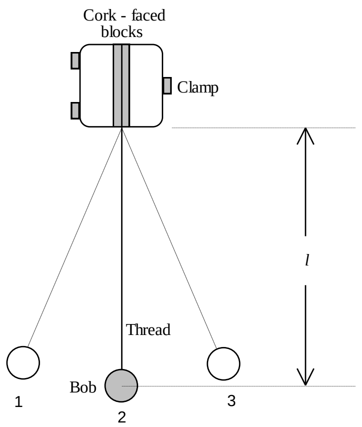
The measurement of acceleration due to gravity using a simple pendulum.

While conducting this experiment, you will be assessed for CPAC1: Following written instructions. Your lab report will be assessed for CPAC4: Correctly tabulating sufficient data and CPAC5: ‘y=mx+c’ analysis and percentage uncertainties.

Aim

To measure the acceleration due to gravity ‘g’ by timing oscillations of a simple pendulum.

Apparatus



In addition to the apparatus shown in the diagram, you will need a tall lab. stand and a stopwatch.

You might also find a protractor useful.

Theory

The time for one complete oscillation (i.e. 2-3-2-1-2) is known as the **period**, T of the pendulum.

Note that the length, l, is measured between the point of suspension and the **centre** of mass of the pendulum bob.

The theory of a simple pendulum assumes that the angle of swing is small. In practice this means no more than 15^{o} from the centre.

If g is the acceleration due to gravity, it can be shown that $$T = 2\pi\sqrt{\frac{l}{g}}$$

Squaring both sides gives us $$T^2 = \frac{4\pi^2}{g} l$$

which is now in the straight line form $y = m \; x + c$ (What are y, x, m and c in this case?)

Method

Measure the period for 20 oscillations (or more if you prefer) with a pendulum length of 0.30 m.
N.B. Time your oscillations from the centre, using a fixed reference point (a fiducial mark). Explain why you should repeat this reading.

Similarly, measure further periods for <u>at least</u> 8 different lengths up to l = 1.00 m.

Make notes of any special precautions you took in handling equipment or maximising accuracy.

Results

Your table headings might look something like this:

l / m	Time for 20 oscillations / s				T / s	T^2 / s^2
	1	2	3	Average		

Calculations and Graph

As you should now realise, if a graph is plotted of $\boldsymbol{T^2}$ against $\boldsymbol{l}$ a straight line through the origin should be obtained.

Plot a graph of $\boldsymbol{T^2}$ against $\boldsymbol{l}$.

Measure the gradient of the graph, giving the rate of change of T^2 with l.

N.B. The gradient has units of (seconds)^2 divided by metres, written as $s^2\ m^{-1}$.

The *gradient* of this graph $= \dfrac{4\pi^2}{g}$ and therefore $g = \dfrac{4\pi^2}{gradient}$ (Explain why in your report.)

Use your value of the gradient to find g.

Discussion and errors

Answer the questions in the Theory and Calculations and Graph sections. Compare your value for 'g' with the accepted value of 9.81 m s^{-2}. **Discuss whether the uncertainties in your experimental measurements could account for any error in your result.**

This experiment is useful for highlighting the distinction between random and systematic errors. Answer the following questions in your written report.

Random errors

These are the errors which happen all the time to cause *unpredictable* differences in your readings.

Can you give an example of random error for this experiment?

How do we minimise the effect of random errors?

How are random errors apparent from a graph?

Systematic errors

These are often less easy to spot, but are present all the time and have a *consistent* effect on the data. You might have consistently measured lengths to the wrong point, or an instrument might be poorly calibrated.

Give an example of systematic error for this experiment.

Conclusion

This should be a simple statement which reflects the stated aim of the experiment. Here it might read:

The acceleration due to gravity was measured to be .... m s^{-2}.