

Curriculum Embedded Performance Task

Middle School Science

Content Standard 8.1



Shipping and Sliding

Student Materials

Connecticut State Department of Education
Bureau of Curriculum and Instruction

Shipping and Sliding

A Guided Exploration of Factors Affecting Friction

ENGAGE

Many of the products we use are made or grown in other countries and sent here by plane, boat or truck. Some companies that make televisions, for example, put them in wood boxes that are carried here by cargo ships. When ocean waves cause the ship to tilt from side to side, the boxes sometimes slide across the cargo room floor and damage the televisions packed inside. Increasing the friction in the cargo room may solve the problem. The television manufacturer is willing to change the box materials and the shipping company is willing to change the floor materials. Imagine that you have been hired to conduct a friction study that will explore ways to increase the friction force and solve the problem of the sliding boxes.

EXPLORE

First, you and your partners will design and conduct experiments to find how friction is affected by different box and floor materials. Next, you will identify and explore another variable that may also affect friction. Then, you will analyze your experimental findings to make recommendations to the television manufacturer or the shipping company.

Get Ready

The first question you will explore in this investigation is the friction force created when different surface materials slide against each other. Gather a variety of different textured materials from home or school that you can test by attaching them to a model shipping box or cargo room floor. You may choose to experiment with **floor** materials (such as felt, carpet, sandpaper or tiles), or you may choose to test different **box** materials such as plastic, metal, wood or different papers.

Bring these materials to class the day before you begin your friction experiments.

In addition to your own collection of textured materials, your teacher will provide your group with the following supplies:

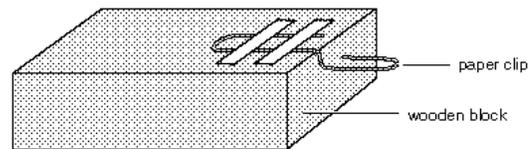
20 small washers	2 plastic cups to hold washers
20 large washers (or 25g, 50g, 100g, 200g weights)	Ruler
1 wooden block (approx. 10cm x 6cm x 3cm) *	Masking tape
1 Masonite test surface *	String (1 m)
2 or 3 jumbo paper clips	Access to a balance or scale
A plastic cylinder (a pen, for example)	Graph paper
	Various surface materials for testing

Experiment #1: Effect of Materials on Friction Force

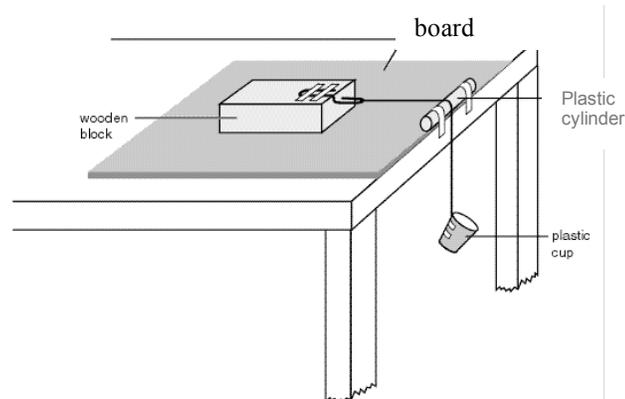
In this investigation, you will explore which combinations of floor and box materials create more or less friction. A simple way to measure friction is described below:

A Method for Testing Friction:

1. Construct a model shipping box like the one in the diagram below. The paper clip will allow you to pull the box with a measured amount of force:



2. Use a piece of cardboard as a model of a cargo room floor.
3. Tape a plastic cylinder along the edge of your work table. Place the cardboard shipping floor on your work table near the plastic cylinder.
4. Tie a loop at one end of the string and attach the loop to the paper clip. Drape the string over the plastic cylinder and use tape to attach the plastic cup to the other end of the string (see diagram below).



5. By adding small washers to the plastic cup, you can measure the pulling force needed to start the box moving. The more force needed to start the box moving, the greater the friction between the floor and the box materials. You can keep track of the number of washers, or you can find the mass of a single washer and keep track of the total mass needed to start the box moving.

Conduct Your Experiment

1. Identify the **question** you will investigate.
2. **Predict**, based on your experiences, which materials will have the greatest and least amount of friction.
3. Design a **procedure** to collect data to answer your research question. Identify the **independent** and **dependent** variables in your experiment. Think about the parts of your experiment that should be kept **constant** so you can collect consistent data.
4. Write your procedure in your science notebook. Include enough detail so that you or someone else could repeat your experiment.
5. Create a **data table** to record data related to your experiment.
6. Do your experiment and **record** your findings in your data table.
7. Think about the data you have collected. Do the data for each trial seem reasonable? If not, do you need to repeat any trials to correct any **errors**?
8. **Analyze** the data.
9. **Interpret** the data. Write your conclusions in your science notebook.
10. **Compare** your experimental design and results with others in your class.

Sometimes, people need to increase friction in order to perform a task. For example, adding ridges to a bicycle tire gives it better traction. At other times, people need to decrease friction. For example, grease is applied to the wheels of a bicycle to reduce friction and let the wheels spin easily.



In addition to the properties of the surface materials, what other factors do you think might affect friction?

Experiment #2: Effect of Mass or Surface Area on Friction Force

Design and conduct an experiment to explore one of these factors. Keep a detailed and organized record of your experimental design, data collection and analysis in your science notebook.

1. What **ideas** do you have about the way in which mass or surface area might affect friction? Discuss your ideas and predictions with your partners.
2. Identify the **question** you will investigate and the results you **predict**.
3. Design a **procedure** to collect data to answer your research question. Identify the **independent** and **dependent** variables in your experiment. Think about the parts of your experiment that should be kept **constant** so you can collect consistent data.
4. Write your procedure in your science notebook. Include enough detail so that you or someone else could repeat your experiment.
5. Create a **data table** to record data related to your experiment.
6. Do your experiment and **record** your findings in your data table.
7. Think about the data you have collected. Do the data for each trial seem generally consistent? If not, do you need to repeat any trials to correct any **errors**?
8. **Analyze** the data. Show your calculations in your science notebook.
9. **Graph** your analyzed data. Think about the most appropriate type of graph to show a relationship between two variables.
10. **Interpret** the data. Based on your experiment, what conclusions can you make about the effect of surface area or mass on the friction between two surfaces?
11. Share and compare your results with others in your class. How were they alike? How were they different?

Communicate Your Findings

Use the findings from your friction experiments to solve the sliding box problem. Talk with your partners about what changes might be made to the shipping boxes, the way the TVs are packed in the boxes, or the cargo room floor to increase the friction and reduce the sliding.



Write a Report:

Write a report to the TV manufacturer or the shipping company describing your research and recommendations for reducing the sliding of the shipping boxes.

Your report should include:

- a clear statement of the problem you investigated;
- a description of the experiments you carried out;
- the results of your experiments (including data presented in the form of charts, tables or graphs);
- your conclusions from the experiments;
- comments about how experimental errors may have affected your results; and
- a recommendation to the company about changes that should be made to the shipping boxes or the cargo room floor to reduce the sliding box problem on the ship.