5B Friction

NAME _____ PER ____

How does friction affect motion?

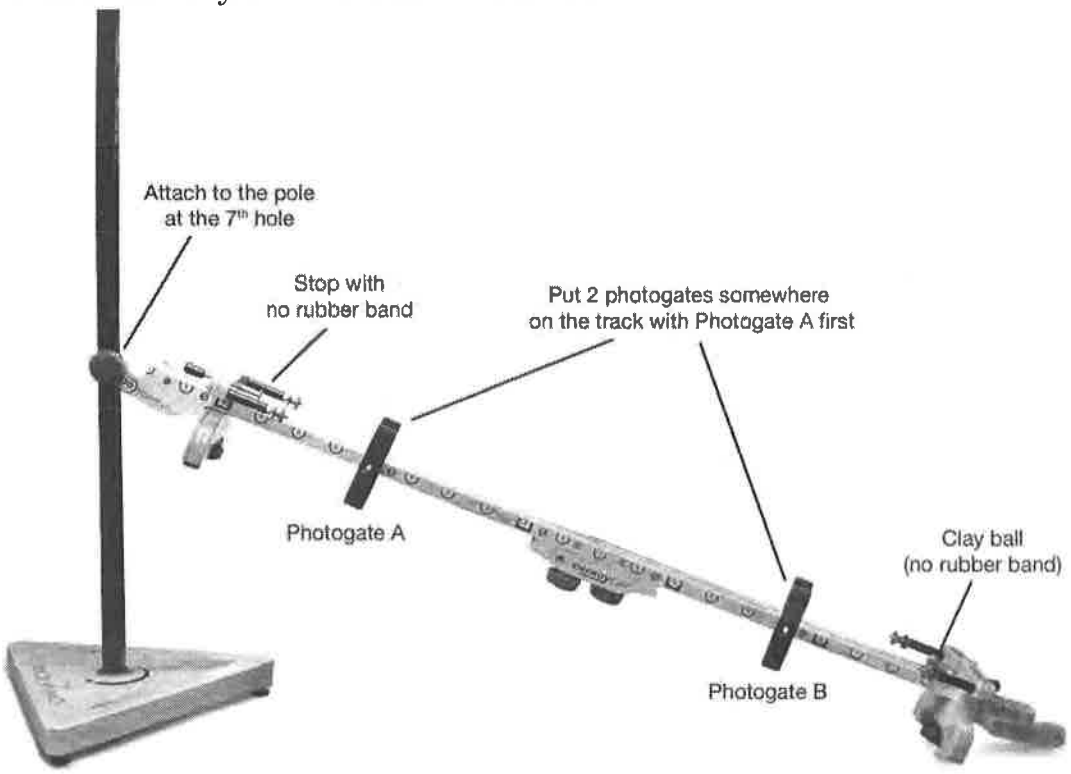
Friction is always present. Sometimes we want friction. For example, friction between tires and the road allows a carto be steered safely and to maintain its direction when moving. Other times we want to reduce friction. Putting oil on a bicycle chain allows it to work more efficiently with the gears. This investigation explores different effects of friction.

Materials

- Energy Car kit (including the sled)
- Physics stand
- Data Collector and photogates
- Tongue depressor
- Large paper plate
- Tape

1 Control setup

The first kind of friction you will be investigating is air friction. You will begin by finding out how the car moves before you add extra air friction.



1. Set up the track as a long straight hill as shown above.
2. Attach the track to the stand at the seventh hole from the bottom.
3. Place one photogate near the top of the track and one near the bottom of the track.
4. Put a steel ball in the middle pocket of the car.
5. Let the car roll down the ramp, and record the time from A to B.
6. Measure the distance between the photogates.
7. Use the distance to calculate the average speed of the car.
8. Repeat two more times, for a total of three trials.
9. Calculate the average speed from your three trials.

Table 1: Control speeds

Trial	Time A to B (s)	Distance between A and B (cm)	Speed (cm/s)
1			
2			
3			
		Average Speed	

2 Create the "sail" car

A paper plate "sail" adds air friction (drag) to the car.

1. Tape a tongue depressor to the flag on the side of the car.
2. Tape a paper plate to the tongue depressor. Use enough tape to make sure it is securely attached.

3 Your hypothesis

a. Write a hypothesis that compares the speeds of the "sail car" and the normal car.

b. Explain the reasoning behind your hypothesis.

4 Do the experiment

1. The track and photogates should be set up as in part 1.
2. Put a steel ball in the middle pocket of the car.
3. Let the sail car roll down the ramp, and record the time from A to B.
4. Calculate the average speed of the car.
5. Repeat two more times, for a total of three trials.

6. Calculate the average speed from your three trials.

Table 2: Experimental speeds; sail car

Trial	Time A to B (s)	Distance between A and B (cm)	Speed (cm/s)
1			
2			
3			
		Average Speed	

5 Stop and think

a. Did your results confirm your hypothesis? Explain.

b. How did air friction affect the car's motion?

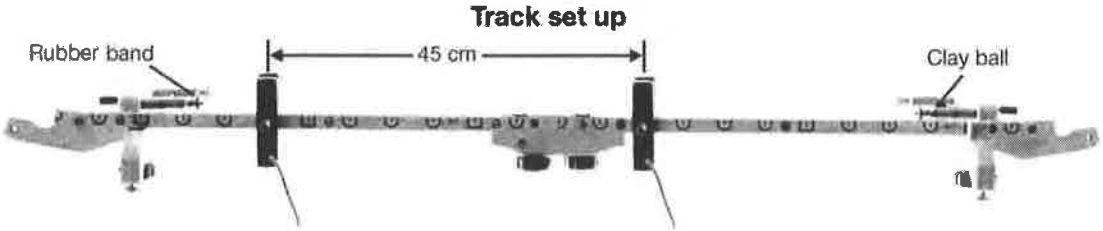
6 Applying what you have learned

a. Friction is a force that opposes motion. Explain where the friction force on the sail comes from.

b. How could you increase the air friction on the car? How could you decrease it?

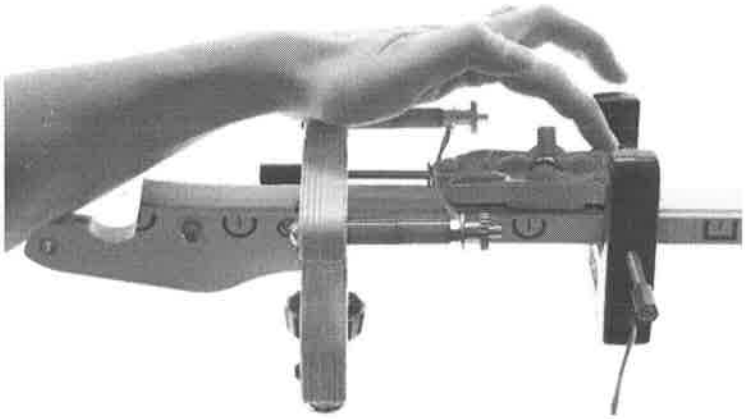
c. Is the sail the only source of friction? Does the car have any friction forces acting on it other than air friction? Explain.

7 Setting up to measure rolling and sliding friction



1. Set up the track so is exactly level. Put a clay ball on the stopper at one end of the track. Put a rubber band on the other end of the track. As you attach it, twist it once so it makes an X. You will be using the rubber band to launch the car and sled.
2. Adjust the stopper near at the launching end of the track so it is approximately 4 cm from the rubber band.
3. Place the sled on the track so the nose of the sled is touching the rubber band.
4. Place photogate A on the mark just ahead of the flag on the sled. The flag should not be blocking the photogate beam. Place photogate B 45 cm from photogate A.

8 Do the experiment



1. Launch the sled by resting your hand on the wooden track support and placing your index finger on the finger grip near the front of the sled. Practice a few times.
2. The sled should make it through both photogates. If it stops too soon, adjust the stopper so you can pull the rubber band back farther.
3. Record the time through each photogate and the time from photogate A to B.
4. Repeat for a total of three trials.

Table 3: Sliding friction data

Trial	Time through A (s)	Time through B (s)	Time from A to B (s)	Speed through A (cm/s)	Speed through B (cm/s)	Acceleration (cm/s^2)
1						
2						
3						
					average	

5. The speed of the sled through photogate A is the width of the flag (1 cm) divided by the time through A. Calculate the speed through A. Repeat for photogate B.
6. Use the two speeds and the average time from A to B to calculate the acceleration. Then find the average acceleration.
7. Repeat steps 3 through 6 using the car instead of the sled.

Table 4: Rolling friction data

Trial	Time through A (s)	Time through B (s)	Time from A to B (s)	Speed through A (cm/s)	Speed through B (cm/s)	Acceleration (cm/s^2)
1						
2						
3						
					average	

9 Thinking about your data

a. Were your accelerations positive or negative? Why?

b. Which decelerated more, the sled or the car?

c. What does your answer to the previous question tell you about the rolling friction of the car compared to the sliding friction of the sled?

d. How could you increase the sliding friction between the sled or track? How could you decrease it?

e. How could you increase the rolling friction between the car and track? How could you decrease it?

f. Compare rolling friction, air friction, and sliding friction. Which do you think has the greatest effect on the car's motion? Which has the least effect?