

Friction Lab

For this lab we will investigate the force due to friction. We will experimentally find static and kinetic friction coefficients, then, using a different method, find them again and compare the two.

Friction is more complicated than forces we previously studied and is often referred to as a phenomenological force - meaning that it is described as an educated guess based upon observed friction properties. From your text you know:

$$f_s = \mu_s N \quad \text{and} \quad f_k = \mu_k N$$

Where:

μ_s = static coefficient

μ_k = kinetic coefficient.

Looking at the above equations what do you see that friction depends on? Would this be different for different types of materials? Why or why not?

Procedure:

Part 1:

a) Determine the static and kinetic coefficients of friction for wood on wood. Placing a block of wood on a board and increase the angle of the board until the block starts to slide. Record this angle. Do this ten (10) times and record the angle each time. Take the standard deviation of the angles to determine the +/- error. The average of all of the angles will be used to give you the static coefficient.

Static angle:

Angle #	Angle (degrees)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Average =	
Standard dev =	

b) Repeat the experiment again but this time give the block a small shove and adjust the board angle so the block appears to slide down with a constant speed.

Kinetic angle:

Angle #	Angle (degrees)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Average =	
Standard dev =	

c) Now to find the *actual* coefficient of friction we need to construct a drawing of the force diagram of your experiment, and then sum the forces and show that the coefficient

$$\mu = \tan \theta_q$$

where θ_q is the angle that the board makes with the table.

1) Draw a side view of the board and block.

2) Write down the sum of the forces in both the x - direction and the y - direction.

3) Combine the equations and obtain the formula in c).

d) Calculate the static and kinetic coefficients of friction using $\mu = \tan \theta_q$:

$$\mu_s = \quad \pm$$

$$\mu_k = \quad \pm$$

e) Repeat the same process for metal on wood. Show your work on the back of this sheet.

$$\mu_s = \quad \pm$$

$$\mu_k = \quad \pm$$

Part 2: Determine the coefficient of kinetic friction using a different method and compare to the kinetic coefficients found in Part 1.

a) Set up the photogate system along your board (about in the middle). Slide the metal object through the photogate and let it come to rest. Record the velocity found by the photogate program and measure how far it went after passing through the photogate until it stopped. Do this ten (10) times. Don't forget to record the units for distance and velocity on the table

	Distance	Velocity
Average =		
Standard dev =		

1) Draw a picture of the setup with force diagram on the metal object, below.

b) From the force diagram you should have

$$\Sigma F_x = ma_x = -\mu N$$

Rearranging: $a_x = -\mu N/m$

Using $v^2 = v_0^2 + 2a_x(x-x_0)$, solve for a_x , and place this value in the equation.

Repeat the process for all ten cases to calculate μ_k and compare your averaged value to the results of Part 1. Show work on back.

	a_x	μ_k
Average =		
Standard dev =		

c) Explain any discrepancies when comparing the two μ_k from the different methods and offer suggestions to reduce the error. Can you think of another way to experimentally determine μ_k or μ_s ?

In the results section of your lab writeup, summarize your results by including the average and standard deviation for μ_k and μ_s from Part 1 and the μ_k (average and standard deviation) from Part 2. A table will display your data nicely and will allow easy comparison between the two μ_k 's. Include these data sheets as well, referring to them in the results section but don't recreate them. Only the summary of what you found (the friction coefficients) and a reference to these data sheets should be in your results section. Remember, the standard deviation is your +/- error. The two coefficients of kinetic friction values found from the two different methods should hopefully overlap. Don't forget to discuss each part in the discussion section.