Uniform and accelerated motion (Item No.: P6105100)

Curricular Relevance

Area of Expertise: Natural Sciences
Education Level: Age 11-14
Topic: Nature and technology
Subtopic: Mechanical devices in daily use
Experiment: Uniform and accelerated motion

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	20 Minutes	2 Students

Additional Requirements:

Experiment Variations:

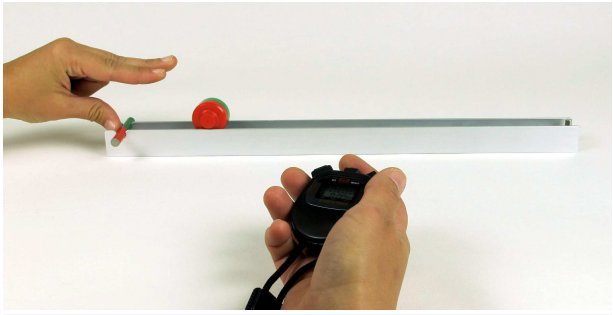
Keywords:

Straight plane, Acceleration, Inclined plane, Velocity

Information for the teacher

Educational objective and competences

During the experiment, the students observe the movement of a roller with the aid of a starter system. They notice that the time of motion on a straight plane does not change, whereas it is reduced when the plane is inclined. They realise that, in the case of uniform motion, the velocity remains constant, whereas in the case of a motion that is accelerated due to weight, the velocity increases.



Experiment set-up

Competences

Process-related competences:

The students can...

K: Knowledge gain
C: Communication
A: Assessment

K02 – develop problem-related questions and formulate hypotheses.
K06 – execute simple experiments independently based on written instructions.
K08 – recognise technical concepts in examples from everyday life.
K09 – plan, execute and document simple experiments by themselves.
K12 – make assumptions about connections and causes.

C02 – describe the technical connections and relationships in everyday language.
C03 – acquire measurement data and extract them from age-appropriate representations.
C05 – present their results with the aid of specified media.
C06 – express and accept criticism.

Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

C07 – work in groups on their own initiative.
C09 – read age-appropriate, relevant texts and relay the content thereof.

A01 – appraise their own results based on a comparison with other groups.
A02 – recognise the role of scientific phenomena in their everyday life.
A03 – evaluate arguments, take up a position and substantiate their point of view.
A06 – explain the areas of application in which scientific knowledge is of importance.

Content-related competences:

The students can...

S: Specialised knowledge

S18 – identify forces as the cause of motion.

S20 – describe linear motion.

S21 – describe accelerated motion.

Material

Position No.	Material	Order No.	Quantity
1	Roadway for magnets	11066-00	1
2	Stairs for roadway	11066-01	1
3	Magnetic roller, spare	11065-01	1
4	Magnet, d=8 mm, l=60 mm	06317-00	1
5	Digital stop watch, 24 h, 1/100 s and 1 s	24025-00	1
6	Measuring tape, l = 2 m	09936-00	1

Saefty information

For this experiment, the general notes and instructions concerning safe experimentation in science classes apply.

Didactic notes

Procedure

- At the beginning, the time measurements will probably be rather imprecise, since your students need to familiarise themselves with the measurement procedure. Let them repeat the various parts of the experiment several times so that they can reach the best possible results. We recommend averaging the results of five successful time measurements.
- The motion takes place relatively quickly over a relatively short period of time. You can let your students increase the duration of the motion by telling them to leave a certain clearance between the two magnets when the experiment is started. However, in order to obtain comparable results, this clearance must remain constant! Two fingers, a rubber or similar can be used for defining the space between the magnets.

Tablet PC option

Apart from the traditional variant, the students can also use a tablet PC in combination with the "measure" app in order to create media objects, such as photos or videos. For this experiment, this facilitates the later reproduction and evaluation of the results. The students can record visual proof of their observations to review or compare them among each other at a later time. We recommend storing the resulting media in the app in a project folder to ensure a clear assignment.

- As an alternative to the stopwatch, it is also possible to use the "measure" app for measuring the time. The advantage is that the times during several experiment runs can be directly averaged. As a result, your students can obtain more accurate results without any separate calculation.
- Apart from measuring the time, it is also possible to record a video of the motion during the experiment. As a result, the measured time can be verified based on the video.

Robert-Bosch-Breite 10
D - 37079 Göttingen

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info@phywe.de
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Experiment

Introduction

Bicycles, scooters, skateboards or skates – all these mobility devices have one thing in common: If you use them and stand still on a straight (horizontal) plane, you will not move forward.
However, if you push briefly, you will continue to move even though you are no longer pushing.

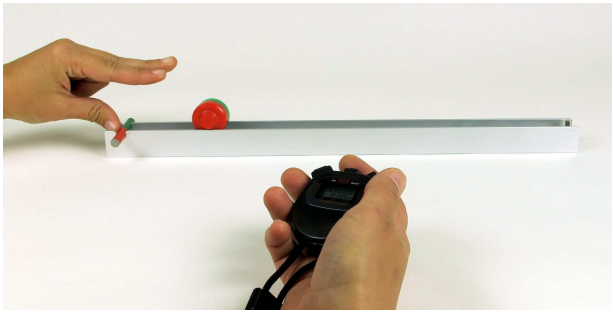
Skateboard on a flat road

Application

- Toy train set: The train moves on the rails always at the same speed.
- Cruise control: Modern cars with cruise control can always travel at the same speed, on flat (horizontal) roads as well as uphill or downhill.

Task

Measure the time when the roller moves along the track. First, let the roller start on a horizontal track and then on an inclined track.



Experiment set-up

Assumption

When will you move faster?

Initial question

You are standing on top of a hill with your skateboard. You push off and ride downhill.
When will you move faster?

- ☐ Not at all.
- ☐ When I push off.
- ☐ When I move without pushing off.
- ☐ When I push off and when I move without pushing off.

Material and procedure

Position No.	Material	Order No.	Quantity
1	Roadway for magnets	11066-00	1
2	Stairs for roadway	11066-01	1
3	Magnetic roller, spare	11065-01	1
4	Magnet, d=8 mm, l=60 mm	06317-00	1
5	Digital stop watch, 24 h, 1/100 s and 1 s	24025-00	1
6	Measuring tape, l = 2 m	09936-00	1

Procedure

It is not easy to measure the time during this experiment. Repeat the measurement several times for every step until you feel

Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
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that the measurement was OK.

1. Position the bar magnet centrally in the recess of the track and position the track on a flat table.

   Position the magnetic roller on the track. Ensure that, for both magnets, the green sides face one another, and the red sides face one another. Hold the roller in position at the start of the track directly in front of the magnet as shown in Fig. 1.

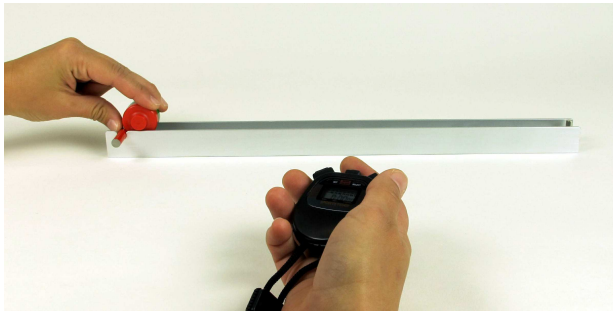

Fig. 1

   Take the stopwatch. Release the roller and start the time measurement at the exact same time. Stop the time measurement when the roller touches the end of the track (Fig. 4).

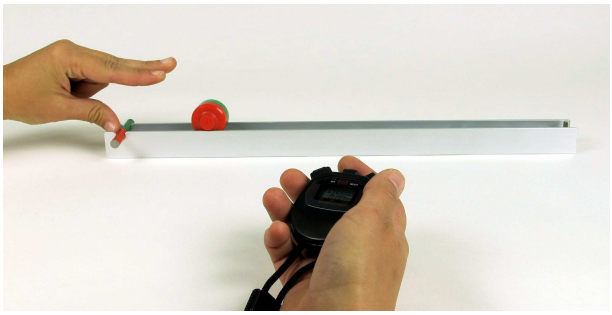

Fig. 2

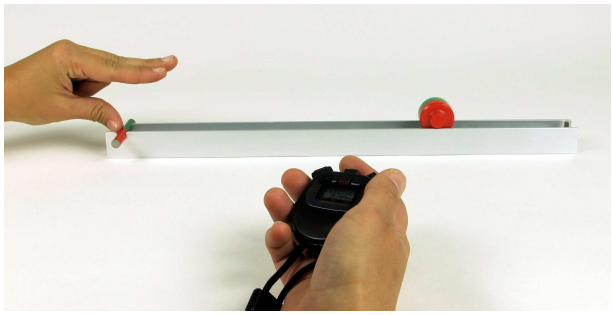

Fig. 3

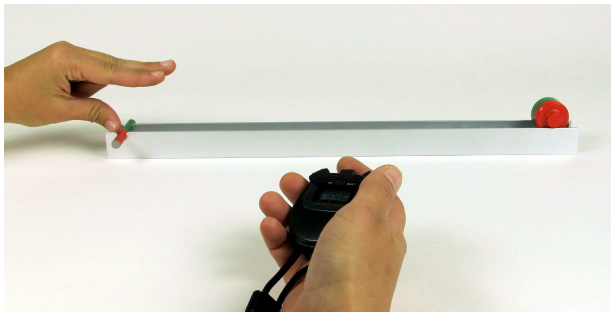

Fig. 4

   Enter the results into the experiment report.

If you use a tablet PC, you can also use the stopwatch of the "measure" app instead of the real stopwatch included in the experiment set.
In addition, you can film the motion with the "measure" app and store the video in a project folder on the tablet PC. This enables you to verify the measured time at a later time.

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2. Specify two segments of the track with the same length. To do so, position the measuring tape next to the track as shown in Figs. 5 and 6. The end of the track is located at the 33 cm mark.

   Start the roller at the beginning of the track but do not measure the time right away!

   Start the time measurement when the roller reaches the 0 cm mark and stop the measurement when it reaches the 15 cm mark (Fig. 5).

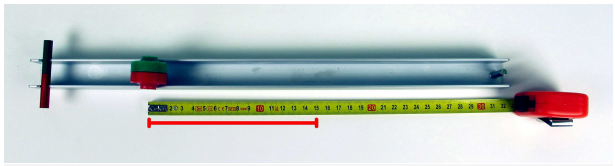

Fig. 5

Then, perform a second measurement. Once again, start the roller at the beginning of the track. Start the time measurement when the roller reaches the 15 cm mark and stop the measurement when it reaches the 30 cm mark (Figs. 6 and 7).

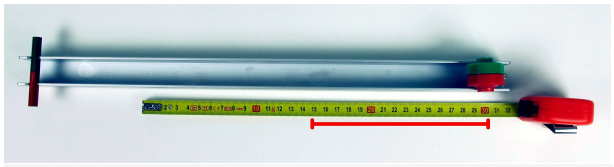

Fig. 6

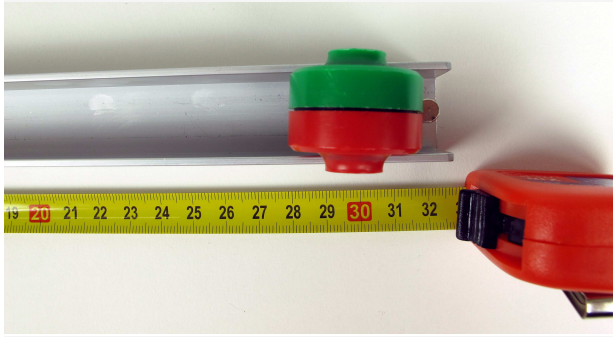

Fig. 7

Compare the two times and enter them into the experiment report.

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3. Then, position the starting end of the track on the first step of the platform as shown in Fig. 8.

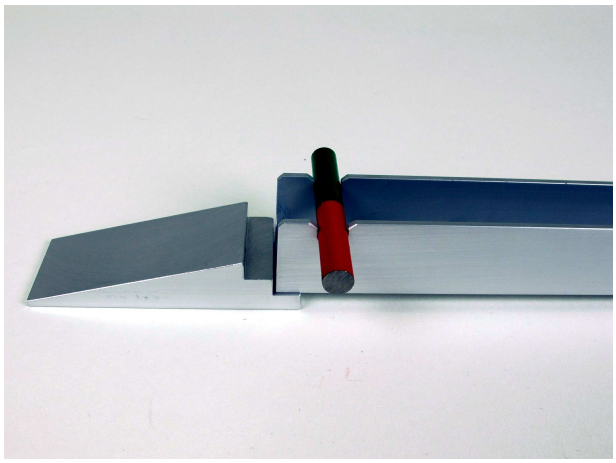

Fig. 8

Start the roller right at the magnet and measure the time until it reaches the end of the track (Fig. 9 to Fig. 11).

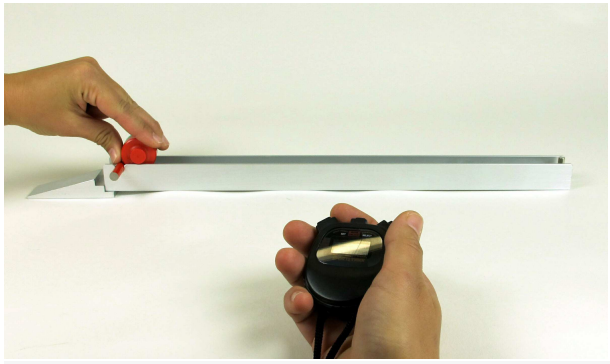

Fig. 9

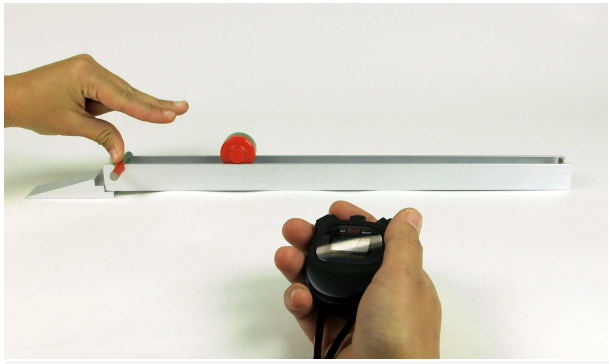

Fig. 10

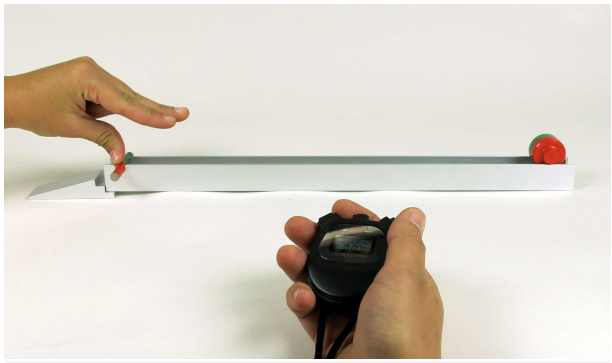

Fig. 11

Compare the time to the time measured without the platform and enter it into the experiment report.

4. Then, measure the time for two identical segments as in the first part of the experiment.

   To do so, position the measuring tape again next to the track as shown in Fig. 7.

   Measure the time for the segment from 0 cm to 15 cm.

   Measure the time for the segment from 15 cm to 30 cm.

   Compare the two times and enter them into the experiment report.

Evaluation

During this experiment, you have measured the time that the roller needs for covering different distances.

Go to the experiment report and answer the questions about the experiment.

Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

Report: Uniform and accelerated motion

Observation - Table (6 points)

Enter the measured times here.

	Time in s for the entire distance	Time in s for the segment from 0 cm to 15 cm	Time in s for the segmet from 15 cm to 30 cm
Straight (horizontal) track	1 ±0.1	1 ±0.05	
Inclinded track	1 ±0.1	1 ±0.05	

Observation - Question 1 (1 point)

On the **straight (horizontal)** track:

You have measured the time for two segments, from 0 cm to 15 cm and then from 15 cm to 30 cm. Is there a difference between these times?

- ☐ Yes, the times are different.
- ☐ No, both times are identical.

Observation - Question 2 (1 point)

On the **inclined** track:

You have measured the time for two segments, from 0 cm to 15 cm and then from 15 cm to 30 cm. Is there a difference between these times?

- ☐ Yes, the times are different.
- ☐ No, both times are identical.

Evaluation - Question 1 (1 point)

Why did the roller move on the straight (horizontal) track? Did the speed of the roller change during its movement?

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Evaluation - Question 1 (1 point)

Why did the roller move on the inclined track? Did the speed of the roller change during its movement?

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Initial question (repeated) (1 point)

You are standing on top of a hill with your skateboard. You push off and ride downhill.

When will you move faster?

- [ ] Not at all.
- [ ] When I push off.
- [ ] When I move without pushing off.
- [ ] When I push off and when I move without pushing off.

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