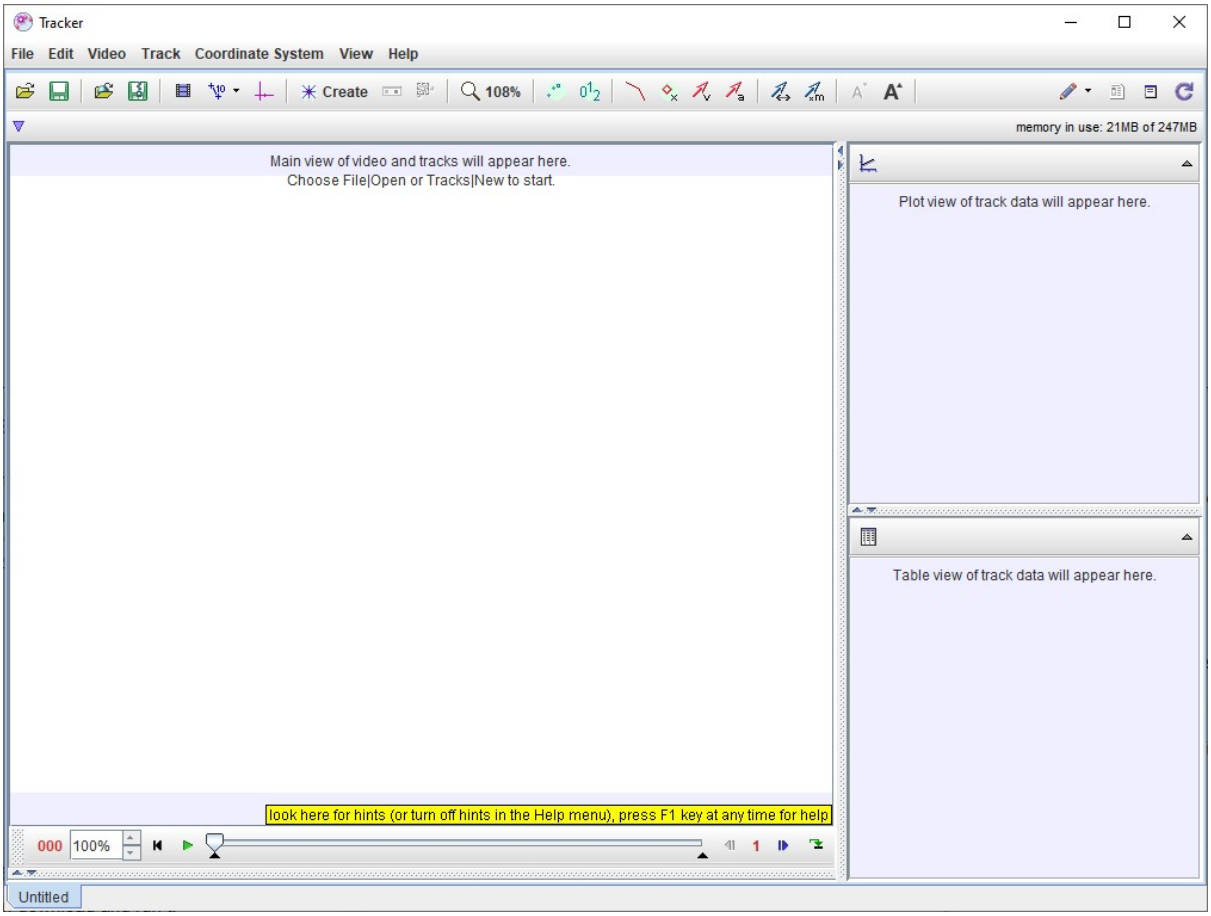
Analysing linear motion using Tracker

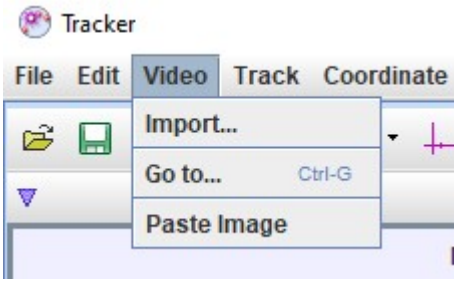
We hope you'll analyse your own clips and we'll say a little about filming them later on. In the meantime, make sure you have our file ***projectiles.mp4*** on your computer.

Launch Tracker. On some systems, it has the amusing habit of taking just long enough to launch for you to think you haven't clicked on it properly, so wait a little.

You should be met with this screen:

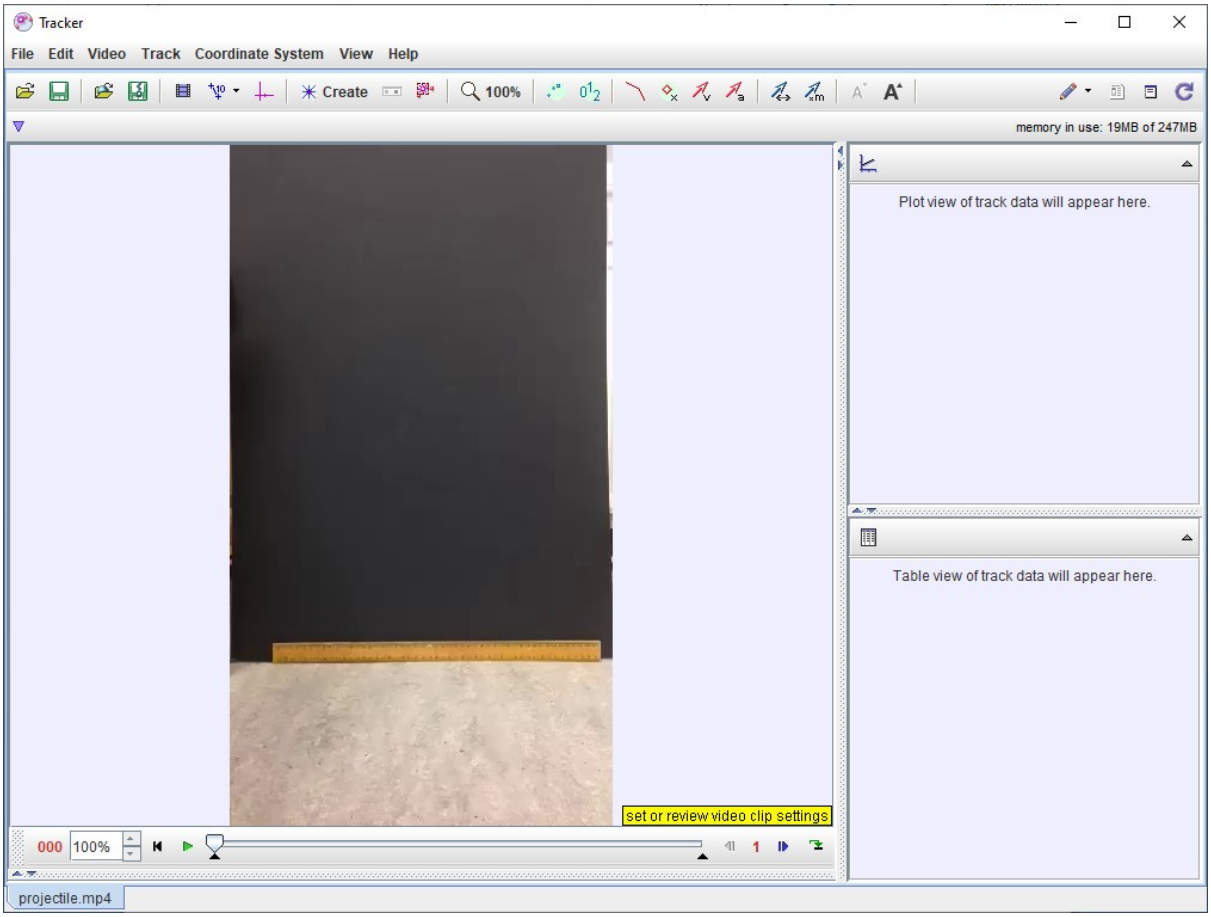


Choose **Video** and select **Import...**



Find the file ***projectile.mp4*** and open it. (Don't confuse this file with the similarly-titled ***projectile for autotrack.mp4***)

You should now see this:

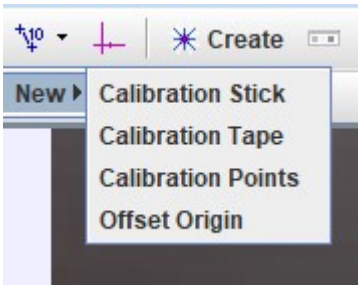


That's a half metre stick lying horizontally. You can't see the moving object – it's going to enter from upper left once we move through the video.

We need to do two things now.

1) Calibrate Tracker
2) Set axes

On the icon bar, click the drop down arrow beside the blue 10 as shown. Choose **New** then **Calibration Stick.**



Shift+Click at either end of the half metre stick, then enter 0.5 in the box above it.

It will add a gratuitously large number of significant figures.

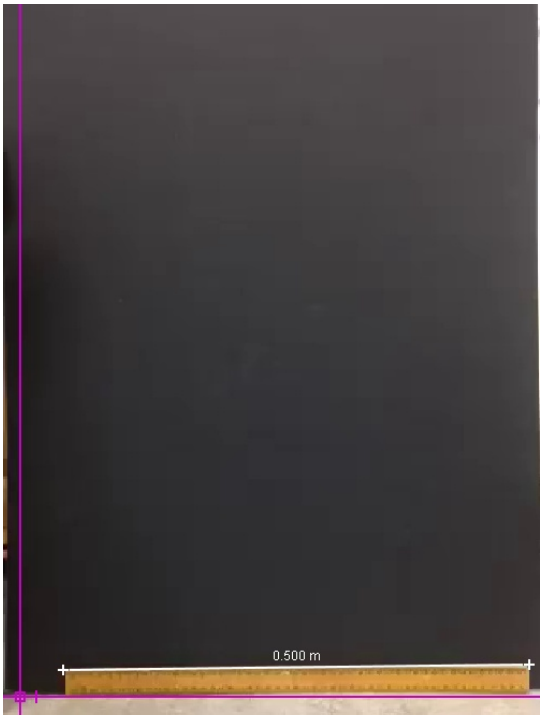
Tracker is now calibrated for this video.

You will do a fair amount of shift+clicking with Tracker.

Next to the calibration icon is the axes icon: 

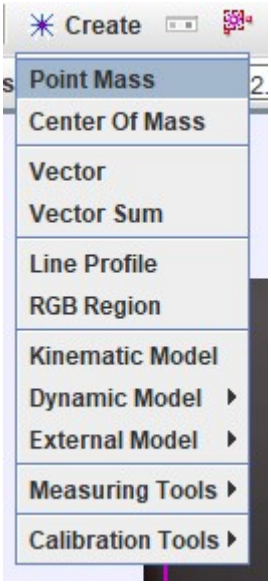
Clicking this makes the axes appear or, if they are already visible, disappear.

Place your mouse cursor on the origin and drag the axes to an appropriate position.



Dragging the little vertical bar to the right of the origin allows you to rotate the axes if motion is, for example, along a slope.

Now click **Create** and select **Point Mass.**



We're about to do some shift+clicking, but at present there's nothing to shift+click. We need to advance through the video until our moving object – a white ball – appears.

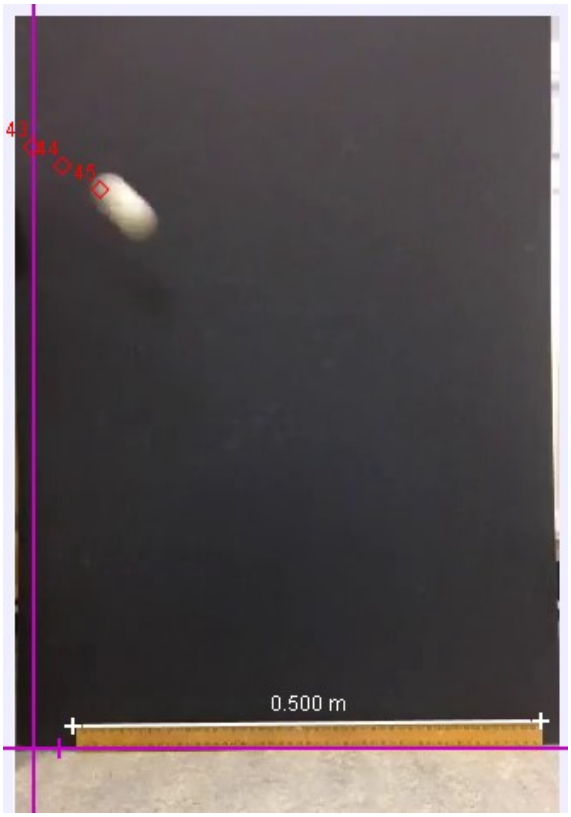
We do this using the slider bar (red arrow) and the **<** and **>** nudge buttons (blue arrow).

Move your cursor to a point on the ball. Hold down shift and left-click.

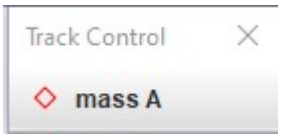
The following things should happen:

1. A marker appears where you clicked
2. The ball moves to a new position (the video has advanced one frame)
3. The frame counter (bottom left) advanced by 1.
4. A point appears on the graph to the right of your video.

Keep shift+clicking on the same point on the ball. It may become a bit blurry at times – try to judge. Do this until it is just about to disappear from the right of the video. Don't be tempted to miss points because you're getting fed up. You'll spoil things.



If at any time you can't shift+click, find this:



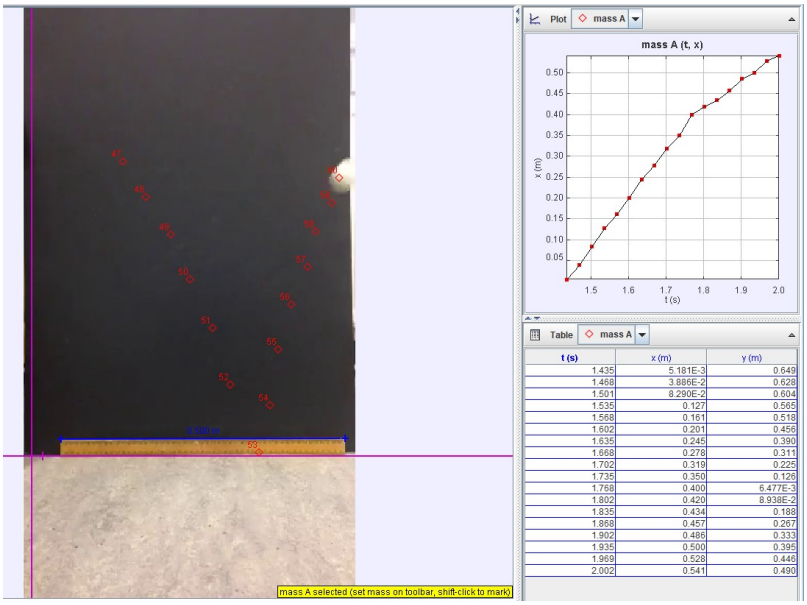
Click it, then try shift-clicking again.

You can step back through your video and move points if you think they're in the wrong place but beware of deleting them and not replacing.

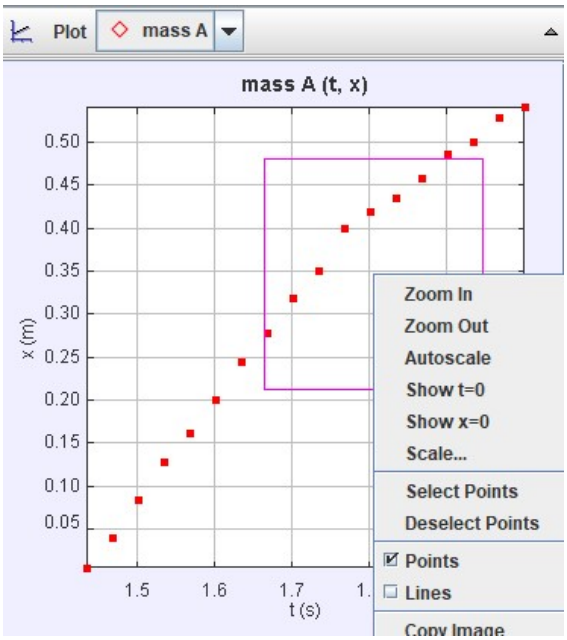
Sometimes, you'll find the axes or calibration tool are in your way. It's OK to move them then put them back.

Eventually, you'll end up with something like the screen on the right.

Let's do something about that graph.

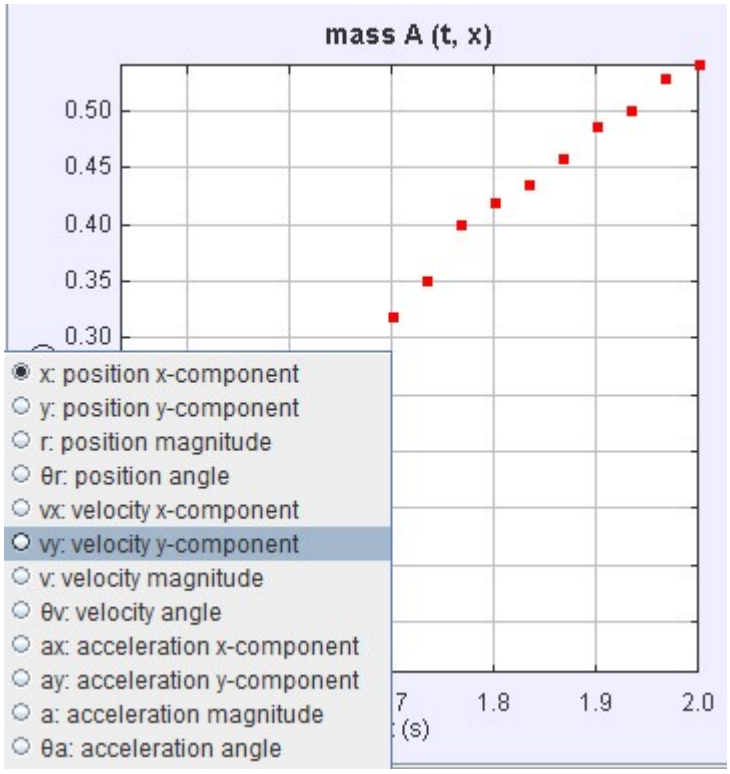


Right clicking on the graph brings up this menu which lets you deselect **Lines** which physicists would want to do.

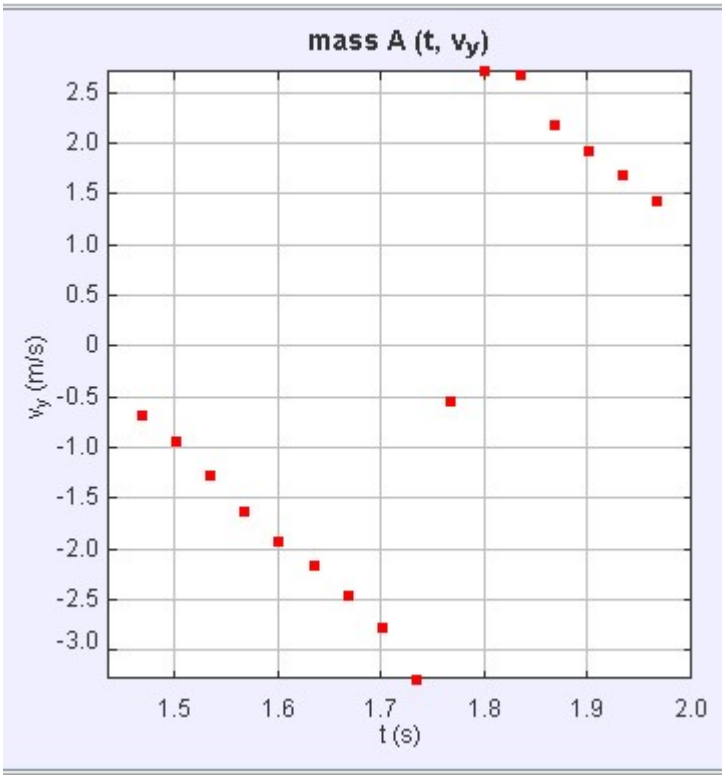


As it stands, the graph shows x displacement versus time. By left clicking on **x (m)** on the y-axis, we are presented with a number of options:

v_y, the y component of velocity is one of the most interesting to look at when we study projectiles, so we'll select that.



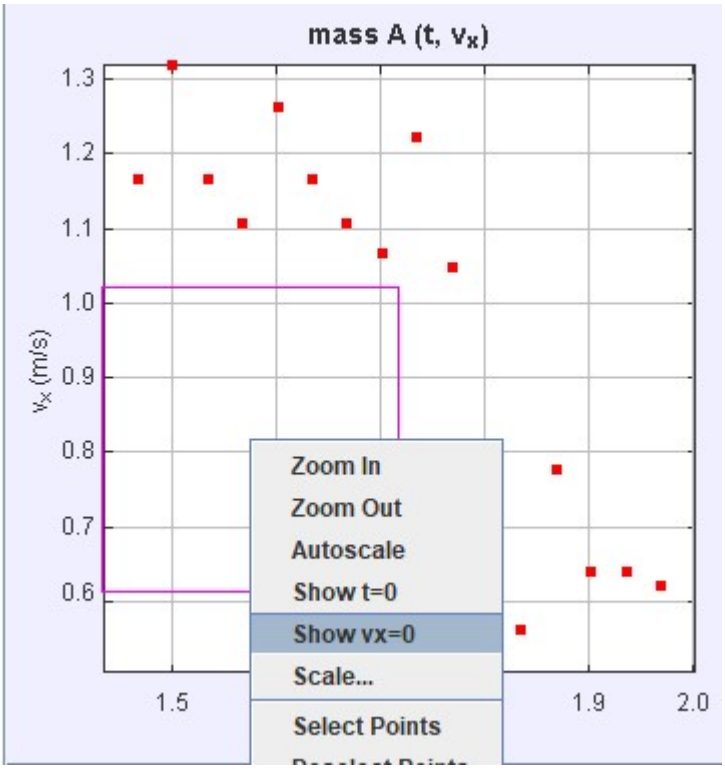
...And here we have a classic y velocity graph.



An x velocity graph looks like a bit of a dog's breakfast because, by default, Tracker autoscales. If we right click on the graph and choose **Show v_x =0** things look a lot better, but it's still not what you'd call a convincingly constant velocity.

You will find that Y acceleration, which should be constant around -9.8 ms^{-2}, apart from when the ball hits the ground, bounces around a bit too.

This is due to the way that Tracker calculates quantities. We can tell you more if you are interested.



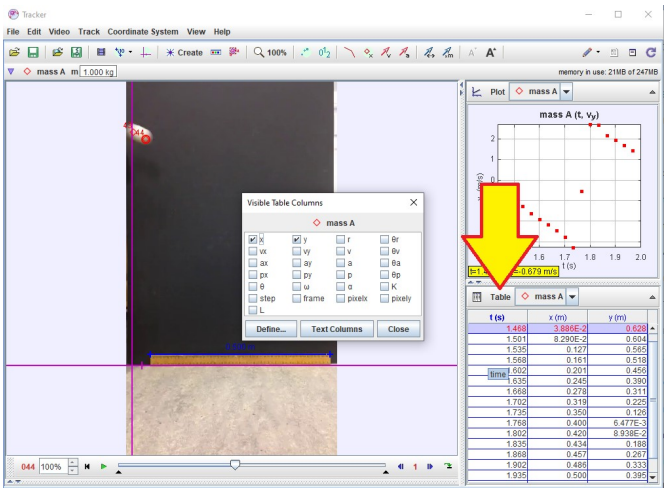
Power user tip: Use this with care – it sometimes has unwanted effects. If you have a 'bumpy' graph, right click on the graph, select **Algorithms** and click the **Bounce detection** button.

Brilliant feature

An absolutely wonderful feature of Tracker is that you can go back and forward through your tracked video using the slider bar and nudge buttons. Each tracked point is highlighted in turn as is the corresponding point on the graph. It's very easy to see what the velocity is when the ball is in a particular place.

Exporting data

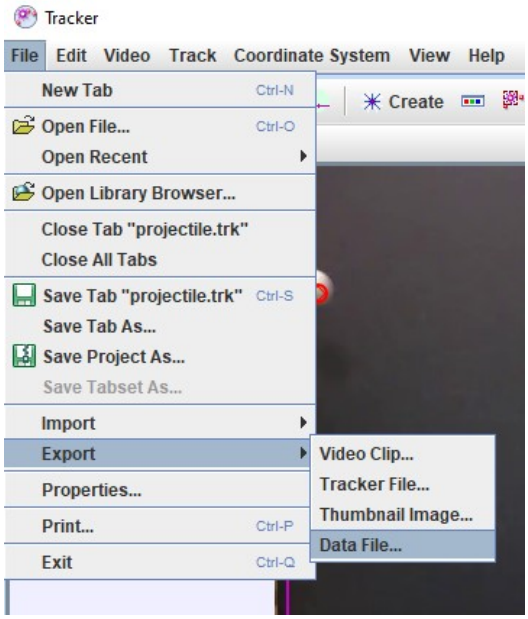
You might want to use more powerful data handling tools (though we haven't finished exploring Tracker's analysis features yet). One way to do this is to export data to Excel. You can only export data shown in the table at the bottom right of the screen. By default, this is only time and x and y positions, but you can choose more options. Click the **Table** button above the table, as shown by the arrow on the image (right).



You'll see a pop-up that allows you to display other data, such as y velocity v_y. Click the box beside v_y.

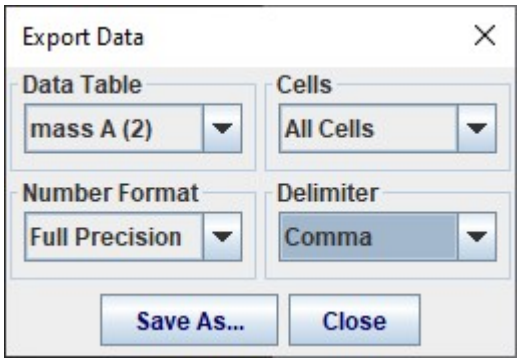
Exporting is a bit counterintuitive.

Go to **File**. Choose **Export** and then **Data File...**



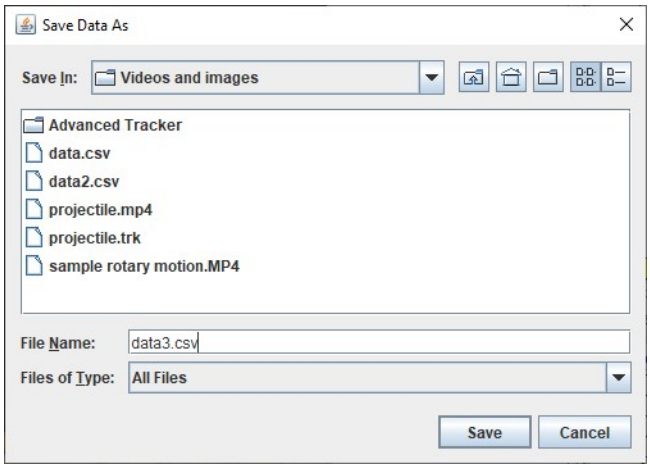
You should see a pop-up like this one. Set the values to those shown in the image. Specifically, set **Cells** to **All Cells** and **Delimiter** to **Comma**.

Click **Save As**.



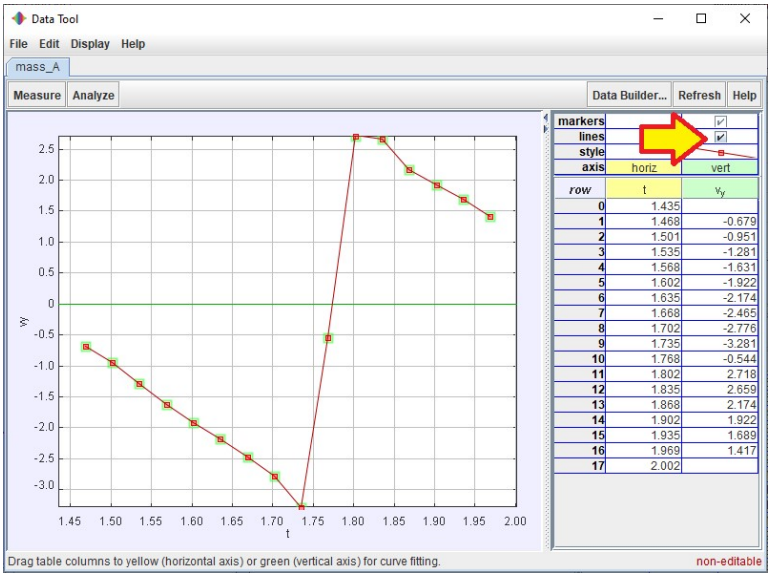
Call your file 'something.csv'.

Adding the .csv file extension means you will be able to open it in Microsoft Excel and many other packages.

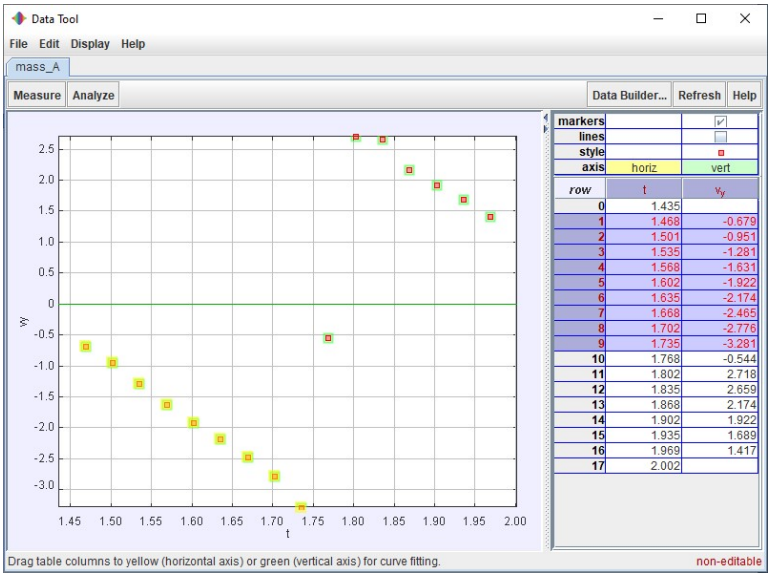


Data analysis within Tracker

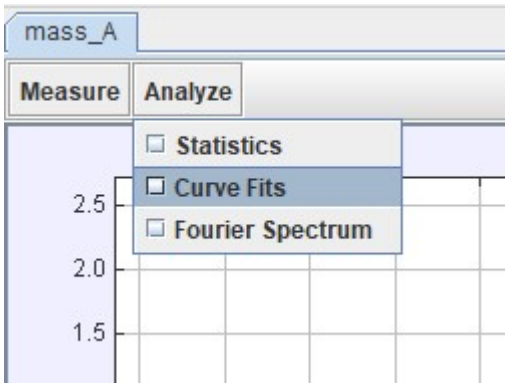
Double clicking a graph creates a larger graph in a new window. If you want to get rid of the connecting lines (and what physicist wouldn't?), uncheck the **lines** box as shown by the arrow.



Drag over a group of points to select them.

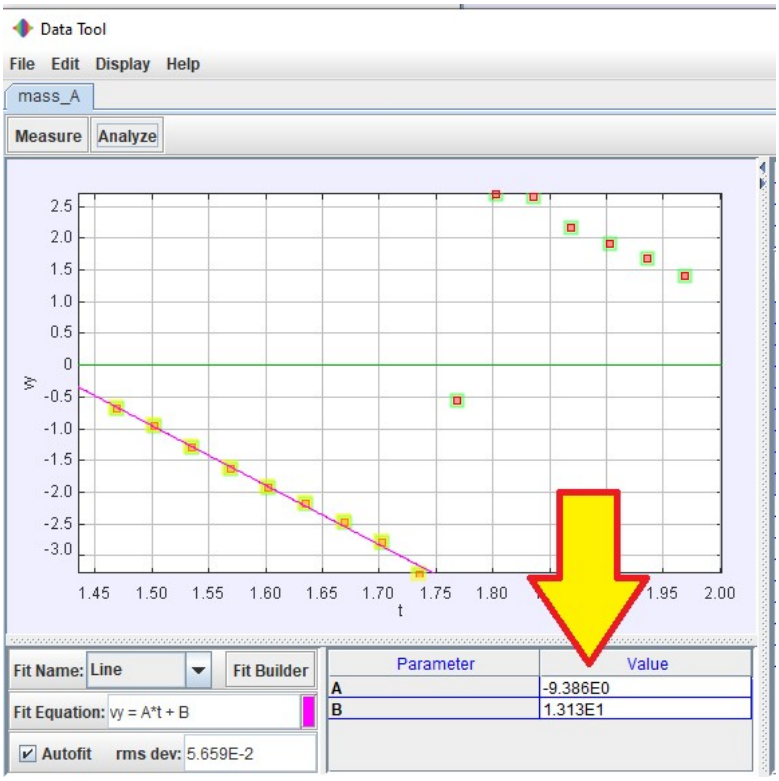


Click **Analyze** and tick the **Curve Fits** box.



Tracker draws a best-fit line and displays the gradient and intercept (the **A** and **B** parameters respectively).

In this case, the gradient of the y-velocity/time graph should be the acceleration due to gravity.



Filming tips

- Keep the camera still – preferably on a tripod or clamped in a stand. Do not try to 'pan' the camera, i.e. follow a moving object like sports camera operators do.
- Make sure the object is moving in a plane parallel to the camera. In other words, the object is not coming towards or moving away from the camera.
- Make sure the metre stick or ruler is lying in the plane of motion – not behind or in front of the moving object.
- It's best to use a dark object on a light background (i.e. the complete opposite of our sample video!).
- If filming using a 'slo-mo' app, be aware that Tracker may not assign the correct time to each frame.