7.3 Instantaneous and Average Speeds

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Task

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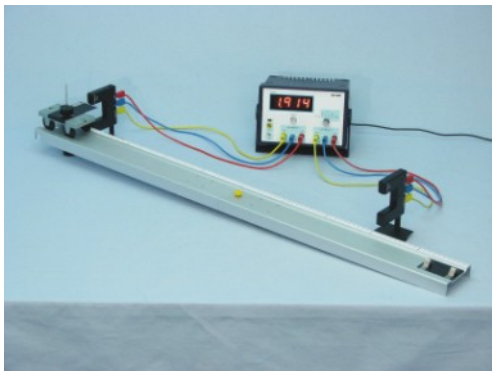
Why is a distinction made between intantaneous and average speeds?

Let a car roll along an inclined track.

1. Measure the time the car requires to cover a given distance with the aid of the photoelectric gates at the start and end of the distance in question. Calculate the average speed from the measured time between the interruption of the light beams at the first and second gate and the distance.
2. Measure also the time which the shade plate on the car needs to pass the gate. Using the time during which there is an interruption of the beam at the gate and the width of the plate, calculate the instananeous speed.

Compare the instantaneous and the average speeds.



Use the space below for your own notes.

Logged in as a teacher you will find a button below for additional information.

Additional Information

In this experiment, the pupils should observe quantitatively those differences between uniform and non-uniform motion which were described more qualitatively in the experiment "Comparison of uniform and non-uniform motion, ME 7.2" and they should become familiar with the concept of instantaneous speed. In the experiment "Uniform linear motion, ME 7.1", v = s/t was introduced. This section clarifies that this is actually the average speed. This should be contrasted with the instantaneous speed.

Note

1. The middle seam of the gate can be used to specify its position.
2. The first gate does not need to be removed before the instantaneous speed measurement. It suffices to press the reset button before the car reaches the second gate.

Material

Material from "TESS-Mechanik ME 1" (order nr. 13271.88), "TESS-Mechanik ME 2" (order nr. 13272.88) and "TESS-Mechanik ME 4" (order nr. 13283.88)

Position No.	Material	Order No.	Quantity
1	Car for measurings and experiments	11060-00	1
2	Shade plate for the measurement car	11060-10	1
3	Holding pin	03949-00	1
4	Slotted weight, black coloured, 50 g	02206-01	3
5	Timer 2-1, incl. power supply	13607-99	1
6	Compact photoelectric gate	11207-20	2
7	Foot plate for the compact photoelectric gate	11207-22	2
8	Connecting cable, blue, 32 A, 1000 mm	07363-04	2
9	Connecting cable, yellow, 32 A, 1000 mm	07363-02	2
10	Connecting cable, red, 32 A, 1000 mm	07363-01	2
11	Track 1, *l* = 500 mm	11302-00	1
12	Track 2, l = 500mm	11303-00	1

Material required for the experiment

Setup

Set up the track (Fig. 1).

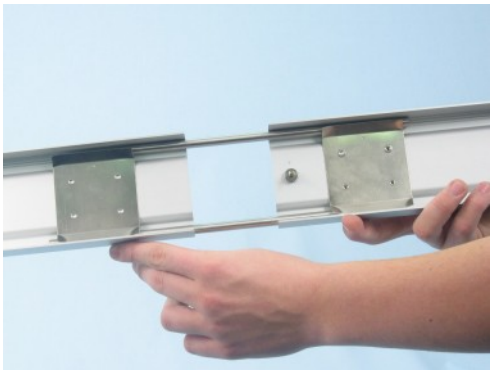


Fig. 1

Screw in the spacing bolts and the foot plates onto the photoelectric gates so that they can be placed well next to the track and so that the shade plate in the car goes through the gates without hitting them (Fig. 2) and connect the gates to the timer (Fig. 3).

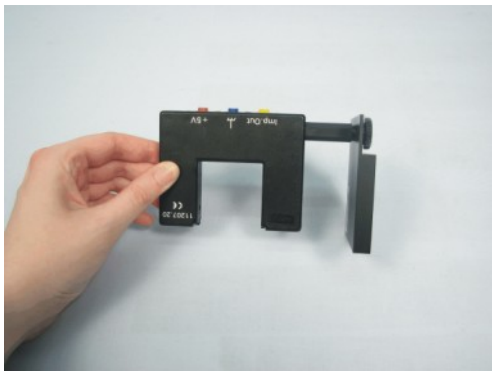


Fig. 2

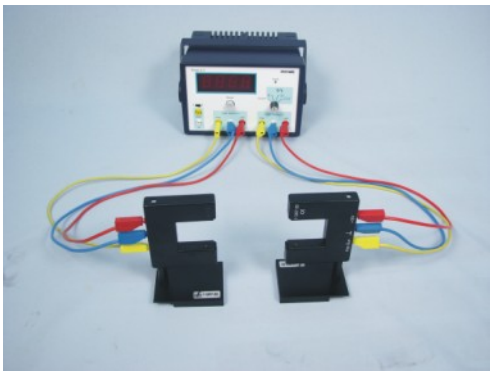


Fig. 3

Move the sliding switch on the timer over the area marked "Start" to the position to the right ( ).

Action

Procedure

To incline the track screw its foot all the way down and place it on top of two 50 g weights placed on top of one another (Fig. 4). In order for the plate to go through the gate, the height of the gate must be adjusted by putting a spacer bolt between the gate and its foot plate.

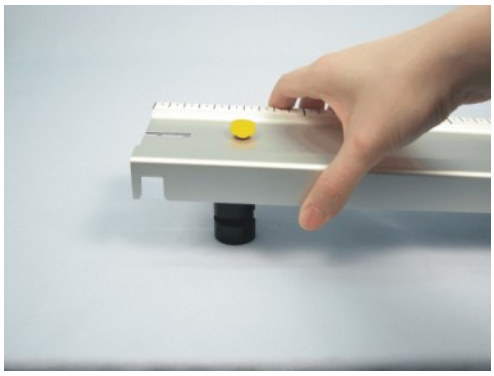


Fig. 4

Fig. 5

At the start, the cars back edge must be flush with the end of the track, seen from above. Hold the car and place the gate so that the plate on the car breaks the gate's beam as soon as possible after the car has been let go and is moving (approximately 8.2 cm from the end of the track).

Place the second gate at a distance of s = 30 cm from the first (Fig. 6).

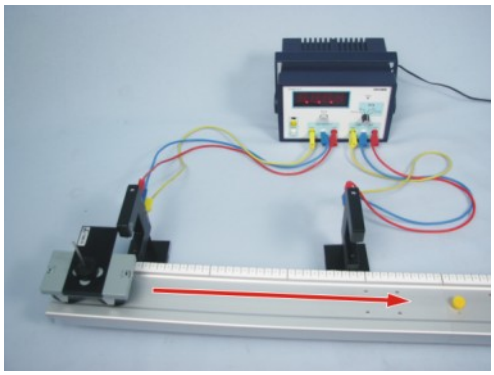


Fig. 6

Place the timer's rotary switch on the " " position, the third from the left. In this way, the timer shows the time between the interruption of the beams at the first gate and the second. In this experiment, this is the time which the car needs to cover the distance s between the gates.

Before each measurement, press the reset button on the timer.

Let go of the car without pushing it and record the time, t, which the car needs to cover the distance s = 30 cm on table 1.

Move the rotary switch to the second position from the left, " ". Here, the timer shows the beam interruption time. This is the time during which the gate's beam is interrupted by the plate. Move the upper gate far away enough from the track so that its beam will not be broken by the car's plate (Fig. 7).

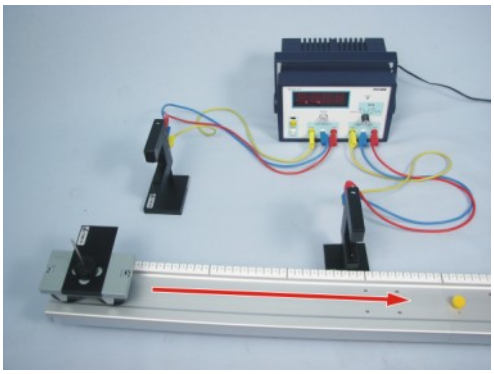


Fig. 7

Let the car run down the inclined track again and record the interruption time, Δt, which the plate with the width Δs = 5 cm has needed to go through the gate after the car has moved along the distance s.

Repeat the measurements for the distances, s, of 20, 50 and 70 cm.

Round off all time measurements to two valid figures, that is, the times t for the distance s to one decimal and the times Δt for Δs to two decimals.

Results

Table 1

s in cm	t in s	Δt in s	v_d in cm/s	v_m in cm/s
20				
30				
50				
70				

Table 1

Measurement Results

s in cm	t in s	Δt in s	v_d in cm/s	v_m in cm/s
20	1.4	0.21	14	24
30	1.7	0.17	18	29
50	2.4	0.14	21	36
70	2.8	0.12	25	42

Evaluation

Question 1

Calculate the average speed, v_d, that is, the quotient of the distance s and time t: $v_d = s/t$. Complete the table.

See table.

Question 2

Calculate the instantaneous speed, v_m, that is, the quotient of the plate width Δs = 5 cm and time Δt: $v_m = \Delta s/\Delta t$. Complete the table.

Siehe Tabelle.

Question 3

Are the speeds v_m equal to one another? Do they show a tendency?

The speeds, v_m , are not equal to one another, but rather, they increase with the length of the distance.

Question 4

How does each instantaneous speed, v_m, relate to the average speed v_d?

The instantaneous speeds, v_m, at the end of the distance, , is always greater than the average speed, v_d, along the same distance. That is, the speed increases along the distance covered.

Question 5

Can one speak of a uniform motion here? Justify your answer.

In the case of uniform motion, the speed is constant. The instantaneous speed, v_m, and the average speed, v_d, would be the same. Here, however, the speed increases along the distance covered, and the instantaneous and average speeds are different. Therefore this is not uniform motion.