Measuring *g* using a Pendulum
Student Worksheet

In this experiment you will measure the time it takes a pendulum to oscillate and will use this data to calculate a value for the acceleration due to gravity.
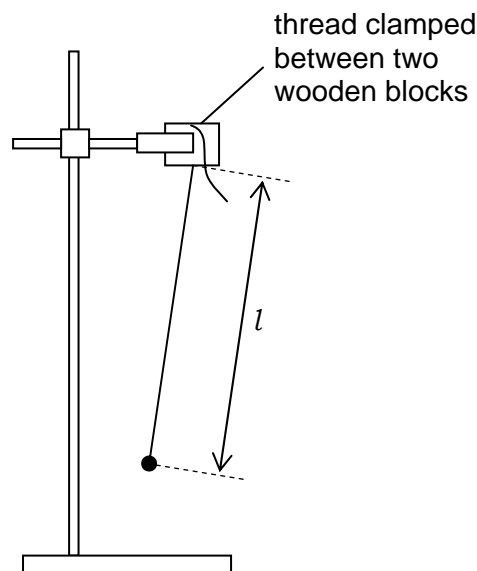
Theory

For small swings, the period of motion of a simple pendulum can be described by the equation

$$T = 2\pi \sqrt{(l/g)}$$

where *T* is the time period for one full swing, *l* is the length of the pendulum and *g* is the acceleration of free fall.

Making measurements and observations

1   Fix a pendulum to a clamp and stand as shown in the diagram.

thread clamped
between two
wooden blocks

l

2   Practice a few times releasing the pendulum and timing ten complete swings. A complete swing is when the pendulum bob moves:
    from the central position,
    out to the left,
    back through the central position,
    out to the right,
    and back to the central position again.
It is important to try and ensure that the pendulum only moves in one plane and does not 'wobble'.

3   Measure and record the length *l* of the pendulum.

4   Measure and record the time period T_{10} taken for ten complete swings of the pendulum.

5   Adjust the length *l* of the pendulum.

6   Repeat **3**, **4** and **5** until you have eight sets of readings for *l* and T_{10}.

Recording and presenting your data

1   Your table of results should include columns for *l*, T_{10}, the period *T* for one complete swing, and T^2.

2   Plot a graph of T^2 (*y*-axis) against *l* (*x*-axis). Draw a line of best fit.

Analysing your data

1   Determine the gradient of your graph.

2   Use your answer to **1** and the equation

$$T = 2\pi \sqrt{(l/g)}$$

to determine a value for the acceleration of free fall *g*.

Evaluation

1   Describe any limitations or problems with the method you used.

2   Suggest ways in which the accuracy of the measurements taken could be improved.

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Teaching Notes

Link to theory

This experiment does not link directly to the AS theory. However, it is a useful exercise for the teaching of practical skills.

Key learning objectives

- To provide an experimental method of the determination of *g*.

- To provide experience of the use of a fiducial marker.

- To give students experience of having to re-arrange a formula and compare it to that of a straight line.

- To give an opportunity to calculate the gradient of a linear graph and identify an unknown variable.

Notes

Whilst the equation for the behaviour of the pendulum does not need to be know for the AS course, this experiment provides an excellent opportunity for developing practical skills in taking readings as well and the subsequent data analysis. The emphasis on the experimental and analytical process, rather than the content, should be stressed to the students. Often students do not measure the correct value of the time, thinking that half one full swing is one full oscillation. This needs to be explained to them before the activity.

The use of a fiducial marker to aid the timing may need to be explained to the students before they carry out the experiment. They may be able to use the line of the clamp stand as a marker if they wish although this is not as precise.

Possible extension work

There are a number of possible developments of this practical although these are best left until the simple harmonic motion section of the A2 course is covered.

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Technical Notes

Apparatus requirements

1   **Pendulum bob.**

2   **Thread,** 1.20 m long.

3   **Clamp stand and boss.**

4   **Stopwatch** reading to 0.1s or better.

5   **Metre rule.**

6   **Cork with pin stuck in it.** For use as a fiducial marker to aid timing.