



(c) Given the accelerations in the last two questions, how do you expect each velocity to change with time? (e.g is it constant, linear, quadratic? Cubic? (Use calculus and antiderivatives!)

(d) Given the accelerations in the last two questions, how do you expect each location to change with time? (e.g is it constant, linear, quadratic? Cubic?

4. Run the “experiment” and take data:

- (a) Run the movie by clicking on the button on the lower left next to the scroll bar. Note that you can step through the movie using the buttons to the right of the scroll bar.
- (b) Place the movie at the beginning by dragging the scrollbar all the way to left.
- (c) On each frame, place and click the cursor directly over the middle of the launched ball. This places the location information in a table. Be sure to click on the same place on the object in each frame. After you have done this for each frame in the movie, you can go back to any frame and adjust the location of the cursor by dragging it with your mouse, or by using the “nudge” tool (the set of four arrows) to move small amounts in any direction.

- (d) Before the data can be analyzed, we need to set the scale for the data by letting it know how many pixels are a meter for this movie. You can do the scaling in the following steps.
- Under the "Movie" menu, select "scale movie".
  - The first dialog box should have the known length to be 1 meter, and the scale "fixed".
  - You will then be instructed to click on one end of a known length: use your cursor to click on one edge of the meter stick in the lower portion of the movie frame.
  - Now you need to click on the other end of the length: click on the other end of the meter stick. Now the computer knows the conversion from pixels to meters and the data is automatically converted.

5. Graph and model the data:

- Click on the graph icon on the left of the screen (or choose "new graph" under the "view" menu).
- The first coordinate is time. Keep it as time.
- The second coordinate is  $x$ . Select position, velocity and acceleration underneath and then click "okay". The plot should pop up. Verify that the units are in meters and seconds.
- Next you should fit the data. First, click on the  $x(t)$  plot to select it, then under the **Graph** menu, chose **Add/Edit Fit**. Fit  $x(t)$  to appropriate function that you choose above in the expectations section. Repeat for  $v(t)$  and  $a(t)$  plots. If the equations don't model the data well, stop and think again about what functional form you expected for each quantity.
- Repeat the above steps for the motion in the y-direction.
- Print out your plots.

