Acceleration of free fall by mean of the Simple pendulum

Apparatus:

1- Pendulum bob (e.g. a metal sphere with a hook attached or with a hole bored through its centre).

2- Cotton thread.

3- Stopwatch.

4- Meter rule.

5- Stand and clamp.

6- Small improvised vice.

Theory:

The periodic time T of a simple pendulum L is given by:

$$T = 2\pi (L / g)^{1/2}$$

Where, g is the acceleration of free fall. By squaring two sides

$$T^2 = 4\pi^2 (L/ g)$$

The acceleration of free fall g is given

$$g = 4\pi^2 (L/ T^2)$$

By drawing the graph between L in x-axis and T^2 in y-axis, the slope of the straight line of the graph is equal to (L/ T^2) with units of cm/s^2. The straight line must pass through the origin point (0,0) if your reading are correct.

$$g = 4\pi^2 / (\text{slope})$$

Method:

1- Tie one meter length of the cotton to the pendulum bob and suspend the cotton from the jaws of an improvised vice, such as two small metal plates held in a clamp. Alternatively two coins, two halves of a cork split lengthwise, or the jaws of a pair of pliers serve equally well for the point of suspension when gripped in a clamp.

2- Place a piece of paper with a vertical mark on it behind the pendulum so that when the latter is at rest it hides the vertical mark from an observer standing in front of the pendulum.

3- Set the pendulum bob swinging through a small arc of about 10°. With a stopwatch measure the time for 10 complete oscillations, setting the stop watch going when the pendulum passes the vertical mark and stopping it 10 complete oscillations later when it passes the mark in the same direction. Repeat the timing and record both times.

4- Determine the length L (90 or 80 cm) of the cotton from the point of suspension to the point of attachment to the bob shorten the length of the pendulum by successive amounts of about 5 cm by putting the cotton through the vice and for each new length take two observations of the time for (10) oscillations.

Experimental Details:

1. When counting the oscillations remember to say 'start' when the stopwatch is started, for if you start at ‘one’ and stop at ‘ten’, only 10 oscillations will have been timed.

2. Be careful to count complete oscillations and not ’swings’ which are only half a complete oscillation.

3. Do not reduce the length of the pendulum below 50cm as the experiment becomes increasingly inaccurate the shorter the length of the pendulum.

4. Should the oscillations of the pendulum bob become elliptical at any time

the timing should be rejected, the pendulum stopped and set oscillating again and a new timing made.

Length of pendulum L /cm	t_1/s	t_2/s	t /s (average)	T/s = (t /10)	T^2 /s^2

Readings & Results:

Use this table below to write your reading

Errors and accuracy:

Errors in timing occur both when the stopwatch is started and when it is stopped. These errors are unlikely to be less than the interval at which seconds hands moves e.g. 0.1 or 0.2 s. Because of the finite size of the pendulum bob there will be an error in the measurement of L in addition to the error inherent in the size of any scale. Estimate the difference between your slope through the points on the graph and the slope of other possible straight line through the points. At last find the percentage of error compare with the real value of (g) that equal to (9.81m/s^2) or (981 cm/ s^2) and discuss the reasons of your errors.