Steps for excel use on lab M13

1. Set time basis
   1. Label cell A1: Time (s/60)
   2. In cell A2, enter “0” (without quotes) – this is your starting time
   3. In cell A3, enter “ =A2+1” – this adds 1/60th of a second to your start time, but in units of 1/60th of a second (NOT in seconds). This makes the x-axis look MUCH better.
   4. Copy cell A3 down. You can look up how to fill or copy down using google search. One method is to move your cursor along the bottom of cell A2 until you to the lower right hand corner of A3. The cursor will look like a plus sign. Click, hold and move down. The formula in A3 will be copied down as many cells as you move. Repeat as needed.
2. Enter position data
   1. Label cell B1: x(cm) – or whatever units you are using (note, sample spreadsheet is in cm).
   2. Copy the data from the uploaded file.
3. Plot your position data
   1. CONTROL-click column A (this will select all the column A values)
   2. CONTROL-click column B (this will select all the column B values)
   3. At the top menu, click the “insert” tab
   4. Select the “chart” button
      1. Select “scatter” then choose the scatter button that has dots (no lines)
   5. Fix the axes labels
      1. Select the “layout” menu from the top
      2. Select the “axis titles” button
      3. Fill in the appropriate data
      4. Fix the chart title by clicking on the chart title itself and editing the text
4. Find average velocity from displacement data
   1. Label cell C1: Vtime (sec/60)
   2. In cell C2 enter “=A2+0.5”. This sets the x-axis velocities you will calculate half way between the displacements.
   3. Copy cell C2 down
   4. Label cell D1: Vave (cm/sec)
   5. In cell D2 enter “=(B3-B2)\*60/((A3-A2)”. This calculates Vave between the points B3 and B2 using the times in A3 and A2. The ‘60’ rescales the time so that V is in cm/s, instead of cm/ (1/60th of a second). Do give this some thought – YOU should understand it.
   6. Copy down the Vave
5. Add Vave data to your graph
   1. Right click on some open area of your graph
   2. From the menu that pops up, choose, ‘select data’
   3. Click the button that says, ‘add’
   4. Add a label - cell D2
   5. Select the x-axis data – this will be the set of numbers under Vtime
   6. Select the y-axis data – this will be the numbers under Vave
6. Fit the velocity with a polynomial
   1. Left click on one of your velocity graph data points graph data points (it does not matter which one)
   2. Now right click on your data – you will get a context menu – select “add trendline”
   3. This will pull up another context menu – select polynomial
   4. Click “Display equation on chart” and “Display R-squared value on chart” from the check boxes.
   5. Move the menu so you can see your graph
   6. Display the equation and R^2 value on the graph by checking the boxes next to these. Change the polynomial order from 2 to 3 to 4 to 5 to 6. Watch how the fit gets better until a certain order, but not really any better after that. We want the MINIMUM order of polynomial that can do the job. R^2 is a numerical measure of how good the fit is, you can find out more in physics 1B.
   7. You can read off the coefficients from the equation on the graph.
   8. Other things you can do
7. Plotting the derivative
   1. Label cell E1: Velocity – derivative (aka, the acceleration). Include appropriate units
   2. Suppose (example) the equation on the Position-time chart was, “5x3+3x+1”. Here, x represents the time.
      1. In cell E2 enter “=5\*3\*A2^2+3”. Note the syntax for squaring and multiplying a value. As usual in excel, do not put the quotes. Have a care for the factor of 60, since this fit is for the time in units of (1/60th) of a second. See the steps in section IV.
      2. Copy down as you did with time above.
      3. Add this data to the graph. For the x-axis, you can either create a new time basis, or just start at 1 second (use the displacement time data).
      4. Use a new y-axis placed on the right. You can do this by changing the chart type to “combo.” Either go to “chart design,” tab and click the “change chart type,” button in the upper right, or right click on an open area of your graph and select “change chart type,” from the menu. Set the secondary axis only for the acceleration.
      5. Make it nice: DO NOT display this as dots – use curved lines to display it. The data is NOT based on measurements, but on a model.
      6. I will show a slightly more fancy method in class….
8. Display the Aave. Follow the steps for finding Vave, but start with the Vave data instead of the displacement data. This will be VERY noisy, but you can compare it to the plotted derivative that is already on the graph.
9. Make the graph nice, etc. Move the chart
   * 1. Right click on the chart area – you will get a contextual menu
     2. From the menu, select “move chart” and set the output to “new sheet”

Good luck!

Writeup: mainly the graph. Compare the acceleration without the rubber band (Mcar = 480 grams, Mhanging = 250 grams, g = 980cm/s^2) to the slope of Vave at the beginning and to the flat part of the acceleration. Comment on your theoretical fit and the noisiness of your data – especially when comparing Aave vs Aderivative!