Survey of Physics

Lab 7: Friction

Name:_____

partner name(s):_____

Theory:

Friction is an important force that opposes motion. *Kinetic friction* is a force between surfaces in motion. *Static friction* is between surfaces that are not moving.

Both types of friction have the form $f = \mu N$, where N is the normal force and μ is the coefficient of friction.

Objectives:

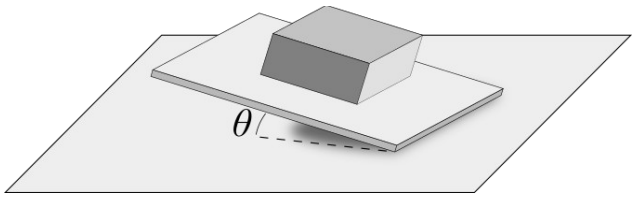
- find the coefficient of static friction by finding the angle at which it slides
- find the coefficient of kinetic friction by pulling a mass across a surface

Equipment: computer running Logger Pro, Vernier interface and force sensor, wood blocks, blocks with tire tread, various friction surfaces and mass sets, digital angle measure

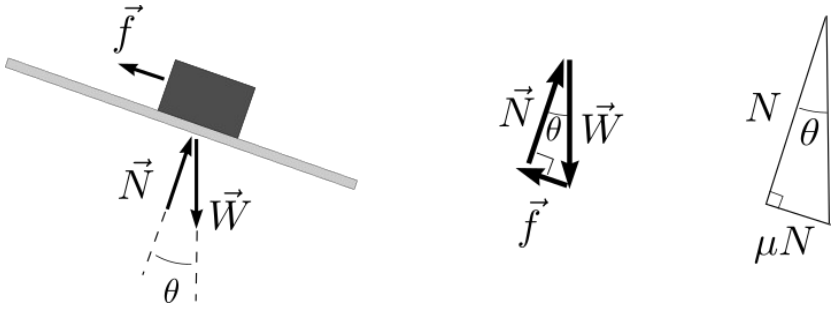
Procedure

Part 1: *Static Friction on an Incline*

1. Chose two types of block and two types of surface. Place a block and an angle measuring tool on a surface, then (while holding the angle measure so it does not slide), tilt the incline slowly. Find the angle at which the block *just begins* to slide. This is when the static friction is at the breaking limit, $f = \mu N$.



2. For a body at rest on an incline, the static friction force prevents it from sliding. In this case the three force vectors must add to zero: gravity ($W = mg$), normal force (N) and friction (f).



If we add the vectors by head-to-tail stacking (see figure), then it makes a right triangle, with friction ($f = \mu N$) on the opposite side and normal on the adjacent side to the angle θ.

Therefore:

$$\tan\theta = \frac{\mu N}{N} = \mu$$

3. For all combinations of the blocks and surface, measure the angle at which the just begin to slide. Complete the table below. Make sure to describe the type of block and type of surface

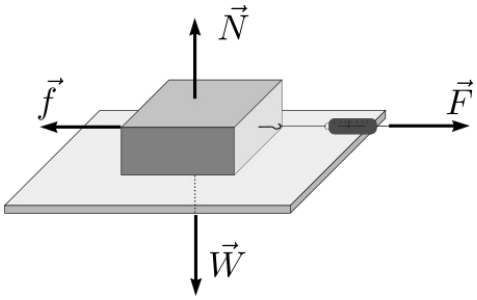
	block type:	block type:
surface:	$\theta =$	$\theta =$
surface:	$\theta =$	$\theta =$

4. Find the coefficient of static friction, μ, from the tangent of the angles you just measured.

	block type:	block type:
surface:	$\mu =$	$\mu =$
surface:	$\mu =$	$\mu =$

Part 2: *Kinetic and Static Friction*

1. Place a wood block on one of the surfaces, horizontally on the lab table. Connect it by string to a force sensor, which is read by Logger Pro.



   Before using the force sensor make sure to "zero" it when there is nothing touching the hook. This is done with the button that looks like Ø.

   Starting from rest, use the force sensor to gently and steadily pull on the block to start it moving. Pull along the table at a slow, steady velocity – keeping the string as level as possible.

   At constant velocity, the acceleration is zero, so the net force must be zero. In this case we expect the vertical forces to balance: $N = W = mg$. And the horizontal forces must balance: $F = f$

   So the applied force F must equal friction, and the normal force N must equal the weight mg. Therefore we can find the coefficient of friction from the applied force:

$$F = f = \mu mg \qquad \text{so} \qquad \mu = \frac{F}{mg}$$

2. You will need the mass of each block. Use the digital mass scales (on the back shelf) to find each mass.

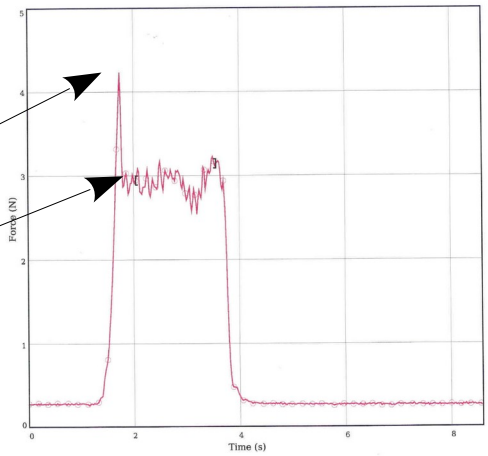
   block type: _____ mass m = _____

   block type: _____ mass m = _____

3. When you drag the block, your force graph should look something like the one shown here. Repeat the process a few times to get a good graph.

   The maximum static friction is at the peak force.

   The kinetic friction is the average force after the peak.



4. For each block and surface, record the maximum static friction force, and the average kinetic friction force.

	block type:	block type:
surface:	$f_{\text{static}} =$ $f_{\text{kinetic}} =$	$f_{\text{static}} =$ $f_{\text{kinetic}} =$
surface:	$f_{\text{static}} =$ $f_{\text{kinetic}} =$	$f_{\text{static}} =$ $f_{\text{kinetic}} =$

5. From the friction force and mass (see the equations in step 1), calculate the coefficient of static friction and the coefficient of kinetic friction in each case.

	block type:	block type:
surface:	$\mu_{\text{static}} =$ $\mu_{\text{kinetic}} =$	$\mu_{\text{static}} =$ $\mu_{\text{kinetic}} =$
surface:	$\mu_{\text{static}} =$ $\mu_{\text{kinetic}} =$	$\mu_{\text{static}} =$ $\mu_{\text{kinetic}} =$

Your static friction coefficients should be similar to those you found in Part 1. If not, check with the instructor.