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CTE Science Laboratory Investigation

THE COEFFICIENT OF FRICTION

**Introduction**

The coefficient of friction between to surfaces is important to understand in almost every aspect of life. Setting a toolbox down on a slanted roof, driving on a snowy road and making sure that you don’t slip while hiking all involve the interaction of two materials.

There are a few terms with which you must be familiar before understanding friction, however. The first is the normal force, usually indicated by the symbol Fn. The normal force is the force that an object is exerting straight down toward the center of the earth. In many cases, it is equal to the weight of the object.

Related to that is the concept of force. Force is the mass of an object multiplied by its acceleration. Put in terms of a formula:

**F = ma**

This is otherwise known as Newton’s second law of motion. So, if you want to increase the force that an object exerts, you can increase its acceleration (this is why a ball that is thrown at your face hurts more than one that is just placed upon it), or increase its mass (this is why an elephant hurts you if it sits on you, while a cat won’t).

Related to force is pressure. Pressure takes into account the force that an object exerts, and the area over which the force is exerted. Assuming a constant force, making the area smaller will increase the pressure. This is why, even if you use the same force, you can punch a hole in sheet metal with a small, pointed tool, but you can’t make a hole with a large rubber mallet. Put in terms of a formula:

**P = F/A**

We can put this all together and determine what factors affect friction. It turns out that friction is fairly simple to define, both in words and in terms of a formula. Friction is the force that opposes motion because of the interaction between two surfaces. So it depends on what the surfaces are and how much force is being applied to them. In terms of a formula:

**Ff = µFn**

So to figure out how much friction an object experiences, and in turn, to figure out how difficult it might be to get moving, all you need to know is the coefficient of friction and the normal force, which, for our purposes, will be equal to the weight of the object. The µ (Greek letter “mu”) in the formula above refers to the coefficient of friction, a dimensionless factor that is experimentally determined by testing the two materials involved. A lower coefficient of friction indicates that the objects slide more easily. The coefficient is different for different surfaces. Rubber on asphalt is different than rubber on ice, which is why tires perform differently on different surfaces.

**Purpose**

The purpose of this investigation is to calculate the coefficient of friction for several surfaces, as well as to differentiate between static and kinetic friction. You’ll also determine what factors go into creating friction and how these factors might be useful in your CTE class.

**Materials**

Wood block PENCIL

Masses Spring scales

Force plate

**Procedure**

PART I – THE COEFFICIENT OF FRICTION BETWEEN YOU AND THE FLOOR.

In this part, you’ll have to determine a way to measure the coefficient of friction between you and the floor. Remember what goes into the formula for friction, and what you might need to measure.

QUESTION 1: How will you calculate the coefficient of friction? That is, what things will you have to measure and the put into the formula to solve for μ?

|  |  |  |
| --- | --- | --- |
| **Normal Force (N)** | **Force of Friction (N)** | **Coefficient of Friction** |
|  |  |  |

Table 1. Data for friction between you and the floor.

QUESTION 2: Would the area of your body touching the floor affect the amount of friction?

PART II – MODEL DIFFERENT SCENARIOS WITH FRICTION

In this part, you’ll use blocks of wood and masses to explore friction further.

1. Obtain a block of wood.
2. Attach a spring scale to it and pull it across the table until it just starts to move. Have your partner read the spring scale while you pull it.
3. The point at which it JUST starts to move is the amount of force that it took to counteract the force of friction, so that force is equal to the force of friction. Record this force in your data table.
4. Do this four more times for a total of five trials.
5. Add 100 g of mass to your block and repeat the procedure, completing five trials.
6. Add even more mass (record the amount in your data table) and repeat the procedure again, completing five trials.
7. When you are done, calculate the normal force for each trial, as well as the coefficient of friction for each trial.

|  |  |  |
| --- | --- | --- |
| **Force to move with no mass** | **Force to move with 100 g** | **Force to move with \_\_\_\_\_\_\_g** |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

Table 2. Wooden block data.

|  |  |  |
| --- | --- | --- |
| **Trial** | **Normal Force** | **Coefficient of Friction** |
| **No mass** |  |  |
| **100 g** |  |  |
| **\_\_\_\_\_\_g** |  |  |

Table 3. Calculated wooden block data.

**Analysis**

QUESTION 3: Compare the coefficient of friction for each trial.

QUESTION 4: How would this experiment be different if you were pulling your block up (or down) a ramp?

QUESTION 5: How would this experiment be different if you were doing it on ice instead of your table?

QUESTION 6: We measured static friction. This is the friction that is preventing something from moving. There is a concept called kinetic friction, which is the friction that an object that is already in motion experiences. Do you think kinetic friction is greater than or less than static friction?

QUESTION 7: What are two things that you would change about this lab if you could?