Coefficient of Static Friction

Background:

When an object is at rest on a surface and an attempt is made to push it, the pushing force is opposed by a frictional force. If the pushing force is not strong enough to start the object moving, the object remains in equilibrium which means that the frictional force automatically adjusts itself to be equal to the pushing force. However, there I s a threshold value for the pushing force beyond which the body will break away and begin to slide. This situation may be expressed in equation form as:

$$f_s = \mu_s F_N$$

Where f_s is the frictional force in the static case and μ_s is the coefficient of static friction. It is found that, for most surfaces, μ_s, is slightly larger than μ_k, which means that a somewhat larger force is needed to start an object sliding than is needed to keep it sliding at a constant speed. This is why a slight push was necessary to get the block started for the measurement of μ_k.

Another way of investigating static friction is to observe the limiting angle of repose, defined as the maximum angle to which an inclined plane may be tipped before a block on the plane begins to slide. The block has a weight w=mg whose component **mgcosθ** is perpendicular to the plane and is thus equal to the normal force F_N. The component, **mgsinθ** is parallel to the plane and is the force urging the block to slide down the plane. As long as the block remains at rest f_s must be equal to **mgsinθ.** If the plane is tipped until at some value θ_{max}, the block just begins to slide:

$$\mu_s = \frac{\sin\theta_{max}}{\cos\theta_{max}} = \tan\theta_{max}$$

When a plane is gradually tipped up until the block just begins to slide, the coefficient of static friction is equal to the tangent of this angle.

Objective:

In this lab you are going to determine the coefficient of static friction between a set of objects and a wooden inclined plane.

Procedure:

1) Measure the length of the inclined plane and record it on your own paper.
2) Using the inclined plane, place a wooden block on the plane with its largest surface in contact, and gradually tip the plane up until the block just breaks away and begins to slide down. Be very careful to tip the plane slowly and smoothly so as to get a precise value of the angle with the horizontal at which the block just breaks away. This is the limiting angle of repose, θ. Measure the distance between the table and the top of the inclined plane (h) when the block begins to slide and record it on your own paper.
3) Determine the limiting angle of repose, $\theta = \sin^{-1}\left(\frac{h}{lengt\ h}\right)$. Record on your own paper.
4) Determine the coefficient of static friction, $\mu_s = \tan\theta$. Record on your own paper.
5) Repeat steps 2-4 two more times.
6) Take the average of the coefficients of friction and record on your own paper.
7) Repeat steps 2-6 for at least 2 of the following: ceramic tile, rubber pad, sandpaper, or metal strap.

8) Determine the percent error between your calculated coefficients of friction against the theoretical values:

Wooden block	0.3
Double Block	0.3
Ceramic Tile	0.1
Rubber Pad	0.55
Sand Paper	0.6
Metal Strap	0.35

9) Write a conclusion on this lab. Include a discussion of how accurately the coefficients you found match the actual coefficients of friction. How did the surface of the object affect the coefficient of friction? Did the values you found match what you originally thought?

$$\%error = \left(\frac{theoretical - measured}{theoretical} \right) x100$$