

ACTIVITY 5

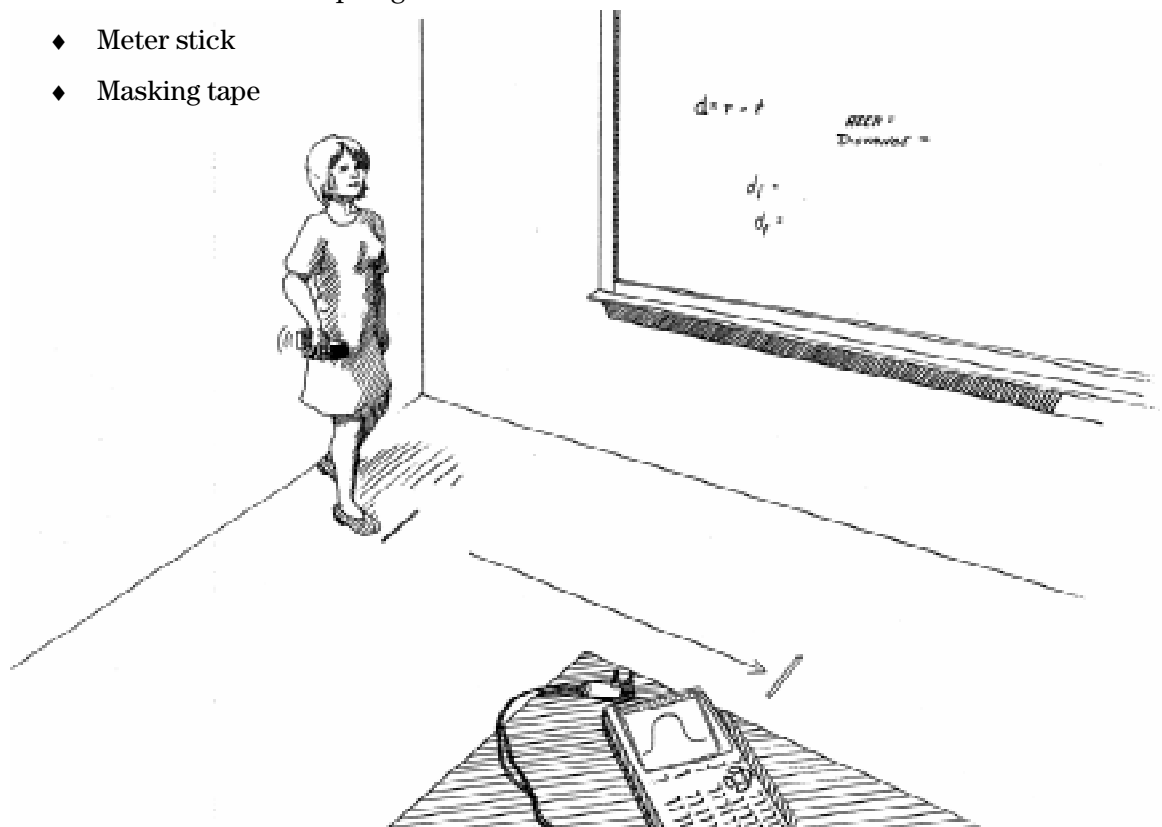
How Far Did You Walk?

For a constant velocity and known time, the distance a person travels can be computed from the known formula $d = r * t$. If the velocity is not constant, then the distance traveled is more difficult to compute. We can approximate the distance by using the same formula but over shorter time periods.

In this activity, you will find the distance traveled when the velocity is constant by examining the area under the Velocity-Time graph and applying the formula $d = r * t$. You also will find the distance traveled for motion when the velocity is not constant by approximating the area under the Velocity-Time graph.

You'll Need

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



Instructions

Use masking tape to set a scale on the floor. Place a piece of tape on the floor 0.5 meter from the wall, and then each 0.5 meter for 3 meters.

1. Run the **RANGER** program on your calculator.
3. Enter the setup instructions.
 - a. From the **MAIN MENU** select **1:SETUP/SAMPLE** to access the setup menu.
 - b. Press **[ENTER]** until the **REALTIME** option reads **no**.
 - c. 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. Press **[ENTER]** and follow the directions on the screen. Detach the CBR when prompted to do so.

MAIN MENU	▶START NOW
REALTIME:	NO
TIME (S):	3
DISPLAY:	VEL
BEGIN ON:	[TRIGGER]
SMOOTHING:	LIGHT
UNITS:	METERS

4. You should stand close to a wall (facing away from the wall) and point the CBR towards the wall. You should begin to walk away from the wall with a constant rate. When you are at least 0.5 meter from the wall, press **[TRIGGER]** on the CBR and continue to walk until the data collecting is done. Reconnect the CBR and follow the directions on the screen.

Note: If you hold the CBR away from your body, you will get a better sample. Otherwise, there will be an unevenness due to the motion of your body.

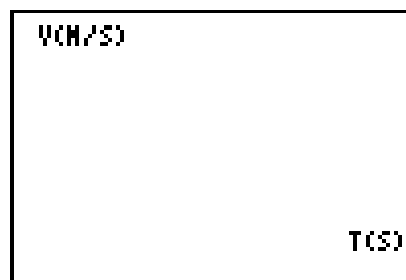
5. This graph should appear reasonably constant. There will be some variation because your walking speed is not constant. If you are not satisfied with your graph, press **[ENTER]** and select **5:REPEAT SAMPLE**. When you are satisfied with your graph, press **[ENTER]** and select **7:QUIT**. Press **[GRAPH]** to display the Velocity-Time graph.

Data Collection

1. Press **[2nd]** **[DRAW]** and select **3:Horizontal**. Use **[↑]** and **[↓]** to draw a horizontal line that best approximates the velocity with which you walked. Record the value below.

$v =$ _____

2. In the space provided, sketch the plot of the velocity data and the horizontal line that represents the Velocity-Time graph.



3. Press **[Y=]** and enter the equation for the horizontal line that represents the velocity in **Y1**. (Use the value from #1.) Press **[2nd]** **[STAT PLOT]**, select **4:PlotsOff** and press **[ENTER]** to turn off the stat plot. Press **[WINDOW]** and enter 0 for **Ymin**. Press **[GRAPH]** to display the horizontal line that approximates the velocity.

Questions - Part One

1. What is the slope of the horizontal line in the Velocity-Time graph?

2. Since the walker walked at a constant rate, what would the acceleration of the walker equal?

How does the slope of the Velocity-Time graph compare with the value of the acceleration?

3. For each of the times given below, compute the area of the rectangle formed by the horizontal line that approximates the velocity and a vertical line at each time by multiplying the height of the rectangle (velocity) and the width of the rectangle (time) together.

Time (sec)	Velocity	Area
0.5		
1.0		
1.5		
2.0		
2.5		
3.0		

4. Run the **RANGER** program and select **4:PLOT MENU** then **1:DIST-TIME**. Record the distance d at time 0. This is the initial distance from the wall to the walker and occurred when **TRIGGER** was pressed on the CBR.

$d =$ _____

5. Use \leftarrow and \rightarrow to trace to each time in the chart below, or as close to the times as possible. The y -value represents the distance from the wall at that time. Record the distance from the wall in the table below.

Time (sec)	Distance from the Wall	Distance Traveled
0.5		
1.0		
1.5		
2.0		
2.5		
3.0		

6. The distance the walker has traveled is the distance from the wall minus the starting distance d . Subtract the walker's starting distance d from the distance to the wall to obtain the distance traveled and record this figure in the last column of the table above.
7. How do the areas in question 3 and the distance traveled in question 6 compare?

-
8. Write a mathematical model that would give the distance traveled at any time t .

$$d = \underline{\hspace{4cm}}$$

Questions — Part Two

The area under the Velocity-Time graph of Part One is the total distance traveled. It is found by computing the product of the velocity and time. This is true even when the person is not moving at a constant rate.

This portion of the activity will use the program **AREA** shown below. You will need to enter it into the calculators that will analyze the data. (Since you must enter this program from the home screen, exit the **RANGER** program if you have not already done so.)

```

ClrHome
ClrDraw
Ø→T
Prompt N
int(94/N)→S
For(I,1,94-S,S)
L1(I)→A
L3(I+.5S)→B
L1(I+S)→C
Line(A,Ø,A,B)
Line(A,B,C,B)
Line(C,Ø,C,B)
S*(L1(2)-L1(1))*B+T→T
Text(1,1Ø,"AREA=")
Text(1,3Ø,T)
End

```

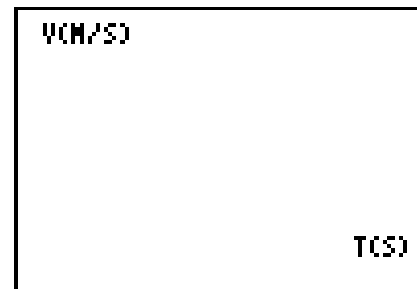
1. Run the program **RANGER** and use the same setup as in Part One. Stand at least 0.5 meter from the wall. Record the distance from the walker to the wall as the initial starting distance d_i .

$d_i =$ _____

2. Follow the directions given and walk *away* from the wall, varying your rate. Mark on the floor the walker's location when the data collection stops. This can be determined when the sound stops or the green light is no longer illuminated. Record the walker's final distance from the wall as d_f .

$d_f =$ _____

3. The graph of the velocity should be positive indicating that you walked away from the CBR. If you are not satisfied with your results, press **ENTER** and select **5:REPEAT SAMPLE**. Sketch the Velocity-Time graph in the space at right.



4. Press **[ENTER]** and select **7:QUIT**. Run the program **AREA** and enter the following values for N . Press **[ENTER]** and N number of rectangles will be drawn. The program will produce valid answers only for the values of N given in the table. The sum of the area of the rectangles is displayed, and it approximates the area under the Velocity-Time graph. Record the areas in the table. Press **[CLEAR]** **[ENTER]** to restart the **AREA** program.

N	Area
5	
9	
15	
23	
47	

5. Do the values appear to be approaching some value? If so, record this value.

Area = _____

6. The total distance the walker walked would be the final distance minus the starting distance. Find the distance the walker walked.

Distance walked = _____

7. How do the values found in questions 5 and 6 compare?

8. What does this tell us about the area under the Velocity-Time graph and the total distance traveled?
