Static and Kinetic Friction — Prelab

If you try to slide a heavy box resting on the floor, you may find it difficult to get the box moving. Static friction is the force that is acting to prevent the box from moving. If you apply a light horizontal push that does not move the box, the static friction force is also small and directly opposite to your push (no acceleration). If you push harder, the friction force increases to match the magnitude of your push. There is a limit to the magnitude of static friction, so eventually you may be able to apply a force larger than the maximum static force, and the box will move. The maximum static friction force is sometimes referred to as starting friction. We model static friction, f_{static}, with the inequality $f_{static} \leq f_{s,max}$, where $f_{s,max}$ is called the maximum static friction. For a given surface, $f_{s,max}$ is proportional to the normal force N: $f_{s,max} = \mu_s N$ where μ_s is called the coefficient of static friction and N is the normal force, the perpendicular component of the force exerted on the object by the surface.

Once the box starts to slide, you must continue to exert a force to keep the object moving, or friction will slow it to a stop. The friction acting on the box while it is moving is called kinetic friction. In order to slide the box with a constant velocity, a force equivalent to the force of kinetic friction must be applied. Kinetic friction is sometimes referred to as sliding friction. For a given surface, the kinetic friction is also proportional to the normal force: $f_{kinetic} = \mu_k N$, where μ_k is called the coefficient of kinetic friction.

In this lab, you will use a force sensor to observe and measure the static and kinetic friction, and then calculate the coefficients of static and kinetic friction. You will also use a motion detector to find the coefficient of kinetic friction by measuring how fast it decelerates a moving box.

This lab has a prelab (see next page). Finish the prelab and bring it to the lab. You can either print or copy the prelab page.

Static and Kinetic Friction—Prelab Questions

I-1: When you push a heavy box across the floor, the force you need to apply to start the box moving is _____ (greater than, less than, or the same as) the force needed to keep the box moving.

I-2: The force needed to push a box across a rough surface is _____ (more than, less than, or the same as) the force needed to push the same box across a smooth surface.

I-3: The force needed to push a light box across the floor is _____ (more than, less than, or the same as) the force needed to push a heavy box across the same floor.

II-1: Draw a free-body diagram for a block being pulled horizontally across a table at a constant speed.

II-2: For the situation above, find equations to calculate the coefficients of static and kinetic friction, μ_s and μ_k from the mass m and the friction forces $f_{s,max}$ or f_k. You need these equations in part II of the lab.

III-1: Draw a free-body diagram for a block sliding on a horizontal surface, with no other applied force except the kinetic friction.

III-2: For the situation above, find an equation to calculate the coefficient of the kinetic friction μ_k from the acceleration a and the gravitational acceleration g. Also derive an equation to calculate the uncertainty $\delta\mu_k$ from δa and δg. You need these equations in Part III of the lab.