COEFFICIENT OF KINETIC FRICTION

LAB MECH 5.COMP

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INTRODUCTION

If you try to slide a heavy box resting on the floor, you may find it difficult to get the box moving. *Static friction* is the force that is acting against the box. The maximum static friction force is sometimes referred to as *starting friction.* Once the box starts to slide, you must continue to exert a force to keep the object moving, or friction will slow it to a stop. The friction acting on the box while it is moving is called *kinetic friction.* In order to slide the box with a constant velocity, a force equivalent to the force of kinetic friction must be applied. Kinetic friction is sometimes referred to as *sliding friction.* Both static friction and kinetic friction depend on the surfaces of the box and the floor. Both types of friction also depend on how hard the box and the floor are pressed together. We model kinetic friction with $F_{kinetic} = \mu_k N$, where μ_k is the coefficient of kinetic friction.

In this experiment, you will use a Motion Detector to analyze the kinetic friction acting on a sliding block. Using the Motion Detector, you can measure the acceleration of the block as it slides to a stop. This acceleration can be determined from the velocity *vs*. time graph. While sliding, the only force acting on the block in the horizontal direction is that of friction. From the mass of the block and its acceleration, you can find the frictional force and finally, the coefficient of kinetic friction.

PURPOSE

The purpose of this experiment is to use a Motion Detector to study kinetic friction and to determine the coefficient of kinetic friction.

EQUIPMENT/MATERIALS

Laptop computer with Logger *Pro*
LabPro with AC adapter
LabPro → computer cable
Vernier Motion Detector
mass set
Graphical Analysis or graph paper
string
block of wood with hook
balance or scale

PROCEDURE

1. Connect the Motion Detector to DIG/SONIC 2 of the LabPro. Open the experiment file Exp 12 Motion Detector. Two graphs will appear on the screen. The vertical axis of the top graph will have distance scaled from 0 to 3 m, and the lower graph has velocity scaled from – 2 to 2 m/s. The horizontal has time scaled from 0 to 5 s.

2. Place the Motion Detector on the lab table 2 – 3 m from a block of wood, as shown in Figure 1

3. . Position the Motion Detector so that it will detect the motion of the block as it slides toward the detector.

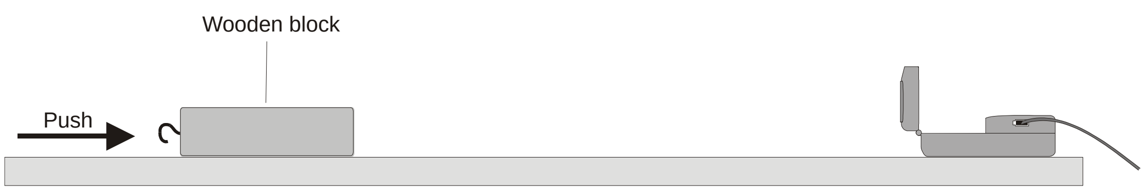

Figure 1

4. Practice sliding the block toward the Motion Detector so that the block leaves your hand and slides to a stop. Minimize the rotation of the block. After it leaves your hand, the block should slide about 1 m before it stops and it must not come any closer to the Motion Detector than 0.4 m.

5. Click Collect to start collecting data and give the block a push so that it slides toward the Motion Detector. The velocity graph should have a portion with a linearly decreasing section corresponding to the freely sliding motion of the block. Repeat if needed.

6. Select a region of the velocity *vs.* time graph that shows the decreasing speed of the block. Choose the linear section. The slope of this section of the velocity graph is the acceleration. Drag the mouse over this section and determine the slope by clicking the Linear Regression button, . Record this value of acceleration in your data table.
7. Repeat Steps 4 – 5 at least two more times.
8. Place masses totaling 500 g on the block. Fasten the masses so they will not move.
9. Repeat Steps 4 – 5 at least three times for the block with masses. Record the acceleration values in your data table.

DATA SHEET

Name ________________________
Name ________________________
Period _______ Class ___________
Date ___________

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DATA TABLES

Data: Block with no additional mass			
Trial	Acceleration (m/s^2)	Kinetic friction force (N)	μ_k
1			
2			
3			
Average coefficient of kinetic friction:			

Data: Block with 500 g additional mass			
Trial	Acceleration (m/s^2)	Kinetic friction force (N)	μ_k
1			
2			
3			
Average coefficient of kinetic friction:			

ANALYSIS

1. Draw a free-body diagram for the sliding block. The kinetic friction force can be determined from Newton's second law, or $\Sigma F = ma$. From the mass and acceleration, find the friction force for each trial, and enter it in the data table.
2. From the friction force, determine the coefficient of kinetic friction for each trial and enter the values in the data table. Also, calculate an average value for the coefficient of kinetic friction for the block and for the block with added mass.
3. Does the coefficient of kinetic friction depend on speed? Explain, using your experimental data.
4. Does the force of kinetic friction depend on the weight of the block? Explain.
5. Does the coefficient of kinetic friction depend on the weight of the block?