

## Concepts

Function explored: parabolic

The motion of sliding down a playground slide is used to illustrate the real-world concept of changing velocity due to friction.

## Materials

- ✓ calculator (see page 2 for available models)
- ✓ CBR 2™ motion detector
- ✓ unit-to-CBR 2™ or I/O unit-to-unit cable
- ✓ EasyData application
- ✓ Playground slide

## Hints

The use of a playground area with several slides is preferable for this experiment. The slides should be straight. Slides with other shapes could be used in an extension. For safety reasons, remind your students not to attempt to pass each other while on the slide steps.

You may wish to carry the interfaces, calculators, and motion detectors to the playground area in a box or boxes, and distribute the equipment to your students there. Remind your students that the Motion Detector does not properly detect objects closer than 15cm.

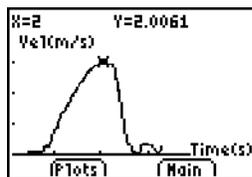
Depending on the type of slides that are available, you may wish to change the way your students position themselves for data collection. Some slides have large platforms where the student with the Motion Detector and the student with the calculator and interface can be located.

Students can use wax paper, slippery cloth, sand, and other materials to increase their speed. To enable your students to be prepared, be sure to alert them to Part II in advance.

## Sample results

	Speed (m/sec)			
	Trial 1	Trial 2	Trial 3	Average
Part 1	1.97	2.02	2.00	2.00
Part 2	2.80	3.07	2.82	2.90

## Typical plots



A Speedy Slide

## Typical answers

1. See the Sample Results.
2. In the Sample Results, the Part 2 speed was 0.90 m/sec greater than the Part 1 speed. Wax paper was used to decrease friction and increase speed.
3. Answers will vary. Speeds will differ because of differences such as contact area, weight, streamlining, and the use of low-friction materials.
4. Answers will vary.
5. Increasing the height of the slide should increase speed.
6. The stone dropped from the top of the slide should hit the ground first because friction and the incline of the slide slow the rolling stone more.
7. The level part at the bottom of a slide slows sliders and prevents injuries.

## Extensions

Design and carry out a plan to measure speed or velocity on a different piece of playground equipment.

Have a contest to see who in the class or group can obtain the greatest speed going down a slide.

You have been familiar with playgrounds and slides since you were a small child. The force of gravity pulls you down a slide. The force of friction slows you down. In the first part of this experiment, you will use a CBR 2™ motion detector to determine your speed or velocity going down a playground slide. In the second part, you will experiment with different ways to increase your speed going down the slide.

## Objectives

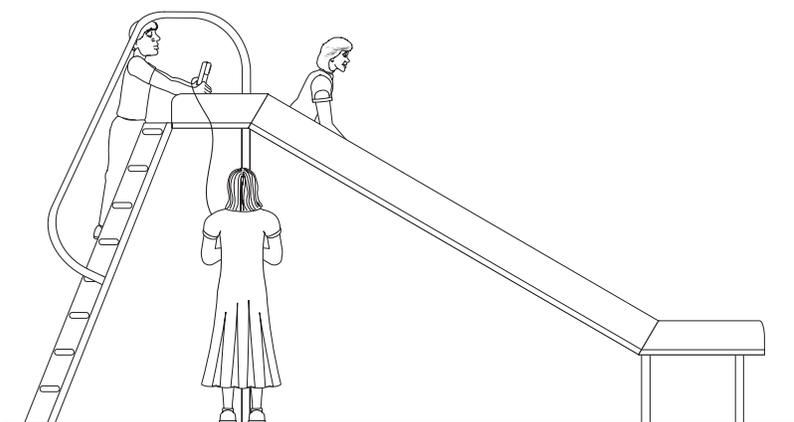
In this experiment, you will:

- use a CBR 2™ motion detector to determine your speed going down a slide
- experiment with ways to increase your speed going down the slide
- explain your results

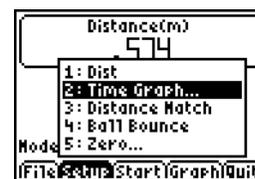
## Data collection, Part 1, Sliding Speed

- 1 Connect the CBR 2™ motion detector to the calculator using an appropriate cable (see below) and firmly press in the cable ends.
  - If TI-83 Plus, use an I/O unit-to-unit cable
  - If TI-84 Plus, use a Standard-B to Mini-A USB cable (unit-to-CBR 2™)
- 2 On the calculator, press **[APPS]** and select EasyData to launch the EasyData App.

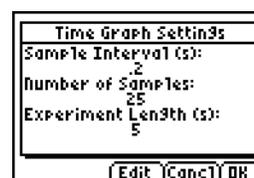
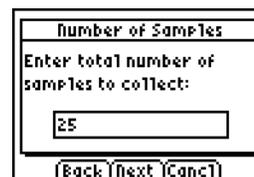
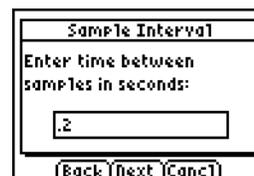
**Note:** EasyData will launch automatically if the CBR 2™ motion detector is connected to a TI-84 Plus using a unit-to-CBR 2™ cable.



- 5 To set up the calculator for data collection:
  - a. Select Setup (press **[WINDOW]**) to open the Setup menu.
  - b. Press 2 to select 2: Time Graph to open the Time Graph Settings screen.



- c. Select Edit (press **ZOOM**) to open the Sample Interval dialog window.
- d. Enter 0.2 to set the time between samples in seconds.
- e. Select Next (press **ZOOM**) to advance to the Number of Samples dialog window.
- f. Enter 25 to set the number of samples. Data collection will last for 5 seconds.
- g. Select Next (press **ZOOM**) to display a summary of the new settings.
- h. Select OK (press **GRAPH**) to return to the main screen.

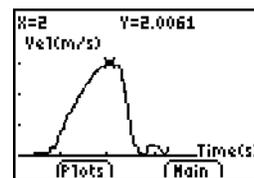


- 4 Take your preliminary data-collection positions.
  - a. One member of the group should first go up the slide steps and sit at the top of the slide.
  - b. A second person, while holding the CBR 2™ motion detector, should go high enough on the slide steps to hold the CBR 2™ motion detector behind the person who will slide.
  - c. The third person should stand on the ground next to the slide, while holding the calculator and interface.
- 5 Take your final data-collection positions.
  - a. The slider, while holding on, should move forward enough to allow a 15-cm distance between his or her back and the CBR 2™ motion detector.
  - b. The person holding the CBR 2™ motion detector should hold the CBR 2™ motion detector steady and aim it at the slider's backside.
  - c. The person holding the calculator and interface should move to a comfortable position that does not cause a pull on the CBR 2™ motion detector cable.
- 6 Collect data.
  - a. Select Start (press **ZOOM**) to begin data collection.
  - b. The slider should begin to slide as soon as a clicking is heard.
  - c. When data collection is done for this trial, the person with the CBR 2™ motion detector should come down to the ground.

**Caution:** No student should attempt to pass another person while he or she is on the steps.

7 Determine the slider's speed.

- After data collection stops and a graph of distance versus time is displayed, select Plots (press **WINDOW**).
- Press 2 to select 2: Vel vs Time to display velocity versus time.
- Use **▸** to examine data points along the graph. As you move the cursor right and left, the time (X) and velocity (Y) values of each data point are displayed above the graph. The highest point on the graph corresponds to the highest speed of the slider. Record this highest speed in the Data table. Round to the nearest 0.01 m/s. (In the example to the right, the highest speed is 2.00 m/s.)
- Select Main (press **TRACE**) to return to the main screen.



8 Repeat Steps 4–7 two more times.

# Activity 3—A Speedy slide

Name \_\_\_\_\_

## Data collection, Part 2, A Speedier Slide

1. Design a plan to increase the slider's speed.
  - a. Try out some ideas for increasing the slider's speed. You may not coat the slide with anything that must be washed off.
  - b. Decide on a plan to best increase the slider's speed.
  - c. Describe your plan in the Speedier Slide Plan section below.
2. Test your plan using Part 1, Steps 4–8.

## Speedier Slide Plan

### Data

	Speed (m/sec)			
	Trial 1	Trial 2	Trial 3	Average
Part 1				
Part 2				

### Data processing

1. Calculate the average speed for your three trials in Part 1. Record the average in the space provided in the Data table. Calculate and record the average speed for Part 2.
2. Subtract your Part 1 average speed from your Part 2 average speed to determine how much your team improved its speed.
3. What methods did other groups use to improve their speeds?

### ***Activity 3—A Speedy slide (cont.)***

4. Which of the methods worked best? Explain why it worked best.
  
5. If you could increase the height of the slide, how would the slider's speed be affected?
  
6. If a stone was dropped from the top of the slide at the same time a similar stone was rolled down the slide, which stone would reach the ground first? Explain.
  
7. What is the purpose of the level portion at the bottom of many slides?