Curriculum-Embedded Performance Task Middle School Science

Content Standard 8.1



Shipping and Sliding

Student Work

Connecticut State Department of Education 2011 Edition

Inquiry Component I - Raising Questions

NAME:

Shipping and Sliding

A Guided Exploration of Factors Affecting Friction

Many 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 crates that are stored in the cargo rooms of freight ships. When ocean waves cause the ship to tilt from side to side, the crates can slide across the cargo room floor and damage the televisions packed inside. Increasing the friction in the cargo room may solve the problem.

Friction is a force between objects that opposes the relative motion of the objects. In this project, you will be studying *kinetic friction* (also called *sliding friction*). When two objects are moving relative to one another, kinetic friction converts some of the kinetic energy of that motion into heat. You can feel the heat of kinetic friction if you rub your hands together. Think about what happens if you rub your hands against a smooth, polished surface, like wood furniture, compared to a surface with a rougher texture, like denim cloth. Which surface produces more kinetic friction?

First, you and your partners will design and conduct experiments to find how friction is affected by different crate 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.

Gather a variety of different textured materials that might be useful for **reducing** sliding. You may choose to experiment with **floor** materials (such as felt, carpet, sandpaper or tiles), or you may choose to test different **crate** materials such as plastic, metal, wood or different papers These can be attached to a model shipping crate or a cargo room floor.

Observe the different materials with and without the hand lens. Notice different properties such as texture, luster, hardness, etc. **Record** your observations in a chart below.

PROPERTIES OF FLOOR MATERIALS

What factors do *you* think will act to increase or decrease kinetic friction? Consider your observations and your experiences. Factors that might affect friction include:

Choose one factor to investigate and write a scientific question:

NAME:

Investigation 1: Effect of Properties of Materials on Friction Force

In this investigation, you will explore the effect of floor and crate materials on the amount of friction force. A simple way to measure friction is described below:

A Method for Testing Friction:

1. Construct a model shipping crate like the one in the diagram below. The paper clip will allow you to pull the crate 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 crate moving. The more force needed to start the crate moving, the greater the friction between the floor and the crate materials.
- 6. 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 crate moving.

Inquiry Component II - Collecting Data

NAME: _____

Design a procedure to explore properties that affect the friction associated with different materials. In this experiment, the dependent variable is "friction." Describe how you will change the independent variable, measure the dependent variable, and keep the other factors constant in your experiment. Include enough detail so that you or someone else could repeat your experiment and get similar outcomes. Repeat trials to gain confidence in your results.

DEPENDENT VARIABLE: _____

INDEPENDENT VARIABLE: _	
CONSTANTS:	

PREDICTION: _____

I predict this because I think that

PROCEDURE:

Get your teacher's approval before you begin your experiment._____

Inquiry Component III - Working With Data

NAME: _____

Conduct your experiment and record your data in a table in the space below. Do the data seem reasonable? If not, do you need to repeat any trials to correct errors? What must be done to the data to make sense of it?

Change the table so it fits your experiment:

(Title)

Inquiry Component III - Working With Data

NAME: _____

Display your data in an appropriate graph. Be sure to:

- Consider what kind of graph is most appropriate to show the data collected
- Include a title and scale, and label each axis with a variable
- Plot appropriate and accurate data that will lead toward a conclusion



Inquiry Component IV - Communicating Conclusions

NAME: _____

- What conclusion can you make based on your data? Write a brief report describing your experiment, your findings, and how they compare to your prediction. Your report should include:
- The question you were investigating
- A summary of your procedure and your data
- A reasonable conclusion supported by data
- A scientific explanation of your findings
- Suggestions for making improvements to the investigation
- New questions you have about factors that affect kinetic friction

Inquiry Component I – Raising Questions

NAME: _____

INVESTIGATE THROUGH RESEARCH



Read books, magazines and Internet sites to learn more about what causes friction and how it affects the design of machinery, such as cars or bikes, or sports performance, such as snowboarding or basketball.

Summarize your understanding of kinetic friction and how it applies to the real world:

Inquiry Component I-Raising Questions

NAME: _____

Investigation #2: EFFECT OF OTHER FACTORS ON FRICTION FORCE

In addition to the properties of the surface materials, what other factors do you think might affect friction? What about the size or weight of an object? Consider your observations, your research and the data you collected in Investigation 1. Factors that might affect friction include:

Choose one factor from your list to investigate and write a scientific question on the lines below:

Design a procedure to explore a friction factor.

DEPENDENT VARIABLE:	
INDEPENDENT VARIABLE:	
CONSTANTS:	

PREDICTION: _____

I predict this because I think that

	Inquiry Component II –Collecting Data NAME:
QUESTION:	
PROCEDURE:	

Get your teacher's approval before you begin your experiment._____

Inquiry Component III – Working With Data

NAME: _____

Conduct your experiment and record your data in a table in the space below.

Display your data in an appropriate graph.

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Inquiry Component IV - Communicating Conclusions

NAME: _____

What conclusion can you make based on your data? Write a brief report describing your experiment, your findings, and how they compare to your prediction. Remember to discuss how confident you are in your results and what might improve your experiment:

Inquiry Component IV - Communicating Conclusions

NAME: _____

Apply your findings

Use the findings from your friction investigations to solve the sliding crate problem. Talk with your partners about what changes might be made to the shipping crates, the way the TVs are packed in the crates, 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 crates.

Your report should include:

- a clear statement of the problem you investigated;
- a summary of relevant scientific information;
- 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 crates or the cargo room floor to reduce the sliding crate problem on the ship.