

Sample Short Lab Report

By Charles M Borener Jr

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Kinetic Friction

Experiment #13

Joe Solution

E00123456

Partner - Jane Answers

PHY 221

Lab Instructor – Chuck Borener

Thursday, 11 AM – 1 PM

Lecture Instructor – Dr. Jacobs

Abstract

In this experiment, we test factors which effect friction. We pulled a wood block across a surface to determine whether the surface area of the block or the type of surface effects friction. We found that the surface area of the block did not change the coefficient of kinetic friction, while the types of materials in contact were directly related to the coefficient of kinetic friction. (66)

Data Tables and Graphs

Data Table 1 - Masses of Objects

Mass of the Wood Block =	0.064139 kg
Mass of one small paperclip =	0.003052 kg
Mass of one large paperclip =	0.000422 kg
Mass of the hanger =	0.00500 kg

$$T = m_h g = (0.005 \text{ kg} + 3 * .003052 \text{ kg}) * 9.81 \frac{\text{m}}{\text{s}^2} = 0.1387 \text{ N}$$

$$N = (M + m)g = (0.064139 \text{ kg} + 0.050 \text{ kg}) \left(9.81 \frac{\text{m}}{\text{s}^2} \right) = 1.119 \text{ N}$$

$$\mu_k = \frac{T}{N} = \frac{0.1387 \text{ N}}{0.629 \text{ N}} = 0.221$$

$$\mu_k = \frac{0.2207 + 0.2043 + 0.1978 + 0.1944 + 0.1922 + 0.1908}{6} = .2000$$

Data Table 2 - Finding the Coefficient of Kinetic Friction

M + m (kg)	N (N)	T (N)			μ_k		
		A	B	C	A	B	C
0.064	0.629	0.1387	0.1686	0.0821	0.2207	0.2682	0.1306
0.114	1.119	0.2285	0.2584	0.1088	0.2043	0.2310	0.0973
0.164	1.609	0.3182	0.3480	0.1553	0.1978	0.2163	0.0965
0.214	2.099	0.4079	0.4079	0.1893	0.1944	0.1944	0.0902
0.264	2.589	0.4976	0.4976	0.2192	0.1922	0.1922	0.0847
0.314	3.079	0.5874	0.5276	0.2491	0.1908	0.1714	0.0809
Average					0.2000	0.2123	0.0967

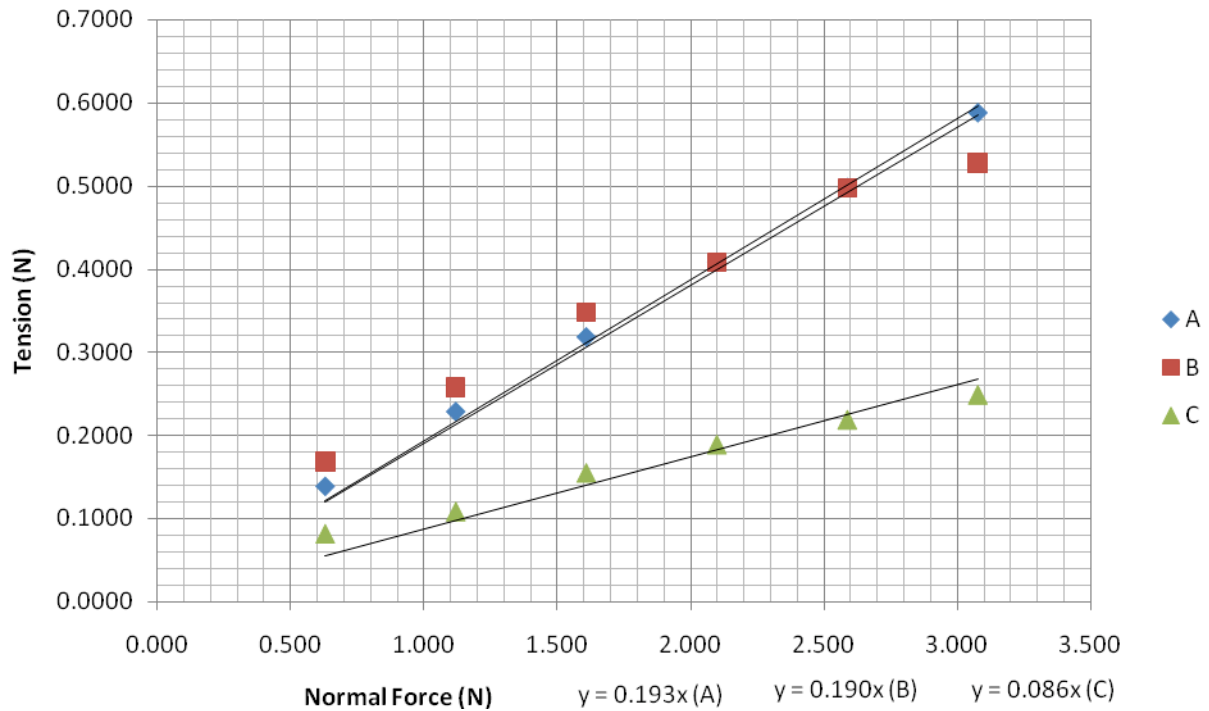


Figure 2 – Graph of T vs N to find μ_k .

$$\%diff = \frac{|value_1 - value_2|}{\frac{1}{2}(value_1 + value_2)} \times 100\% = \frac{|.200 - .193|}{.5 * (.200 + .193)} \times 100\% = 3.56\%$$

The percent difference for data set B is 11.1%, while the percent difference for data set C is 11.7%

Error Analysis

There were two main sources of error in this experiment. The biggest error is the sensitivity of the apparatus to accidental bumps. Anytime we bumped the table, even slightly, the horizontal surface on the apparatus would shift. It was very difficult to avoid this error, as even the slightest bump would make it move. This bump could change incline of the surface by as much as 10 degrees. If it were tilted 10 degrees upwards, this would make it so there were weight and tension components in two dimensions. Using Newton's Laws, I was able to derive the following equation:

$$\mu_k = \frac{m_h \cos(10) - (m + M) \sin(10)}{m_h \sin(10) + (m + M) \cos(10)}$$

By my calculations, this would change the first μ value in column A to 0.043, a difference of 130%.

The second error in this experiment is the non-uniformity of the black surface from one end to the other. Since the surface is not uniform, the value of μ_k is not constant. This means we are only finding an average value of μ . This leads to inconsistencies of μ , since the block will not always follow the exact same path on the surface. Another source of inconsistency was a “stuttering” effect of the block as it moved across the surface.

When we analyze side C of the block, the range of values for μ_k is 0.0809 to 0.1306. Using the average value from the slope of the best fit line, the percent difference between the high and average values is 41.1%, while the percent difference between the low and average values is 6.2%. This trend continues for the other faces of the block. From these percents, it shows that the values for μ_k are more accurate as the mass increases. A more massive block/hanger would have greater inertia, and be less prone to the effects of the “stuttering” motion of the block down the surface.

Questions for Thought

- 1)** The value of sliding friction does depend on the normal force between the two objects. This is shown by the equation, $f_k = \mu_k N$. This is also shown by Table 2. Whenever the normal force increased, the frictional force increased.
- 2)** The value of sliding friction between two objects does not depend on the area of contact between the two objects. This is shown by my data in columns A and B.
- 3)** The value of sliding friction between two objects does depend on the materials that are in contact. This was shown by my data when I compared column C with columns A and B.
- 4)** The percent differences are close to one another. My percent difference for the data in column A is 3.56%. My percent difference for the data in column B is 11.1%. My percent difference for the data in column C is 11.7%. These are reasonable percent differences when comparing an average value and using a best fit line.

5) I believe the slope of the best fit line gives a more accurate value for μ_k . When Excel creates a best fit line, it uses the method of least-squares for the line. The least-squares fit accounts for the uncertainty in the experiment. An average does not account for uncertainty. This is the reason I believe the slope best fit line is more accurate than the average to find μ_k .

6) I would use rubber on one side of the block to reduce the error in measuring μ . I believe by using a material of higher μ , error will be reduced by being able to use higher numbers. In general, when higher numbers are used, error is decreased. A material that is easy to find with a low μ value is aluminum. We could attach aluminum foil to one of the surfaces to test yet another case for μ .