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Osnovna škola Višnjevac

Friction
(determining the dynamic sliding friction factor)

Workshop 2.
How slippery is a banana?
(dynamic sliding friction)

In order to come to a conclusion about the slippery nature of the banana, you need to perform a couple of physics experiments. You have already done the friction force from the physics class in elementary school.

Remember what the friction force is and how you measure it, what the friction factor is, then apply it to our experiments and finally answer the question from the title.

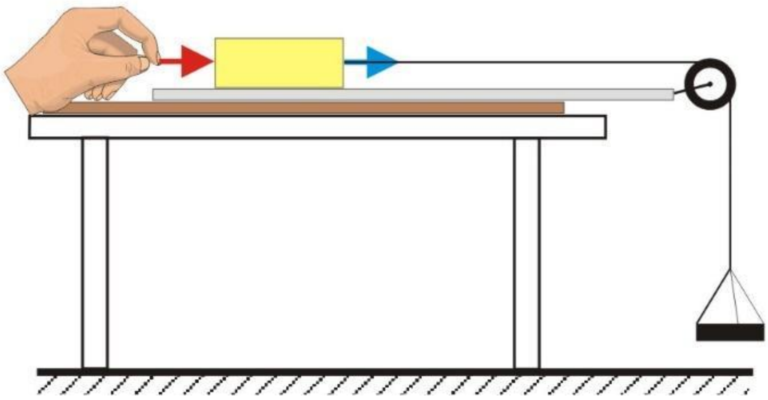
Tasks:

1. Conduct an experiment for dynamic sliding friction on a tribometer and calculate the dynamic friction factor for the given body (squares with hooks). Perform the same experiment at least several times for each body.
2. Turn the tribometer to the other side and perform the previous experiment with one shoe or sneaker of the workshop participant.
3. Carry out experiments with the shoe or sneaker from the previous experiment by loading it with some mass (eg 1 kg or 2 kg, if you don't have weights you can put smaller weights, stones,...).
4. Carry out experiment 2, but now by placing a banana peel between the shoe and the tribometer, and calculate the dynamic friction factor. Carry out at least a few similar experiments by changing the conditions with the banana peel (eg banana peel downwards or upwards, 2 peels facing each other, banana peels placed crosswise, ..., let your imagination run wild).

5. Compile the tables for all the experiments of this workshop according to the template in the text, and write the measurement results in the tables. Calculate the arithmetic mean of each set of measurements (mean value of measurements).
6. Answer the questions.

List of accessories:
Tribometer (wooden board) with pulley, friction bodies (wood, sandpaper, rubber), thread, set of weights or pebbles, digital kitchen scale, bowl, hook, 2 bananas, shoe, paper, pencil, calculator.
Experiment to determine the dynamic friction factor:

Let's measure the mass $\boldsymbol{m_1}$ of the given body (block) for which we want to determine the dynamic sliding friction factor and place it on the tribometer (a wooden board with a pulley at one end). Let's prepare a tribometer as shown in Picture 5. A tribometer is a measuring instrument or device for measuring friction. Since with every movement of a physical body on a surface, an external force must always overcome the friction, we can measure the friction with this external force. Using a rope, passed over a pulley, at the end of which there is a bowl with weights, we can move an object made of any material. The pulley serves only to change the direction of the force (in our case from horizontal to vertical).



Picture 5. Measurement of the dynamic friction factor

On one side of the body there is a hook to which you attach the thread. Then pass the thread over the pulley, and hang a weight bowl (plastic cover) on the other end of the thread. We ignore the mass of threads and hooks. Now put in the bowl, which is hanging on a thread, so many weights (or pebbles, screws, marbles,...), $\boldsymbol{m_2}$, that the wooden body, $\boldsymbol{m_1}$, slides at a uniform speed on the board when you give it an impulse with your finger, i.e. push it forward (the body does not stop or accelerate). Then, with uniform movement of the body, the traction force is equal in amount to the friction force. Weigh and record the mass of the weights and the plastic cover (bowl) $\boldsymbol{m_2}$ and repeat the process several times.
Let's recall the definition of the friction factor, from physics class, and write the formula and shorten the same term (remember, does the friction factor have a unit of measure?),

and then we will get an expression with which we can calculate the dynamic sliding friction factor (the derivative of the expression at the end!) :

$$\mu = \frac{F_T}{F_P} = \frac{m_2 \cdot g}{m_1 \cdot g} = \frac{m_2}{m_1}$$

Enter the results of measurements and calculations in the tables.

Table 3: The results of the measurement of the dynamic sliding friction factor

Body 1. ______________________				
measurements	m_1	m_2	F_T	μ
unit	kg	kg	N	-
1.				
2.				

Table 4: Some isolated sliding friction factors

Materials in contact	**Rest friction factor**	**Sliding friction factor**
leather and metal	0,6	0,2 - 0,25
wood on wood	0,4 - 0,65	0,2 - 0,4
rubber on asphalt	0,9	0,8
steel on ice	0,027	around 0,014

Questions:

1. For which body or for contact surfaces, is the dynamic sliding friction factor the highest?

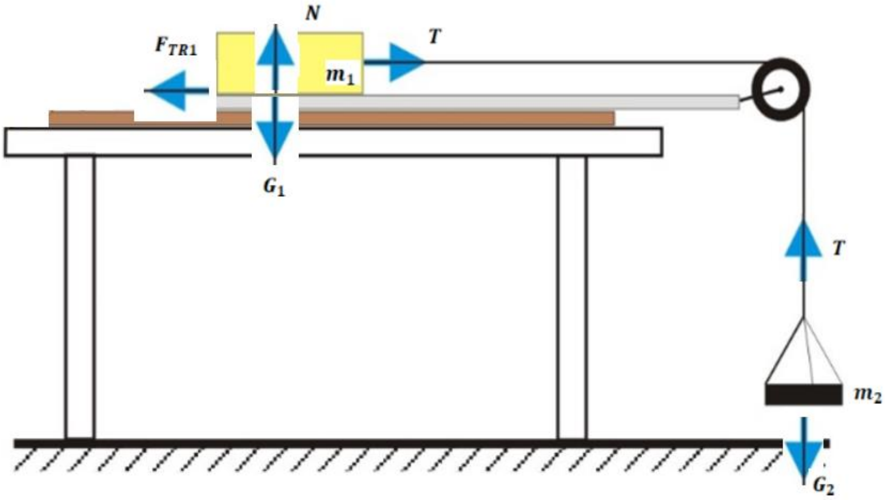
2. What is the amount of the friction force if the friction factor is greater, i.e. what is the relationship between the friction force and the friction factor (with a constant mass of the body)?

3. Does the friction factor depend on the mass of the object?

4. Why is the sole of a shoe (sneaker) made of rubber in terms of the amount of friction?

5. Compare the friction factor in the experiment with the shoe and with the shoe and banana and conclude how slippery is the banana peel?

Derivation of expression:



It follows from Newton's first law:

$$m_1 : x\ axis \ \rightarrow\ T - F_{tr1} = 0 \ \ (1)$$
$$y\ axis \ \rightarrow\ N - G_1 = 0 \ \ (2)$$
$$m_2 : y\ axis \ \rightarrow\ G_2 - T = 0 \ \ (3)$$

By adding (1) and (3) we get: $G_2 - F_{tr1} = 0 \ \Rightarrow\ F_{tr1} = G_2$

$$\eta \cdot N = G_2$$

From equation (2) we know that $N = G_1 \ \rightarrow\ \eta \cdot G_1 = G_2$

$$\eta = \frac{G_2}{G_1} = \frac{m_2 g}{m_1 g} = \frac{m_2}{m_1}$$