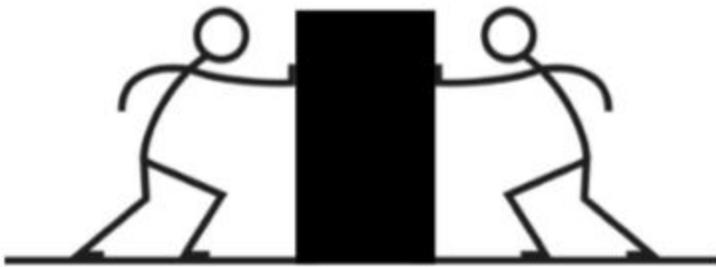


Unbalanced Forces: How Does Surface Area Influence Friction and the Motion of an Object?

Introduction

The motion of an object is determined by the combination of all the forces acting on that object. Those forces may come in the form of a simple push or pull that result from contact forces, such as pushing a box with your hand, or non-contact forces, such as gravity pulling an object toward Earth. When forces are acting on an object from the same direction, the influence of each force is added together. Think of two people pushing a box across the floor. If they push from the same

Two people pushing on opposite sides of a box

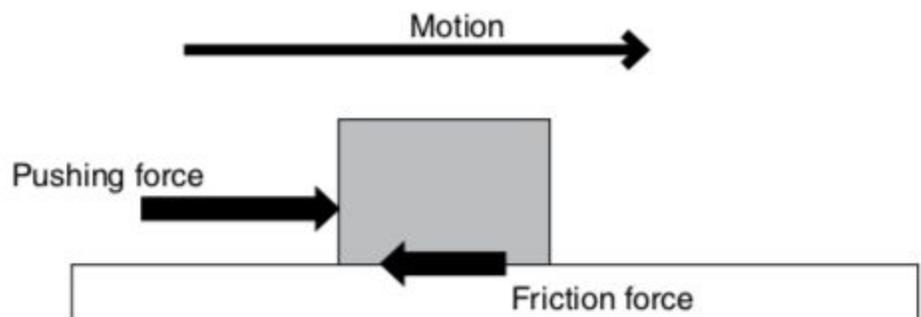


side, the forces acting on the box are unbalanced, meaning that there is more force on one side of the box than the other. When the forces acting on the box are unbalanced, the box moves in the direction of that force. However, if the two people stand on opposite sides of the box and push again, their forces are working against each other (see figure to the left). One person is trying to push the box to the right and the other person is trying to push the box to the left. In this case, their forces are balanced and cancel each other out. When the forces acting on an object are balanced, the motion of the object does not change.

When two people push on a box in opposite directions, it's easy to see that there are opposing forces acting on the box, but sometimes there are opposing forces acting on an object that are less obvious. If you give a book a push and let it slide across a table, it will eventually come to a stop. The book stops because there is an opposite force acting on it, just like the person pushing on the opposite side of the box. The force that causes the book to come to a stop is called friction. Friction is a force that occurs when two surfaces are in contact with each other. The force of friction always works on an object in a direction that is opposite of the motion of the object (see figure below). Therefore, friction is always trying to slow an object down or keep an object from moving. Trying to slide a heavy object is often difficult due to friction. Placing a heavy object on a cart with wheels can make it easier to move. The amount of friction is greatly reduced by the wheels, so it is easier to move the heavy object.

The amount of friction between two objects depends on several factors. One important factor is the specific surfaces involved. The amount of friction between two objects as they slide past one another depends on the specific surfaces that are rubbing against each other. For example, a cardboard box sliding on a wooden floor has a different amount of friction

A box sliding across the floor experiences a friction force that opposes the motion of the box.



than the same cardboard box sliding on a carpet floor. Different combinations of surface materials will result in different amounts of friction. Another factor that influences the amount of friction is the weight of the object that is moving. The heavier the object, the more friction there will be that opposes the motion of the object.

Reducing friction is often an important goal when there is work to be done. There are many different ways that someone can try to reduce the amount of friction when moving an object. One strategy is to change the surface that an object is sliding on. For example, there is very little friction between ice and other materials, therefore objects slide over ice very easily. Another strategy for reducing the amount of friction when trying to slide an object would be reducing the mass of the object; then there would be less force between the moving object and the surface it is sliding on. A third strategy would be to change the shape of the object and change the amount of contact between the two surfaces that are rubbing together. For example, instead of sliding two separate boxes side by side, perhaps stacking them one on top of the other would reduce the amount of friction and make them easier to move.

Your Task

Use what you know about forces and motion, patterns, and stability and change to design and carry out an investigation that will allow you to test how changing the amount of surface area between two objects influences the amount of friction between the objects and how changing the amount of surface area influences the motion of the object.

The guiding question of this investigation is: ***How does surface area influence friction and the motion of an object?***

Materials

You may use any of the following materials during your investigation:

- Friction block set
- 20 N spring scale
- 10 N spring scale
- 5 N spring scale
- Mass set
- Meter Stick
- Stopwatch

Getting Started

To answer the guiding question, you will need to design and conduct an investigation to measure the amount of friction between the friction block and the surface of your table and test how changes in the amount of surface area influence the motion of the block. To accomplish this task, you must determine what type of data you need to collect, how you will collect it, and how you will analyze it.

To determine *what type of data you need to collect*, think about the following questions:

- How will you determine the force due to friction?
- What information or measurements will you need to record?
- How will you determine the surface area of the block?
- Will you test different surface combinations?

To determine *how you will collect your data*, think about the following questions:

- What equipment will you need to collect the data you need?
- How will you make sure that your data are of high quality (i.e., how will you reduce error)?
- How will you keep track of the data you collect?
- How will you organize your data?

To determine *how you will analyze your data*, think about the following questions:

- How will you determine the influence of surface area on friction and motion of the block?
- What type of table or graph could you create to help make sense of your data?

To help you write your conclusion:

The impact of balanced versus unbalanced forces is summed up in Newton's second law of motion, which describes that the acceleration of an object is directly proportional to the sum of the forces acting on that object and inversely proportional to the mass of the object. Also gleaned from Newton's second law of motion is the concept that the motion of an object will not change unless the object is acted on by an unbalanced force. Newton's second law of motion is often written as follows:

$$\Sigma F = ma, \text{ where}$$

- ΣF is the sum of the forces (F) or net force on the object;
- ΣF is measured in newtons ($1 \text{ N} = 1 \text{ kg}\cdot\text{m}/\text{s}^2$);
- m is the mass of the object, measured in kilograms (kg); and
- a is the acceleration of the object, or the change in velocity for the object, measured in meters per second squared (m/s^2).

Report

Once you have completed your research, you will need to prepare an investigation report that consists of four sections (be sure to have section headings):

1. Introduction: Give some background information on the topic. Explain what question were you trying to answer and include a hypothesis. (Background info, research question and hypothesis)
2. Procedure: What did you do during your investigation and why did you conduct your investigation in this way? (How you collected and analyzed data)
3. Data: Include a data table and/or graph to show your results. Be sure to include a title for your table or graph with labels for the variables.
4. Conclusion: What is your argument? (Claim - Evidence - Reasoning)

Your report should answer these questions in two pages or less. The report must be typed, and any diagrams, figures, or tables should be embedded into the document. Type your report on Google Docs (12 point font, double-spaced) and share it with your teacher. Your report will be graded based on the rubric in the class syllabus.