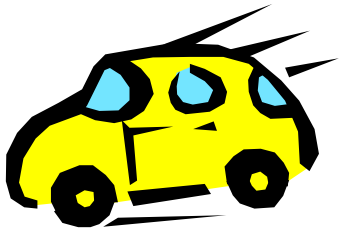
EXERCISE: Uncertainty in Gradient & Intercept

This is a workshop exercise in which you determine the gradient of a linear graph line and its uncertainty. You will consider the gradient range by appreciating the uncertainty bars, not the scatter of data about the regression line.

An electric toy car is traveling along a straight line and measurements of its position and time are taken. The uncertainty in the time Δt is $\pm 0.005\text{s}$ and the uncertainty in the distance Δs is $\pm 0.1\text{m}$. The following data has been recorded:



Data	Distance s / m $\Delta s = \pm 0.1\text{m}$	Time t / s $\Delta t = \pm 0.005\text{s}$
1	0.3	0.802
2	0.7	1.103
3	1.0	2.110
4	1.6	3.615
5	2.0	4.610

(1) Graph distance against time. Plot the data points as small circles with a dot in the center of each circle. Use the graph paper provided on the next page or you can do this on your computer.

(2) Ignoring the origin, construct the best-straight line graph for this data. Extend the line to cover the entire graph sheet.

(3) Determine which uncertainty (either in time or in distance) is the most significant. Construct uncertainty bars on your graph for all the data points for just one quantity.

(4) Determine the gradient (slope) of your best straight-line. What physical quantity does the graph's gradient represent? Comment on the motion of the toy car.

(5) Construct the minimum and maximum gradients for your graph and calculate their values. You are to construct minimum and maximum lines by appreciating all (or most) of the ranges represented by all the data point uncertainty bars.

Express the best gradient value with its absolute uncertainty $m \pm \Delta m$ using the range of the minimum and maximum gradients. Pay attention to significant digits.

Do the same for the y–intercept, find $y \pm \Delta y$. Comment on the origin. Does that toy car start at zero displacement? Does the car accelerate?