Name ______________________________

Date ______________________________

EXPLORATIONS

ACTIVITY 7

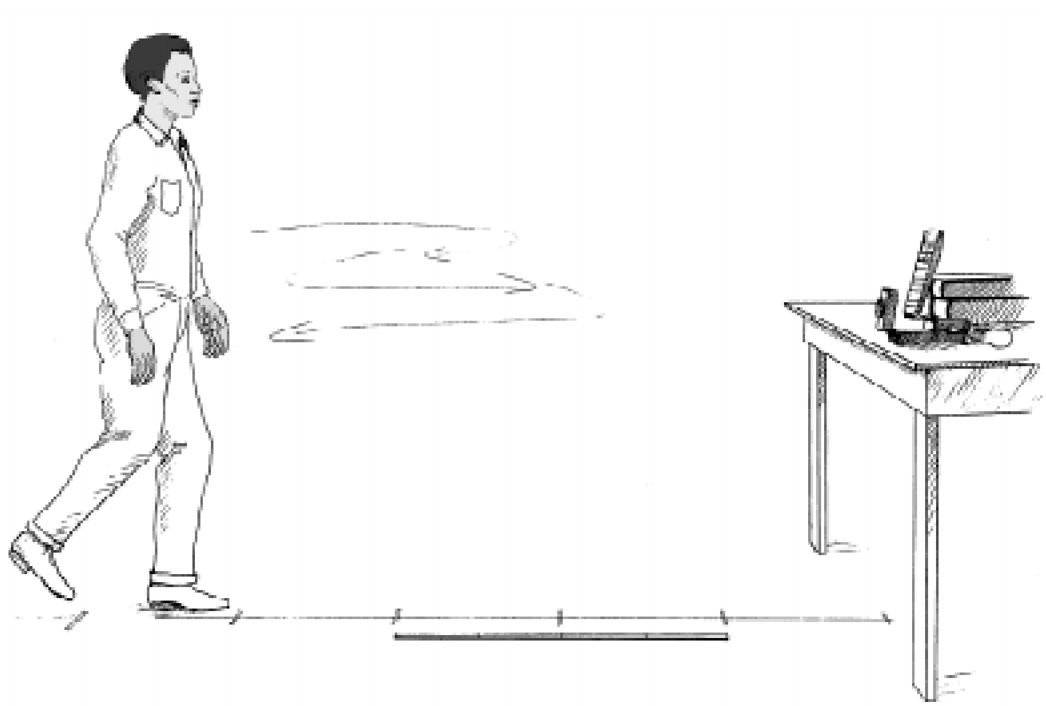
Match This

Graphs of real-world data cannot always be described with only one simple equation. Often times, the graph is made up of separate pieces, which together describe a situation. Equations that are defined in pieces are called *piece-wise defined functions*. If you move back and forth in front of a CBR unit, your motion would be described in separate pieces that together describe the total motion.

In this activity, you will match your motion to a given graph by moving back and forth in front of the CBR unit. You will then describe your movements by writing a piece-wise defined equation for the motion.

You'll Need

- 1 CBR unit
- 1 TI-83 or TI-82 Graphing Calculator
- Meter stick
- Masking tape

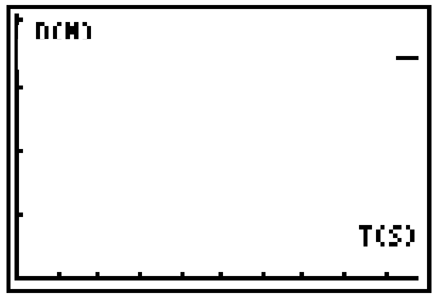


Instructions

1. Set the CBR on a table so that it is aimed at the waist or chest of the walker. Use masking tape to set a scale on the floor. Place a piece of tape 0.5 meter from the CBR and then each 0.5 meter for 4 meters. The CBR will not accurately collect data if you are closer than 0.5 meter. Therefore, you should not move in front of the first strip of tape.
2. Run the **RANGER** program on your graphing calculator.
3. From the **MAIN MENU**, select **3:APPLICATIONS**. Select **1:METERS**. then select **1:DIST-MATCH**. Follow the directions on the calculator screen. Use the tape markers on the floor to help gauge your distance from the CBR. If you are not happy with your results, press [ENTER] and select **1:SAME MATCH** and try again.

Data Collection

When you are satisfied with your results, press [ENTER] and select **4:MAIN MENU**.



a. From the **MAIN MENU**, select **4:PLOT MENU**. Select **1:SHOW PLOT**.

b. From the plot, press [ENTER] to return to the **PLOT MENU** and then press **5:QUIT**.

c. Press [GRAPH] to view the graph. Sketch your resulting Distance-Time graph on the axes provided.

Questions

You will now write an equation that describes the motion shown in the plot. You will first write an equation for each section of the graph and then put the pieces together to write a piece-wise defined equation.

1. Press [TRACE] and record the X and Y coordinates of the first point on the graph as **X1** and **Y1**. Record your values in the table below. Trace to the end of the first section of the graph and record the X and Y values as **X2** and **Y2**.

X1		**Y1**	
X2		**Y2**	

2. Calculate the slope of the line, m. Begin by writing the formula for slope and then showing your calculation. Include the units of the slope when you record your answer.

Slope Equation: ______________________________

Calculation: ______________________________

m = ______________________________

3. What is the y-intercept for this graph?

b = ______________________________

4. Since each section of the graph is approximately linear, it can be described with a linear equation in the form y = $mx + b$. Write the linear equation for this first section of the graph.

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Check to see that the equation does fit the data for the first section of the graph. Press [Y=]. Enter the equation in the **Y1** function register and press [GRAPH]. If the equation does not match the data for the first section of the graph, make adjustments to m or b so that it gives a better fit.

5. Press [Y=] and turn off the equation in **Y1** by moving the cursor over the equal sign and pressing [ENTER]. When the equal sign is no longer highlighted, the equation is turned off and will not graph, but will remain in memory. Press [TRACE]. Use [◄] and to move to end of the second section of the graph. Record the X and Y values as **X3** and **Y3** in the table below.

X3		**Y3**	

6. Since this section of the graph is horizontal, the value of **Y3** should be approximately equal to the the value of **Y2**. Record the slope of the horizontal line. Include the units of the slope.

m = ______________________________

If this line is extended to the y-axis, what is the value of the y-intercept?

b = ______________________________

7. Press [Y=]. In the **Y2** function register, enter the equation for the horizontal section of the graph. Press [GRAPH]. If this equation matches the data well, record the equation on the line below. If this line does not match well, make the necessary adjustments and record the equation below.

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8. Press [Y=] and turn off the equation in **Y2** by moving the cursor over the equal sign and pressing [ENTER]. Press [TRACE] and use the arrow keys to move to the end of the third section of the graph. Record the X and Y values as **X4** and **Y4** in the table below.

X4		**Y4**	

9. Find the slope of the line between points (**X3**, **Y3**) and (**X4**, **Y4**). Record the value below. Include the units.

m = ______________________________

10. The point slope form of the equation of a line is $Y - Y_1 = m(X - X_1)$. Substitute the values of either (**X3**, **Y3**) or (**X4**, **Y4**) for **X1** and **Y1** and solve for Y to find the equation for the third section of the graph. Show your work.

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11. Press [Y=]. In the **Y3** function register, enter the equation for the third section of the graph. Press [GRAPH]. If this equation matches the data well, record the equation on the line below. If this line does not match well, make the necessary adjustments and then record the equation below.

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12. Press [Y=]. Turn off **Y3**. Move the cursor to **Y4**. You now want to write a single equation in pieces that describes the data for your entire walk. When you see **X2**, **X3**, and **X4** enter the values for these variables from your tables above.

a. Since your data is described by the equation in **Y1** for values of X between zero and **X2**, first enter the graph of **Y1** for the values of X less than or equal to your **X2** value.

> **For the TI-83:** Press [(] [VARS] [▶] [ENTER] [1] to paste in the variable **Y1**, followed by [)] [×] [(] [X,T,Θ,n] [2nd] **[TEST]** [6] **X2** [)] (where **X2** is the value from your table).
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> **For the TI-82:** Press [(] [2nd] **[Y-VARS]** [ENTER] [1] to paste in the variable **Y1**, followed by [)] [×] [(] [X,T,Θ,n] [2nd] **[TEST]** [6] **X2** [)] (where X2 is the value from your table).

b. Now, you want to add the second part of the graph to the equation. This step adds on the value of the equation **Y2** for values between **X2** and **X3**.

> **For the TI-83:** Press [+] [(] [VARS] [▶] [ENTER] [2] to paste in the **Y2** variable, followed by [)] [×] [(] [X,T,Θ,n] [2nd] **[TEST]** [3] **X2** [2nd] **[TEST]** [▶] [1] [X,T,Θ,n] [2nd] **[TEST]** [6] **X3** [)] (where **X2** and **X3** are the values from your table).
>
> **For the TI-82:** Press [+] [(] [2nd] **[Y-VARS]** [ENTER] [2] to paste in the **Y2** variable, followed by [)] [×] [(] [X,T,Θ,n] [2nd] **[TEST]** [3] **X2** [2nd] **[TEST]** [▶] [1] [X,T,Θ,n] [2nd] **[TEST]** [6] **X3** [)] (where **X2** and **X3** are the values from your table).

c. Finally, add the equation for the third section of the graph.

> **For the TI-83:** Press [+] [(] [VARS] [▶] [ENTER] [3] followed by [)] [×] [(] [X,T,Θ,n] [2nd] **[TEST]** [3] **X3** [2nd] **[TEST]** [▶] [1] [X,T,Θ,n] [2nd] **[TEST]** [6] **X4** [)] (where **X3** and **X4** are the values from your table).
>
> **For the TI-82:** Press [+] [(] [2nd] **[Y-VARS]** [ENTER] [3] followed by [)] [×] [(] [X,T,Θ,n] [2nd] **[TEST]** [3] **X3** [2nd] **[TEST]** [▶] [1] [X,T,Θ,n] [2nd] **[TEST]** [6] **X4** [)] (where **X3** and **X4** are the values from your table).

Press [GRAPH] to display the graph with the data plot. The equation should match the data. If it does not, check the equation in **Y4**.

13. Look at the slope values recorded on the previous pages. What does the slope represent in each section of the graph? In other words, what does the slope in each section of the graph tell you about the motion of the person?

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14. What does the y-intercept in the first section of the graph tell you about the motion of the walker?

How is the y-intercept related to the strips of tape that you placed on the floor?

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15. Explain how the graph would look if the walker moved at the same speeds for each section of the graph, but began 1 meter farther from the CBR.

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16. Does the y-intercept of equations in **Y2** and **Y3** have physical significance? Explain your answer.

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17. Joan begins 1.5 meters from the CBR and walks at 0.5 m/s for 4 seconds. She then stops for 2 seconds and walks back towards the CBR 0.25 m/s for 4 seconds. Sketch a Distance-Time graph of Joan's motion. Label your axes.