Phy 9A
Spring 2024
Lab 3 report
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Static Friction

Goal

This lab is split into two parts. The goal of the first part of the lab is to investigate static friction when our mass is parallel to the ground, and being dragged by weights off an edge. In the second part of the lab, we only rely on gravity to pull our block down, and explore what angle will make it happen. Overall, our goal is to explore how static friction works in different orientations.

Hypothesis

We hypothesize that the coefficient of static friction will be equal to a number such that multiplying it by the normal force of our block will give us a value around the weights we hung over the edge. Additionally, for part 2, we hypothesize that the angle required to make our block move will be such that the gravitational pull overcomes the static friction coefficient times the normal force. In other words, we expect the formula $F \leq \mu N$ to hold true for both parts of our lab, where μ is consistent.

Procedure

Preparation

In order to collect enough data, we first have to choose how many trials we would like to run. After consulting our TA and the lab manual, we settled on 5 trials to find the weight that makes our block move.

As for the block, it is especially important in this context to make sure that the carpet and block interact the same each time. This means, no pressing down on it for on trial, or placing it slightly different. To account for this, we add a part in our procedure which involves placing our phone on an arbitrary point, and slowly laying the block down starting at that point. We will keep the phone on there to create a mark of where the wood block is, that way the block interacts with the carpet the same each time. We will also be laying it down the same, since the *history* of the block also matters.

Our materials include a wood plank, sliding block with string, pulley, hanging weights, adjustable platform, meter stick, and a triple beam balance.

We first measure the mass of the wooden block. Next, we hang the triple beam balance off of the string to make sure our string is parallel to the ground. After this, we slowly start adding on weights to the end of the pulley, until it moves. Once it does, we slowly take it off until we are just at the right point where the block barely moves.

For the second part, we make sure the jack touches our plank at a fixed point only, such as the hypotenuse always stays the same, and by adjusting the jack we are only changing Θ.

Uncertainty

A source of error is likely to come from the swinging mass when we add weight to the string. The motion of the string may cause a difference in the force being applied to the block, ultimately affecting whether or not our block can overcome the static friction. To overcome this, we tried to hold the string still before we let it drop from our hands, that way we could control the sway.

The contact point of our jack with the plank may also produce errors with our data. If the contact point was not consistent throughout the second part that means the hypotenuse changed, and therefore Θ is not equal to our calculations. If the Θ isn't right, that means we would have calculated the downwards force wrong as well, skewing our data.

Data

Mass of the block = 0.361 kg

Trial Number	Mass (grams)	Static Friction Coefficient (μ
1	141g	0.390582
2	133g	0.368421
3	125g	0.34626
4	134g	0.371191
5	135g	0.373961

Trial Number	Height (cm)	Static Friction Coefficient	angle
1	14.5cm	0.409	22.25
2	13.8cm	0.386	21.12
3	13.2cm	0.367	20.16
4	13.2cm	0.367	20.16
5	13.0cm	0.361	19.84

Analysis

The carpet had an average static friction coefficient of 0.366 for part 1,

$Part\ 1$

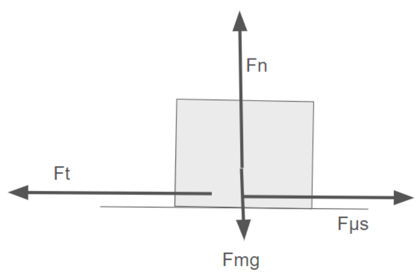
$\Sigma F_x = F_t - F_{\mu s}$

$0 = m_{weights}g - \mu N$

$\mu(m_{block}g) = m_{weights}g$

$\mu = \frac{m_{weights}g}{m_{block}g}$

$\mu = \frac{m_{weights}}{m_{block}}$



$Part\ 2$

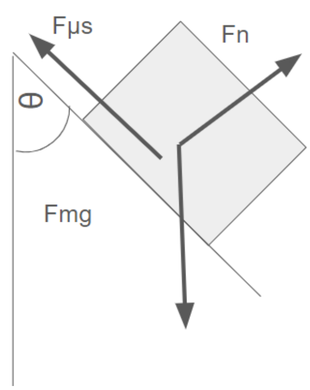
$\Sigma F_x = F_{gravity} - F_{\mu s}$

$0 = sin\Theta \times m_{block}g - \mu N$

$\mu(cos\Theta * m_{block}g) = sin\Theta \times m_{block}g$

$\mu = \frac{sin(\Theta)\times m_{block}g}{cos(\Theta)m_{block}g}$

$\mu = tan(\Theta)$



Part 2

Average height = 13.54

$\sigma m = \sqrt{\frac{\Sigma (x_i - \bar{x})^2}{n-1}} = 0.6148$

$e_{M_s} = \frac{0.6148}{13.64} \times 100 = 4.5\%$

Absolute uncertainty = $\sigma_M = \frac{e_M}{100\%} \cdot M_s = \frac{4.5}{100} \cdot 0.378$

$\sigma_M = 0.01781$

Part 1

Average Mass = 133.6

$\sigma_m = \sqrt{\frac{\Sigma (x_i - \bar{x})^2}{n-1}} = 60.3$

% uncertainty = 45 %

absolute uncertainty = $\frac{45}{100} \cdot 0.366 = 0.165$

$\Delta M_s = \sqrt{(0.378)^2 + (0.165)^2} = \boxed{0.4125}$

$M_1 - M_2 = 0.378 - 0.366 = 0.012$

Conclusion

For both parts our static friction coefficients lie within our uncertainty percentage proving that the equation does hold true and that our hypothesis is correct.