# Using Video and Logger Pro to Measure the Motion of Objects

1. Collect video of the object(s) whose motion you wish to analyze.
   - Make sure to include something in the video of known length (a meter stick is ideal). You will use this to set the scale for your motion analysis.
   - To the best of your ability, video the motion from a perspective perpendicular to the two-dimensional plane within which the majority of the motion is occurring.

2. If you use your phone to record the video, email the video file to yourself. Usually you will want to place this video on your school Google Drive. That way the video can be downloaded onto one of the school computers having *LoggerPro* software.

3. Open *LoggerPro* (this icon may be on the desktop – otherwise search the computer for the program). Your version of *LoggerPro* may differ from the "3.14" shown here.

4. Once *LoggerPro* has opened, choose "Movie" from the INSERT MENU. A window showing your video will open with several tools.

5. Click on the "Enable/Disable video analysis" button (circled in red in the diagram at right). Once you do this, several additional tools will appear.

6. Click on the "Set Scale" button (the button with the yellow horizontal ruler circled in green in the diagram at right). Drag over an object of known length in your video (a meter stick is helpful here, but not necessary). Enter the known distance (using the correct units) in the box that appears when you finish your drag.

7. Fast forward the video using the "Next Frame" button (circled in orange) until just before the action that you wish to analyze starts. Each click advances the video by one frame. The total frame count is displayed at the top of the window. In the diagram shown, frame 59 of 110 is being displayed.

8. Set the origin by using the "Set Origin" button (circled in blue above). Wherever the cursor is clicked becomes (0,0). Horizontal position values (x's) to the right of this point will be positive, while values to the left of this point will be negative. Vertical position values (y's) above this point will be positive, while positions below this point will become negative. Usually it is helpful to make your origin at a location where an object starts to move. Additionally, think about the best place on the object to make as your origin (for instance, the front of the object or the back of the object). It may not matter – it all depends upon what you are attempting to do.
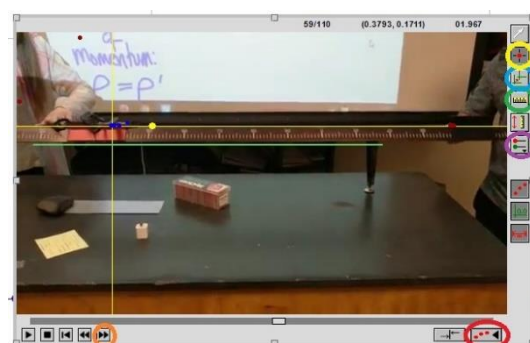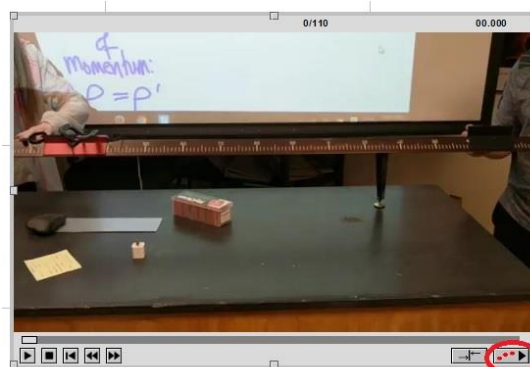
9. Next, you will place a data point on each frame of the video corresponding to a point on the object whose motion you wish to analyze. Each click places a point locating the x and y coordinates of your object (relative to the origin), and advances the video by one frame. Adjusting your cursor so that it is on the same point of the object as the first click and clicking again identifies the position of the object in the second frame. Take some care and try to consistently click on the same point on the moving object. Note that both x as well as y-direction data is being plotted for each click. Often you will only be interested in motion in one of these two directions. Continue adding points up to and just past the frame (and therefore time) at which you want to end your analysis.

10. At this point, you are finished with data collection *IF* you are only wanting to look at the motion of a single object. If you wish to analyze the motion of multiple objects, you should
    *   Select the "Set Active Point" button (circled in purple above).
    *   Advance the video backward to the frame in which the analysis of the first object was started (if appropriate . . . there are cases where you might not want to do this).
    *   If you click again in the video window, the dot will be a different color as it is now associated with a different series of points, and presumably a different object.
    *   Repeat Step #9 for the second object.
    *   Repeat for as many objects as you wish to analyze.

11. To begin the analysis of motion, you need to look at the graph that has been plotted. (The graph is likely hiding behind the video window).

12. The positions of an object can be obtained by reading the coordinate values from the x and the y-axis. Be careful here – both the *x* and the *y* positions for each object are displayed. You often will only be interested in one of the two directions.

13. To find the velocity of an object, you need to determine the slope of the graph for that object at the point of interest. There are a couple of ways to do this.
    1. The fasted way is to simply select the "Tangent" button, denoted with an "M", and circled in red in the adjacent diagram. When selected, the x-direction and y-direction velocities of every object is displayed in the box (circled in orange on the attached diagram). While this is the fasted method,

    it may also be prone to the most error as it is simply finding the instantaneous velocity at one instant in time. If your data selection (i.e. the placement of points) was not perfect . . . .
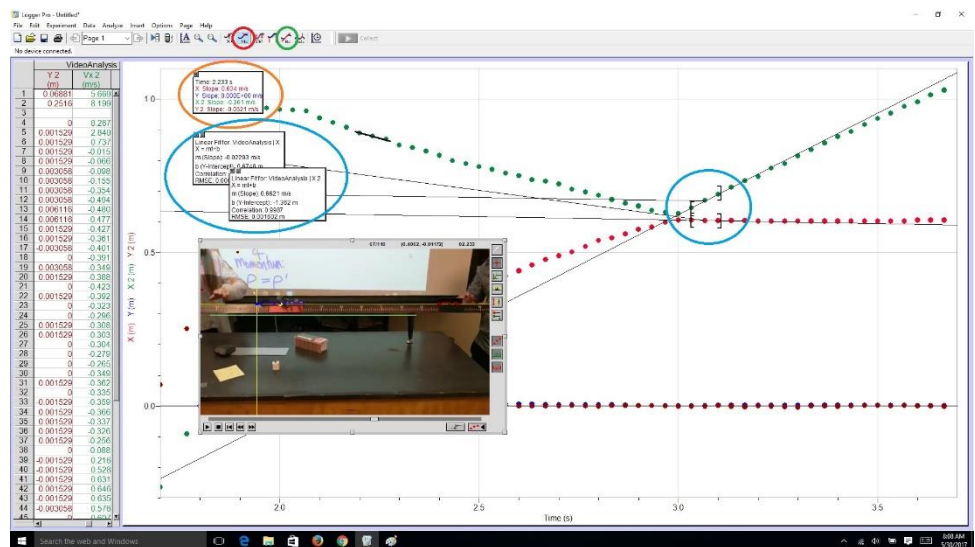
2. A second method is to simply select the "Linear fit" button, denoted with an "R", and circled in green in the adjacent diagram. This is more like an average, not being dependent on a single data point. First, click and drag over a region of time in the graph in which you want. This portion of the graph is now shaded gray. When you click on the "Linear Fit" button, a box will open asking which of the data sets to place a fit for). Once selected, a linear fit is determined JUST FOR THE SHADED REGION. Brackets will be placed over the region of time used to determine the linear fit (circled in blue). The slope can be read directly from the boxes that appear on the graph (circled in blue).

14. If your object has both x and y-components of velocity, they must be added together AS VECTORS. $v_{total} = \sqrt{v_x{}^2 + v_y{}^2}$ Consult with your instructor as needed.

15. One final note. The data table that is partially displayed on the left side of the diagram above is the tabulated data depicted in the graph as data points. If ever in doubt about the data, you can always go to this table and the data itself. The data in these cells can always be cut and pasted into a spreadsheet as needed.