Friction with SMARTsense (Item No.: P1000369)

Curricular Relevance

Area of Expertise: Physics

Education Level: Age 14-16

Topic: Mechanics

Subtopic: Forces, simple machines

Experiment: Friction with SMARTsense

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	10 Minutes	2 Students

Additional Requirements:

Experiment Variations:

Keywords:

static friction, kinectic friction

Teachers information

The students should familiarize themselves here with the basic characteristics of friction. With the help of the Cobra SMARTsense-Force sensor, little experiments should show that friction depends on surface and weight, but is independent from the contact surface. The difference between F_1 (static friction) and F_2 (kinetic friction) can also be shown.

Notes on the implementation

It should be ensured that the force sensor is tared – zero speed should also show zero friction.
Since friction is independent of velocity, it does not play a role in the experiments. It is only important that the block is pulled evenly: When the speed is constant, the kinetic friction force and traction force cancel each other out, and you have a constant value.

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Introduction

Why can’t we wheel on our bikes for infinite time without padelling?

Wouldn’t it be nice if we could just sit on our bike, give a few kicks and then just go on and on and on without pedalling? (Assumed we’re moving on a plain route of course). But no, without pedalling our cycling tour would be extremely short. Anyway, we even have to apply a force to even start moving. This is all because of friction between the tyre and the ground. Every movement on earth is connected to friction and therefore energy loss. But friction does have good effects as well. It makes sure, that we stop when we use the break – very useful when you’re going 130 km/h on the freeway.

Equipment

Position No.	Material	Order No.	Quantity
1	Cobra SMARTsense-Force	12904-00	1
2	Friction block	02240-01	1
3	Holding pin	03949-00	1
4	Slotted weight, black, 50 g	02206-01	1
5	Fishing line, l=20 m	02089-00	1
Additional materials:			
6	Sheet of paper, A5 or A4		1
7	Wooden plate or table		1
8	Tablet PC with "measure" App		1

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Tasks

Measure the force required to pull a wooden block across a table. Determine the static and kinetic friction for different materials, weights and contact surfaces.

Set-up and procedure

Set-up

- For this experiment, you need the Cobra SMARTsense Force.
- Turn on the Cobra SMARTsense-Force sensor. Open the „measure" app and select the force sensor.
- Cut off approx. 15 cm of the fishing line and make a loop on both ends. Make sure that the line is not too long in the end.
- Attach one loop of the fishing line to the hook of the force sensor as you can see in figure 1.
- Put the friction block with the wooden part on the table and attach the other loop of the fishing line to the hook of the friction block. Make sure that the fishing line between the friction block and force sensor is not under tension.

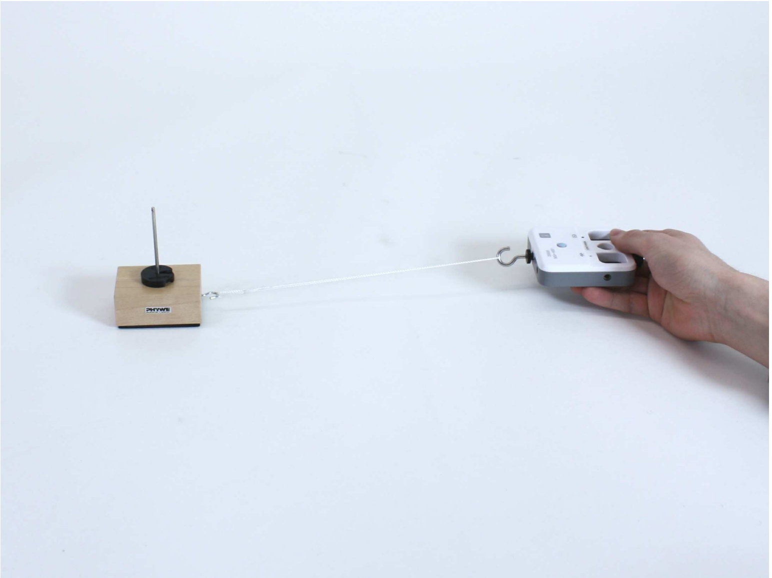

Figure 1: Experimental set-up

Procedure

- Make sure that the force sensor is selected in the app.
- The fishing line between sensor and friction block is not bow-taut. Select "Set to zero" in the app.
- The force displayed above your diagramm should now show 0.000 N.
- Start the measurement .
- Start pulling the Sensor-Unit slowly so that the line tensens and the block starts moving. Try to let the block slide evenly with an almost constant velocity over the table.
- Take heed that there is no other force, meaning that the fishing line looses all its tension as soon as the friction block stops.
- End the measurement and save it.
- The plot should look pretty much similar to the measurement example in figure 2.

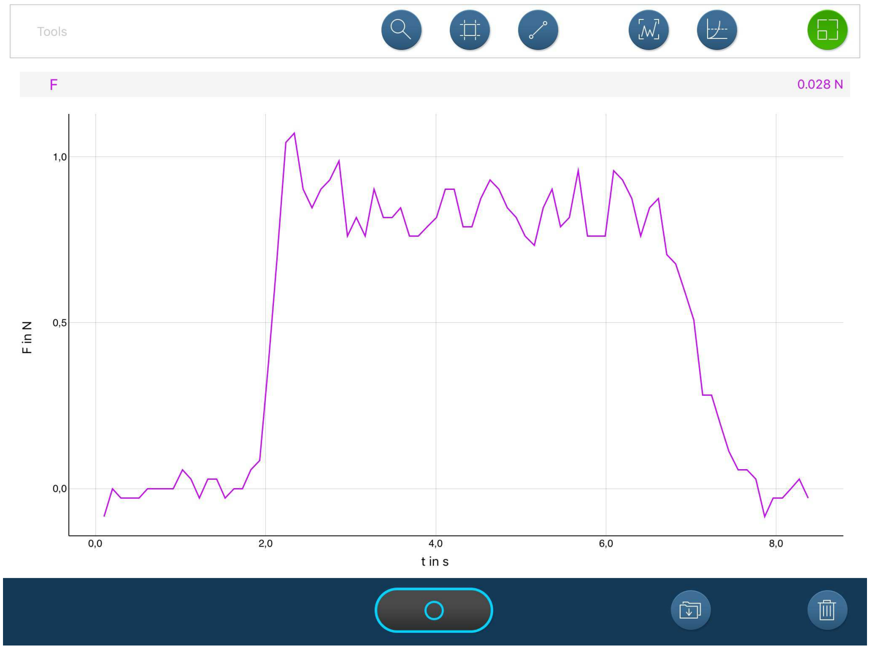

Figure 2: Measurement example

1. Make notes on which saved measurement belongs to which experiment so that you will be able to distinguish the figures later on. Create a suitable project where you will save all the measurements of this experiment.
2. Repeat the measurement in simialr way with the rubber side of the friction block and also save the measurement in your project.
3. Cut out a piece of paper in the same size as the friction block and place it underneath the wooden side. Repeat the measurement.
4. Now conduct the experiment with the rubber side of the block and a slotted weight of 50 g. As to that insert the holding pin with the thicker end in the hole in the friction block. Then add the slotted weight.
5. Last but not least, repeat the measurement on the long side of the friction block so that the contact area between block and table is reduced.

Observation and Results

Observation and results

The graph shows the force, which has to be applied to pull the friction block. When it is motionless the force is also 0. When you start to pull it, the force increases suddenly and then becomes more or less constant when pulled at constant speed. When you stop pulling, the force returns to 0. The maximum force that acts when the friction block is started is the so-called static friction F_1. The constant force that acts during the movement, when the friction block is pulled evenly, is called kinetic friction F_2.

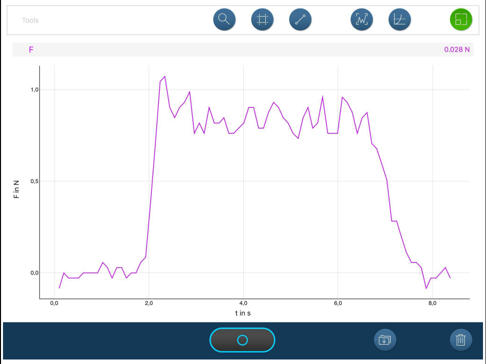

Fig. 3a: Measurement example - Experiment with the wood side of the friction block

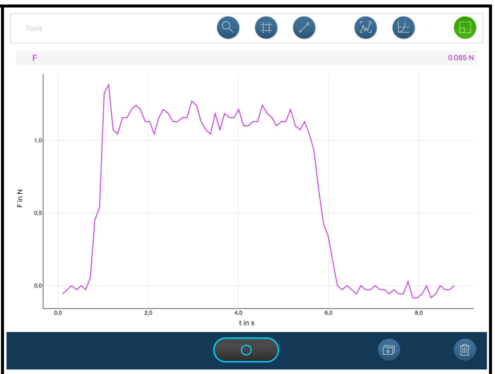

Fig. 3b: Measurement example - Experiment with the rubber side of the friction block

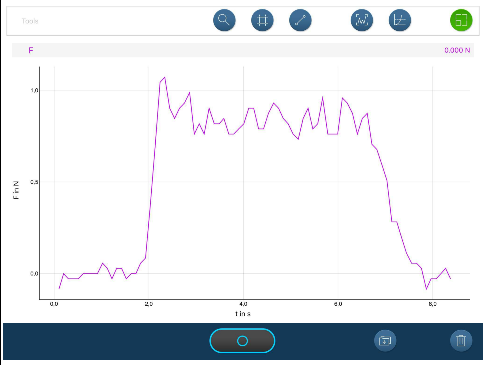

Fig. 3c: Measurement example - Experiment with the long side of the friction block

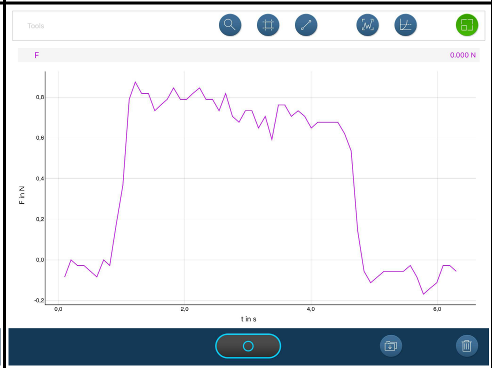

Fig. 3d: Measurement example - Experiment with paper

Report: Friction with SMARTsense

Result - Table 1

Successivley, reload the measurements from your project into the app. Choose the “measurement” tool to determine F_1 and F_2 for each measurement. Enter the values in table 1.

Table 1: F_1 and F_2 (with the wooden side and with the rubber side of the friction block)

	F_1 (N)	F_2 (N)
Wood	1 ±0.05	1 ±0.05
Rubber	1 ±0.05	1

Result - Table 2

Now, use the "measurement"-tool to determine the dynamic friction F_2 for the measurements with paper, the weight and long of the wooden block. Enter the values in table 2.

Table 2: F_2 of the friction with paper, a slotted weight and the long side of the friction block

	F_2 (N)
Paper	1
Slotted weight, 50g	1
Wooden long side	1 ±0.05

Evaluation - Question 1

Compare the values from table 1 of the static and dynamic frictions F_1 and F_2 for each measurement What do you notice?

Evaluation - Question 2

Can you explain the differences?

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Evaluation - Question 3

Compare the force F_2 for the measurement with wood, rubber and paper. What do you observe? How did this impact your pulling the friction block during the measurement?

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Evaluation - Question 4

Compare the measurement with the rubber side of the friction block with and without weight. Is there a difference? How can you explain this?

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Evaluation - Question 5

Compare the measurement of the wooden side of the friction block with the measurement of the wooden long side. What do you determine?

Evaluation - Question 6

Ice is very slick. What can you do to prevent slipping?

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