Labs 06 and 07: Using Tracker for conducting video analysis of oscillating objects

In lab this week you will be using an online video analysis tool, called Tracker, to collect measurements for the period of an oscillating mass on a spring. These instructions will be similar to how Tracker was used in previous weeks but there are some differences, particularly starting with Step 6. Also, be sure to read the Tips at the end of this document.

1. **Download** onto your computer the videos to be analyzed using Tracker.

2. **Open** the Tracker Video Analysis and Modeling Tool at https://physlets.org/tracker/

3. **Download** Tracker, if needed, by choosing the appropriate option on the screen:

    Tracker 5.1.5 installers: **Windows   OS X   Linux 32-bit   Linux 64-bit**

    Already have Tracker? Upgrade now to version 5.1.5:   Windows   OS X   Linux 32   Linux 64

4. Once in Tracker, use the Open File option (see right) and open the video file you downloaded in Step 1.
    -   If the screen is dark, hit the play button at the bottom of your screen as the video may be starting on a dark section.
    -   **Change size.** Use the magnifying glass on the tool bar above the video to pan out so you aren't able to see the full set up.

    -   **Play the video** a few times to understand the event on the video. You will need to click on the Rewind icon (see right) under the video to return to the start frame:
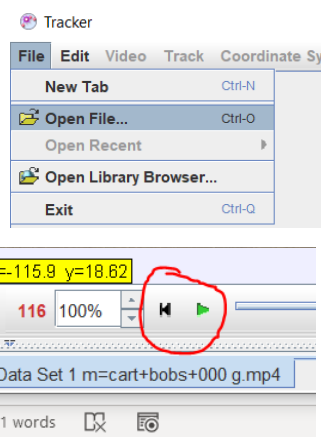
5. **Trim the video.** In lab you will be analyzing videos to determine the period of an oscillating mass on a spring. However, you only need a small segment of the video where the object is actually moving. Here are instructions on how to trim the video:
    -   **Set start frame.** Drag the slider under the video until the moment you wish to start the video. Right click on the slider and chose the "Set start frame to slider" as shown below. The small black triangle under the play bar will move to that location.
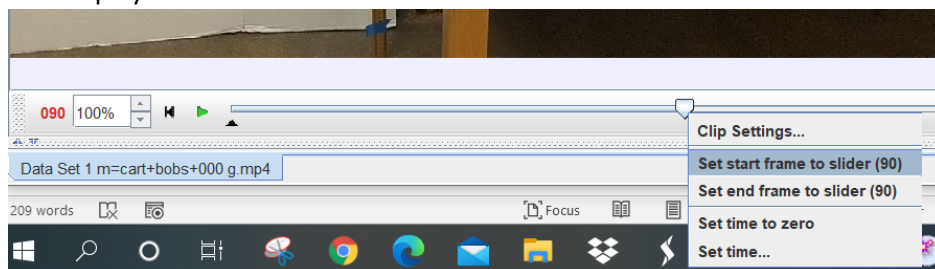
    -   **Set end frame.** Repeat for where you wish to stop the video (see figure 1b) but this time choose "Set end frame to slider" as shown at right.
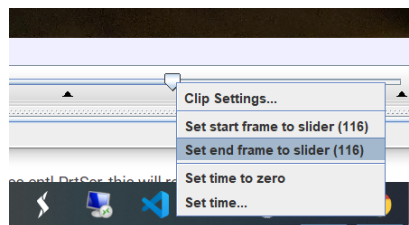
6. **Calibrate video distance**. There is a meter stick placed in the background near the plane of motion of the oscillating mass. ==The distance between the two pieces of blue tape is 0.4 m.== This needs to be set in Tracker.

- Use the drop down arrow near the Calibration icon shown in red circle at right. Select "Calibration stick".
- Now, hold down the SHIFT KEY on your keyboard. You will notice the cursor on your screen changes. Move the cursor to the bottom edge of the blue tape and LEFT click the mouse. A marker is placed here.
- Repeat for the top edge of the tape at the bottom of the screen. A blue line connecting the two will appear.
- The distance marked along the side of your calibration stick is not correct. Click on it and type in 0.4 (Tracker will automatically assume it is in meters).
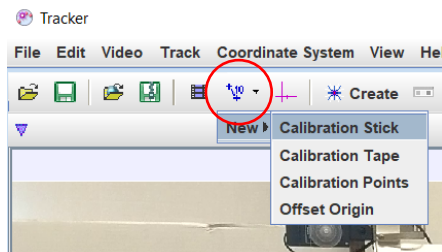
7. **Set origin**. Click on the axis icon on the top tool bar (in red circle below). A purple axes will pop up on the screen.
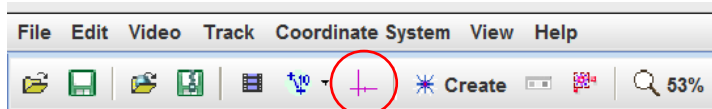
- **Move the axes.** Drag the center of the axes to some point on the mass (see at right). The location isn't critical in this lab.
- **Position the y-axis.** The y-axis should be parallel to the motion of the mass as it oscillates. You shouldn't have to change the tilt of the axes for this experiment. If you feel the need to do so, however, the axes can be titled by dragging the +x axis up or down.
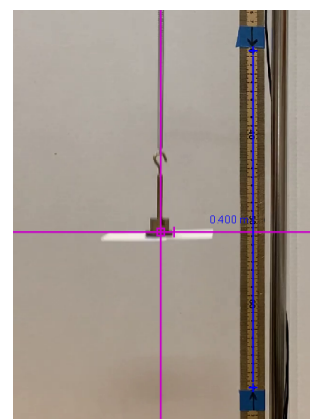
8. **Tracking an object**. Once everything is set up and calibrated, the next step is to engage in analysis of the video.

- **Create a point mass.** Click on "Create" in the top tool bar as shown on the right. Select "Point Mass". A "Track Control" box with Mass A in it will pop up in the upper left corner.

- **Enable Autotracker.** Click on Mass A in the Track Control box in the upper left corner. Choose Autotracker.
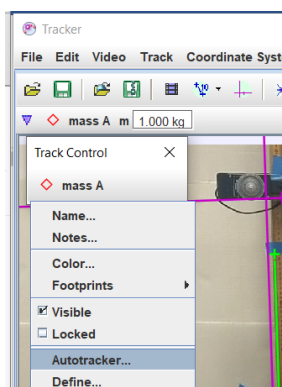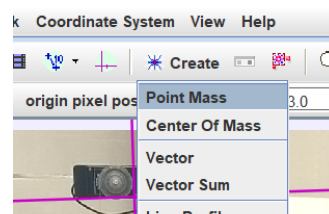
- The software needs to be told which object to track. Simultaneously hold down the SHIFT and CONTROL keys and then use your mouse to click on one point of the mass on the spring. Try to pick a point that will be easy for the system to track. See the dashed box around the hanging mass below. Tracker will try to locate this in each frame of the video. NOTE: A piece of white paper is under the mass to help in visualizing how far the mass is pulled down before release. Sometimes the paper might making tracking difficult. You will know this happens when you get a message (see the blue typed message in the lower right below which will change to an error message if necessary). If this happens, simply click on "mass A" in the upper left and delete using the drop down menu. Try again but this time drag the bottom right corner of the dashed box that appears on the screen around your object and make the box smaller.
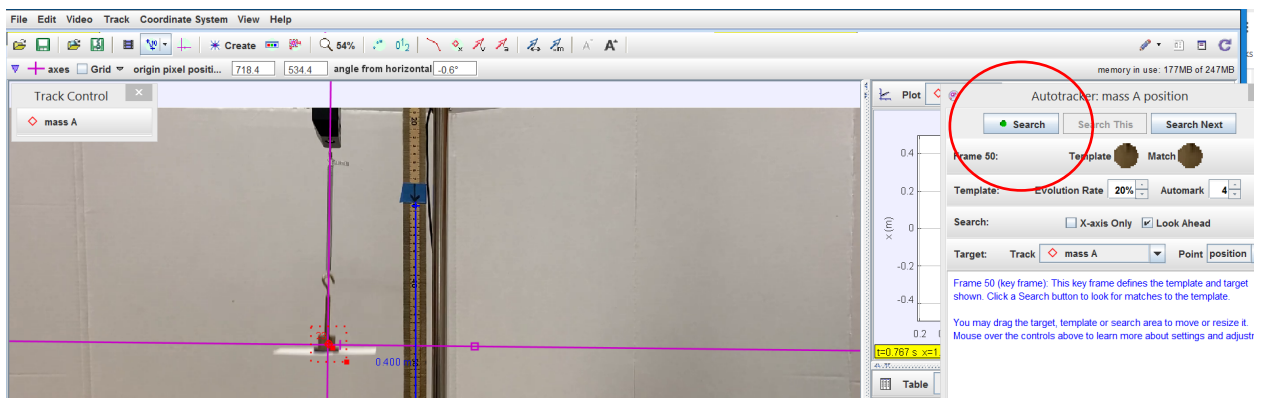
- Now click on Search button (see the red circle on the right above).
- Tracker will automatically play the video and track the motion of the oscillating mass frame by frame. If it doesn't automatically track, you probably have the video at the end. Reset the video or manually move the slider back to the start frame. Hit the Search button again.
- See below. Notice the graph and data table that are generated by Tracker during the motion. Close the Autotracker window so they can be seen.
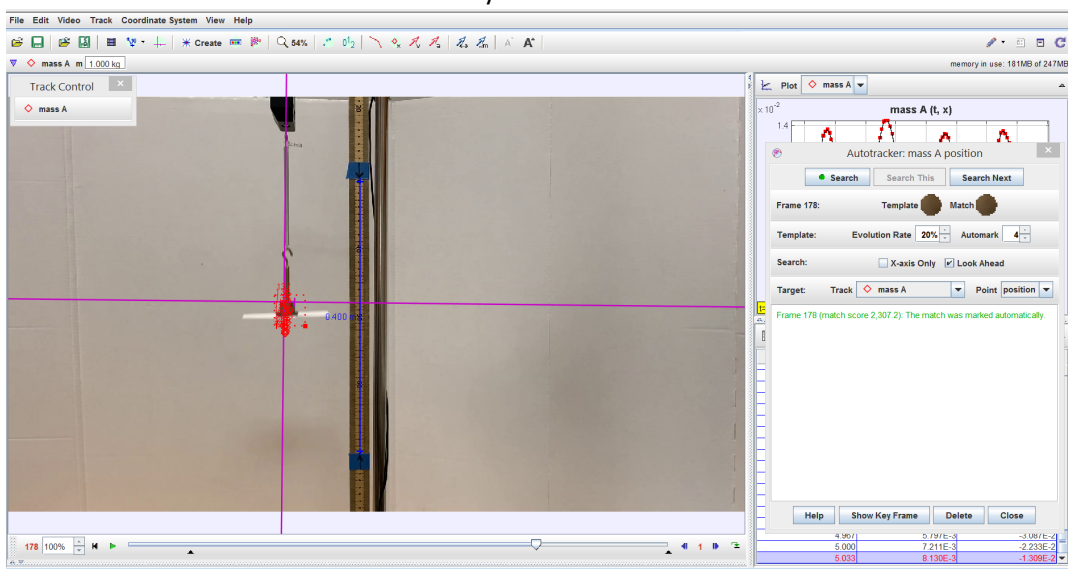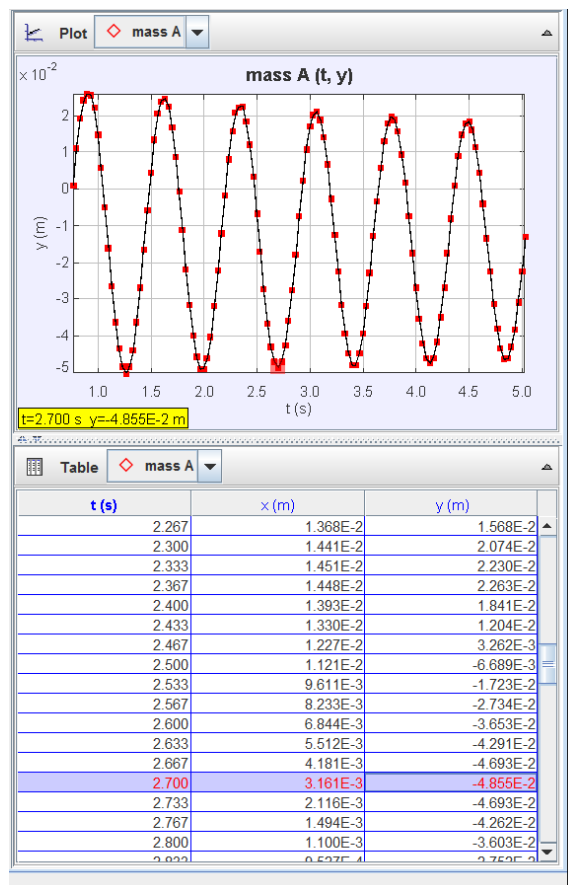
9. **Determine the period.** The graph that is generated is a position (x) vs time graph. A position (y) graph is needed to determine period of oscillation. Click on the x(m) on the y-axis and select the 2ⁿᵈ option down which is "y: position y-component".

The motion in the y direction should resemble a sin wave (see below). Period is the time until the cycle repeats, or just one wave peak-to-peak or trough-to-trough.

Find a point at the peak or trough and click on it. A small red box will highlight the point (see at right). A yellow box pops up with the time at this point, in this case, 2.700 s. Record the number and then click on another point that is one period away and find the difference in the times. This is the period.

For further certainty, notice that when you click on a point on the graph, the data line is highlighted in purple in the data table below. In this case we know we have chosen the lowest value in the y-direction because the position is the most negative (see the right column). Use the data table, as needed, to be sure you have chosen the true peak or true trough when you find the time values to determine period.

That's it! Upload another video and repeat the process for each period measurement needed in your investigation.

t (s)	x (m)	y (m)
2.267	1.368E-2	1.568E-2
2.300	1.441E-2	2.074E-2
2.333	1.451E-2	2.230E-2
2.367	1.448E-2	2.263E-2
2.400	1.393E-2	1.841E-2
2.433	1.330E-2	1.204E-2
2.467	1.227E-2	3.262E-3
2.500	1.121E-2	-6.689E-3
2.533	9.611E-3	-1.723E-2
2.567	8.233E-3	-2.734E-2
2.600	6.844E-3	-3.653E-2
2.633	5.512E-3	-4.291E-2
2.667	4.181E-3	-4.693E-2
2.700	3.161E-3	-4.855E-2
2.733	2.116E-3	-4.693E-2
2.767	1.494E-3	-4.262E-2
2.800	1.100E-3	-3.603E-2

Tips:

1. If Tracker is having a hard time tracking your object (you will know this as you will get error messages in the message box on the right of your screen), you will need to repeat Step 8 and try to identify a smaller or easier area of the object to track.

2. Remember that Tracker has limited memory. The top right corner will let you know how much space is left (see screen shot). Close windows in Tracker as needed to be sure you have enough memory space.

3. Sometimes Tracker has a hard time Tracking and the sin curve can be strange in parts. Choose the best part to get a reading from.

4. Graph your data before moving on to the next experiment. Repeat measurements for any data points that seem out of line with the others. Tracker sometimes struggles following the mass.