

## 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 by finding the period of oscillation for a simple pendulum over a range of pendulum lengths.

### 1. Enter the data.

There are 5 period measurements for each length.

Create columns for length and 5 period measurements in your spreadsheet, then copy & paste the following values into your columns:

pendulum length l (m)	period of oscillation T (s)				
	period 1	period 2	period 3	period 4	period 5
0.2	0.88	0.83	0.91	0.91	0.87
0.3	1.09	1.07	1.13	1.11	1.05
0.4	1.28	1.19	1.25	1.39	1.31
0.5	1.42	1.56	1.36	1.30	1.48
0.6	1.57	1.45	1.62	1.52	1.67
0.7	1.71	1.82	1.77	1.62	1.65
0.8	1.80	1.88	1.83	1.74	1.77
0.9	1.90	2.00	1.83	1.89	1.89
1.0	2.01	2.05	2.00	2.01	1.99
1.1	2.10	2.04	2.08	2.11	2.15
1.2	2.14	2.10	2.22	2.20	2.05
1.3	2.32	2.21	2.38	2.33	2.36

## 2. Add additional columns.

At the appropriate position in the table, create columns for;  
mean period

random uncertainty in period

scale reading uncertainty in period

absolute uncertainty in period

%age uncertainty in period

$T^2$

%age uncertainty in  $T^2$

absolute uncertainty in  $T^2$  \*

absolute uncertainty in length \*

\*absolute values are required to produce independent error bars for each point on your graph.

## 3. Enter calculations.

Use the **Excel formula builder** to produce calculations for each empty cell in the 1<sup>st</sup> row of data. Excel's **AVERAGE**, **MAX**, **MIN** & **COUNT** functions are useful here. Any other calculation probably requires creation of an expression from scratch.

**Be careful with brackets!**

When building expressions, the following functions may be required;

multiplication \*

division /

raise to power ^

If you need to use  $\pi$  in a calculation, use **PI()** in the relationship.

**PI()** will require 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 (pendulum length) and y-axis data ( $T^2$ ). Include column headings if you want Excel to use these as data labels.

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

## 5. Add error bars.

Click on any data marker inside your chart. From the 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  $\pm$  in the uncertainty. Repeat this process for the other axis

## 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

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.