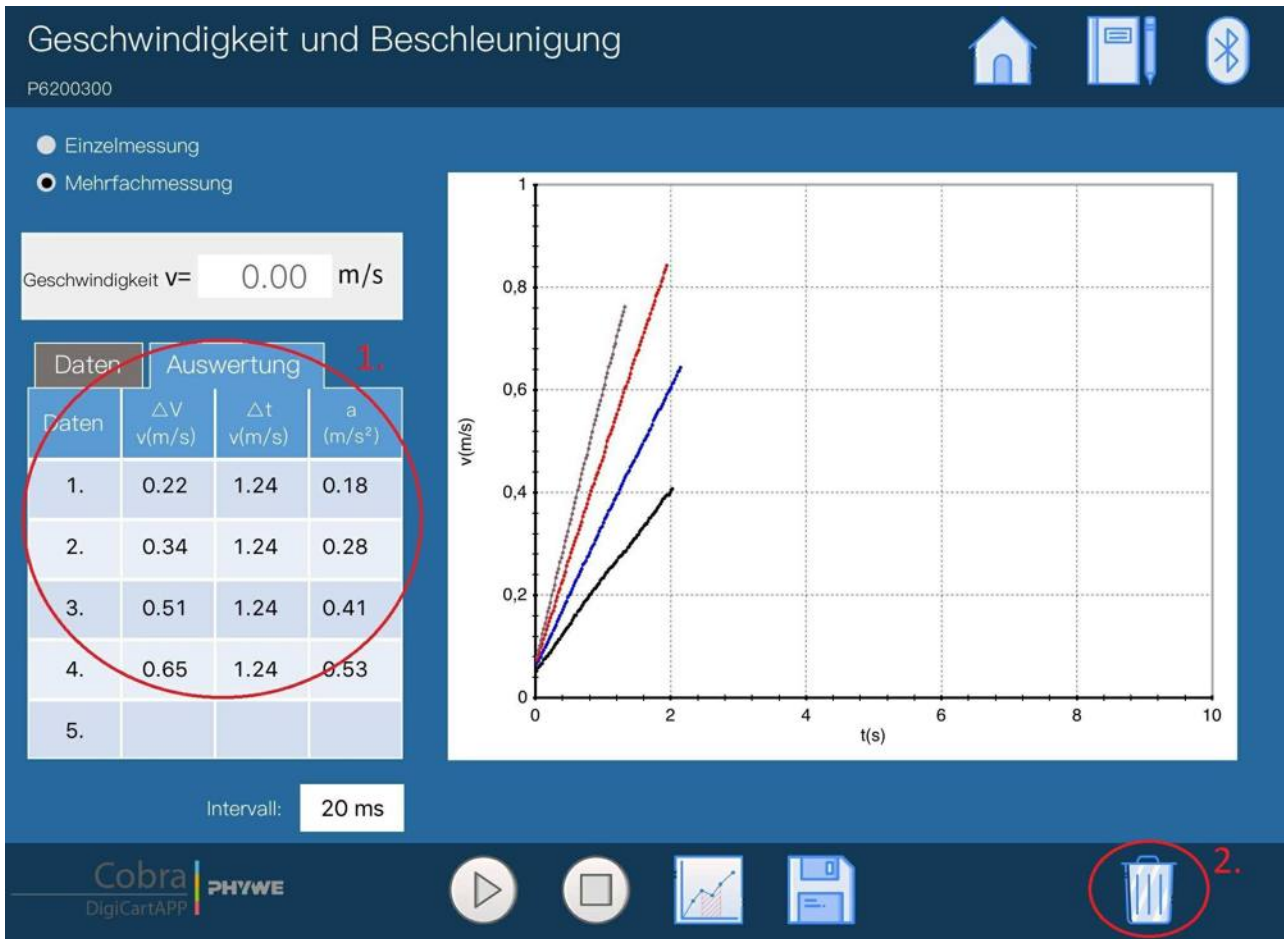


Figure 4: Evaluation procedure.

Speed and Acceleration of Linear Motion

Results - Evaluation 1 (1 point)

Which physical quantity is responsible for the change in velocity?

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

- The acceleration specifies the change in velocity per time.

Scoring Mode: Automatic Scoring with Keywords on Finding ONE

Results - Evaluation 2 (1 point)

How is the acceleration calculated?

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

- As ratio of velocity change and time interval of the change.

Scoring Mode: Automatic Scoring with Keywords on Finding ONE

Results - Evaluation 3 (1 point)

In analogy to experiment 2, what is the significance of instantaneous and average acceleration?

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

- Instantaneous acceleration is the acceleration that the body assumes at a certain point in time. To calculate the average acceleration you need two points in time, start and end.

Scoring Mode: Automatic Scoring with Keywords on Finding ONE

Results - Evaluation 4 (1 point)

Which problem related to average speed occurs with average acceleration?

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

- Details of the motion are lost because only the start and end values are included in the calculation. Everything that happens in between is ignored.

Scoring Mode: Automatic Scoring with Keywords on Finding ONE