About the Lesson

In this activity, students will explore the relationship between how they move in front of a CBR 2 and the resulting distance-time graph. As a result, students will:

- Know that walking toward the CBR 2 makes a distance-time graph where distance decreases as time increases.
- Know that walking away from the CBR 2 makes a distance-time graph where distance increases as time increases.
- Know that standing still in front of the CBR 2 makes the distance-time graph a horizontal line.

Vocabulary

- distance-time graph
- plot
- with respect to
- rate

Teacher Preparation

- Decide beforehand if you want the students to walk in front of the CBR 2 (with the CBR 2 stationary) or if the students in pairs walk with the CBR 2 pointed toward a wall with one holding the CBR 2 and the other holding the calculator (the CBR 2 moving).
- Arrange the room so that each group of students have about 8 feet of walking space.
- Students will be using the Vernier EasyData® App in this activity. See the additional information in the Teaching Notes.

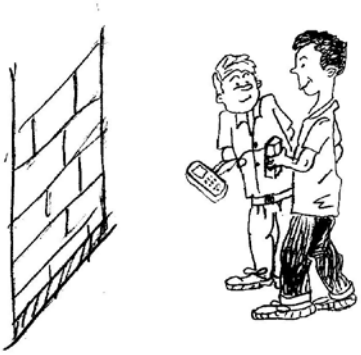
Activity Materials

- Compatible TI Technologies:

  TI-84 Plus*
  TI-84 Plus Silver Edition*
  TI-84 Plus C Silver Edition
  TI-84 Plus CE

** with the latest operating system (2.55MP) featuring MathPrint™ functionality.*

- CBR 2™ motion sensor unit with mini-USB connecting cable
- Vernier EasyData® App



Tech Tips:

- This activity includes screen captures taken from the TI-84 Plus CE. It is also appropriate for use with the rest of the TI-84 Plus family. Slight variations to these directions may be required if using other calculator models.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials
- Any required calculator files can be distributed to students via handheld-to-handheld transfer.

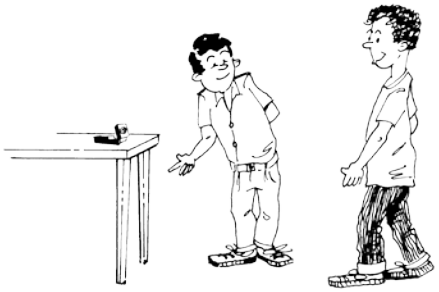
Lesson Files:

- Which_Way_Student.pdf
- Which_Way_Student.doc

Tech Tip: While using the EasyData® app, the tabs at the bottom of the screen indicate menus that are accessed by pressing the key directly below it. A frequent example is shown below:

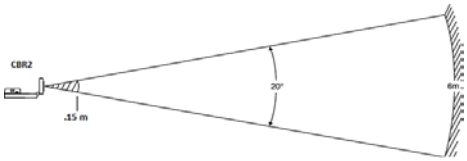
Introduction

This activity is designed to challenge students to make a connection between how they collect the data and the distance-time graph that is produced. Step-by-step instructions were not given so that students can utilize their higher order thinking skills to create the given graph.



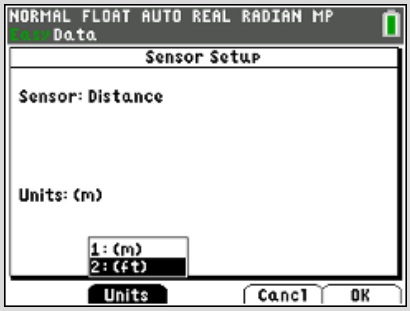
Teaching Notes:

- The path of the CBR 2 beam is not a narrow, pencil-like beam, but fans out in all directions up to 10° in a cone-shaped beam.



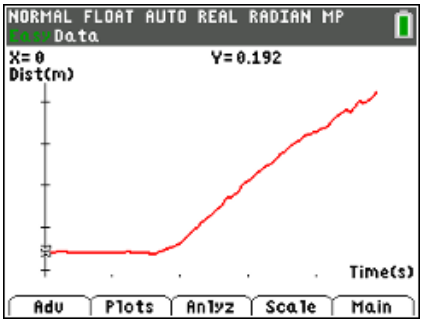
- To avoid interference from other objects in the vicinity, try to establish a clear zone in the path of the CBR 2 beam. This helps ensure that objects other than the target are not recorded by the CBR 2. The CBR 2 records the closest object in the clear zone.
- Be sure that students stay within the range of the CBR 2 (0.15 – 6 meters).
- When using a stationary CBR 2, most students prefer to face the CBR 2 when walking. This allows them to stay directly in front of the unit during data collection.

Tech Tip: If you prefer to do this activity using feet instead of meters, select Setup by pressing window. Select Units by pressing window and select (ft).

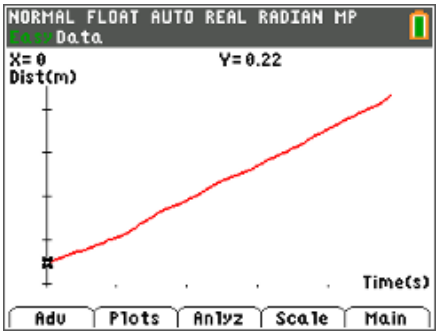


Trial 1

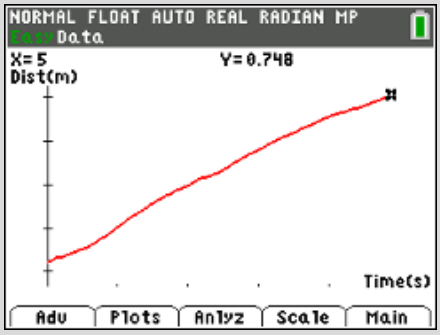
The first graph that students make may look like the one on the right. You can facilitate this situation by asking the students, "What can you do differently on the next attempt to take out the horizontal part?" It may take them a few more attempts to realize that moving at a steady rate **before** starting the CBR 2 will remedy this issue.



Sample description:
I started 0.22 meters from the CBR 2. I walked away at a steady rate for 5 seconds and ended the graph at 0.75 meters from the CBR 2.

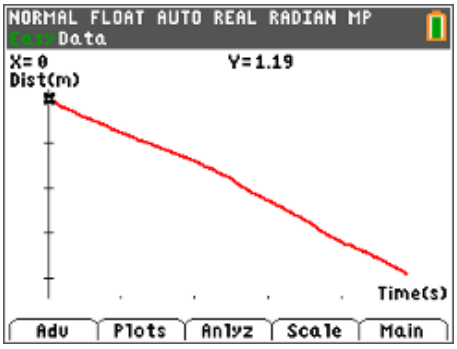


Tech Tip: When students have made a graph, to find their distance at the end of the walk, they can use the right arrow key ~ to move through the data.

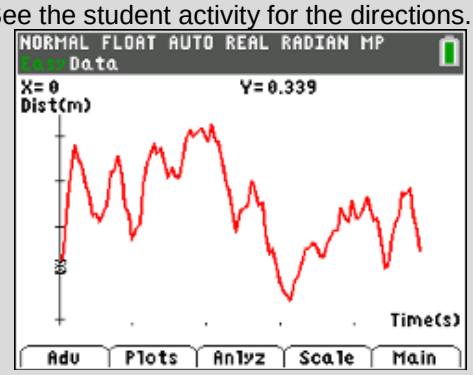


Trial 2

Sample description:
I started 1.19 meters from the wall. I walked toward the wall at a steady rate for 5 seconds until I was 0.35 meters away.



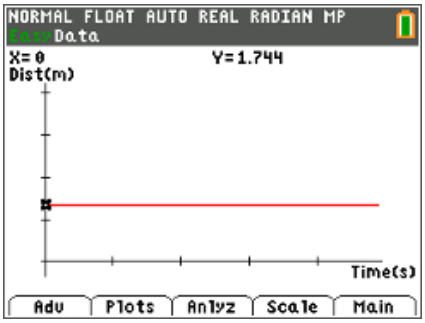
Tech Tip: Because EasyData® zooms in to the extremely small variations while the student is not moving to make the horizontal line. When the graph at the right has the y-axis rescaled properly, the graph will be a horizontal line. See the student activity for the directions.



Trial 3

Sample description:

I stood still in front of the CBR 2 at 1.74 meters for 5 seconds.



Looking at the Results

1. Why does the plot of Trial 1 go up as it moves from left to right? (Be sure to use the words "time" and "distance" in your explanation.)

   Student answers will vary.

   Sample response: As time, which is represented by the x values, is increasing, distance, which is represented by the y values, is also increasing.

2. Why does the plot of Trial 2 appear to be moving downward? (Be sure to use the words "time" and "distance" in your explanation.)

   Student answers will vary.

   Sample response: As time, which is represented by the x values, is increasing, distance, which is represented by the y values, is decreasing.

3. Why is the plot of Trial 3 a horizontal line? (Be sure to use the words "time" and "distance" in your explanation.)

   Student answers will vary.

   Sample response: As time, which is represented by the x values, is increasing, distance, which is represented by the y values, remains the same.

4. Write a short paragraph summing up how the direction in which you move affects a plot of your distance from the CBR 2 with respect to time.

   Student answers will vary.

   Sample response: When the walker is moving away from the CBR 2, the plot rises as it moves from left to right. When the walker is approaching the CBR 2, the plot falls as it moves from left to right. If the walker is standing still, the plot stays level as it moves from left to right.

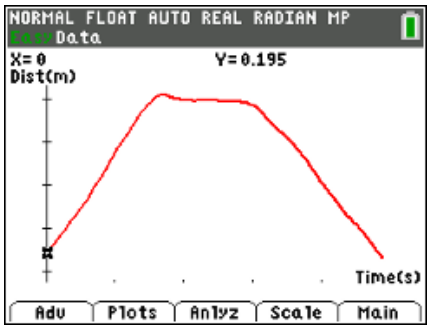
Going Further

1. If you combined the three previous trials into one trial by first walking away, then standing still, and finally walking toward the CBR 2, describe in words what the resulting plot would look like.

   Student answers will vary.

   Sample response: The plot would resemble a mountain with a plateau on top.

2. Make a sketch of the motion you described in question 1 and try it. Were you successful?



Student answers will vary.

Sample response: The plot would look like the graph on the right.

3. Try walking in front of the CBR 2 so that the distance-time graph will look like an uppercase 'W.' Write a summary of what you did.

Student answers will vary.

Sample response: To make an uppercase 'W,' start about 2.5 meters from the wall and walk at a rapid steady rate toward the wall for 1.5 seconds. Immediately walk backwards at the same rapid steady rate for 1 second. Quickly change direction walking at the rapid steady rate for 1 second toward the wall. Then immediately change direction one last time and walk away from the wall for 1.5 seconds.

4. Try walking in front of the CBR2 so that the distance-time graph will look like an uppercase 'O.' Write a summary of what you did.

Student answers will vary.

Sample response Making the letter 'O' with the CBR 2 is impossible, because time cannot go backwards.

Tech Tip: If your students have a difficult time walking the letter 'W,' you can increase the time by going to Setup and select Time Graph. Select Edit and change the number of samples to 140. This will make the experiment 7 seconds in length. You may also try other sampling intervals and other number of samples according to what works for the students.