

## Activity 1 - Keep The Pace

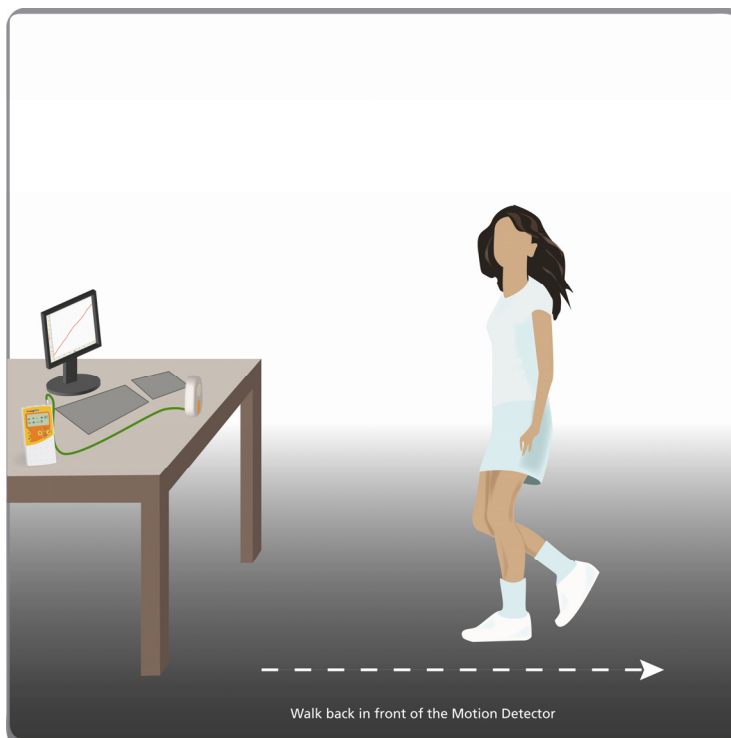


Figure 1-1

### Introduction

The equation  $f(x) = mx + b$  represents a linear function. Two quantities are linearly related if changes in one quantity are proportional to changes in the other quantity. A linear function can be represented in the form:

$$(1) \quad y = mx + b$$

where  $m$  and  $b$  are constants. This form is known as the slope-intercept form of linear functions. Here  $m$  is the slope and  $b$  is the y-intercept. In the x-y plane linear functions are represented by straight lines.

If  $(x_1, y_1)$  and  $(x_2, y_2)$  are two points on the line, then the slope is:

$$(2) \quad m = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

The intercept is the y coordinate of the point at which the line crosses the y-axis,  $(0, b)$ .



In this activity you will use the Distance sensor to create linearly increasing distance vs. time graph. You will then analyze the graph in order to formulate the slope-intercept presentation of the graph.


## Equipment

- MultiLogPRO or Nova or TriLink data logger
- Distance sensor

## Equipment Setup Procedure

1. Turn on the data logger

**Note:** If you are using the 10-bit version of MultiLogPRO you will first need to configure it to measure distances in the range of 0.4 to 10 meters

2. Connect the Distance sensor to input 1 (I/O-1) of the data logger
3. Connect the data logger to the computer
4. Run MultiLab
5. Click **Setup wizard**  on the upper toolbar and program the data logger according to the specifications below

## Data Logger Setup

### Sensors:

Input 1: Distance

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### Rate:



10 samples per second

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### Recording time:

10s (100 samples)

## Experimental Procedure


1. Place the Distance sensor on a table so that it points toward an open space which is at least 4 m long (see Figure 1-1)
2. Produce a graph of your motion when you walk away from the Distance sensor with constant velocity. To do this, stand about half a meter from the Distance sensor and have your Lab partner click **Run**  on the upper toolbar to begin recording data. Walk slowly away from the Distance sensor when you hear it begin to click. Try walking with a constant pace. You have 10 seconds to complete the task before data logging stops
3. Watch the graph you have just produced. If you are satisfied with it, save the data by clicking **Save**  on the upper toolbar. Otherwise return to step 2

## Data Table




Quantity	Value
$b$ , the y-intercept	
$\Delta x$	
$\Delta y$	
$m$ , the slope	
Automatic linear fit	


## Data Analysis

Trim any unwanted data keeping only the linearly increasing part of the graph:

1. Click **Toggle first cursor**  on the graph toolbar to display a cursor on the graph. Drag it to the point where the linearly increasing part of the graph starts




2. Click **Toggle second cursor**  on the graph toolbar to display a second cursor on the graph. Drag it to the point where the linearly increasing part of the graph ends
3. Click **Graph** on the menu bar, then click **Crop**
4. Click **Add graph to project**  on the graph toolbar to preserve the current graph, then click **Save** 


**Note:** Notice that a new graph icon  has been added to the **Data Map** under the graph category

Now it's time for modeling the data. You will do it in two different ways.

### Manually calculating the slope and y-intercept

1. Click **Toggle first cursor**  on the graph toolbar to display a cursor on the graph. Drag it to the y-intercept point and record the y-coordinate value in the data table




**Note:** The point coordinates appear in the information bar at the bottom of the graph window.

2. Click **Toggle second cursor**  on the graph toolbar to display a second cursor on the graph


**Note:** The information bar will now display the difference between the two coordinate values.

3. Drag the cursors and place them on two well separated points
4. Record  $\Delta x$  and  $\Delta y$  in your data table
5. Calculate the slope (see equation 2) and record it in your data table

### Plotting the manual line fit on the graph

1. Click **Analysis wizard**  on the main toolbar, then click the **Functions** tab
2. Select **Linear** in the **Functions** drop list
3. Select **Cropped data: Time** in the **G1** drop list
4. Enter the slope value into **A** edit box
5. Enter the y-intercept value into **B** edit box
6. Check the **Synchronize scale with** check box and select **Cropped data: Distance** in the drop list
7. Type **m** in the **Unit** edit box
8. Click **OK**
9. Click **Add graph to project**  on the graph toolbar to preserve the current graph, then click **Save** 

### Applying automatic curve fit to your distance vs. time plot

1. Double click the first graph icon in the Data Map to return to the original cropped data graph
2. Click **Linear fit**  on the main toolbar

**Note:** The fit equation appears in the information bar at the bottom of the graph window.

3. Record the fit equation in your data table



## Questions

### Manually calculating the slope and y-intercept

1. Discuss the physical meaning of the slope and the y-intercept
2. What are the units of the y-intercept and the slope?
3. Compare the actual data graph with the linear fit. Is linear function an appropriate model for this activity?
4. Can the linear model describe a real physical situation?

### Applying automatic curve fit to your distance vs. time plot

1. Compare the y-intercept and the slope obtained by the automatic fit to the manually calculated values. Why are they not identical?