

Names:

## Motion on an Inclined Plane

**Purpose:** The purpose of this lab is to model the acceleration, velocity and position of a cart moving up an inclined plane; first by taking data, then by finding a pattern in the data.

**Setup:** For this experiment you need to turn on the ULI and Mac, launch MacMotion, and display at  $x$ ,  $v$ , and  $a$  plots. Next, give a slight incline to the 2 meter track at your table; you just need enough incline so that the cart will roll down the track away from the sonic ranger and toward the padded bumper (so that the cart wont be damaged!)

**Warning:** Please keep the carts some distance (a foot or so) away from the computer. Most of the carts have magnets inside that can damage the computer.

**Data Taking:** Start the motion detector. Give the cart a push up the ramp, making sure the cart goes nearly up to .5 meters from the ranger. (You will probably find there are regions of the data when you are pushing the cart, when it gets too close to the ranger, when it hits the bumper. These are not the simple motion we are looking for, but their presence is no concern as long as there is a region of data at least three seconds long for which these outside influences are not affecting the motion.) Feel free to take several runs in order to get a long stretch of data for the simple motion of the cart moving up the ramp.

**Look at the Data:** Look at a section of data for which there were no influences from your hand or the bumper.

(You may find it useful to change the graphing region so that you can focus on this data. To change the graphing region click on the first or last numbers on the plotting scale to highlight the number, then type in the number you wish. You can do this for both horizontal and vertical axes.)

Part of the work of a physicist is to recognize trends or patterns in the data and then to model those patterns with an equation.

Describe your data for  $x(t)$ . Does the data appear to resemble any function that you are familiar with?

Describe your data for  $v(t)$ . Does the data appear to resemble any function that you are familiar with?

Describe your data for  $a(t)$ . Does the data appear to resemble any function that you are familiar with?

**Data Analysis:** You have noticed some patterns simply with your eyes, but now we need to be more precise about those patterns. For example, one of the plots may have looked linear, but we want to know the slope of that line and also get a measure of how linear it is. This is done by “fitting” the data, which we will describe a bit more later.

Choose Analyze data A under the Analyze menu. Then take your cursor and highlight the section of data that appears to be valid (i.e., unaffected by your hand or the bumper). Click on the  $a(t)$  plot so that it is active.

Next, under the same menu, choose Fit. The Fit window allows you to choose many different functional forms for the fit. Pick the functional form that matches what you saw by eye. Click the fit button and write down the formula for the fit below. Also print out the plot with the fit on it.

Do you think that this function is a good model for the data? That is, does it represent the data well? Explain.

Repeat the fitting for  $v(t)$  and  $x(t)$ . (You have to close the fit window and select the plot you want to fit before reselecting fit from the Analyze menu.) Don't forget to print out the plots and write the fit equations below.

Fit equation for  $v(t)$ :

Do you think that this function is a good model for the data? That is, does it represent the data well? Explain.

Fit equation for  $a(t)$ :

Do you think that this function is a good model for the data? That is, does it represent the data well? Explain.

**Learning from the model:** Look back at the equations for  $a$ ,  $v$  and  $x$ . We need to relate the numbers in the equation to the physics system.

1. In each case you probably have a term  $(t - a)$ , where  $a$  is a number. What are the units of that number? What is that number telling me about the physical situation of the cart going up the ramp?
2. Look at the numbers in the  $a(t)$  equation. What do they tell you about the physical situation (again, knowing the units of the number can help your interpretation).
3. Look at the numbers in the  $v(t)$  equation. What do they tell you about the physical situation (again, knowing the units of the number can help your interpretation).
4. Look at the numbers in the  $x(t)$  equation. What do they tell you about the physical situation (again, knowing the units of the number can help your interpretation).