Name ______________________________

Date ______________________________

EXPLORATIONS

ACTIVITY 3

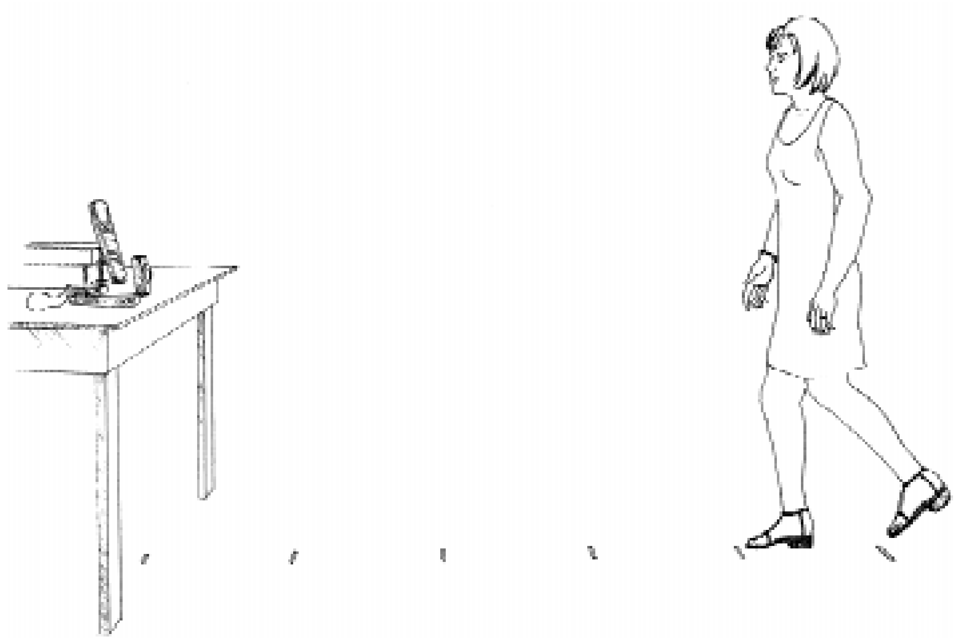
Walk This Walk

If you travel by car at 35 miles per hour for 2 hours, how far will you travel? If you need to travel 150 miles across state and the maximum speed limit is 55 miles per hour, how long will the trip take? Motion questions like these are common. The relationships between distance, velocity, and time are some of the most common mathematical relationships in our lives.

In this activity, you will study motion by walking back and forth in front of a motion detector to create Distance-Time graphs. You will first experiment by creating various graphs to determine how the CBR unit creates Distance-Time graphs and then write mathematical descriptions of motion with constant velocity.

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 class members. 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 3 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 **2:SET DEFAULTS**. With the cursor at ▶**START NOW**, press [ENTER]. Follow the directions on the screen to collect data as a walker from your group moves back and forth in front of the motion detector. Answer the following questions before proceeding with the activity. If you need to repeat the walk, press [ENTER] and then **3:REPEAT SAMPLE** to try again.

   a. What type of motion causes the graph to increase with time?

   b. What type of motion causes the graph to decrease with time?

   c. What type of motion causes the graph to remain as a horizontal line with time?

4. Predict what the graph would look like if the walker moved away from the CBR at a constant speed. Describe your prediction below.

5. Follow these instructions to collect data for a group member walking away from the CBR at a constant speed. (We will not use the **SET DEFAULTS** because it collects data for 15 seconds which is too long for this activity.)

   a. Press [ENTER] to access the **PLOT MENU** and then **4:MAIN MENU**.

   b. From the **MAIN MENU** select **1:SETUP/SAMPLE** to access the setup menu.

   c. Press [ENTER] until the **REALTIME** option reads **no**.

   d. Press [▼] (the down arrow) to select the next line **TIME (S)** and press [ENTER] [3] [ENTER] to change the time to **3** seconds.

   d. Press [▼] to select the next line. Correct or verify the settings and press [ENTER]. Repeat until the options for each line read as shown at right.

   e. Press [▼] to move the cursor to the **START NOW** command. Do *not* press [ENTER].

```
MAIN MENU      ▶START NOW

  REALTIME:  NO
   TIME(S):  3
   DISPLAY:  DIST
  BEGIN ON:  [ENTER]
 SMOOTHING:  NONE
     UNITS:  METERS
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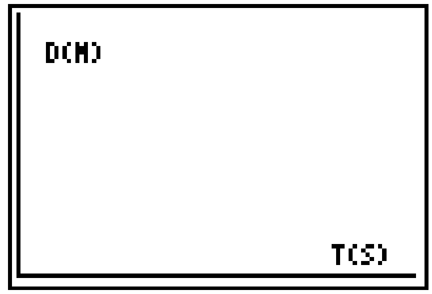
6. Have the walker stand at the 0.5 meter mark. Signal the walker to begin walking away from the CBR at a constant speed and *simultaneously* press [ENTER] on the calculator.

Data Collection

The plot of the data should be linear. If you are not satisfied with the data, press [ENTER] and then select **5:REPEAT SAMPLE** to repeat the data collection. When you are satisfied with the data, press [ENTER] and then **7:QUIT** to quit the program. Press [GRAPH] to view the plot. Sketch the plot of Distance-Time in the space provided.



Questions

1. Your graph shows a line with positive slope. Note that the distance units on the y-axis are meters and the time units on the x-axis are seconds. Slope of a line is the rate of change of the quantity on the y-axis with respect to the quantity on the x-axis. The equation for the slope of the plot shown is *the change in position divided by the change in time*, or

   $slope = \frac{\Delta d}{\Delta t}$.

   Press [TRACE]. Use [◀] and to move along the graph. Select two points on the graph that are not close together. Record the values below.

t1 =		**d1 =**	
t2 =		**d2 =**	

   Record the change in distance, $\Delta d =$ ______________________________

   Record the change in time, $\Delta t =$ ______________________________

   Calculate the slope.

   Record the result along with the units. m = ______________________________

2. The y-intercept is the y-value of the graph where the x-value is equal to zero. Press [TRACE] and use the arrow keys to move to the y-intercept of this line.

   Record the value, b = ______________________________

3. Use the slope and y-intercept to write the equation of the line using slope-intercept form. Your equation should be written as $y = \text{m}\,x + \text{b}$.

   ____

4. Check to see if this equation matches the data collected by the CBR. Press [Y=]. Enter the equation in one of the function registers. Press [GRAPH]. Describe how the equation matches with the data. If the equation does not match well, check the values of the slope and the y-intercept. If necessary, make adjustments and record your new equation below.

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5. What does the slope represent in the graph? (**Hint:** Look at the units.)

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6. What does the y-intercept of this graph represent?

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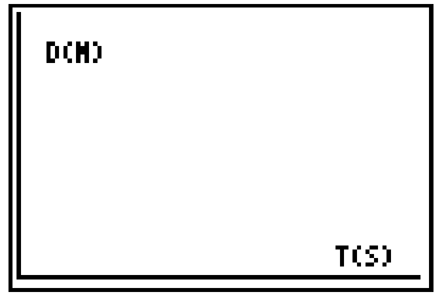
7. Write the equation for a person who starts 1 meter from the CBR and walks away at a speed of 1 meter per second for 3 seconds. Sketch the graph of this motion. Include scale markers on your axes. Be sure to correctly label the y-intercept and use the correct slope for this walker.



y = ______________________________

8. How would your motion graphs differ if the walker moved towards the CBR with a constant speed?

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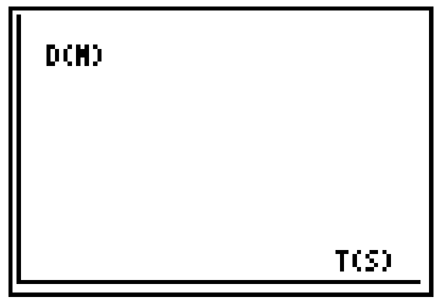
9. Repeat the above activity for a person walking towards the CBR at a constant speed. The starting point should be at least 3 meters from the CBR. (If you need instructions, repeat those in step 6 of the **Instructions** section on page 12.) Record your graph in the space provided.



10. Press [TRACE]. Select two points on the graph which are not close together. Record the values below.

t1=		**d1=**	
t2=		**d2=**	

Record the change in distance, Δd = ______________________________

Record the change in time, Δt = ______________________________

11. Calculate the slope.

Record the result along with the units. m = ______________________________

Press [TRACE] and use the arrow keys to move to the y-intercept of this line.

Record the value, b =______________________________.

12. Use the slope and y-intercept to write the equation of the line using slope-intercept form. Your equation should be written as $y = mx + b$.

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13. Check to see if this equation matches the data collected by the CBR. Press [Y=]. Enter the equation in one of the function registers. Press [GRAPH]. Describe how the equation matches with the data. If the equation does not match well, check the values of the slope and the y-intercept. If necessary, make adjustments and record your new equation below.

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14. Describe the characteristics of any equation of motion for a person moving at a constant speed away from the CBR.

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How does this equation differ if the person is moving at a constant speed towards the CBR?

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15. Velocity differs from speed in that it indicates direction. If the slope of the Distance-Time graph is positive, the velocity is positive. If the slope (as in the above example) is negative, the velocity is negative. What does it mean when the CBR indicates that a person is moving with a negative velocity?

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