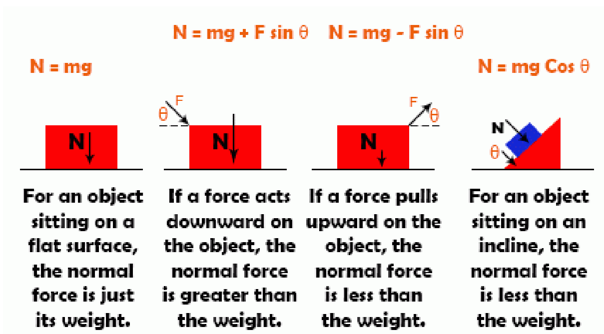
Friction Lab

Friction is a reaction **force** between two objects and is defined as the resistance that one surface or object encounters when moving over another. Frictional force depends on two factors

- Pressure between an object and the surface supporting it
- The degree of surface roughness between two objects

1. The amount of pressure between an object and the surface supporting it is called the **"normal force."** The normal force is comprised of the object's weight, multiplied by the cosine of the angle that its supporting surface makes with the horizontal.

$$F_n = Mass*g*Cosine(\theta)$$



In the instance that the supporting surface is horizontal, the pressure between the two surfaces is simply the weight of the object resting on its supporting surface

2. **The degree of surface roughness between two objects** is represented by the Greek letter **"Mu"** (μ), and represents the ratio of how much friction force is generated by a certain amount of surface pressure. Mu **has two variants**;
   - μ_s = Static Friction
   - μ_k = Kinetic Friction

μ_s , ("Mu sub-s"), for static friction, when objects don't move against each other, and μ_k , ("Mu sub-k"), for kinetic friction, when objects are in motion against each other. With the basics of friction force described, the mathematical relationships which describe, and quantify them can be written.

Purpose:

In this lab, students are to make some basic measurements of friction. Students will first measure the **coefficients of static friction** between an object and a surface. Next, students will measure the **coefficients of kinetic friction** using the same two combinations used to calculate the coefficient of static friction.

Materials

- Spring scale
- Weights
- Wood desk
- Sand paper
- Textbook
- Floor

Procedures

Part 1: Static Friction

The coefficient of static friction μ_s can be measured experimentally for an object placed on a flat surface and pulled using a known force. The coefficient of static friction is related to the Normal Force F_N of the object on the surface, when the object just begins to slide.

1. Students will test TWO different combinations of materials FIVE times.
    - Weight {Test object} and Wood desk
    - Weight {Test object} and sandpaper
    - Weight {Test object} and tile floor
    - Weight {Test object} and wood*
    - Weight {Test object} and foil pan
    - Weight {Test object} and textbook

2. Determine the mass of the weight provided.
3. Record the mass and material in the data table.
4. Students are to calculate the normal force (F_N) of the selected test object (weight) sitting on a flat surface (see previous illustration).
5. The student places the test object (weight) on the selected surface and hooks the spring scale to some convenient point on the object.
6. The student then begins to gently pull at a **horizontal angle**, noting the value on the scale.
7. As the reading on the scale increases, the student carefully watches for the maximum reading on the scale, until the object slips. The student records the reading on the scale when the object flips. This reading is F_f , friction force.
8. Students will perform the procedure SEVEN times, discarding the lowest and highest measurements. The remaining FIVE values are kept and averaged.
9. After the average reading has been obtained, students are to calculate the static coefficient of friction.
    - $\mu_s = F_f / F_n$
10. Students are to repeat procedures utilizing a different weight and surface.

Procedures

Part 2: Kinetic Friction Theory:

Students can calculate the coefficient of kinetic friction, μ_k using a variation of the method used for the coefficient of static friction. Students will measure μ_k using a procedure similar to the one used to measure μ_s. **Using the same combinations used for the static friction part of the experiment, students will measure the amount of kinetic friction.**

1. While moving the weight across the surface at a constant speed, record the reading of on the spring scale.
2. Students are to record data within data table.
3. Students are to discard the highest and lowest reading of the seven trials.
4. Students are to calculate the average kinetic friction.
5. Students are then to calculate the coefficient of kinetic friction.

Static Friction

Surface #1

Mass of Weight: -

Calculated Normal Force: -

Trial #	Friction Force
1	
2	
3	
4	
5	
6	
7	
Average Friction Force {Minus highest and lowest reading}: -	
Coefficient of Static Friction: -	

Static Friction

Surface #2

Mass of Weight: -

Calculated Normal Force: -

Trial #	Friction Force
1	
2	
3	
4	
5	
6	
7	
Average Friction Force {Minus highest and lowest reading}: -	
Coefficient of Static Friction: -	

Kinetic Friction

Surface #1

Mass of Weight: -

Calculated Normal Force: -

Trial #	Friction Force
1	
2	
3	
4	
5	
6	
7	
Average Friction Force {Minus highest and lowest reading}: -	
Coefficient of Kinetic Friction: -	

Kinetic Friction

Surface #2

Mass of Weight: -

Calculated Normal Force: -

Trial #	Friction Force
1	
2	
3	
4	
5	
6	
7	
Average Friction Force {Minus highest and lowest reading}: -	
Coefficient of Kinetic Friction: -	

Object	Surface	Normal Force	Average Static Friction	Average Kinetic Friction	Coefficient of Static Friction	Coefficient of Kinetic Friction

Post-Lab Questions

1. How do the values of μs compare to the values of μk? (Of course, you can only compare them for the same pairs of materials.)
2. Is the relationship between μs and μk what you expected?
3. Of the two parts of the experiment, measurement of μsand measurement of μk, which had more sources of error? What were some of the sources of error?
4. Could μk or μs ever be greater than 1? Explain why or why not. 5. Is the coefficient of friction the same as when the block was standing on its larger (or smaller) end? Is one value within one standard deviation of the other? 6. Think about your results. Do they make sense when you consider your everyday experiences?
5. Will a car's tires provide their best braking force when they are sliding, or when they are in normal contact with the road?
6. Why is it difficult to regain control of an automobile, once it enters a skid?
7. Of the materials tested in the sample panel, which would make the best pair for a braking system?
8. Why do heavier objects generate a greater friction force?
9. What is your conclusion about the values of static versus kinetic friction?