MEASUREMENT OF g BY FREEFALL

Specification reference: **AS Component** **1.2 – Kinematics**

A level Component **1.2 – Kinematics**

Theory:

An equation of motion can be used to calculate the acceleration due to gravity, g.

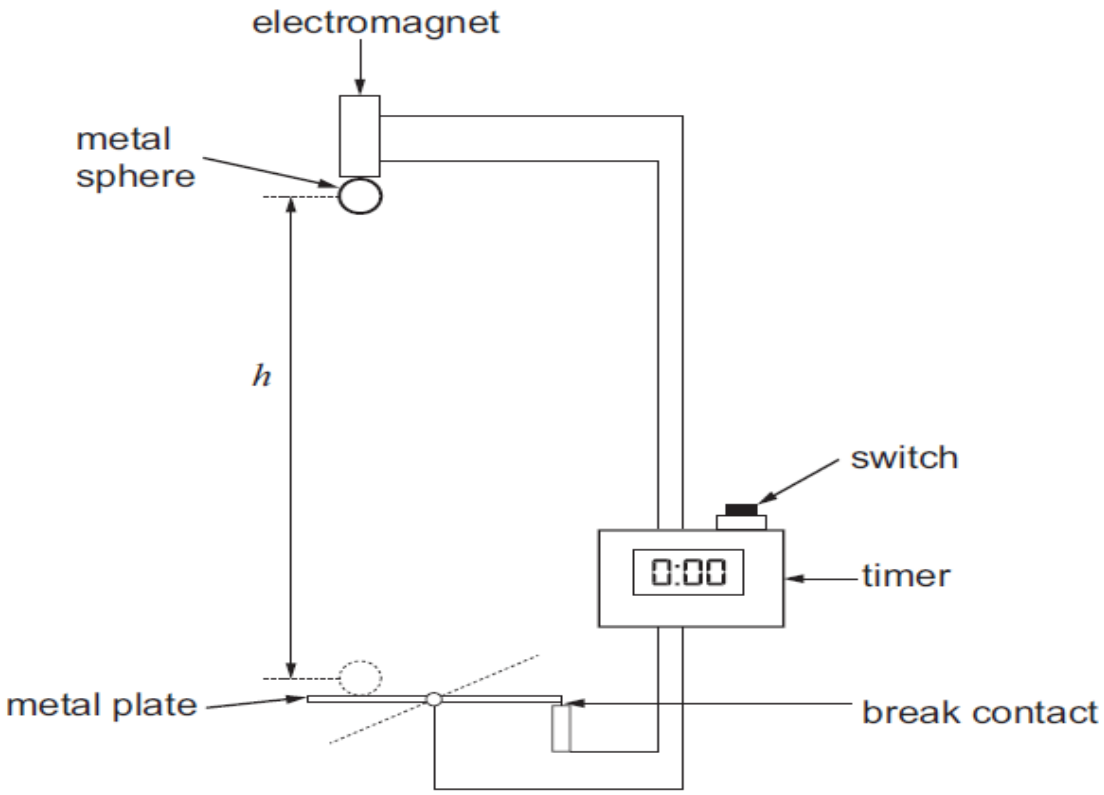
$$s = ut + \tfrac{1}{2}at^2$$

Where: u = initial velocity = 0,
s = height, h and
a = acceleration due to gravity, g

This gives $h = \tfrac{1}{2}gt^2$

If a graph of height, h, (y-axis) is plotted against time squared, t^2, (x-axis) the gradient will equal $g/2$, or $g = 2 \times$ gradient.

Apparatus:



Further guidance for technicians:

A metre rule of resolution ± 0.001 m will be needed to record the height, h. A ball bearing of diameter 1 – 2 cm will work well.

Experimental Method:

When the switch is pressed it disconnects the electromagnet releasing the metal sphere. At the same instant the timer starts. When the sphere hits the magnetic switch it breaks the circuit stopping the timer, thus recording the time it takes for the sphere to fall through a height, h. The time taken for the ball bearing to fall through a range of different heights needs to be measured. Plot a graph of height, h, (y-axis) against time squared, t^2, (x-axis) and calculate the value of g using: $g = 2 \times$ gradient.

Extension:

Students could progress to use their value for g to estimate the mass of the Earth, M_E.

From $F = \frac{GM_E m}{r^2}$ and $F = mg$ we get: $M_E = \frac{gR^2}{G}$

Where:
M_E = mass of the Earth
R = radius of the Earth (6.38×10^6 m)
G = gravitational constant (6.67×10^{-11} N m^2 kg^{-2})

Practical Techniques:

- Use appropriate analogue apparatus to record a range of measurements (to include length/distance, temperature, pressure, force, angles, volume) and to interpolate between scale markings.
- Use appropriate digital instruments, including electrical multimeters, to obtain a range of measurements (to include time, current, voltage, resistance, mass).
- Use methods to increase accuracy of measurements, such as timing over multiple oscillations, or use of fiduciary marker, set square or plumb line.
- Use stopwatch or light gates for timing.
- Use ICT such as computer modelling, or data logger with a variety of sensors to collect data, or use of software to process data.

Relevant previous practical past papers:

- PH6 2010 Data analysis task