Friction lab report essay sample

This experiment measures the coefficient of static friction (μs) and kinetic friction (μk) between objects of different materials. Friction is a force that must be overcome before an object can move across a surface. A plain block of wood and a block of wood with sandpaper on one side and glass on the other were used. All of the blocks had a soup can with a mass of 0. 41 kg placed on top in order to provide enough mass to allow readings to be taken. They were moved along a wood plank while being attached to a 500-g spring scale in order to record the values when a) the block first moved, representing μs and b) as it traveled at a constant speed, representing μk. In one experiment the wood block was placed on its side and the experiment repeated. Overall, the results showed that μs > μk, and that the block that had the least surface area on the plank also had lower coefficients of friction when compared to one with more surface area on the plank.

Introduction

The purpose of this experiment is to observe the friction force and to determine the coefficient of kinetic friction as well as static friction of materials of different roughness. Various types of materials were used, as well as horizontal versus inclined ramps.

Friction occurs when two surfaces come into contact. The rough areas of each surface can come into contact and become cold-welded. Before an object can move over a surface, these cold-welds must be broken. It is a non-conservative force; the force used to overcome the frictional force and allow an object to move is dissipated into heat energy and will not return to the system once the movement stops.

Specifically, this lab will calculate the coefficient of friction. Unlike most coefficients in Physics, friction behaves differently depending on whether the object is at rest or at motion. (Nate). This is due to the cold-welds formed as discussed above. Once the object is in motion, cold-welds cannot form so therefore force is not needed to break them as in the case of a static object.

The first case, the static coefficient of friction, fs, is the force that keeps an object from moving. If there is an applied force to a block, and the block remains at rest, then fs = F. As the magnitude of F increases, fs will increase proportionally until is exceeded. It is proportional to the normal force, N, acting on the block. The basic equation for the coefficient of friction is: fs ≤ μsn

where μs is the coefficient of static friction. If the block is just about to move, then fs = fsmax = μsn. The force of friction is in the opposite direction of the movement. To calculate the coefficient of friction, the following equation will be used: μs = fsmax/FN

Friction is actually a much more complex force than it appears from this introduction, or from the following sets of experiments. Intuitively it would seem that the smoother the surface, the lower the coefficient of static friction would become. However, it has been found experimentally that when two very smooth pieces of metal have been stacked together, given that all contaminates have been removed and they are placed in a vacuum, they become cold-welded and the coefficient of static friction is very high. It has also been found that two sheets of smooth glass placed on top of each other have a higher coefficient of static friction than two sheets of roughly ground glass (Singh, 2007).

For the case of the coefficient of kinetic friction, F = fk if the block is moving at a constant speed. Once the force is removed that is causing the movement, the block will slow down and eventually come to rest. The only difference between the two coefficients is, once again, whether or not cold-welds have to be overcome. During movement those do not form, so $\mu k < \mu s$.

Lastly, the case of an inclined plane will be examined. Recall that the frictional force is proportional to the normal force acting on the block. The applied force acts perpendicular, normal, to the surface. The normal force is therefore calculated to be: $N = (mg) (\cos \theta)$

From this diagram, we can see the $\mu s = F/N$, where $F = mg*\sin \theta$ and $N = mg*\cos \theta$. Therefore $\mu s = mg*\sin \theta / mg*\cos \theta$, or $\tan \theta$ (Serway, 1994). For measuring purposes, $\tan \theta$ = height/base which will make the calculations much easier. The length of the plank is known, and the height can be measured. Using the Pythagorean Theorem, the base can be calculated and then used to determine μs.

Methods

Materials:

Ramp board, 4 feet long set at 10 cm off the ground.

Can of soup

500-g spring scale

Meter tape

Friction block set (one wood, one glass, one sandpapered)

Protractor

Procedure: 2

Part 1

1. A can of soup will be used to add weight to the friction blocks. Weigh the plain wood block and the can of soup. Record the combined weight in grams and Newton's. 2. Place ramp board horizontally on a table. Secure the board so that it does not slide. 3. Set the block and soup can on a board with the largest surface of the block in contact with the surface of the board. Connect the block's hook to the 500-g spring scale. 4. Using the spring scale, slowly pull the block lengthwise along the horizontal board. When the block is moving with a constant speed, note the force indicated on the scale and record. Repeat two more times. 5. While carefully watching the spring scale, start the block from rest. When the block just starts to move, note the force on the spring scale and record. Repeat two more times.

Part 2

1. Turn the wood block on its side.

2. Repeat the entire process from Part 1 three times and record the force of kinetic and static friction for each trial.

Part 3

1. Determine the force of kinetic and static friction for the glass surface and sandpapered surface blocks.

2. Repeat Parts 1 – 3 with at least two flat surfaces around the lab such as rubber, tile, cork, etc. Record the findings in tables similar to Data Table 3.

Part 4

1. Place the plain wood block with the largest surface in contact with the board while the board is lying flat. 2. Slowly raise one end of the board until the block just breaks away and starts to slide down. Be very careful to move the board slowly and smoothly so as to get a precise value of the angle of repose, θ_{max}. Measure with the protractor and record the result. An alternative way to measure for θ_{max} would be to measure the base and height of the triangle formed by the board, the support, and the floor or table. The height divided by the length of the base equals the coefficient of static friction: $\tan \theta = opp/adj$. 3. Perform two more trials. Return the board to the horizontal position and carefully move it up until the limiting angle of repose is reached.

Overall, the experimental results supported the theories on the coefficient of friction. In all cases, the kinetic coefficient of friction was smaller in value than the static coefficient of friction. While it was expected that the least difference between the two would to be with glass, it was actually sand paper on the wood plank. This is most likely because it took much more force to move the sandpapered block, and the roughness between the sandpaper and the plank made it difficult to keep a steady speed.

It is also expected that the coefficient of friction for the wood block would be the same whether the plank was flat or at an incline, but the difference between the two coefficients of static friction was 12. 7%. The coefficients for the wood on its side were lower than when the wood was on the side with the most surface area. This fits in with the concept that the rough parts of the material are cold-welded and difficult to move. When the block is on its side there is less contact between the block and plank, thus needing less force to move the block. The difference between the experimental values showed this to be true. On its back, μs was 0. 55 compared to a μs of 0. 42 when on its side. The same held true for μk, 0. 42 compared to 0. 28.

There is quite a bit of experimental error involved with the measurements. It was difficult to maintain a steady speed to measure μk. The plank used had quite a bit of raised grain that varied in pattern throughout the length of the board. This meant that the surface roughness was constantly changing as the block moved down the plank. Ensuring that the 500-g spring scale was at the same angle was also a challenge. Changes in angle could alter the readings on the scale, slightly. A few times the block was moved in such a way that a value of zero grams showed on the scale as the block was moving. It is suggested that the experimenter practice with the equipment before conducting the experiment.

The incline experiment was even more prone to error. The same issue of uneven plank surface was in evidence which meant the block had to be placed in the exact same position each time. This was accomplished by drawing an outline of the starting position. Sanding the plank would have helped in this area, though. The most difficult part was attempting to lift the board at a smooth, steady rate. It was difficult not to jerk it at some points, or to maintain a nice, slow, steady upward movement. Practicing lifting the board smoothly a few times before running the experiment will help lessen this problem. The manner in which the block was placed also affected the outcome. If the block was placed in such a way as to be pressed into the board, the height would become much greater before the block began to move. The experimenter had to take care to lightly place the block on the plank. Again, practicing placing the block in the same manner each time will help lessen this experimental error.

Overall, the experimental results for the Friction lab did back up the concepts and theories concerning friction. The static coefficient of friction was found to be larger than the kinetic coefficient of friction in all cases. The coefficients also increased when more surface area came into contact with the plank. Rough objects had greater coefficients of friction than smoother objects. From this experiment, it can be concluded that an object with a smooth surface on wood will require less force to move than an object with a rougher surface on wood. It can also be concluded that it takes less force to keep an object moving on wood, than the initial force needed to get it to move. Lastly, the less surface contact between an object and a surface, the less force needed to move the object.

References

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