Activity 1—Graphing your motion notes for teachers

Concepts

Function explored: linear

This activity requires the EasyData App.

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
- ✓ Masking tape
- ✓ Meter stick

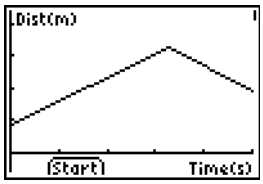
Hints

This experiment may be the first time your students use the CBR 2™ motion detector. A little coaching on its use now will save time later in the year as the CBR 2™ motion detector is used in many experiments. The following are hints for effective use of the CBR 2™ motion detector:

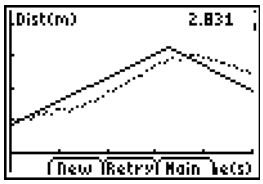
- In using the CBR 2™ motion detector, it is important to realize that the ultra sound is emitted in a cone about 30° wide. Anything within the cone of ultrasound can cause a reflection and possibly an accidental measurement. A common problem in using motion detectors is getting unintentional reflections from a desk or chair in the room.
- Often unintended reflections can be minimized by tilting the CBR 2™ motion detector slightly.
- If you begin with a velocity or acceleration graph and obtain a confusing display, switch back to a distance graph to see if it makes sense. If not, the CBR 2™ motion detector may not be properly targeting the target.
- The CBR 2™ motion detector does not properly detect objects closer than 15 cm. The maximum range is about 6 m, but stray objects in the wide detection cone can be problematic at this distance.
- Sometimes a target may not supply a strong reflection of the ultrasound. For example, if the target is a person wearing a bulky sweater, the resulting graph may be inconsistent.
- If the velocity and acceleration graphs are noisy, try to increase the strength of the ultrasonic reflection from the target by increasing the target's area.

You may want to have your students hold a large book in front of them as they walk in front of the CBR 2™ motion detector. This will produce better graphs because it smoothes out the motion.

Typical plots



Distance vs. Time



Matching Distance vs. Time

Answers to questions

9. The slope of the portion of the graph corresponding to movement is greater for the faster trial.

   Results will probably vary between groups as they may walk at different rates.

   Walking towards the motion detector will produce a negative slope. While walking away from the motion detector will produce a positive slope.

12. Note that the slope is close to zero (if not zero) when standing still. The slope should be zero, but expect small variation due to the variation in collected data.

Activity 1—Graphing your motion linear

Graphs made using a CBR 2™ motion detector can be used to study motion. In this experiment, you will use a CBR 2™ motion detector to make graphs of your own motion.

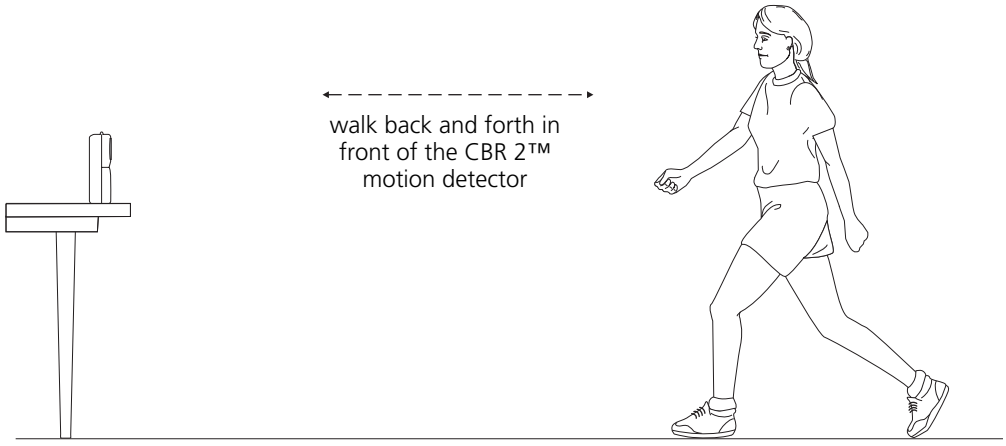
Objectives

In this experiment, you will:

- use a motion detector to measure distance and velocity
- produce graphs of your motion
- analyze the graphs you produce

Data collection: Distance vs. Time Graphs

❶ Place a CBR 2™ motion detector to a tabletop facing an area free of furniture and other objects. The CBR 2™ motion detector should be at a height of about 15 centimeters above your waist level.



❷ Use short strips of masking tape on the floor to mark the 1-m, 2-m, 3-m, and 4-m distances from the CBR 2™ motion detector.

❸ 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™)

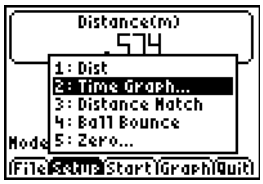
❹ On the calculator, press APPS and select EasyData to launch the EasyData App.

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.

❺ To set up the calculator for data collection:

a. Select Setup (press WINDOW) to open the Setup menu.

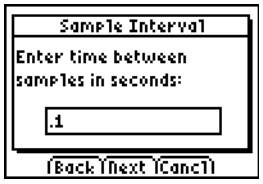
b. Press 2 to select 2: Time Graph to open the Time Graph Settings screen.



c. Select Edit (press ZOOM) to open the Sample Interval dialog window.

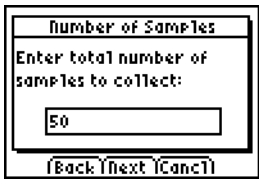
d. Enter 0.1 to set the time between samples to 1/10 second.

e. Select Next (press ZOOM) to advance to the Number of Samples dialog window.



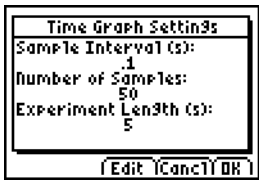
f. Enter 50 to set the number of samples to collect.

The experiment length will be 5 seconds (number of samples multiplied by the sample interval).



g. Select Next (press ZOOM) to display a summary of the new settings.

h. Select OK (press GRAPH) to return to the main screen.



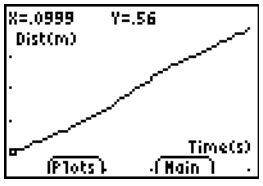
❻ Explore making distance *vs*. time graphs.

a. Stand at the 1.0-m mark, facing away from the CBR 2™ motion detector.

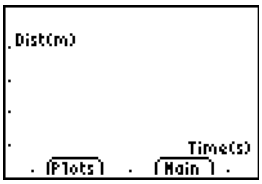
b. Signal your partner to select Start (press WINDOW).

c. Slowly walk to the 2.5-m mark and stop.

d. When data collection ends, a graph plot is displayed.



e. Sketch your graph on the empty graph provided.

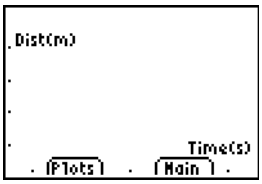


f. Pick two points on the graph and determine the slope from the x and y-coordinates.

Point 1:_____ Point 2: _____ Slope:_____

g. Select Main (press TRACE) to return to the main screen.

❼ Repeat Step 6, this time standing on the 2.5m-mark and walk towards the 1.0m-mark. One time walking slowly, and again walking more quickly.



Point 1:_____ Point 2: _____ Slope:_____

❽ Sketch your new plots on the empty graph provided.

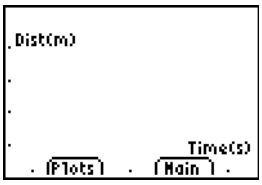
❾ Describe the differences between your graphs (step 6e and step 8)

_____

_____

_____

❿ Repeat Step 6, while standing still on the 2.5m-mark.



⓫ Sketch your new plot on the empty graph provided.

⓬ Calculate an approximate slope for all your graphs.