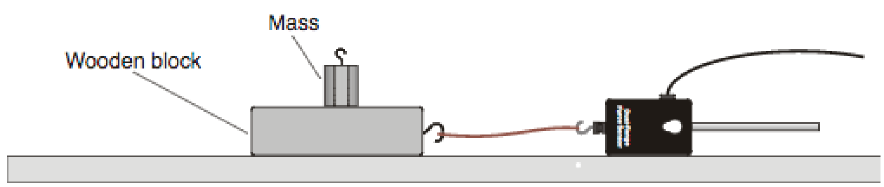
Regis University – Physics 305A – Fall 2019 – Lab 9: Friction

You have talked about friction forces in general terms. In today's lab, we will study them quantitatively. Friction forces oppose the sliding motion of two surfaces that are in contact with each other. The more firmly the surfaces are pressed together, the larger the friction forces are. We can capture this relationship in an equation: $F_f = \mu F_N$: the friction force is proportional to the normal force, with a proportionality constant known as a "coefficient of friction" and represented by the Greek letter μ (mu). A small value of μ indicates that the surfaces are slippery, and a large value indicates that they are rough or sticky. For example, Teflon-on-Teflon has $\mu \approx 0.04$, while wood-on-wood might fall somewhere between 0.3 and 0.5, depending on the details.

In fact, we can further divide friction forces into two categories: static and kinetic. If the two surfaces are sliding on each other, then *kinetic* friction applies, and $F_{KF} = \mu_k F_N$. If they are not (yet) sliding on each other, then *static* friction prevents them from starting to slide, with $F_{SF} \leq \mu_s F_N$. The "less than or equal to" sign indicates that the static friction force may not need to be that large to prevent sliding – it will only be as large as it needs to be, up to the limit set by $\mu_s F_N$. For most kinds of surfaces, $\mu_s > \mu_k$, which implies that more force is required to start an object sliding than to keep it sliding after it has started.

1 Measuring coefficients of friction

In the first part, you can use a Vernier force sensor to pull a block of wood across the table with varying amounts of weight stacked on top:



From a graph of F vs. time, you should be able to identify the maximum static friction force (at a time just before the block moves) and the kinetic friction force. You can plot graphs of F_{SF} versus F_N and F_{KF} vs. F_N to determine μ_s and μ_k. Please use a program such as Logger Pro (rather than Excel) to fit lines to these graphs so that you can determine the *uncertainty* in your measurement of each coefficient.

2 Measuring acceleration of the block

Start by making a prediction, based on your results from the previous section: if you give your block of wood (without any weights on top) a push so that it slides across the table, what will its acceleration be as it gradually comes to a stop?

Now, do the experiment, using a Vernier motion detector to track the position, velocity, and acceleration of the block. You will need to be careful to slide the block in a way that it goes straight and does not rotate; this will take some practice.

Take at least 5 "good" runs (where there is no obvious rotation) and record the acceleration for each run. Compute the average (mean) value for the acceleration and its uncertainty (remember $\sigma/\sqrt{N}$, where σ is the standard deviation).

Does this value agree, within a reasonable multiple of your calculated uncertainty, with your original prediction?