Introduction to Friction Activity

**Purpose**: To observe and measure the variables that may affect the force of friction on an object.

**Equipment**: 4 Textbooks, Force sensor, GLX, assortment of fabrics

**Pre Questions:** What do you think are some factors that can affect the force of friction an object experiences? Explain your answer.

Would a frictionless world be a good place to live? Why or why not?

**Procedure**:

1. Measure the mass of 1 textbook. Record this value
2. Place the textbook on the table.
3. Set the GLX Sample Rate to 50, and have it set to graphs.
4. Begin recording on the GLX and push the textbook across the table with the force sensor. Make sure that you are just pushing it with enough force to keep it moving, but not speeding up.
5. Using the methods from the 2nd law lab, record the average force needed to keep the book moving.
6. Stack another textbook on the first one and repeat. Do this for all 4 textbooks.
7. Grab a piece of fabric/material and repeat process with the fabric between the books and the table.
8. Answer all questions.

**Data**:

Mass of 1 textbook: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |
| --- | --- | --- |
| Number of textbooks | Force of push on Table | Force of push on Fabric |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |

**Data Analysis**:

1. Draw the force diagram for a stack of books being pushed at constant velocity:
2. From your force diagram, can you create an equation for the friction force?
3. Calculate the Normal force for the different numbers of textbooks. Show sample calculation

|  |  |
| --- | --- |
| Number of textbooks | Normal Force |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |

1. Find the ratio of the friction force to the Normal force (f/N) for both surfaces. Show sample calculation.

|  |  |  |
| --- | --- | --- |
| Number of textbooks | Ratio for Table | Ratio for Fabric |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |

Avg: Avg:

1. How do these ratios compare to each other?
2. What do you think these ratios represent?
3. How would the friction change if the textbooks were pushed up a ramp? Explain your reasoning, draw a force diagram as part of your explanation.

As a class we will have a quick discussion on Static and Kinetic Friction, then work with your group to answer the remaining questions.

A 100 N box is initially held at rest against a rough vertical surface. The coefficient of static friction between the box and the surface is 0.6 and the coefficient of kinetic friction is 0.4. A woman is applying a horizontal force to the box to the right (positive *x-*direction) to hold it in place. Several students are discussing the frictional force on the box one second after she applies a horizontal force of 200 N:

Ari: “The frictional force is 60 N since the box will not be moving and the coefficient of static friction is 0.6.”

Bratislav: “The frictional force is 100 N upward since the box has a weight of 100 N downward.”

Curtis: “The frictional force will be 120 N since the box will not be moving and the normal force will be 200 N.”

Deshi: “The frictional force will be 40 N for the kinetic frictional force and 60 N for the static frictional force. The weight is 100 N and the coefficient of kinetic friction is 0.4 giving 40 N for the kinetic friction. Likewise, for the static frictional force it has a coefficient of static friction of 0.6 giving a static frictional force of 60 N.”

Which, if any, of these students do you think is right?

***Ari*** \_\_\_\_\_\_\_ Bratislav \_\_\_\_\_\_\_ ***Curtis*** \_\_\_\_\_\_ ***Deshi*** \_\_\_\_\_\_ None of them \_\_\_\_\_\_\_

Explain your reasoning.

A 100 N box is initially at rest on a rough horizontal surface. The coefficient of static friction between the box and the surface is µs = 0.6 and the coefficient of kinetic friction is µk = 0.4.

A 35 N force is applied to the box horizontally as shown.

Identify from choices (a)-(e) how each change described below will affect the frictional force on the box by the surface *one second after the horizontal force is applied*.

Compared to the case above, this change will:

(a) *increase* the frictional force exerted on the box by the surface.

(b) *decrease* the frictional force exerted on the box by the surface but not to zero.

(c) *decrease* the frictional force exerted on the box by the surface to zero.

(d) *have no effect* on the frictional force exerted on the box by the surface.

(e) *have an indeterminate* effect on the frictional force exerted on the box by the surface.

All of these modifications are changes to the initial situation shown in the diagram.

1. The weight of the box is changed to 50 N. \_\_\_\_\_\_

2) The weight of the box is changed to 200 N. \_\_\_\_\_\_

3) The applied force is increased to 50 N. \_\_\_\_\_\_

4) The applied force is increased to 80 N. \_\_\_\_\_\_

5) The coefficient of static friction is increased to 0.7. \_\_\_\_\_\_

6) The coefficient of kinetic friction is increased to 0.5. \_\_\_\_\_\_

7) The coefficient of kinetic friction is increased to 0.5 and the coefficient of static friction is increased to 0.7. \_\_\_\_\_\_

8) The weight of the box is changed to 200 N and the coefficient of static friction is increased to 0.7. \_\_\_\_\_\_

9) The weight of the box is changed to 200 N and the coefficient of kinetic friction is increased to 0.5. \_\_\_\_\_\_

10) The weight of the box is changed to 200 N and the applied force is increased to 50 N. \_\_\_\_\_\_