Static and Kinetic Friction

Part 1: factors affecting frictional forces

1. For a body moving on a horizontal plane, what are the forces acting on the body when you pull it along the surface? What do you think are the factors affecting this kind of motion?

2. In this step use the wooden block that has wooden surfaces and felt surfaces. Attach the dynamometer to the block (with the wooden side to the table) and try to move it by pulling slowly on the dynamometer, record the reading *at the instant just before the block starts moving*. Repeat the same process with the felt side to the table and with the other boxes you have and record your reading, what do you notice?

3. Flip the wooden block to its side so that it rests on a smaller lateral area and move it by pulling the dynamometer, record your reading and compare with reading from step 2 for the large wooden side. Does the contact area affect the frictional force?

4. Increase the mass of the block by putting an additional mass on top of it and record your reading of the dynamometer. What do you conclude?

5. The force of friction acting on an object is actually given by the equation $f = \mu N$ where N is the normal force on the object and μ is a constant called the coefficient of friction which is different for different materials. μ_s and μ_k for static and kinetic friction , respectively. Does this equation agree with your observations in the previous steps? Explain.

6. What kind of frictional force were you measuring with the dynamometer? Static or kinetic? Before the block starts to slide, how do you explain that the block remains at rest even though you are increasing the force you are applying?

Part 2: Kinetic Friction

In this part and part 3 use the block that has a wooden surface and a rubber black surface.

7. Attach the pulley to the surface keeping the surface horizontal. Set the block on the surface (let's call its mass m_0). Hang a second mass M at the end of a string passing over the pulley. This mass applies a force on the block. Increase M until it causes the system to move. As the mass M falls, the block slides on the horizontal surface. If the mass M is chosen so that its weight just balances the friction force, then the masses move at constant speed. *(Note: tap the surface slightly just in front of the block each time you increase M to test if it's going to start sliding)*

8. What are the forces acting on the system? Draw a free body diagram for each.

9. Apply Newton's law to the system to find an equation for the coefficient of kinetic friction.

10. If you add extra weights with total mass m on top of the block (so that the total mass of block and added weights is $m + m_o$, and increased M accordingly so as to move the block with constant speed, how would the equation you found in step 7 change? Suggest an experiment that would allow you to find the coefficient of kinetic friction using this new equation.

11. Carry out the experiment and tabulate your data and draw the needed graph and from it find μ_k . Also find from your graph the mass m_o of the block and compare it to the actual mass measured by a mass scale.

Part 3: Static Friction

12. Setup the inclined plane so that the support is the farthest possible point from the pivot. Place the block on the inclined plane with the wooden side down. What are the forces acting on the block? Is the block moving or not? Why?

13. Slowly move the support inward .Keep moving the support inward until the block starts to slide, Measure that angle of inclination. If you can't measure it directly, think of another method to find it.

14. Apply Newton's law and find the coefficient of static friction.

15. Return the support to its original position and repeat step 13 and 14 four more times and find the average μ_s.

16. From your results, which is larger μ_s or μ_k ? Does this explain to you why you needed to tap the surface in step 7?

Bonus question

- When you are trying to move a very heavy object like a desk, why does it seem like the hardest part is getting it to start moving while it gets easier to continue moving it after that?