

Coefficient of Static Friction Activity (Teacher)

In this activity, you will explore factors potentially affecting the coefficient of static friction: **surface area**, **mass**, and **surface material**.

There are two methods given to perform this experiment. In the first, **Option A**, a box is pulled across a horizontal surface using the force of gravity acting on an attached basket. In **Option B**, a ramp is lifted until the point where a box starts moving.

Your group may also come up with another, more innovative, method to determine the coefficient of friction.

You will test a minimum of 4 different materials.

Group Materials

- 1 m fishing line
- Small cardboard boxes of varying sizes (i.e. 10 cm x 10 cm x 10 cm or 12 cm x 12 cm x 12 cm)
- 1.2 m ramp
- Stopwatch
- Various masses
- Small wicker or plastic basket with a handle
- Desk or table
- Scale
- Tape

Additional Materials:

- Wax paper
- Several grids of sandpaper
- Felt
- Aluminum Foil
- Different types of cardboard
- Talcum powder
- Water
- Oil

Part A: Box and Basket Instructions

1. Record the masses of the box and the basket (in kg).
2. Tie the fishing line around perimeter of the box and tape it around the box.
3. Once in place, tape the line in place so that it does not slip off or shift during testing.
4. Attach the other end of the line to the basket handle and hang the basket off the edge of a desk/table while placing the box in the center of a desk/table.
5. Place a mass (~500 g) in the box, and slowly and gently add masses, in 5-10 g increments, to the basket until the box just begins to slide.
6. Record the total mass in the basket that finally caused the box to begin sliding.

Part B: Ramp Instructions

1. Create a ramp using some books or other objects to make a “rise”. Mark the starting point with tape or a marker.
2. Place a mass (~500 g) in the box near the top of the ramp and gradually raise the end of the ramp until the box begins to slide down. Repeat this step 2 or 3 times.
3. Use a metre stick or tape measure to measure the “rise” and “run” of the ramp.
4. Record the “rise” and “run” of the ramp.

Analysis

- A. Draw a set-up diagram and free-body diagrams for either **A. Box and Basket**, **B. Ramp**, or **another set-up** of your choice.
- B. Use the Coefficient of Friction Data Sheet to record data and then calculate the coefficient of friction for each trial.
- C. Why use fishing line instead of string or thread for this experiment?

Fishing line is used because it is smoother and will not affect the experiment as much.

- D. How is the coefficient of friction affected by changing the mass in the box?

The coefficient of friction is unaffected by changing the mass in the box. The coefficient of friction is independent of mass.

- E. How is the coefficient of friction affected by changing the material under the box?

Changing the material under the box changes the coefficient of friction. Different materials will have a greater coefficient of static friction and it will, therefore, be more difficult to get the mass moving. For example, sandpaper has a higher coefficient of friction than wax paper. It is more difficult to start a mass moving on sandpaper.

- F. How is the coefficient of friction affected by changing the size of the box?

The size of the box does not affect the coefficient of friction because if the area of contact doubles, you may think that you should get twice as much friction. But when you double the length of an object, you halve the force on each square centimeter, because less weight is above it to push down.

- G. Why can you not use the same calculations to determine both the static and kinetic coefficients of friction?

The coefficient of static friction can be calculated because it is the ratio between the frictional force and the normal force acting on the mass at the moment it begins to slide. However, the coefficient of kinetic friction must be calculated when the object is moving at a constant velocity, and this would be much more difficult to set up with these materials.

- H. List at least one other way in which to reduce the coefficient of static friction?

To reduce the coefficient of static friction between two surfaces, one could coat the surfaces in oil.

- I. Name at least 2 sources of experimental error in this experiment.

Two sources of error may include: movement along more than one axis, overfilling the basket in Part A, lifting the ramp too quickly in Part B, etc.

Activity adapted from

https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_energy/cub_energy_lesson04_activity2.xml.