

4.2: Activities

Equipment

- wood plank
- sliding block with string
- pulley apparatus
- hanging weights
- adjustable-height platform
- triple beam balance
- meter stick

The General Idea

In this lab, we are going to explore static friction. Static friction is a bit trickier than kinetic friction, inasmuch as it is not a fixed quantity – it depends upon the other forces applied to the object. But there is one aspect of it that is fixed – the maximum value that it can acquire for a given pair of surfaces in contact. This maximum is characterized by the coefficient of friction, which is what we will be measuring in this lab. We will do this by measuring the minimum force we can apply to the object parallel to the surfaces that will make the object accelerate.

To make sure that the *type* of parallel force is not important, and that the contact force between the surfaces also does not affect the coefficient of static friction, we will do two different experiments. One will use tension to pull the block along a horizontal surface (so gravity does not contribute to the parallel force, and the magnitude of the contact force equals the entire weight of the block), and the other will involve an inclined plane with no string pulling (so that only a component of gravity is the parallel force, and only a fraction of the block's weight equals the magnitude of the contact force). We will then compare the results obtained for the coefficient of static friction in the two cases, incorporating the uncertainties of the two experiments to determine if the results are "close enough" to each other to declare our result to be valid.

Some Things to Think About

Effects of static friction can be pretty touchy to measure accurately. In addition, this "touchiness" makes the process of estimating uncertainty of measurements troublesome, so here are a few things to keep in mind:

- The string needs to be parallel to the sliding surfaces. Also, swinging weights are to be avoided, because they provide more tension than if they are stationary.
- The cradle for the hanging weights is not weightless (but you have a scale!).
- If the block is not in precisely the same position on the plank for every trial, then the two surfaces in contact are not exactly the same – some parts of the plank may be smoother than others.
- Somewhat strangely, the *history* of the block on the plane seems to play a role. If it has been resting in the same place for awhile, the ability to make it slide may be significantly different from if it was just placed there. Also, the temperature of the surfaces (warmer if they have just recently been rubbed) may also play a role. [I told you it was touchy!]. Try to come up with a way to keep these variables under control.
- Even with all of the above controls in place, you will find that repeated runs under the same conditions (as "same" as you can make them) yield different results. These varied results will be the best source of your estimated experimental uncertainty for the weight hung from the string (in experiment #1) and the height of the ramp (in experiment #2) – better than using the smallest unit you can measure. For example, even though you can adjust the hanging weight by as little as one gram, you will find that one gram is not actually the degree of uncertainty you are working with. A similar issue occurs with measuring the height of the ramp at which the block slides. You don't have to compute the uncertainties statistically (though you can if you wish), but you do need to repeat the procedure to get enough of a sense of the variation of results to make a good estimate.
- Be sure to carefully follow the procedure outlined in the [Background Material](#) with respect to using the weakest link rule and comparing the two results.

Lab Report

Craft a lab report for these activities and analysis, making sure to include every contributing group member's name on the front page. You are **strongly encouraged** to refer back to the [Read Me](#) as you do this, to make sure that you are not leaving out anything

important. You should also feel free to get feedback from your lab TA whenever you find that your group requires clarification or is at an impasse.

Every member of the group must upload a separate digital copy of the report to their lab assignment in Canvas *prior to leaving the lab classroom*. These reports are not to be written outside the lab setting.

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