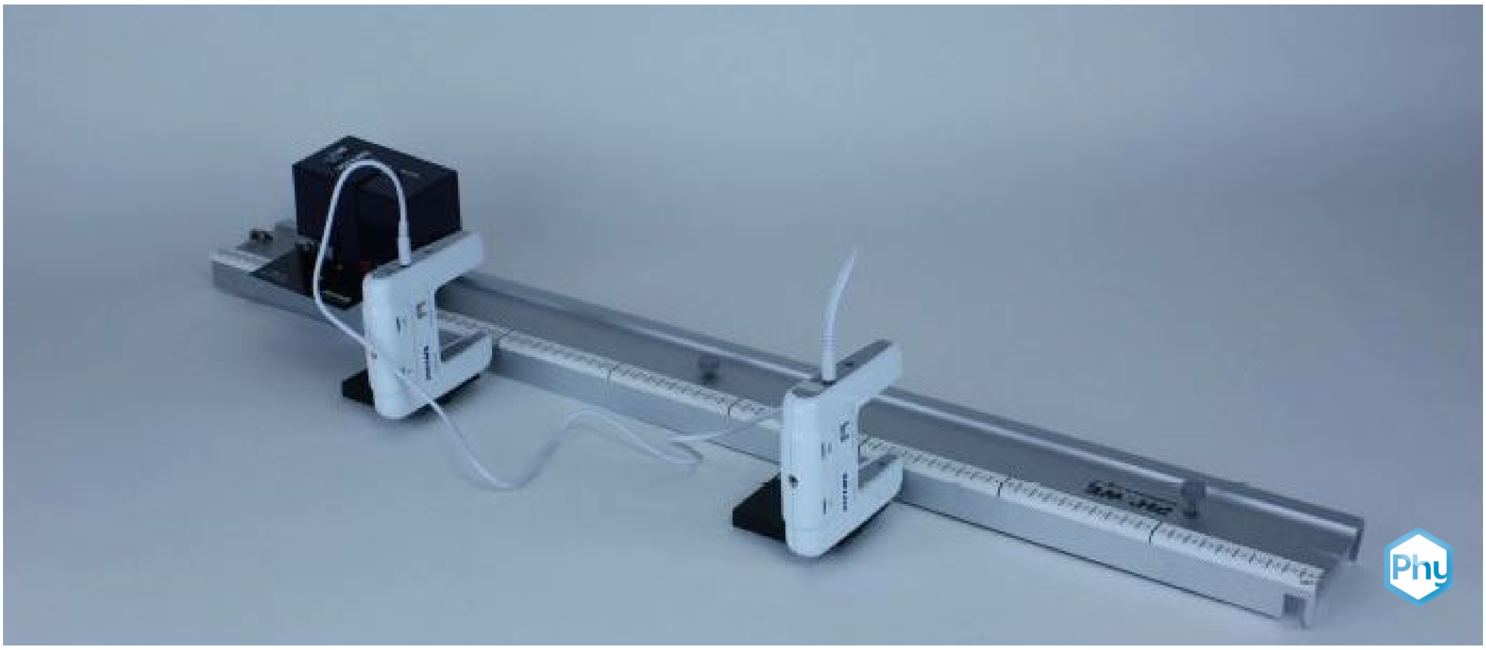
Uniform linear motion with Cobra SMARTsense



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/5f2823d8a1b7310003b0e3bf

Teacher information

Application

conveyor belt

Uniform straight-line movements are found in technology wherever something is moved uniformly from one place to another, such as conveyor belts: Here, an object or material moves in a constant direction at a constant speed that is determined by the belt.

By using two light barriers, the average speed of an object between the two barriers can be determined. This measuring method can be used in a slightly more complex way, for example to measure the average speed of individual vehicles in road traffic over a longer distance.

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Other teacher information (1/2)

Prior knowledge

The students should know how a light barrier works.

Notes on construction and implementation:

The speed of the test van can be strongly dependent on the charge level of the batteries/accumulators of the measuring cart.

Scientific principle

The measuring cart is driven by an electric motor and travels at constant speed over the road. Accordingly, the same shading times and thus speeds are always measured with the same speed setting of the measuring carriage.

Other teacher information (2/2)

Learning objective

The students should work on the properties of uniform rectilinear motion and learn the speed as a ratio s/t to be determined experimentally from the distance and time measurement (distance-time diagram) of a measuring cart with drive. The students should realize that the speed within the measuring distance is constant in this experiment.

Tasks

1. Measurement of the time required by the experimental cart for a certain distance, using two light barriers at the beginning and end of the respective distance.
2. Calculation of the speed from the measured time between the interruption of one or the other light barrier and the distance travelled.
3. Creation and discussion of the path-time diagram.

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Safety instructions

The general instructions for safe experimentation in science lessons to be applied to this experiment.

Student Information

Motivation

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conveyor belt

As you know, speed refers to the property of a movement and implies how fast or slow starting from one place another is reached. For vehicles in traffic, the speed changes continuously. A typical example of a movement with constant speed is conveyor belts, which are effective aids for transporting all kinds of goods in many areas.

They are used, for example, to extract rock or coal from mines or in the logistics of large forwarding companies. The transported goods move on the conveyor belt at a constant speed. In this experiment you will learn how to determine a uniform straight-line movement.

Tasks

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1. Measure the time t which the cart has to travel for a certain distance s required, with the help of two light barriers at the beginning and end of the respective line.
2. Calculate from the measured time t between the interruption of one and the other light barrier and the path length s the respective quotients s/t .
3. Display the determined regularities in graphical form.

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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	Adapter plate for Light barrier compact	11207-22	2
7	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Set-up (1/4)

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 (2/4)

Fastening the shut-off panel

Attach the shading screen to the measuring carriage and then place one end of the carriage on the flat road.

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Set-up (3/4)

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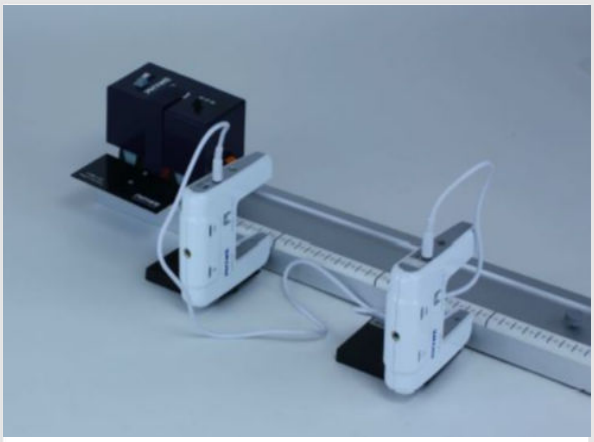

Connect light barrier with adapter plates

Screw the adapter plates to the two forked light barriers in such a way that they can be positioned well beside the carriageway and the screen on the carriage can pass through the light barriers without hitting them.

Set-up (4/4)

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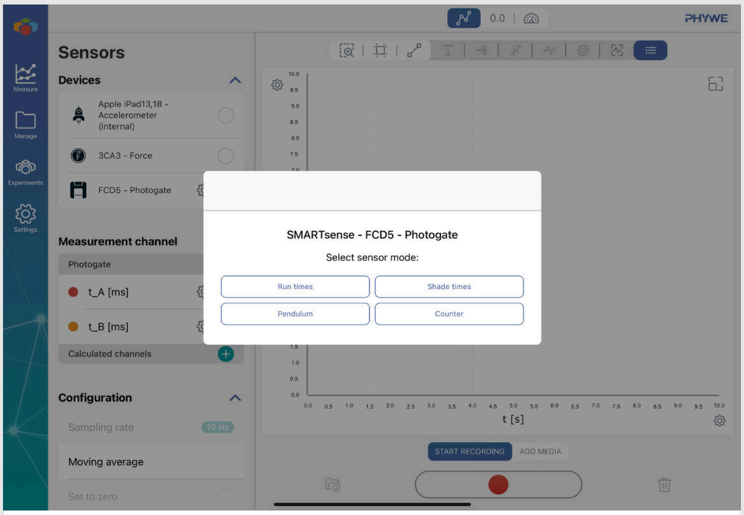

Make sure that the light barrier marked "B" is the rear one. Then connect both light barriers with the jack cable and switch them on. Select the light barriers in measureAPP under "Devices" and select "Run times" in the menu which then appears.

Place the starter light barrier (A) at the 20 cm mark on the roadway and position the stop light barrier (B) at the 30 cm mark so that there is a distance of 10 cm between the two light barriers.

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Procedure (1/4)

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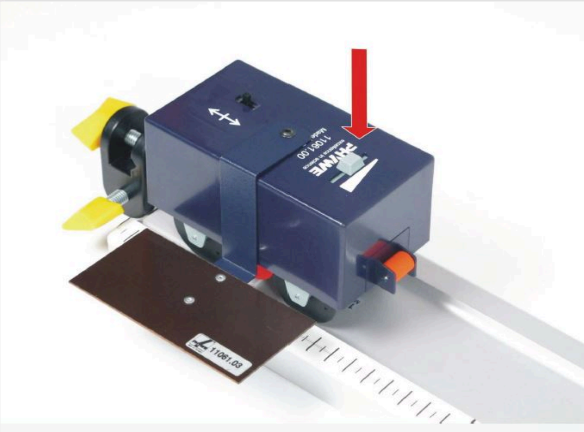

Setting the speed on the cart

- Set the speed slider on the cart to the lowest speed (left stop).

Procedure (2/4)

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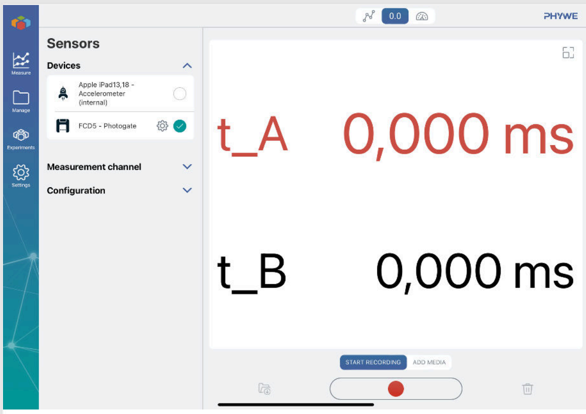

Starting the measurement

- Select the digital display variant in measureAPP so that the measured times are shown as numerical values.
- Then start the measurement.

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Procedure (3/4)

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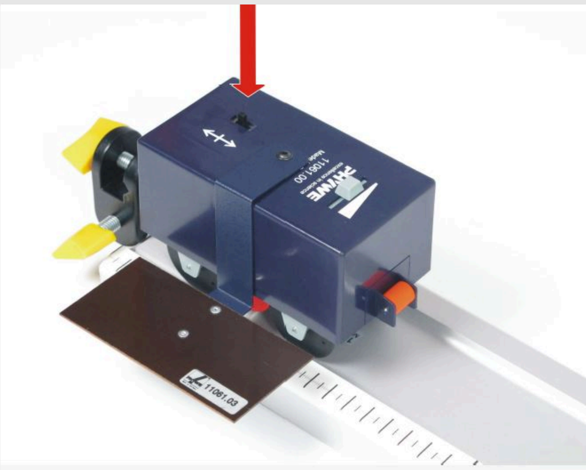

Starting the car

- Now start the car with the direction switch in the desired direction.
- The times at which the car has passed the light barriers after the start of the measurement are output as measured values. End the measurement in the app.
- Calculate the difference between the two measured values to obtain the running time of the car between the light barriers round to hundredths of a second (two decimal places).
- Note the value in the Report in Table 1.

Procedure (4/4)

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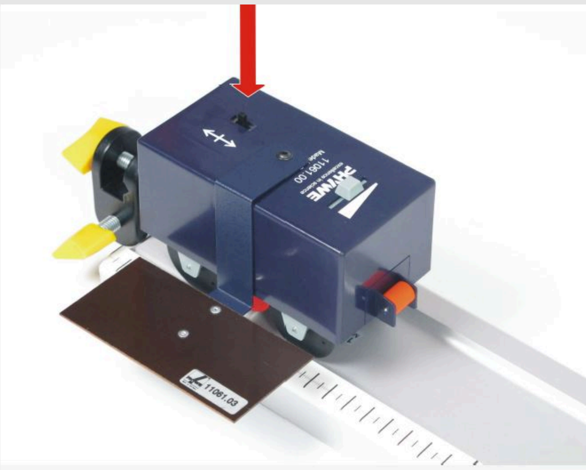

Starting the cart

- Repeat the experiment for the distances s of 20 cm, 30 cm, 50 cm and 60 cm. Also note these measured values in the Results in Table 1.
- Now set the speed controller on the measuring cart approximately to the middle position.
- Measure the times the cart needs for the measuring distances of 10 cm, 20 cm, 30 cm, 50 cm and 60 cm.
- Also note these measured values in Table 1.

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Report

Table 1

Carry the measured values for the travel times at low speed $(t_1\ [s])$ and at medium speed $(t_2\ [s])$ in the respective table. Then calculate from the travel paths s and the associated travel times t the speed as quotients $v = s/t$ and enter them as well.

$s\ [cm]$	$t_1\ [s]$	$v_1\ [cm/s]$
10		
20		
30		
50		
60		

$s\ [cm]$	$t_2\ [s]$	$v_2\ [cm/s]$
10		
20		
30		
50		
60		

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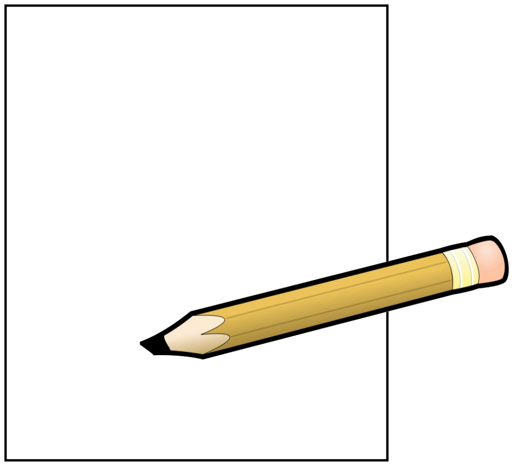
Task 1

Now take a piece of paper and create a diagram on it. In this diagram you set the distance you have travelled s (y-axis) as a function of time t (x-axis).

Draw the curves for low and medium speed.

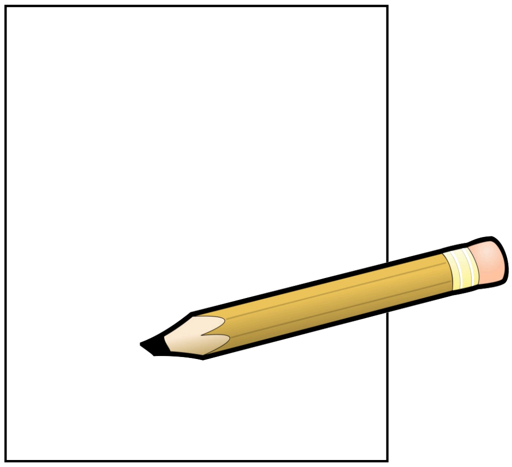


Task 2

Which curve shape was approximated?

- ○ Constant function.
- ○ Square function.
- ○ Linear function.

Check



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Task 3

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Which of the statements apply to the path-time diagram found?

- ○ The way s is the time t proportional.
- ○ The distance travelled s grows squarely with time t.
- ○ There is no connection between way s and time t.

Check

Task 4

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In table 1 you have the speed as the respective ratio $v = s/t$ calculated.

Which statements apply to this experiment?

- ☐ The speed within a trip can be considered constant.
- ☐ The speed depends on the travel time.
- ☐ The higher the speed, the less time is needed to cover the same distance.
- ☐ The greater the travel distance, the greater the speed.

Check

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Table 2

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This table refers to the partial test with the average speed of the test trolley.

Enter for the sections listed in the table Δs the required times that the test van requires for these same sections in the second column.

To do this, look up the travel times that the measuring cart needed to reach the respective route in Table 1 and calculate the time difference accordingly Δt.

In the third column, enter the speed of the route section ($v = \Delta s / \Delta t$).

$\Delta s\ [cm]$	$\Delta t\ [s]$	$v = \Delta s / \Delta t\ [cm/s]$
20 - 10 = 10		
30 - 20 = 10		
50 - 30 = 20		
60 - 50 = 10		

Task 5

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What is the relationship between the diagram sections (for the measuring cart at medium speed in the diagram) and the section speeds calculated in Table 2?

- ○ The diagrams produce different results.
- ○ The diagrams have the same result.
- ○ No analogy whatsoever can be drawn.

Check

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Task 6

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Which statement is true?

- ○ The line section speeds are (approximately) the same: there is a uniform motion.
- ○ The section speeds vary greatly, which is why the movement is called uniform.
- ○ The term "uniform" has nothing to do with the line section speeds.

Check

Slide	Score / Total
Slide 21: Curve shape	0/1
Slide 22: path-time diagram (1)	0/1
Slide 23: path-time diagram (2)	0/2
Slide 25: Context of the test results	0/1
Slide 26: Section speed	0/1

Total amount 0/6

Solutions Repeat Exporting text

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