EXPLORATIONS™

Activity 2

Objectives

- Find models using the "eyeball" method
- Apply knowledge of the slope-intercept form of a line to find a mathematical model using the "eyeball" method

Lines, Models, CBR™— Let's Tie Them Together

One of many methods that can be used to find a mathematical model is the "eyeball" method. This method is quite simple to do by hand as long as you are only looking for the line, not its equation. When working with linear data, you can use spaghetti, a ruler, or any other item with a straight edge, to help "eyeball" a best-fit line. To do this, move the item over the data until you have what you think is a reasonable model.

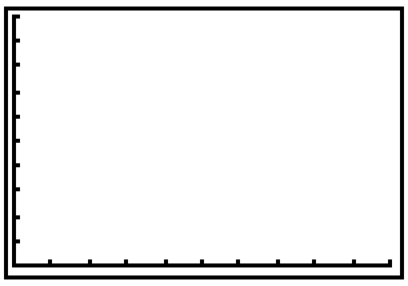
First you need some data to "eyeball." Use the Calculator-Based Ranger™ (CBR™) unit to collect "linear" motion data.

Collecting the CBR data

A CBR will record the distance from the CBR to a person walking away from or toward it. For this activity, the person should try to walk at a constant rate.

The CBR on your graphing handheld plots time as the independent variable and the person's distance from the CBR as the dependent variable.

Questions for Discussion



1. How should the plot appear if the person walks at a constant rate away from the CBR? Sketch your guess on the coordinate system. Be sure to label the axes appropriately.

2. Why do you think the grid contains only the first quadrant?

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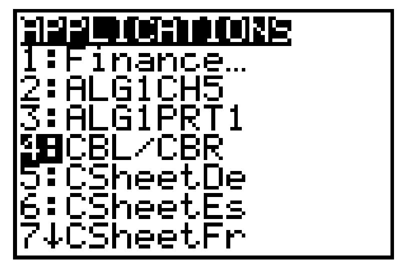
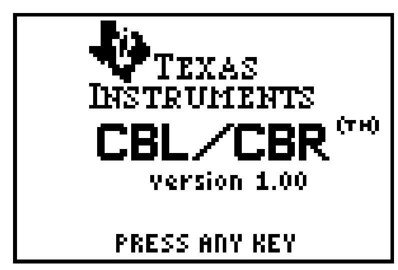
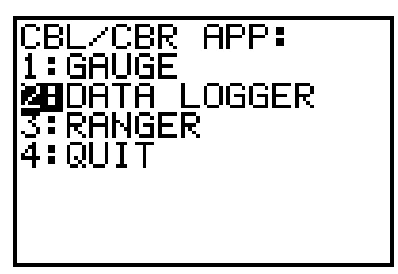
Data Collection

1. Use the unit-to-unit link cable to connect the CBR™ unit to the graphing handheld.
2. Press [APPS] and select **CBL/CBR**.

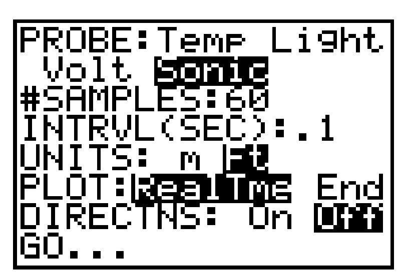


3. Press any key to advance past the introduction screen, and then select **2:DATA LOGGER**.

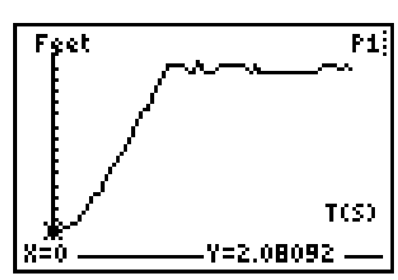




4. Make the selections in the setup menu as illustrated. These settings will allow the CBR to collect and record one reading every 0.1 second for 6.0 seconds.

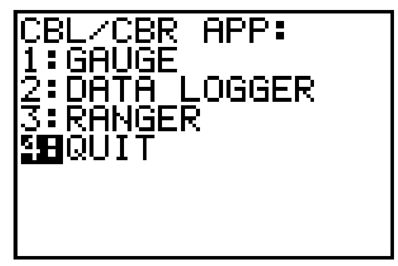


5. Place the CBR on a table facing into an open area of the room. A student should stand approximately 1.5 feet from the CBR, facing away from the CBR. Instruct the student to walk at a slow constant pace away from the CBR when you say "go." Use the cursor key (▼) to move to **GO**. Simultaneously press [ENTER], and tell the student to "go."

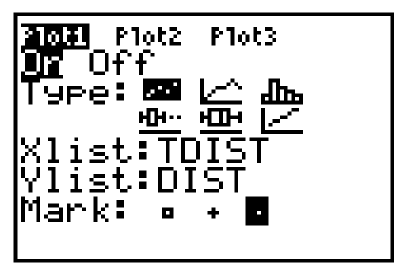


6. The CBR™ unit starts recording the distance to the student. After the 6 seconds have passed, the plot will rescale the window automatically using **ZoomStat**.

7. Press [2nd] [MODE] **4** to select **4:QUIT** to exit the application.



8. The CBL™/CBR™ application leaves the data connected. It is easier to “eyeball” a model with the points in unconnected form. Press [2nd] [STAT PLOT] **1** to select **1:Plot 1**, and then select the unconnected scatter plot option.



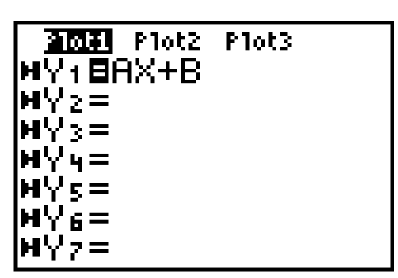
9. When you have reasonable data, link the graphing handhelds so that everyone in the class has the same data.

Finding The Model

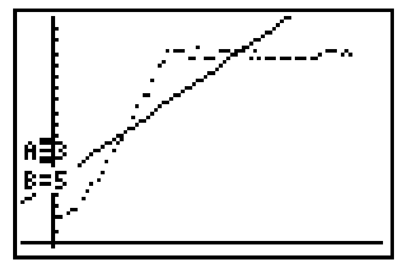
You will use the scatter plot of the data you collected to find a reasonable model.

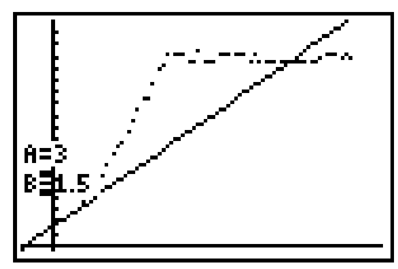
1. Press [APPS] and select **Transfrm** to activate the application. Press [MODE] and make sure the graphing handheld is in the **Func** mode.

2. Press [Y=]. Clear all equations from the **Y=** editor. At **Y1**, enter **AX+B**, the slope-intercept form of a line ([ALPHA] **A** [X,T,Θ,n] [+] [ALPHA] **B**). Press [◄] to move to the left of **Y1**, and press [ENTER] until you have selected the Play-Pause mode (**>||**).



3. Display the graph by pressing [ZOOM] **9** to select **9:ZoomStat**. The plot is displayed and a line is graphed. The line contains values for *A* and *B* that were in the handheld's memory from a previous plot, so you will need to adjust the values to fit your data.





Note: *In this example, the points plotted indicate that the walker was not moving away from the CBR™ unit for the entire time the data was collected. The data you collected may be quite different. For all portions of this activity, your model should focus on the data points that reflect a change in the walker's distance from the CBR.*

What does the value of *B* represent in this problem? What would be a good starting value for this coefficient?

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4. Use the [▼] key to move to **B=**. Enter **1.5** and press [ENTER]. Adjust this value as needed so that your model fits the *y*-intercept more accurately.

a. What does the value of *A*, the slope of the line, represent in this example?

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b. If the CBR unit is measuring in feet and taking readings in seconds, what is the unit of measure of the values of *A*? Remember that all measurements must have a unit of measure.

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c. The line in the sample does not appear to be steep enough if **A=1** is used. What does that indicate about your model? How should you adjust your model? What does that mean about the speed at which the student was walking?

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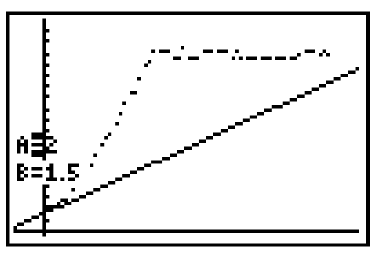
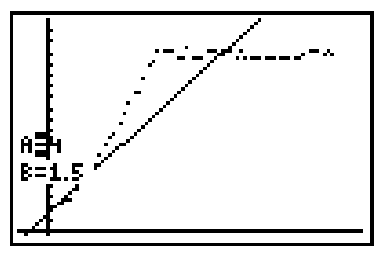
5. The scatter plot needs a model with a steeper slope. To refine the model, press [▲] to go to **A=**, and enter different values for *A* until your line is a better fit to the data.

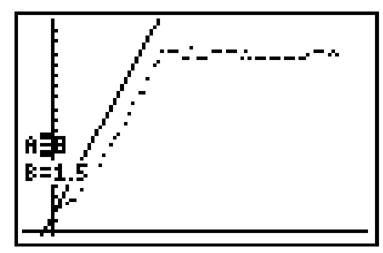
Note: *To enter values, type a number and press* [ENTER]*. The line will move to reflect the new value.*



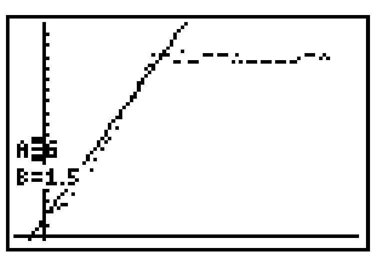
A=2



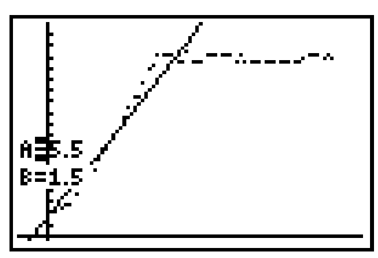
A=4



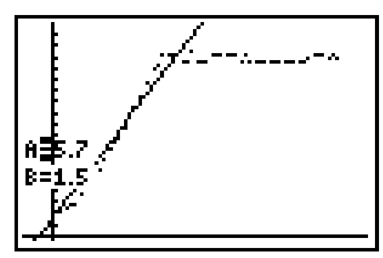
A=8



A=6



A=5.5



A=5.75

6. After you have a reasonable value for *A*, you might decide that you need to revise your value for *B*. Press [▼] to move to **B=** and refine that value.

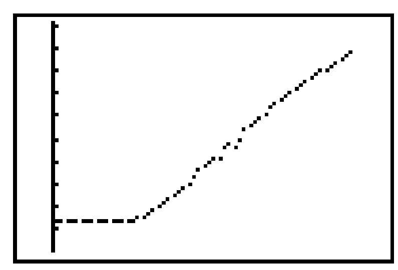
Student Worksheet

Name ________________________

Date ________________________

Walker 2

Using the same CBR™ unit setup, do a second trial. This time, have a second student try to duplicate the model pictured (x = time; y = distance). When you have good data, link the data to the rest of your class and use the Transformation Graphing App to help find the plotted data for this "walk."



1. What does the walker need to do to match the plotted data?

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2. Compare this graph to that from the previous trial. Which of the two walkers was walking faster? How could you tell?

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3. What is the y-intercept of this model? What does that indicate?

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4. What does the slope of the line indicate? What other way could you use to find that same value?

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5. How would the slope change if the student walked more quickly? How would it change if the student walked more slowly?

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6. What does a y-intercept of 5 mean for this activity?

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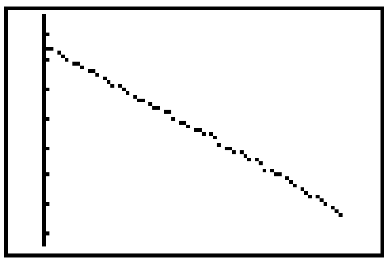
Walker 3

Using the same CBR™ unit setup, do a third trial. Have the student try to match the model pictured (x = time; y = distance). After you collect good data, link the data to the rest of the class and use the Transformation Graphing App to help find an appropriate model.



1. What will the walker have to do?

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2. What does the negative slope mean?

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3. Which of the three students walked most quickly? Most slowly? How important is the sign of the slope for this question?

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4. Did the walker in this trial walk at a constant speed? How can you tell?

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5. Sketch a graph that would represent a walker walking at a non-constant rate.

Teacher Notes

Activity 2

Lines, Models, CBR— Let's Tie Them Together

Objectives

- Find models using the "eyeball" method
- Apply knowledge of the slope-intercept form of a line to find a mathematical model using the "eyeball" method

Materials

- TI-84 Plus/TI-83 Plus
- CBL™/CBR™ application
- CBR unit

Time

- 90 minutes

This activity is intended as a follow-up to Activity **1**. The purpose is to give the student practice with the "eyeball" method of finding appropriate models. This method helps students develop an understanding of the effects of the parameters of a function and will be continued throughout this book. At some point later in your study, you might want to compare their "eyeball" models with those found using linear regression.

Depending on how many CBR units are available, you can have students work in groups to collect data. If only one CBR unit is available, have many students carry out trials to collect a large data set.

Once data collection has ended, you can link graphing handhelds to share data. All students should have the same data set to plot.

This activity is the second of two on the slope-intercept form. In this activity, the use of student walkers to create the data set allows the students to visualize the relationship between a physical action and a mathematical and/or graphic model of that action.

You might want to have the students walk along a number line on the floor. In this way you can measure where they start and how far they walk as a method of relating the equation to the real world.

Be sure to emphasize the importance of units of measure and labeling units on the axis. No unit labels were given in the activity. You can set Data Logger to collect data in either meters or feet.

Walker 2 presents an opportunity to discuss the issue of domain and range of a model. There are two distinct parts of the graph: the walker standing still, and then moving. This may present a challenge to students when interpreting the meaning of the *y*-intercept for their model of the motion portion of the graph. Although the equation that is developed has a domain of all real numbers, it has a direct meaning only for values while the walker is moving.

If you choose to ask students to model the complete graph, there should be two distinct parts over $0 < x < 6$. This could be used to introduce piecewise-defined functions if the topic is appropriate for your students.

Answers

Collecting the CBR Data: Questions for Discussion

1. The sketch should be a line indicating a positive linear relationship between time walking and distance from the CBR™ unit.
2. The CBR cannot record distances behind it; thus, there are no negative *y*-values. The CBR cannot go back in time; thus, there are no negative *x*-values.

Finding the Model

3. *B* represents the *y*-intercept that shows how far from the CBR the student was at the start. The walker was asked to start 1.5 feet from the CBR, so 1.5 would be a good starting value for *B*.
4. **a.** The slope represents the rate of speed of walking. (distance/time).

   b. The unit of measure for *A* is in feet/sec; a unit of speed or velocity.

   c. The data in the example shows a walker who is walking faster than the model says. The scatter plot in the example needs a model with a steeper slope, meaning that the student was moving faster than 1 foot/sec. You need to increase the value of *A*.

Student Worksheet

Walker 2

1. The walker must first stand motionless and then move at a constant rate away from the CBR.
2. Answers will vary. Students should look at the slope of each model to determine which is steeper.
3. Answers will vary, but should be in the range of 1.5 feet. The *y*-intercept indicates the starting point of the student walking.
4. The slope indicates the speed at which the student walked.

$$\text{speed} = \frac{\text{distance traveled}}{\text{time traveled}}$$

   You can use **TRACE** to find the point at which the walker started to move and the last point recorded. Insert these values into this formula:

$$\text{speed} = \frac{\text{final position} - \text{starting position}}{\text{final time} - \text{starting time}}$$

   This would be accurate only if the walker moved at a constant rate.

5. The slope would be steeper. The slope would be more gradual.
6. A *y*-intercept of 5 would indicate that the student started at 5 feet/meters from the CBR™ unit.

Walker 3

1. The walker will have to move *toward* the CBR at a constant rate.
2. The walker was walking toward the CBR. The distance decreased over time.
3. Answers will vary. The sign of the slope is inconsequential. The sign of the slope tells the direction, not the speed.
4. It would appear that the walker walked at a constant rate because the line is relatively straight. The more constant the speed, the more linear the data.
5. Answers will vary; any nonlinear graph.