Results – Data: Taking and Recording

A reminder of the different types of data.

Qualitative data can be observed but not measured. They can only be sorted into groups or categories such as brightness, type of material of construction, or type of device. Not useful in this context.

Quantitative data can be measured. Length, area, weight, temperature and cost are all examples of quantitative data. This is the type of data we wish to collect in this context.

- **Discrete** consist of only integer numerical values, not fractions; for example, the number of pins in a packet, the number of springs connected together, or the energy levels in atoms. These can only be presented as a column graph that enables comparison.
- **Continuous** allow for any numerical value within a given range; for example, the measurement of temperature, length, weight and frequency. This means they can be graphed using *x*–*y* axes. A graph can reveal a relationship between two quantities.

Measuring the Data

Here we want to be as accurate as possible. However, we are limited by the equipment we have available.

Some of equipment you could use is:

Mass

- Slotted masses of known mass. Simple to use; accurate; comes only in multiples of a set weight, e.g. 50 g.
- Electronic balance. Very accurate; very good for small masses; simple to use.

Length

- Metre ruler. Accurate; good for a range of distances; can be read to about 0.5 mm. Will be suitable for most of our tasks

Time

- Stopwatch. Simple to use; accurate down to your reaction time; not reliable for short time intervals.
- Electronic timer. Requires some instruction; very accurate; best suited for short time intervals. Some data logging devices, such as Pocket Lab, have timing capabilities.

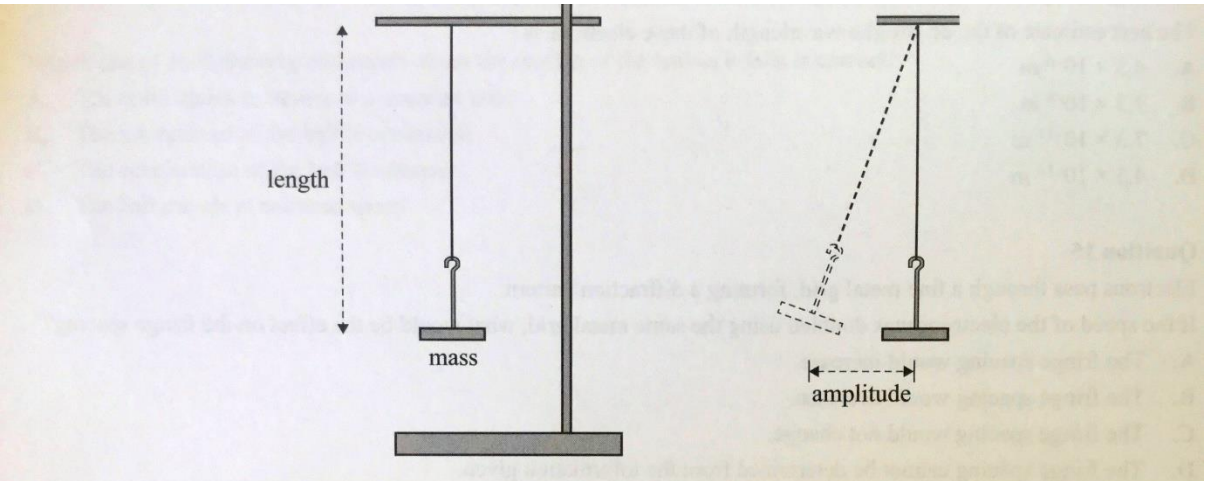
Motion

- Ticker timer. Simple to use; limited in accuracy; best with objects moving over a short distance; can be time consuming to analyse.
- Video with analysis software. Quite accurate; requires some setting up; data obtained from software. Free video motion analysis software for Computers, iPads and Phones is readily available. Examples are Video Physics, VidAnalysis, Tracker and PhysMo.
- Data loggers. Some of these, such as Pocket Lab, can either export data to Excel or plot their own graphs.

Depending on the equipment we have available, we may not be able to measure directly what we are after without creating a large error/uncertainty in the result.

More detail on errors, uncertainty and limitations is in the document titled
6 - Discussion - Errors, Uncertainty

On the 2019 Year 12 VCAA Exam – Section A Question 19, asked about why the time for 5 oscillations was measured instead of 1. This was a follow up to Q 18.



The students use a constant mass and a constant amplitude of swing, changing only the length of the pendulum and then measuring the time for five oscillations. They obtain four different time readings for four different lengths of the pendulum.

Question 19

Which one of the following best explains why the students measured the time for five oscillations rather than the time for one oscillation?

A. One oscillation is too quick to see.
B. Five oscillations reduce the effect of air friction.
C. Five oscillations reduce the uncertainty of the measured period.
D. Five oscillations reduce the uncertainty of the measured length.

The answer is of course C. Why?

The main uncertainty in the timing would be the reaction time for the student to start and stop the timing.

The reaction time remains the same whether 1 or 5 oscillations are measured.

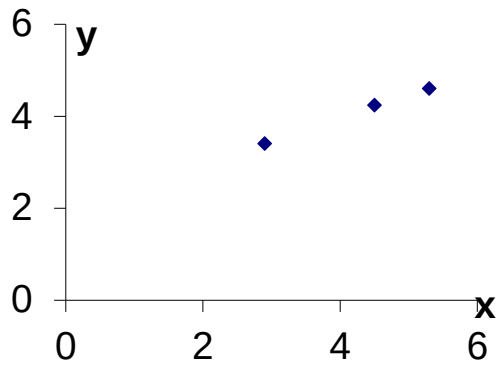
However, as a percentage of the overall time. The reaction time is a much smaller percentage of 5 oscillations than it is for 1.

How much data do I need?

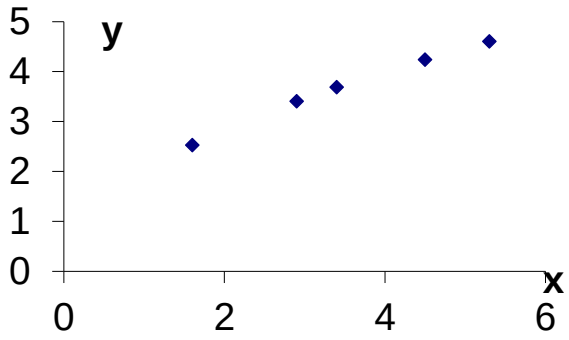
Enough to see if there is a trend. Three data points will not be enough, twenty is possibly more than you will need. As a rule of thumb around ten will give you a good idea.

Equally important is to have a range of values.

Consider the following graphs. All were produced using the same function.

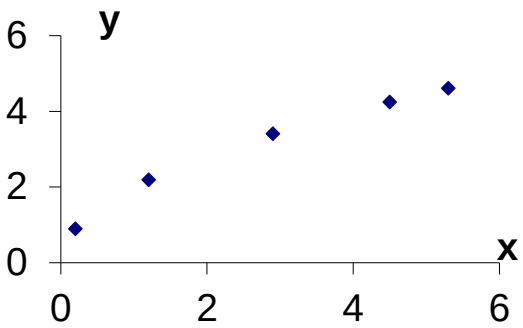


3 data points

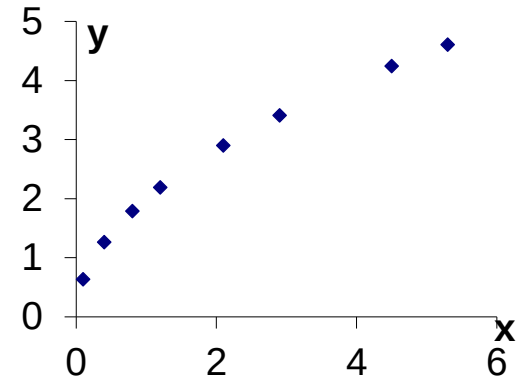


5 data points

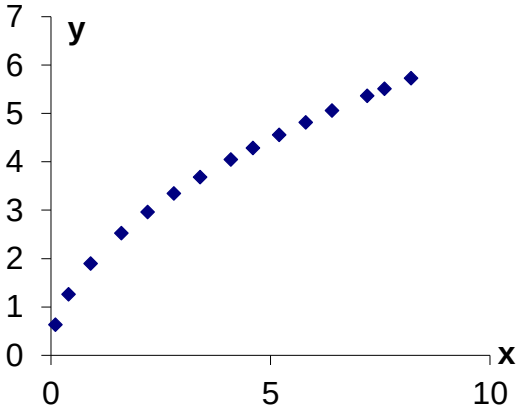
Looking at these graphs there appears to be a linear relationship.
However, the lowest point has an *x*-value of just less than 1.
What happens if we have one much lower?



The left hand end looks like it might curve.
Is this the trend or just a dodgy piece of data?
To confirm one way or the other we need more data. Particularly for $x < 2$.



8 data points



15 data points

8 data points confirms that the left hand end curves. As does 15 data points, however, we don't really get any more. Thus 15 points is, in this case, overkill.

Recording Data

Record your data in a table.

Tables organise data into rows and columns of varying complexity.

Tables can be used to organise raw data and processed data or to summarise results.

The simplest form of a table is a two-column format.

Tables should have the following features:

- a descriptive title
- column headings (including the unit)
- the independent variable placed in the left column
- the dependent variable placed in the right column.