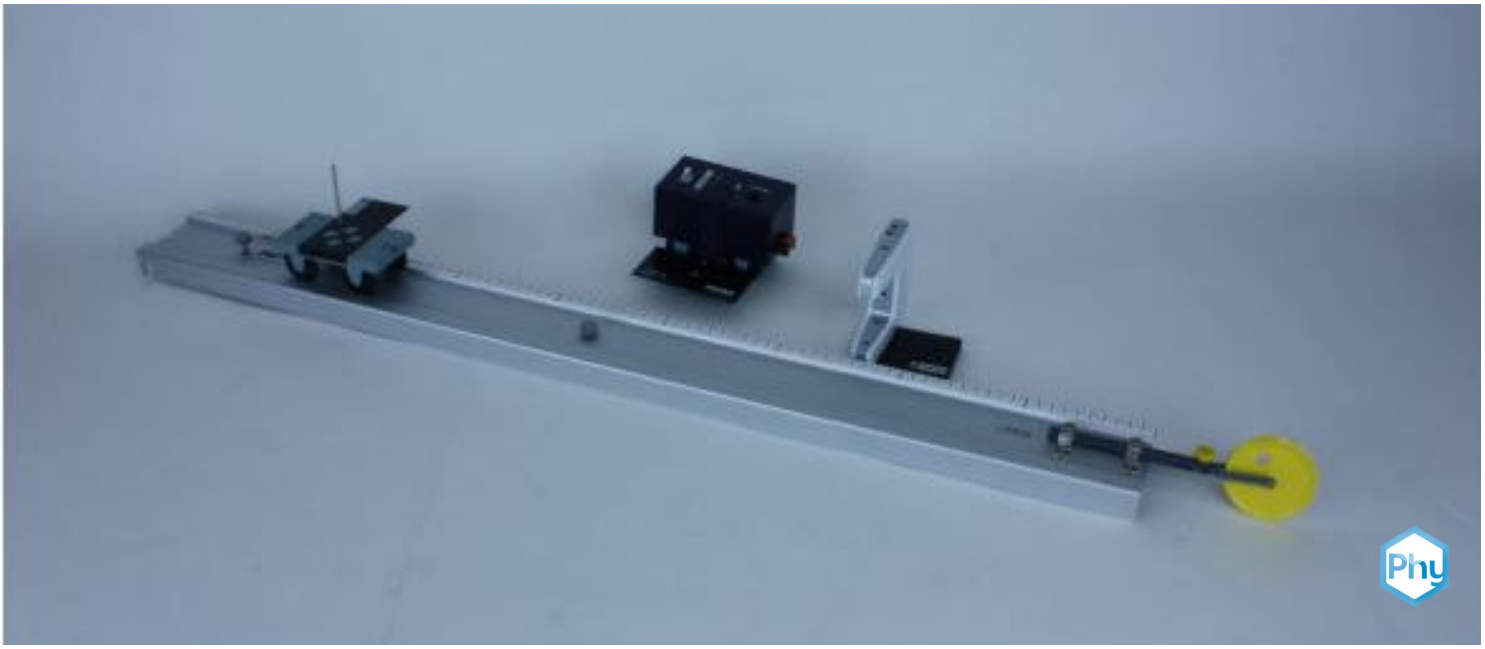
Comparison of uniform and non-uniform motion with Cobra SMARTsense



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/5f2837d9a1b7310003b0e42c

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Teacher information

Application

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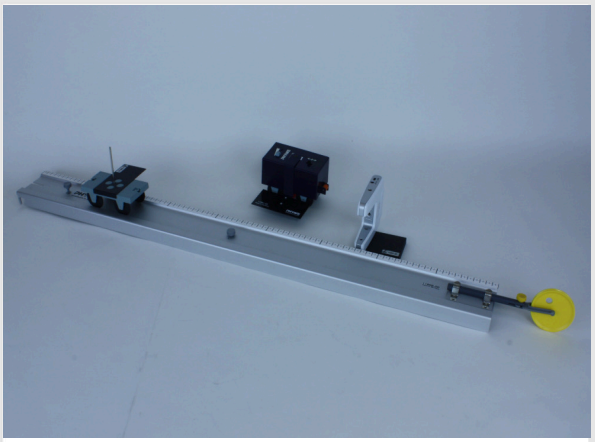

Experiment set-up

We encounter the non-uniform motion as a general case of movement in many places of everyday life.

Probably the most vivid example are vehicles that change their speed while driving. The current speed is usually displayed in the vehicle with the help of a speedometer.

In order for a non-uniform movement to occur, the object in question must be accelerated. This means that a force must be applied. In the case of the vehicle, the essential factors for acceleration are the torque transmitted from the engine to the tyres, the braking effect or the air resistance and friction of the tyres on the road.

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Other teacher information (1/2)

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Prior knowledge

Students should basically know what speed means and that it is in principle calculated as a quotient of distance and time.

Scientific principle

The battery-operated measuring cart travels at a constant speed over the track. Accordingly, the speed is independent of location and the movement is described as uniform. The drive-free measuring cart is accelerated by the weight force onto a suspended mass so that the speed increases with the location. The speed depends on the location and is therefore described as non-uniform. With the help of the shadowing time and the known length of an aperture, the speed can be measured with a light barrier.

Other teacher information (2/2)

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Learning objective

In this experiment, the students should recognize that not the uniform motion, but the non-uniform motion of a body is the general case of a movement. Rather unconsciously, the students are given a feeling for momentary and average speed.

Tasks

1. One measuring cart driven by the fall of a weight through a pulling string moves along a track.
2. A battery operated measuring cart travels at constant speed over the track. The students again determine the speed for different positions with the light barrier.

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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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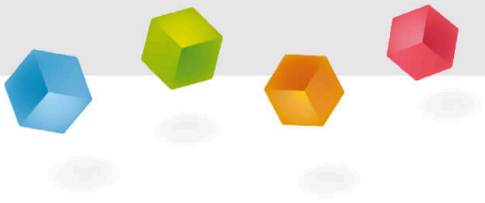

Student Information

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Motivation

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Speedometer of a vehicle

The uneven movement can be found everywhere in everyday life. Think of the speed of a car in city traffic, for example. The constant accelerating and braking ensures that you adapt your speed to the given traffic conditions (traffic lights, pedestrian crossings, other road users, road layout, etc.). This means that you move sometimes faster and sometimes slower. This means that you are moving unevenly.

The respective instantaneous speed is usually determined electronically. In this experiment you learn to determine the momentary speed for a non-uniform movement.

Tasks

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1. Use the measuring cart without its own drive and accelerate it up to the middle of the track with the help of an attached mass. Determine the speed at various points along the road by measuring the shading times of the aperture using the light barrier.
2. Then use the battery-operated measuring cart with electric motor and let it drive over the road at a constant speed. As before, determine the speeds at different points along the carriageway by measuring the shading times of the aperture using the light barrier.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense - Photogate, 0 ... ∞ s, two pieces (Bluetooth)	12909-00	1
2	Track, l 900 mm	11606-00	1
3	Meter scale, demo. l=500mm, self adhesive	03005-00	2
4	Car, motor driven	11061-00	1
5	Shutter plate for car, motor driven	11061-03	1
6	Cart for measurements and experiments	11060-00	1
7	Shutter plate for cart	11060-10	1
8	Holding pin	03949-00	1
9	Silk thread, l = 200 m	02412-00	1
10	Weight holder, silver bronze, 1 g	02407-00	1
11	Slotted weight, blank, 1 g	03916-00	4
12	Pulley,movable,dia.65mm,w.hook	02262-00	1
13	Rod for pulley	02263-00	1
14	Adapter plate for Light barrier compact	11207-22	1
15	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Set-up (1/7)

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For measurement with the **Cobra SMARTsense sensors** the **PHYWE measureAPP** is required. The app can be downloaded free of charge from the relevant app store (see below for QR codes). Before starting the app, please check that on your device (smartphone, tablet, desktop PC) **Bluetooth** is **activated**.

iOS

Android

Windows

Set-up (2/7)

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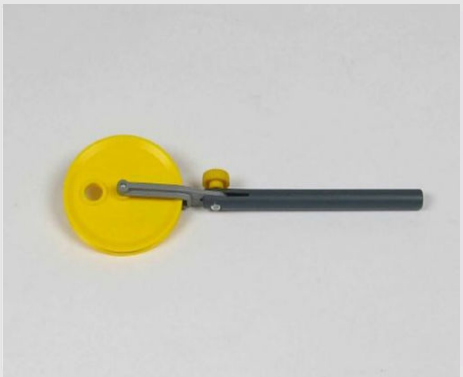
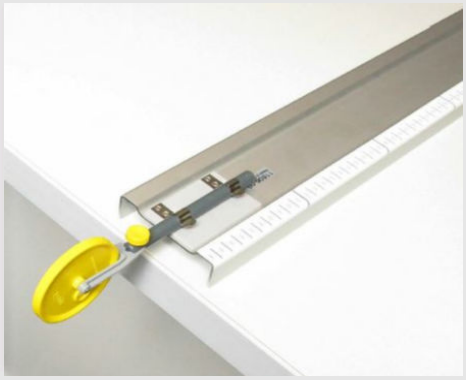
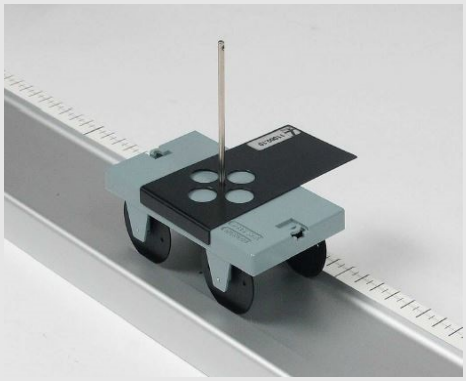
Connect the pulley to the handle and then carefully slide the handle under the retaining clips at the end of the track. To do this, lightly lift the holding clamps with your fingers. Position the track at the end of the table so that the pulley can rotate freely. Take the measuring cart without drive and fix the holding bolt and the shading plate to it.







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Set-up (3/7)

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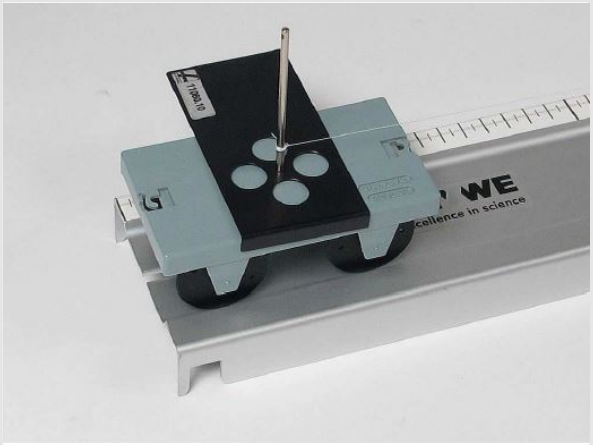

Cart with shading screen on the track

Put the cart in the middle of the track.

Attach one end of the sewing silk to the weight plate.

Guide the thread over the deflection roller.

Knot the other end of the thread to the holding bolt and select the length of the thread so that the weight plate arrives straight on the floor when the car is in the middle of the road.

Set-up (4/7)

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Measuring cart is pulled over the track

Push the cart to the beginning of the roadway so that it ends with it. Now let the cart, pulled by the weight plate, roll off without hitting it. Make sure that the thread always runs over the roller and that it can rotate freely.

The cart should roll approximately to the end of the carriageway, whereby the weights only pull it to the middle of the carriageway. So you probably need to put additional 1-g weights (1-3 pieces) on the weight plate to give the car enough momentum. Do not put more weights than necessary on the weight holder to get good results.

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Set-up (5/7)

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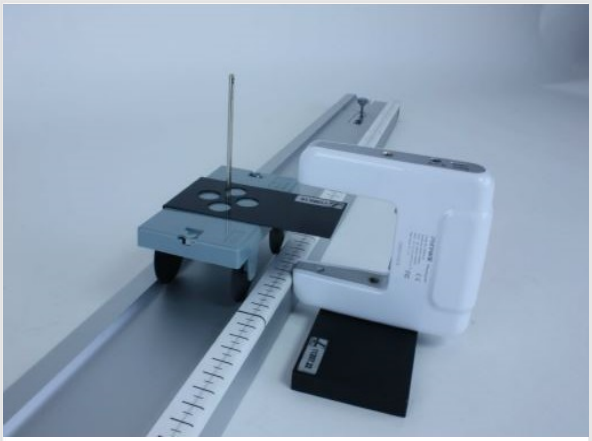

Connect adapter plate and light barrier

Connect the forked photoelectric sensor A to the adapter plate in such a way that it can be placed easily next to the carriageway and the screen on the carriage can pass through the photoelectric sensor without bumping into it.

Set-up (6/7)

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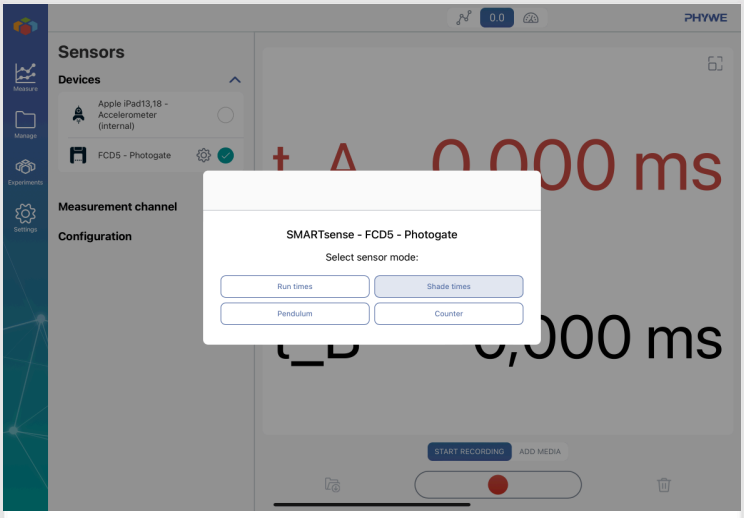

Switch on the light barrier and select it in measureAPP under "Devices".

In the menu that appears, select the option "Shade times". In this measurement setting, the so-called shade time of the light barrier is measured, i.e. the duration for which the aperture interrupts the light beam when the barrier is passed through.

Then select the digital display to show the measured values.

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Set-up (7/7)

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Battery operated measuring cart

Finally, take the battery-operated measuring cart, attach the appropriate shading screen to it and place the cart on the table next to the track.

Set the speed slider to the lowest speed (left stop) as shown in the figure.

Procedure (1/2)

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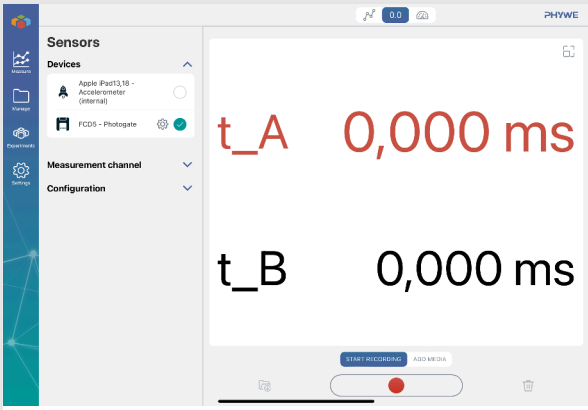

Display of the digital measured values in the measureAPP

- Position the light barrier at the 15 cm mark and push the measuring carriage to the beginning of the road. Start the measurement in measureAPP and release the measuring carriage without pushing it.
- Read off the measuring time. Enter the value rounded to two decimal places in Table 1 in the Report.
- Repeat the measurement for light barrier positions of 30 cm, 45 cm, 55 cm, 65 cm and 75 cm.
- Note: Before each cart start, make sure that the string runs over the roller and that it can rotate freely. Always make sure that the measuring cart is flush with the edge of the carriageway when rolling off.

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Procedure (2/2)

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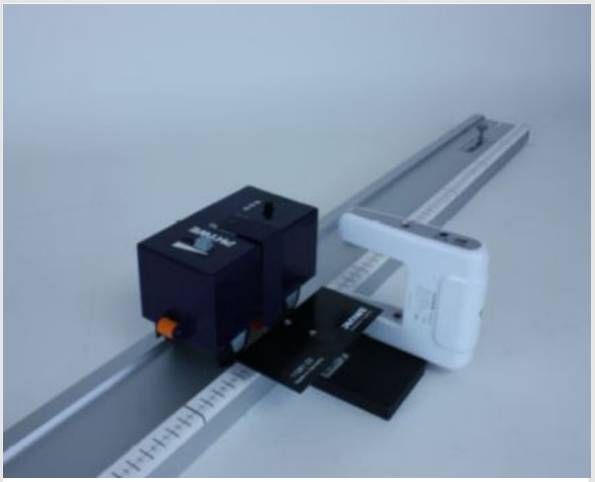

Battery operated measuring cart on the road

- Now replace the measuring cart without its own drive with the battery-powered measuring cart.
- Place it also at the beginning of the track and set up the light barrier first at the 20 cm mark.
- Start again a measurement in measureAPP and start the car at the direction switch.
- Repeat the experiment for light barrier positions of 30 cm, 40 cm, 50 cm, 60 cm and 70 cm.
- Enter all measured values in Table 2 in the Report as before.

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Report

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Table 1

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Enter here the shadowing times Δt for the measuring carriage without drive, which is pulled by the weight. From this, calculate with the length of the shading diaphragm of $\Delta s = 5\,cm$ the corresponding driving speeds $v = \Delta s / \Delta t$.

$Position \quad x \ [cm]:$	15	30	45	55	65	75
$\Delta t \ [s]$						
$v \ [cm/s]$						

Table 2

PHYWE

Enter here the shadowing times Δt for the battery-powered measuring cart. Calculate from this with the width of the shading diaphragm of $\Delta s = 10\,cm$ again the corresponding travel speeds $v = \Delta s / \Delta t$.

$Position \quad x \ [cm]:$	20	30	40	50	60	70
$\Delta t \ [s]$						
$v \ [cm/s]$						

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Task 1

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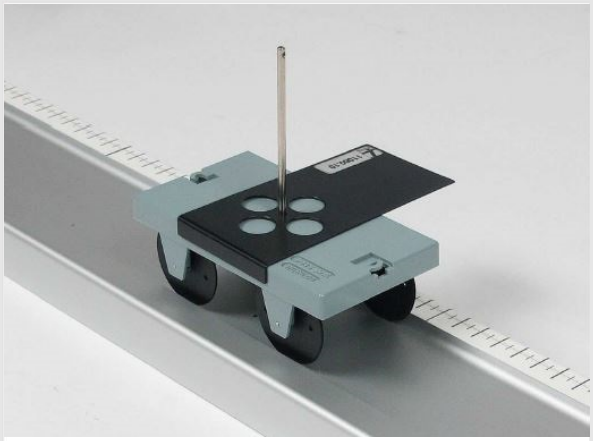


Measuring cart without own drive

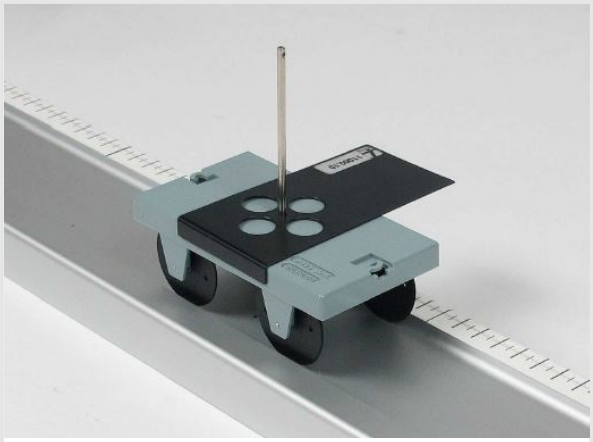
Which of the following statements can you confirm based on the measured values?

- ○ The greater the shading time $\Delta t$the greater the speed v.
- ○ There is no direct connection between the shading time Δt and the speed v.
- ○ The smaller the shading time $\Delta t$the greater the speed v.

Check

Task 2

PHYWE



Measuring cart without own drive

Drag the words to the right places. What did you observe?

The measuring cart pulled by the weight becomes _____ since the beginning until it reaches its _____ speed approximately in the middle of the road. From there on, the ratio $\Delta s/\Delta t$ turns _____.

maximum | faster | smaller

Check

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Task 2

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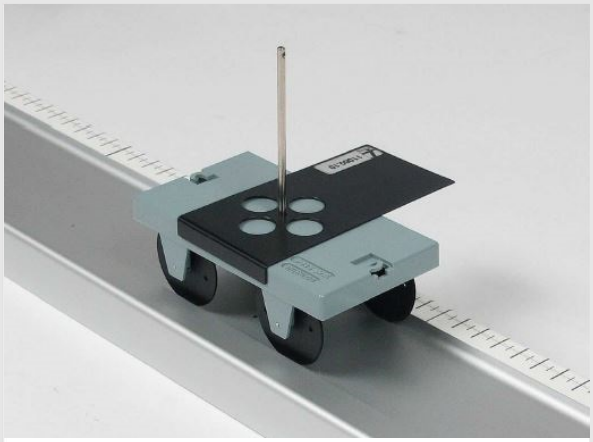

Measuring cart without own drive

Drag the words to the right places. What did you observe?

The measuring cart pulled by the weight becomes _____ since the beginning until it reaches its _____ speed approximately in the middle of the road. From there on, the ratio $\Delta s / \Delta t$ turns _____.

maximum | faster | smaller

Check

Task 3

PHYWE

Mark the correct statements considering the measured values!

- [ ] The speed of the battery-operated measuring cart is almost constant over the entire travel distance.
- [ ] The movement of the cart without its own drive must be regarded as uneven.
- [ ] The movement of the battery-powered cart can be regarded as uniform.
- [ ] The movement of the cart without its own drive can still be regarded as uniform.
- [ ] The speed of the cart without its own drive depends on the location.

Check

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