ACTIVITY 22

Friction

BROWARD COUNTY ELEMENTARY SCIENCE BENCHMARK PLAN

Grade 5—Quarter 3
Activity 22

SC.C.2.2.2
The student knows that an object may move in a straight line at a constant speed, speed up, slow down, or change direction dependent on net force acting on the object.

SC.C.2.2.4
The student knows that the motion of an object is determined by the overall effect of all of the forces acting on the object.

SC.H.1.2.1
The student knows that it is important to keep accurate records and descriptions to provide information and clues on causes of discrepancies in repeated experiments.

SC.H.1.2.2
The student knows that a successful method to explore the natural world is to observe and record, and then analyze and communicate the results.

SC.H.1.2.3
The student knows that to work collaboratively, all team members should be free to reach, explain, and justify their own individual conclusions.

SC.H.1.2.4
The student knows that to compare and contrast observations and results is an essential skill in science.

SC.H.3.2.2
The student knows that data are collected and interpreted in order to explain an event or concept.

ACTIVITY ASSESSMENT OPPORTUNITIES

The following suggestions are intended to help identify major concepts covered in the activity that may need extra reinforcement. The goal is to provide opportunities to assess student progress without creating the need for a separate, formal assessment session (or activity) for each of the 39 hands-on activities at your grade.

1. Point out that although friction may require additional work to move some things, it can be an advantage in certain situations. Ask students to list a few occasions where friction is helpful. (Friction is useful when we walk, ride a bike, throw an object, or drive a car.) As a follow-up, ask students to list the role friction plays in a few sports activities. (Possible examples: runners need friction to move on a track; basketball players need friction to run

as well as shoot the basketball, and the basketball needs friction to rebound off the backboard; football players need friction to run and accurately throw or catch the ball.)

2. Use the Activity Sheet(s) to assess student understanding of the major concepts in the activity.

In addition to the above assessment suggestions, the questions in bold and tasks that students perform throughout the activity provide opportunities to identify areas that may require additional review before proceeding further with the activity.

ACTIVITY 22

Friction

OBJECTIVES

Students examine friction and how it affects the amount of force needed to move an object a certain distance.

The students

- observe the effects of friction
- examine variables that increase and decrease friction
- discover one method of reducing friction

SCHEDULE

About 40 minutes

VOCABULARY

friction
lubricant

MATERIALS

For each student

1	Activity Sheet 22
1 pr	safety goggles*

For each team of four

1	book*
1	meterstick*
1	spring scale
1 piece	string (from Activity 21)
1	wooden board†

For the class

	paper towels*
1 tube	petroleum jelly
8 shts	sandpaper
1 pair	scissors*
1 roll	tape, masking
8 shts	waxed paper

*provided by the teacher

†in separate box

PREPARATION

1. Make a copy of Activity Sheet 22 for each student.
2. Cut each sheet of sandpaper into strips approximately 8 cm (about 3 in.) wide and 25 cm (about 10 in.) long. Cut each sheet of waxed paper in half.
3. Each team of four will need a book, a spring scale, a meterstick, a 1-m piece of string, three strips of sandpaper, two pieces of waxed paper, a wooden board, a few long strips of masking tape, a dab of petroleum jelly, and some paper towels.

BACKGROUND INFORMATION

The number-one enemy of any machine is friction. ***Friction*** is a force that resists motion whenever the surfaces of two objects rub against each other.

Regardless of how it may feel, no surface is perfectly smooth. All surfaces contain imperfections—tiny bumps, craters, and sliverlike "projections." When two surfaces are rubbed against each other, the roughness of one surface catches on the roughness of the other surface, resulting in friction. ***Lubricants*** are substances that reduce friction between solid surfaces by smoothing over the bumps, craters, and projections on these surfaces.

In this activity, students pull a heavy object over surfaces that produce varying degrees of friction, then observe one method of reducing friction.

▼ **Activity Sheet 22**

Friction

Work = Force × distance

1. Record your observations in the table below. For each surface tested, calculate the amount of work performed.

Surface tested	Force (newtons)	distance (meters)	Work (joules)
wooden board	middle	0.6	middle
sandpaper	most	0.6	most
waxed paper	least	0.6	least

2. On which surface was the most amount of work done by moving the book? Why?

The sandpaper; the friction was the greatest.

Guiding the Activity

1 Begin by instructing the students to stand behind their desks with their chairs pulled out. Tell them to push their chairs in, then pull them back out again. Ask, **Why did you have to use force to move your chair?**

Answers will probably involve the weight of the chair.

Have the students observe, feel, and then describe the texture of both the floor and the feet of their chairs. Have them pay particular attention for signs of wear.

Ask, **What caused the wear?**

The students will probably say that dragging the chairs across the floor caused the wear.

Explain that no matter how smooth a surface may feel, there are always rough spots—tiny bumps, craters, and sliverlike "projections"—on that surface. When the chair was pushed and pulled, the roughness on the surface of the floor rubbed against the roughness on the surface of the chair feet, making it somewhat difficult for the two objects to slide past each other.

Additional Information

Guiding the Activity

Additional Information

Write the word *friction* on the board. Explain that **friction** is the resistance created by two surfaces rubbing together.

2 Have the students rub their hands together briskly until their palms become warm. Then ask, **Where did the heat come from?**

Students may suggest that friction produced the heat.

Explain that when two objects are rubbed together, the friction between the two surfaces produces heat.

Tell students that in this activity, they will investigate friction, its causes, and how to reduce it.

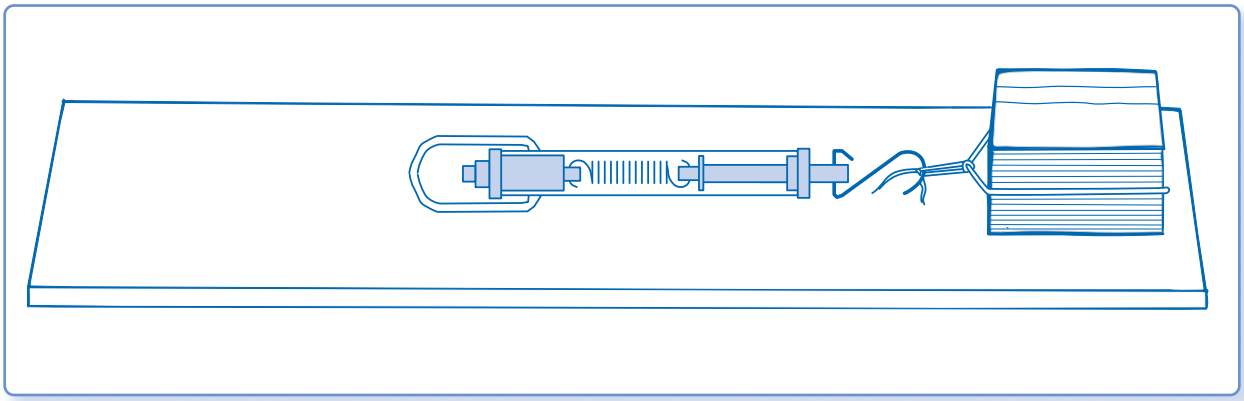
3 Distribute a copy of **Activity Sheet 22** to each student, and a wooden board, a spring scale, a piece of string, a meterstick, three sandpaper strips, two pieces of waxed paper, and a few long strips of masking tape to each team.

Have students use their metersticks to measure the length of the wooden board.

Each board is 0.6 m (60 cm) long.

4 Instruct the students to place the board flat on the floor or desktop. Tell them to tie one end of the string around one of their books and the other end to the spring scale, and place the book at one end of the board (see Figure 22-1). Have one student hold the board still while another uses the spring scale to pull the book the entire length of the board.

Students should tie the string around the book so that no string is under the book as it is pulled.



▲ ***Figure 22-1.*** *The setup.*

Guiding the Activity

Guiding the Activity	Additional Information
Have the students record on their activity sheets the force required to move the book and the distance the book was moved. Then have them calculate the amount of work done.	*You may need to remind them of the equation* W = F × d.
5 Next, instruct the students to place their sandpaper strips end to end and tape them to the board. Tell them to use the spring scale to pull the book across the sandpaper the entire length of the board. Remind them to record their results on Activity Sheet 22.	
6 Finally, instruct the students to remove the sandpaper, place the pieces of waxed paper end to end, and tape them to the board. Tell them to repeat the procedure, dragging the book the length of the board. Remind them to record their results on the activity sheet.	
7 After everyone has finished experimenting, recording, and calculating their results, ask, **In which of the three setups did you do the most work?**	*The students should realize that, because the distance was the same for each trial, they did the most work when they used the most force—that is, when they moved the book across the sandpaper.*
Ask, **Why do you think more force was needed to move the book across the sandpaper than across the other surfaces?**	*The students might point out that the surface of the book seemed to stick to, or get caught on, the surface of the sandpaper.*
Ask, **What was different about the board in each setup?**	*the smoothness of the surface of the board*
Ask, **In which setup was the book easiest to move?**	*when the book was moved across the waxed paper*

Guiding the Activity

	Guiding the Activity	Additional Information
	Ask, **Why do you think the book moved most easily across the waxed paper?**	*If the students do not mention it, point out that the surface of the waxed paper was smoother than both the surface of the plain board and the surface of the sandpaper, and so did not catch as much on the surface of the book.*
	Ask, **In which situation did the book and the surface of the board display the most friction? The least friction?**	*The students should note that the most friction occurred when the book was moved over sandpaper, and the least friction occurred when the book was moved over waxed paper.*
8	Ask, **What rule can you state about friction and the surfaces of objects rubbing against one another?**	*The smoother the surfaces that rub together, the less friction there will be.*
9	Ask, **What other variables might increase or decrease friction between two surfaces?**	*If the students do not mention it, prompt them to think about wet and dry surfaces.*
	Tell students to rub their thumb and forefinger together and listen to the sound it makes. Tell them that this sound is produced by the friction between the surfaces of their two fingers. Ask, **What else do you notice about your two fingers?**	*Students may notice that their fingertips have become warm. Remind them that heat is produced by friction.*
10	Walk around the room and apply a dab of petroleum jelly to each student's forefinger. Tell the students to rub their thumb and forefinger together again. Ask, **What do you observe now?**	*Students will notice that the sound has been reduced or eliminated, and that their fingertips did not become as warm this time.*
11	Write the word *lubricant* on the board. Explain that a **lubricant** is a substance that reduces friction between two moving parts.	
	Ask, **Is petroleum jelly a lubricant? Can you name any other lubricants?**	*Yes, petroleum jelly is a lubricant. Oil, grease, and other slippery liquids or semisolids are also used as lubricants.*
	Distribute paper towels for the students to wipe the petroleum jelly from their fingers.	

Reinforcement

Have students describe what would happen if, as they walked, there were no friction between their shoes and the sidewalk. How does snow or ice affect friction?

Science Journals

Have students place their completed activity sheets in their science journals.

Cleanup

Have the students discard the waxed paper and the paper towels and return the wooden boards and spring scales to the kit.

Connections

Science Extension

- Have students use the following procedure to determine whether increasing the mass of an object affects its speed down a slope. Tie one end of a length of smooth thread to a doorknob, and tie the other end to a heavy object. Position the object on the floor so the thread is stretched taut. Unbend a paper clip to form an S-hook, hang it at the top of the slope, and put a metal washer on the hook. Time how many seconds it takes for the washer to reach the bottom of the slope. Repeat the procedure adding one washer at a time. Students will discover that increasing the object's mass increases its speed because the opposing force of friction is in effect "overwhelmed" by the increased force of the more massive object descending the string.

- Obtain an ice cube and a blunt knife. Tell students that you will try to cut through the cube, first by simply pressing down on the knife and then by sawing back and forth with it. Which method is more successful, and why? (Sawing, because the friction of the knife against the cube creates heat that melts the ice.)

Science and the Arts

Ask a student, parent, or teacher who plays a bowed instrument to demonstrate it to the class. Explain that the sound production depends on friction between the bow and the strings and that the musician applies rosin to the bow to maximize friction.

Science and Language Arts

Ask students what everyday life would be like without friction. Commonplace activities such as walking and writing would be impossible. Suggest that they write poems, short stories, or skits about life in a frictionless world.

Science and Math

- Have students create a bar graph of their results from the activity sheet investigation with the horizontal axis labeled *Types of Surfaces* and the vertical axis labeled *Work* (in joules).

- Have students create a bar graph of their results from the first Science Extension connection, with the horizontal axis labeled *Number of Washers* and the vertical axis labeled *Time* (in seconds). Students also could determine the mass of one washer and create a line graph with the horizontal axis labeled *Mass* (in newtons). Students can then extrapolate the speeds of masses they could not test, such as masses equal to 1-in. and 2-in. washers.

Science, Technology, and Society

- Students might enjoy reading about attempts throughout history to design and build perpetual motion machines. Have students explain why such machines are impossible.

- Encourage students to research and report on hovercraft and hydrofoils—methods of transportation whose operation relies on reducing friction between the vehicle and a surface.

- As appropriate, encourage supervised use of the Internet for research projects related to simple machines. A list of related websites is provided in the References and Resources section.