EXPLORATIONS

Activity 2

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

In this activity, you will practice finding models using the "eyeball" method on data you collect. The activities will allow you to apply what you have learned about the slope-intercept form of a line.

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 to help "eyeball" a best fit line. To do this, move a piece of spaghetti over the data until you have what you feel is a reasonable model.

In this activity, you will use your TI-83 Plus with the Transformation Graphing application to "eyeball" fit a linear model. This method will also give you an equation for your model.

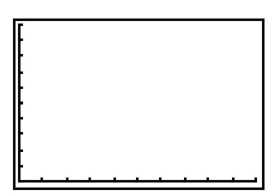
First you need some data to "eyeball." Use the CBR to collect "linear" motion data.

Collecting the CBR data

A CBR will record the distance from the CBR to a walker walking away from it (or towards it). In this activity the walker should try to walk at a constant rate.

The CBR/TI-83 Plus combination plots time as the independent variable and the walker's distance from the CBR as the dependent variable.

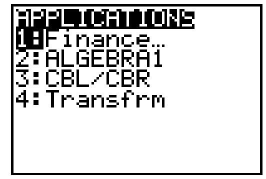
Questions for Discussion



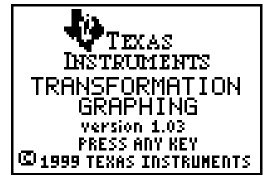
1. How should the plot appear if the walker successfully walks at a constant rate away from the CBR? Sketch your guess on the coordinate system.
2. Why do you think the grid contains only the first quadrant?

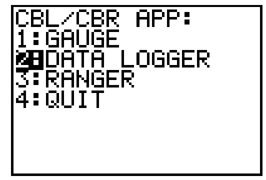
Procedure

1. Use the unit-to-unit link cable to connect the CBR to the TI-83 Plus.
2. Press [APPS] and then choose **CBL/CBR**.

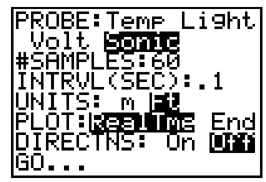


3. Press any key to advance past the introduction screen and then select **2:DATA LOGGER**.

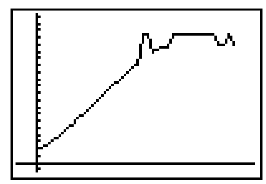




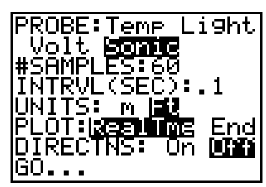
4. Make the selections in the setup menu as illustrated. These settings will allow the CBR to collect and record one reading every 0.1 second for 6.0 seconds.



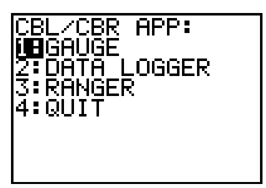
5. Place the CBR on a table facing into an open area of the room. A student (the walker) should stand approximately 1.5 feet from the CBR, facing away from the CBR. Remind the walker that they are trying to walk slowly at a constant pace, away from the CBR. Tell them that when you say "go" they should start. Use the cursor control key ([▼]) to move to **GO**. Press [ENTER] and tell the walker to go.



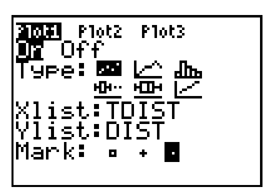
6. The CBR will start recording the distance to the walker. Once the 6 seconds has passed, the plot will re-scale the window automatically using **ZoomStat**.
7. You are still running the CBL/CBR Application. You should exit this application.



Press [ON] [2nd] [QUIT] **4:QUIT**.



8. The points from the plot are connected by the CBL/CBR application. It is easier to "eyeball" a model with the points in unconnected form. Press [2nd] [STAT PLOT] **1:Plot 1** and then select the unconnected scatter plot option.



Repeat the previous steps until you have a reasonable scatter plot.

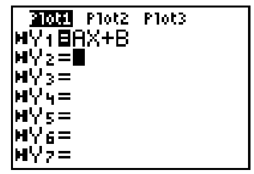
9. Once you have reasonable data, link the calculators so everyone in the class has the same data.

Finding The Model

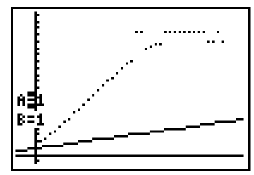
Use the data you just collected to find your model.

1. Activate the Transformation Graphing application.

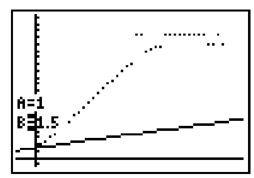
2. Enter the slope-intercept form of a line in **Y1**. Press [Y=]. Clear all equations from the **Y=** editor. Press [▲] to move to **Y1** and enter **Y1** = [ALPHA] **A** [X,T,Θ,*n*] [+] [ALPHA] **B**. Press [◄] to move to the left of **Y1** and continue to press [ENTER] until you have selected the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



3. Display the graph by pressing [ZOOM] **9:ZoomStat**. The plot will be displayed and a line will be graphed. The line will contain the present **A** and **B** values from the calculator. These values have absolutely nothing to do with the activity and thus the graph should have little relationship to the points.



   What is the physical meaning of the y-intercept (**B**) in this problem? What would be a good starting value for this coefficient?



   The y-intercept tells how far from the CBR the walker started *if the walker and the CBR started at exactly the same time*. The walker was asked to start 1.5 feet from the CBR, so 1.5 would be a good starting value for **B**.

4. Use the up/down cursor keys ([▲] [▼]) to move to the **B**= and enter 1.5. Adjust this value to match the y-intercept more accurately.

   Note: A later section of this activity shows an example where the walker and the CBR do not start together.

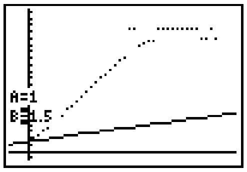
   a. What is the physical meaning of the slope (**A**) of the line in this example? Can you make a good estimate for its value?

   b. If the CBR is measuring in feet and taking readings in seconds, **A** is in what unit of measure? It is very important that measurements have a unit of measure.

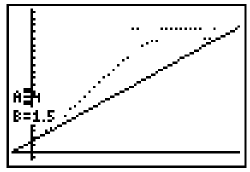
      The slope (rate of change of the function) shows the speed of the walker. With Transformation Graphing, you can easily make many different estimates for the slope.

   c. The line in the sample does not appear to be steep enough if **A=1** is used. What does that mean about your model? Does your model have the walker walking too fast or too slow?

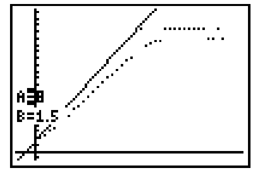
5. The scatter plot in the example needs a model with a steeper slope, meaning the walker was moving faster than 1 foot/sec. To refine the model, press [▲] to go to **A=** and enter different values for **A** until you like the fit. Remember, to enter values, type a number and press [ENTER]. The graph will move to reflect the new value.



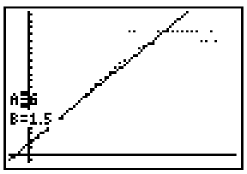
A = 2



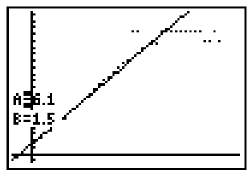
A = 4



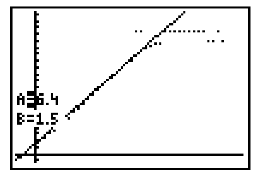
A = 8



A = 6



A = 6.1



A = 6.4

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

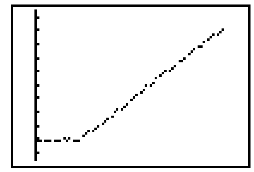
Homework Page

Name ________________________

Date ________________________

Walker 2

Using the same CBR setup, have a second walker try to duplicate the pattern pictured at the right. Once you have good data, link the data to the rest of your class and use Transformation Graphing to help find a model for this "walk."



1. What does the walker need to do to match the picture?

2. Could you tell from watching which of the two walkers in your classroom moved the fastest? If it was noticeable, which one walked the fastest?

3. How fast was each walking?

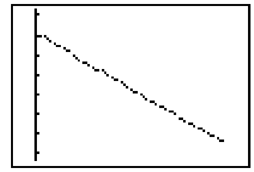
4. Does the y-intercept of your linear model have any meaning in this example? Explain your answer.

5. Tyler's Algebra II teacher said he should use a piecewise defined function for his model. What did she mean? With respect to the physical situation, why would that make sense?

6. You have used the slope of your model as the speed of the walkers. Is there another way to find the walker's speed?

Walker 3

Using the same CBR setup, have another walker try to match the pattern pictured at the right.



1. What will they have to do?

Once you collect good data, link the data to the rest of the class and use Transformation Graphing to help find a model.

2. What does the negative slope mean?

3. Which of the three walkers walked fastest? Slowest? Did you disregard the sign of the slope for this question? Why or why not?

4. How can you tell if the walker walked at a constant speed?

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

Notes for Teachers

Note: You can use either a CBL or CBR to collect the data. The directions you are using assume the TI-83 Plus APP named CBL/CBR is used. There are many other programs available that can be used, including the HIKER program and activity, available as a free download from the Texas Instruments Web site at ***education.ti.com****. There are other workbooks in the Exploration series that use material that could be helpful in the development of this activity.*

This activity is intended as a follow-up to Activity 1. The purpose is to give the student practice with the "eyeball" method of modeling. This method is a great aid in the development of a sense 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 to those found using linear regression.

After each student walk, the data should be linked to each calculator in the classroom so all students can work with the same data.

If enough CBL/CBRs are available, this activity should be continued with the students in groups.

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 the slope and y-intercept of the equation use as a model. The students can (and will want to) do many variations on their walks.

You might want to have the walkers 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 units 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. Although the equation that is developed to match the walking part of the graph has a domain of all reals, it only has a direct meaning for values while the walker is moving.

There are two distinct parts of the graph for walker 2: the walker standing still, and then the walker moving. There should be two distinct parts for the model over $0 < x < 6$ if you try to model the complete graph. This could be used to introduce piecewise defined functions *if appropriate for your students.*

Answers

Collecting the CBR Data: Questions for Discussion

1. Linear data.
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. The y-intercept shows how far the walker started from the CBR.
4. a. The slope is an estimate of the walker's speed.
   b. **A** is in feet/sec. A unit of speed or velocity.
   c. You need to make **A** larger. The data in the example shows a walker who is walking faster then the model says.

Homework Page

Walker 2

1. The walker must first stand motionless and then move at a constant rate away from the motion detector.
2. Answers will vary.
3. Answers will vary.
4. In this problem the y-intercept has no meaning. The walker did not start moving until after t=0. The model has meaning only while the walker is moving, and since t=0 is not where the model has meaning, the y-intercept has no meaning.
5. One function would be used to model while the student was standing still and another function used to model the walking portion. Thus the plot could be considered to have two pieces.
6. $$\text{speed} = \frac{\text{distance traveled}}{\text{time traveled}}$$

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

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

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

Walker 3

1. Move toward the CBR at a constant rate.
2. The walker was walking toward the CBR.
3. Answers will vary. You should disregard the sign of the slope. The sign of the slope tells the direction, the magnitude gives the speed or rate.
4. The more constant the speed, the more linear the data.
5. Answers will vary. Any non-linear graph.