Using Excel in AH Physics Investigations

The aim of this activity is to ensure you can set up a spreadsheet for data entry and automate calculations (such as uncertainties) using formulae. There is an introduction to the LINEST function, which provides information (gradient, y-axis intercept and their associated uncertainties) on lines of best fit.

Data for this activity was obtained using the centripetal force vs angular velocity experiment.

1. **Enter the data.**
   There are 5 period measurements for each mass. Create columns for mass and period in your spreadsheet, then copy & paste the following values into your columns:

Mass (kg)	Period 1 (s)	Period 2 (s)	Period 3 (s)	Period 4 (s)	Period 5 (s)
0.01	3.32	3.68	3.66	3.18	3.43
0.02	2.62	2.76	2.73	2.75	2.73
0.03	2.36	2.39	2.38	2.39	2.35
0.04	2.17	2.19	2.21	2.17	2.17
0.05	1.99	2.00	2.00	2.01	1.99
0.06	1.86	1.84	1.86	1.87	1.88

2. **Add additional columns.**
   At the appropriate position in the table, insert columns for
   uncertainty in mass (%)
   centripetal force (N)
   %age uncertainty in centripetal force (%)
   absolute uncertainty in centripetal force (N) *
   mean period (s)
   uncertainty in mean period (%)
   angular velocity (rad.s^{-1})
   angular velocity squared ([rad.s^{-1}]^2)
   %age uncertainty in angular velocity squared (%)
   absolute uncertainty in angular velocity squared ([rad.s^{-1}]^2) *

   * these columns are calculated using the % uncertainty values, absolute values are needed to produce point-dependent error bars for your graph.

3. Enter calculations.

Use the **Excel formula builder** to produce calculations for each empty cell in the 1st row of data. Excel's **AVERAGE**, **MAX**, **MIN** & **PI()*** functions are useful. Any other calculation probably requires creation of an expression from scratch. Be careful with brackets!

When building expressions, the following functions may be required;

<div align="center">

multiplication *
division /
raise to power ^

</div>

*Use of **PI()** requires control of significant figures - how could you achieve this in Excel?

4. Plot the chart.

Once you are happy with the values obtained, plot a chart to show the results.

Highlight the x-axis data (centripetal force) and y-axis data (w squared). Include column headings if you want Excel to use these as data labels.

Once columns are highlighted, choose Chart > Scatter to produce the graph.

Once the chart is drawn, right-click on any of the data markers and select **add trendline**. There are several options available, for this example, choose **linear**.

5. Add error bars.

Click on your chart. From the **Chart Layout** options, pick **error bars**. Choose the custom option and enter the range of cells containing your **absolute** uncertainty values. (note that % uncertainties do not work with the custom option). The same range should be entered for the positive and negative fields to account for ± in the uncertainty.
Repeat this process for the other axis

Remember you may need to combine uncertainties, e.g. scale reading **and** random uncertainties, before generating error bars.

6. Calculate line of best fit data (gradient, intercept).

Highlight a grid of empty cells – 2 columns x 5 rows.

Keeping the cells highlighted, choose the LINEST function from the formula bar. LINEST has 4 arguments in the brackets, i.e. LINEST(1,2,3,4).

1 = range of y-axis values (without column heading)
2 = range of x-axis values (without column heading)
3 = TRUE
4 = TRUE

In practice, your formula will look something like

"=LINEST(N5:N10,C5:C10,TRUE,TRUE)"

where "TRUE" is just a switch to provide statistical analysis of the specified data ranges.

When you have entered the formula, make sure you press SHIFT + CONTROL + ENTER together to fill the highlighted cells with data.

The result should look something like this, with the important information shown in the top 2 rows.

gradient   y-axis intercept

16.1094394	2.004468009
0.526285209	0.20085947
0.995748998	0.215757681
936.9545524	4
43.61652434	0.186205507

Uncertainty in gradient

Uncertainty in y-axis intercept

7. Add gridlines and axis titles to your graph.
A graph produced by hand will have background squares pre-printed on the paper. Any Excel chart you include in your LO3 or investigation report also requires a squared background.

Click on your chart to highlight it. Click on **Chart Layout** > **Gridlines**. Select major & minor gridlines for both the horizontal and vertical axes.

Titles for the chart itself, both axes and any legend text are also entered using the Chart Layout bar.

Your final chart should look similar to the one shown below. Avoid small charts like this in your report, graphs are better when they fill the page.
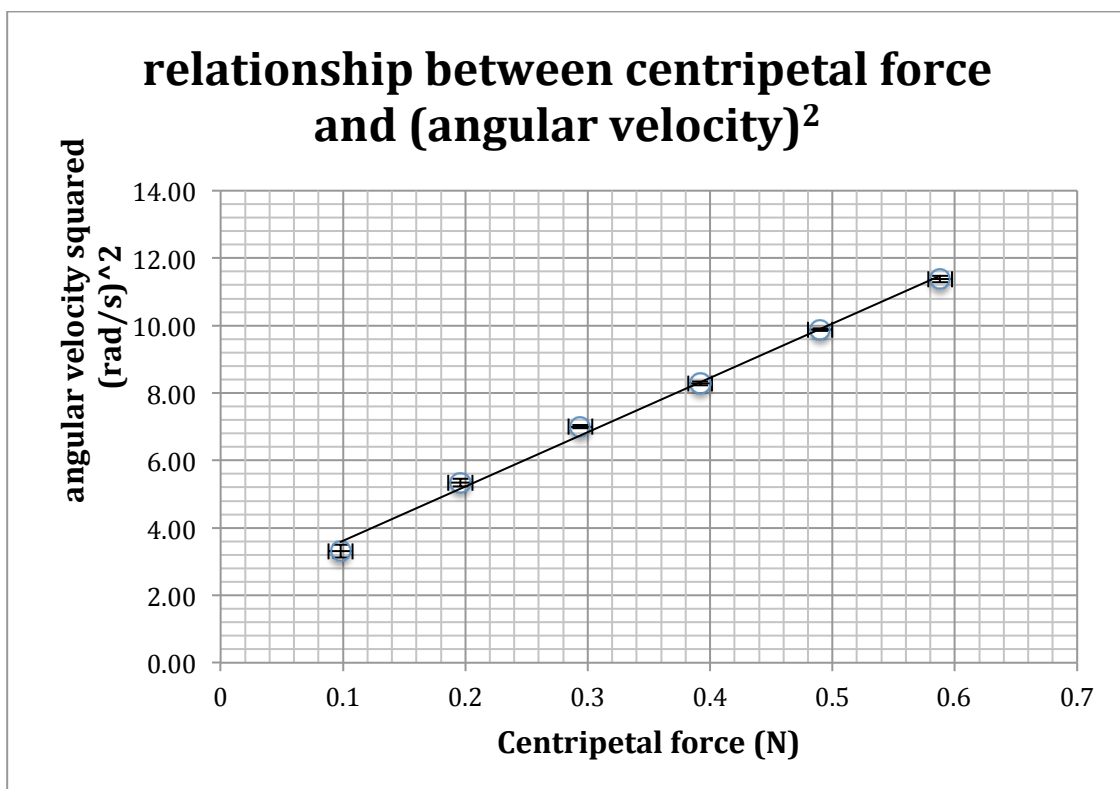
You can access tutorials on LINEST on my site via the following link

http://mrmackenzie.co.uk/2011/09/27/ah-help-using-excel/

or by typing "linest" in the search box.