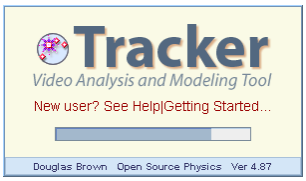
Name: _____ Date: _____

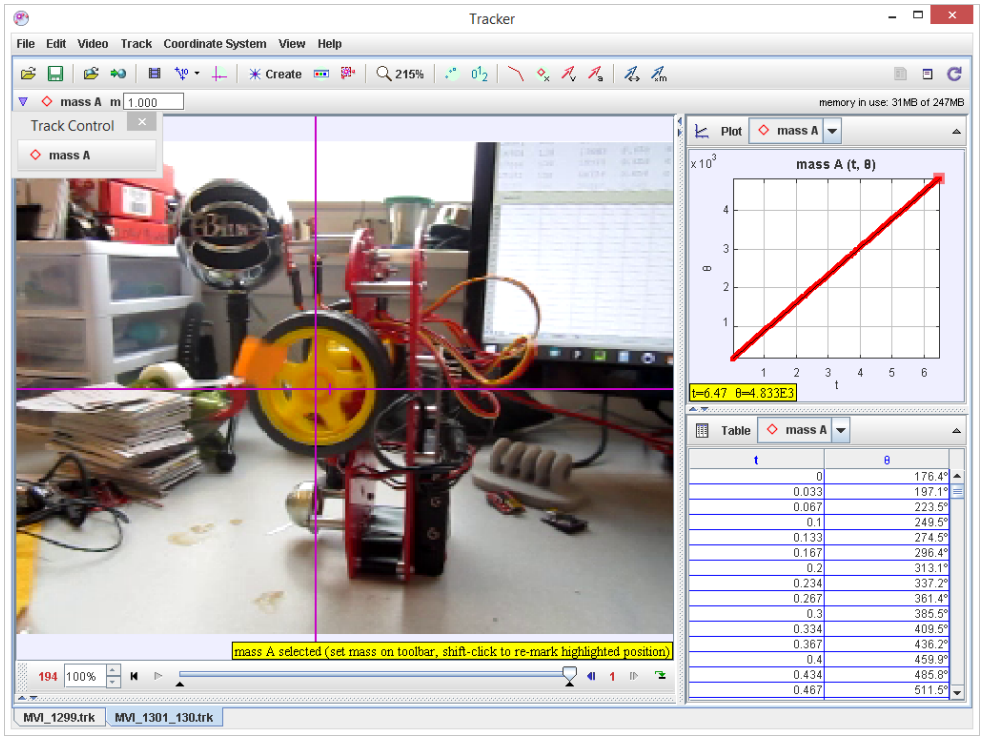
Raw Motor Speed (No Load)

Introduction

According to the product information page, the “No Load” speed of the motors is 90 RPM (+/- 10 RPM). The motors are enclosed inside a 48:1 gearbox -- it is assumed that the 90 RPM is at the output of the gearbox / motor assembly. Let’s see if we can characterize the speed of these motors!



At full speed, you will notice that it is very difficult to measure or watch the movement of the motors. So, for this investigation, we will use Tracker (http://bit.ly/OSPtracker), a video analysis tool developed through the Open-Source Physics group (http://www.opensourcephysics.org/). [Note: if you are installing this on a PC, you must install the 32-bit Java Run-time engine for this program to run properly -- even if your machine is a 64-bit computer].



Setup

- In this investigation, we want to setup our RedBot to measure the actual motor speed. Because the motor is enclosed inside a gearbox, we can’t quite get to the motor itself. We can, however, watch the speed of the spinning wheel. To do this under a “no load” condition, we must have the wheels up and off the table. Set the Redbot on the flat end so that the front points upward.

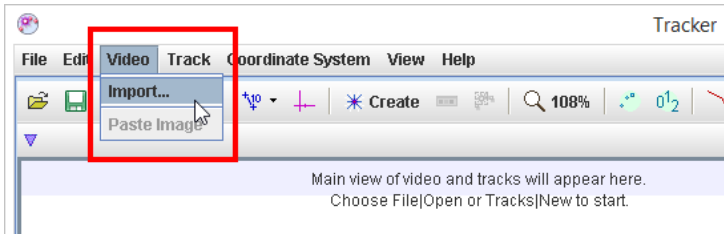
- Place a piece of tape or a bright sticky flag on the edge of the wheel using something with a strong contrast.

- Program the RedBot to run at a designated drivePower. You might want to start it at a medium power of 150.

- Setup your video frame using either a cell phone camera, standard (digital) video camera, or a webcam. Line it up so that you are looking directly at the wheel -- like in the image above.

- Run the wheels, record video -- for a few seconds. Standard video cameras capture video at a rate of 30 frames per second. In 3 - 4 seconds, you'll have over 100 frames of data to look at!

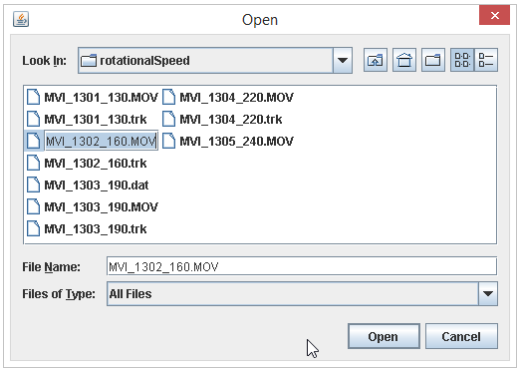
Data Processing



- Copy the video onto the computer that has **Tracker** installed on it.

- Open up the Tracker application.

- Click on the **Video** menu → **Import**



- Select the file you just recorded. (Hint: write down in your notes the video filename and the setup you used -- i.e. drivePower = 150).

- Click play to make sure it's the right video. You can pause the video, move forward and backward frame-by-frame.

- Click Show Coordinate axes.

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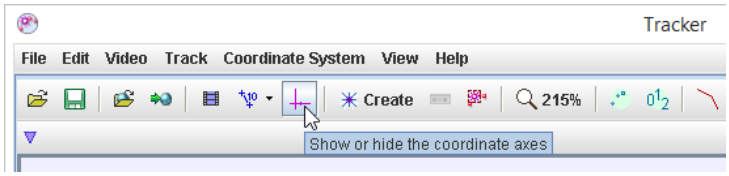
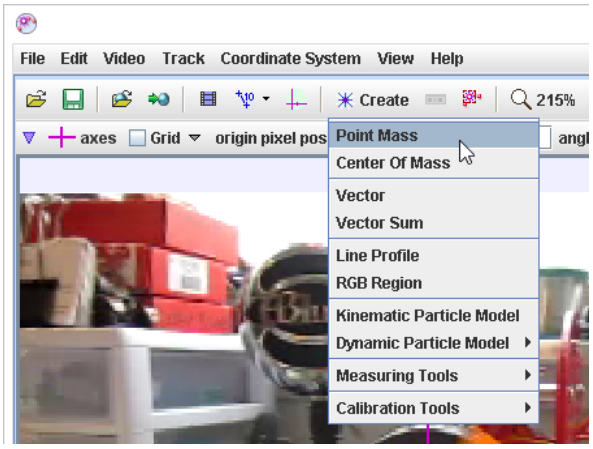


- Move the axes (purple line near the **bottom-right corner** of the screen) so that it lines up with roughly the center of the wheel.

- Click Create → Point Mass.

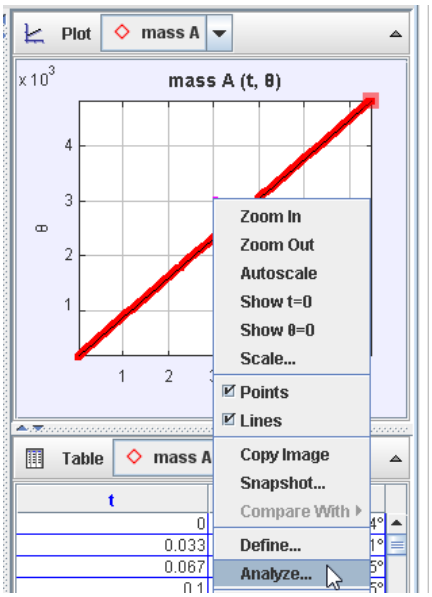
- Now, move the mouse cursor over the center of the piece of tape or sticky flag you placed on your wheel.

  Using the SHIFT-left-mouse-click combination, mark. on the center of it. The frame will automatically advance. Continue this until you've collected enough data. Now, time for the analysis.



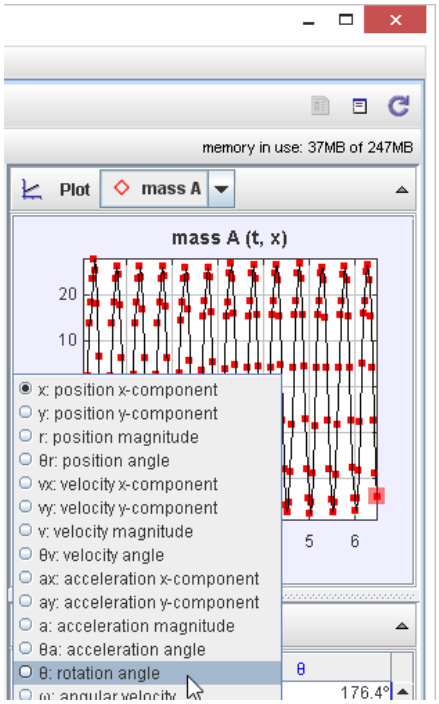
Analysis

The graph on the right will generally default to x vs. t. This is convenient if you're analyzing linear movement (which you will do next), but, here what we want is **θ: rotation angle**.



Next, right-click on the graph and select **Analyze**. Notice what shape the graph is??

Now, it's up to you. Export the data, use Excel, use the built-in analysis tools of Tracker to find the best fit line.



Task: Characterize the "no load" rotational speed for the motor at a minimum of three different drivePower settings. Pick from settings you've tested before so that we have data to compare against.

Discussion

Once you know the rotational speed, how would you calculate the theoretical "ground speed"? Derive this relationship (formula) in detail.

How does the rotational speed & theoretical "ground speed" compare to the measurements you made in the previous experiment?

What happens if you added weights to the RedBot (be sure to add the weights between the drive wheels and the caster). What happens to the performance of the RedBot? Why is this?