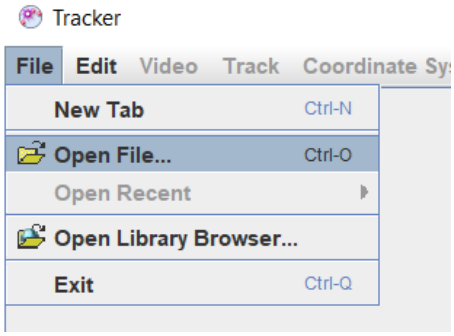
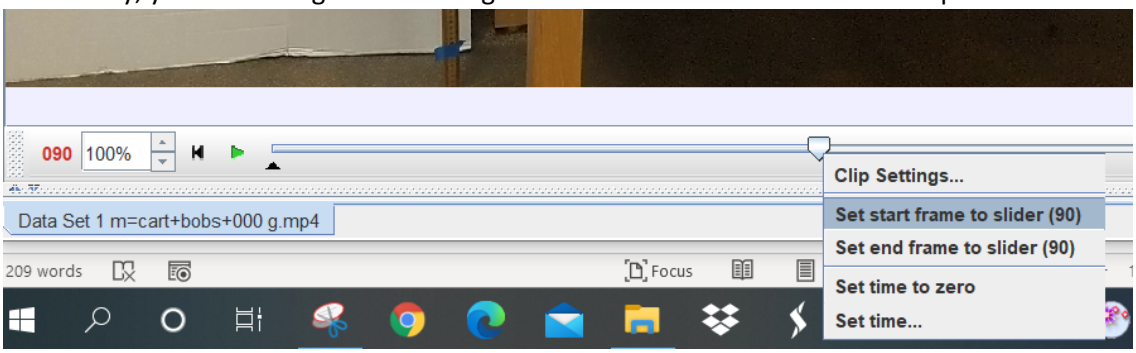
Force and Motion Part I-- Using Tracker Video Analysis to Measure Acceleration

For this lab you will be using a set of videos of the experiments you would have conducted in lab had the course not been online this term. This document includes the directions for determining the acceleration of a moving object using Tracker, an online video analysis tool.

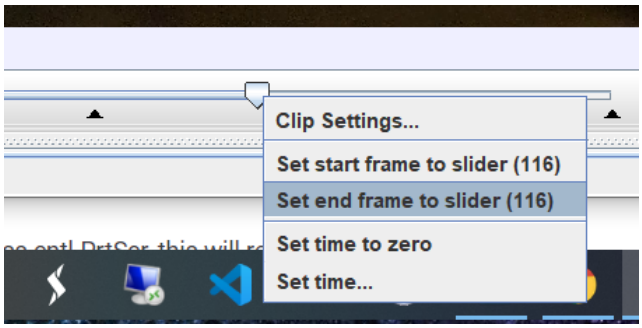
1. **Open** the Tracker Video Analysis and Modeling Tool at https://physlets.org/tracker/
2. **Open** the mp4 video file you wish to analyze. You may have to download it first on your computer.



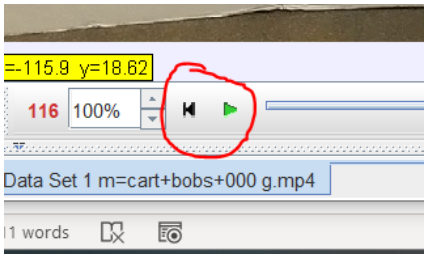
3. Watch the video and decide where you wish to **start tracking**. You can do this as follows:
   - Drag the white slider to moment in video you wish and then right click on slider and choose start
   - Alternately, you could drag the left triangle under the bar to the selected start point



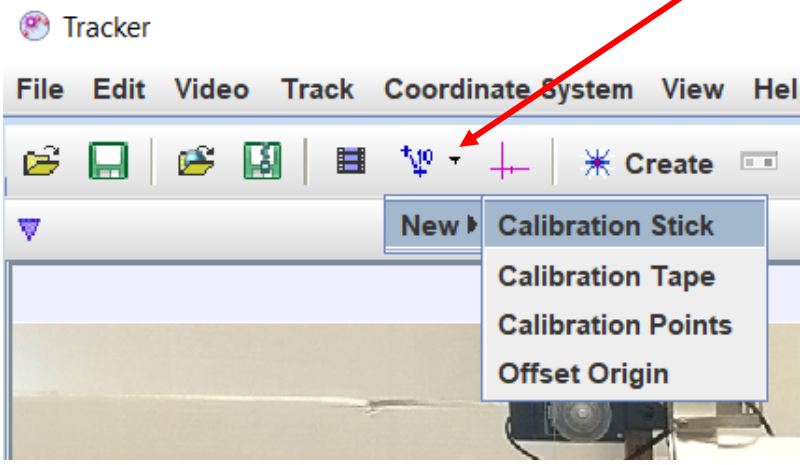
4. Decide where to **stop tracking**
   - Drag the white slider to the moment in the video you wish to stop tracking and right click on slider and choose start.
   - Alternately, you could drag the left triangle under the bar to the selected start point.



5. Click on the **Rewind** icon (black triangle) to return the slider to the Start frame.

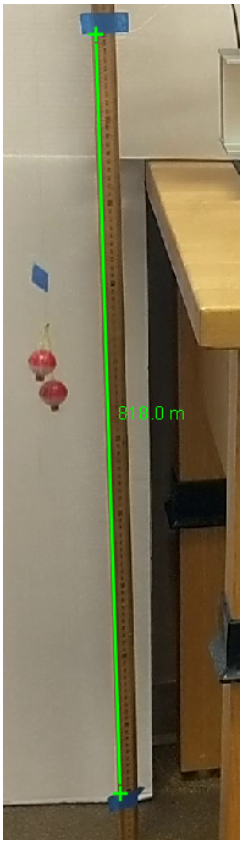


6. You must now **calibrate** the video for distance. Note the 2-meter measuring stick placed vertically in the video down the left edge of the table. Blue tape has been placed at the top and bottom of the measuring stick such that there is 1 m in between the tape edges. Use the drop down menu as shown and select New and then choose Calibration Stick.

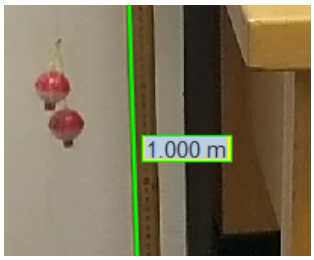


7. Place your cursor at the bottom edge of the top piece of tape and hold down the shift button on your keyboard. A box will appear that can be moved using your cursor such that it aligns with the bottom edge of the tape. You made need to use the magnifying glass on the tool bar to scroll in to see this edge better. While holding down the shift key, right click the mouse and a mark will be made on the screen.

8. Repeat for the top edge of the piece of tape located at the bottom of the 2-meter stick. A colored line should appear connecting the two marked points as shown on the right.

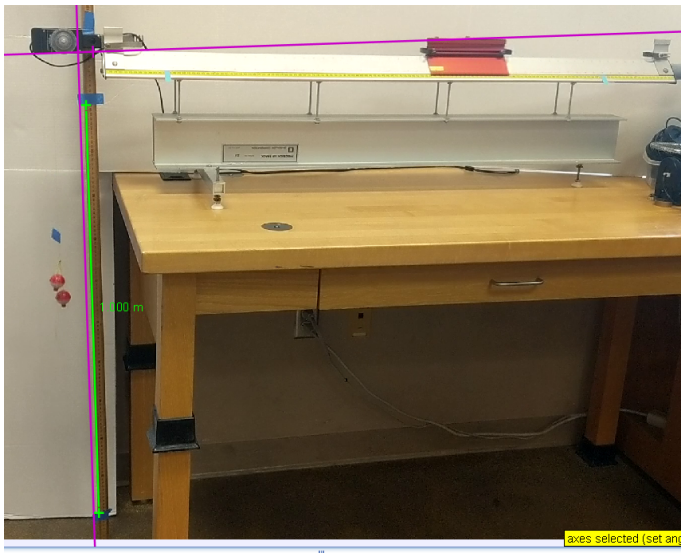


9. Note the distance marking in the middle of the line. Click on the number and type 1 m in the box. If no unit is used, the default is meter.

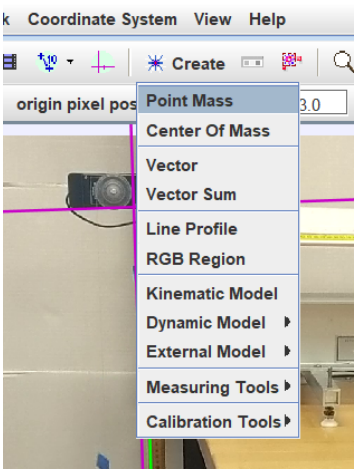


10. You have now finished the calibration. To hide the calibration line, click on the calibration tool on the tool bar. This calibration will need to be repeated for each video that you choose to analyze using Tracker.

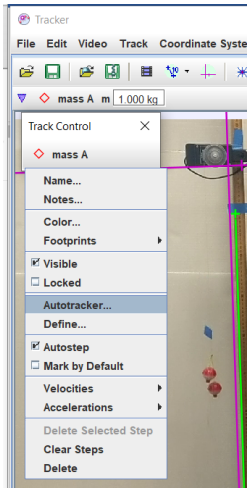
11. Set origin and axes
    - Click on the axis icon on the top tool bar. A purple axis will pop up on the screen
    - Drag the origin of the axes to be near the bottom edge of the pulley and the 2-meter stick as shown on the right.
    - Rotate the axes by typing an angle in the "angle from horizontal" box in the tool bar. The goal is to have the y-axis parallel with the 2-meter stick. Do not worry that the cart is no longer on the x-axis. We will track the motion of the falling masses (two red fish bobs) instead of the cart. Because they are connected by a string, any resulting acceleration will be the same for both.



12. Create a point mass (mass A) for the hanging bobs. To do this, click on the Create button and select Point Mass as shown at right. A Track Control box should pop up on your screen with Mass A now included.

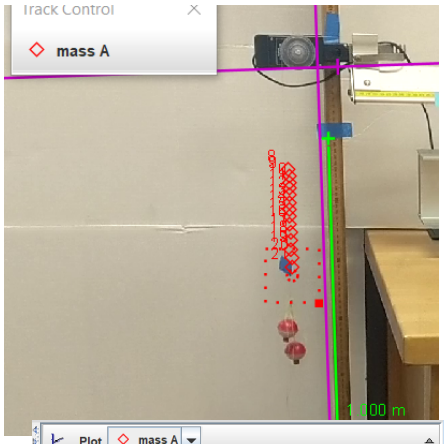


13. Click on Mass A in the Tracker Control box and from the drop down menu choose Autotracker as shown below.

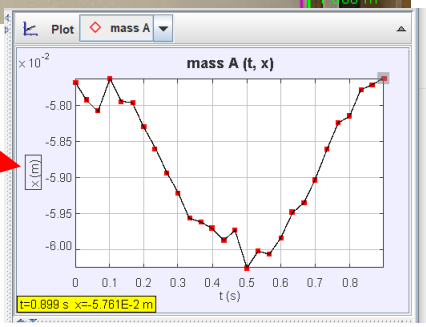


14. Be sure the video is reset to the starting point. Hold down the shift and control buttons and then click on the center of the ball masses on the screen. A dashed red box will form around the points with a 0 indicating starting position.

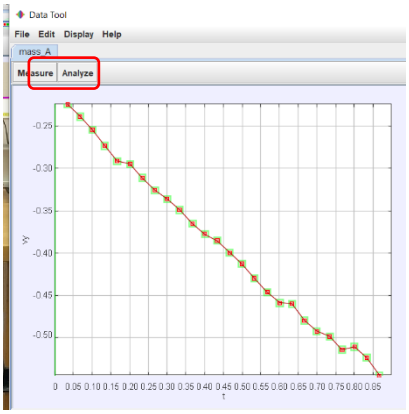
15. Click on Search in the Autotracker pop up window that should still be on your screen. As the ball falls, the autotracker feature automatically records the position of the ball over time for the portion of the video selected earlier.



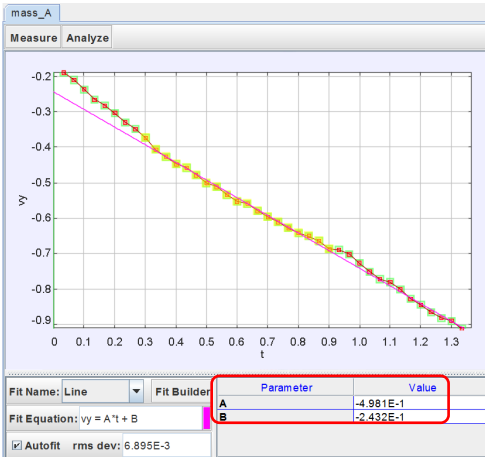
16. While the ball is falling, the plot and data table on the right should populate (see screen shot to the right). The plot is a position vs time graph and in order to determine acceleration, a velocity vs time graph is needed. Click on the y-axis of the plot and select "V_y: velocity y-component" from the drop down.



17. Double-click inside the new plot to bring up the Data Tool window as shown on the right. Click on Analyze, then select Curve Fits. Under the graph choose Line as the Fit Name when the additional boxes appear.



18. The equation of the best fit line should now be shown below the graph, where A is the slope of the line (i.e. the acceleration). Look at how well the line passes through the points and select a smaller section of the graph, if necessary. You can do this by positioning your cursor at one end of the targeted section, right clicking the mouse and holding it down as you drag the cursor over the points you wish to select. Release the mouse when you have selected the region of interest (see yellow highlighted data points in the plot at the right). Record the value of the acceleration (i.e. slope of the fitted line).



19. Analyze a new video by selecting "New Tab" under File at the top left of the screen. Note that a new workspace is opened in a new tab and you can switch between tabs, if needed, by clicking between them on the bottom of your screen. Repeat the above steps for each new video to be analyzed.