The Simple Pendulum

Abstract: In this experiment, the factors that affect the period of oscillation of a simple pendulum were determined and tested. Most of the factors that affect the accuracy of our results were controlled. From these testings, we concluded that neither the mass of bob nor the amplitude of the pendulum doesn't effect on the period of motion but only the change of string lengths.

Aim: To investigate the factors that affect the period of oscillation of a simple pendulum.

Hypothesis: The period of oscillation will not be affected by the neither the mass nor the amplitude of the pendulum. The period only fluctuates when there is a change in length or gravitational force.

Equipment:

1 × Retort stand and clamp

1 × Pendulum bobs set (mass varying from 100 to 350)

1 × Stopwatch

1 × Metre ruler

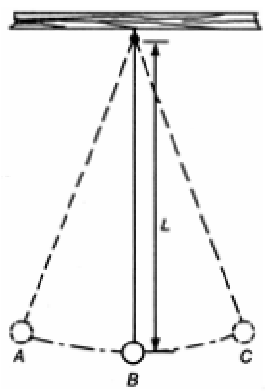
1 × Nylon string

Background Information:

A simple pendulum can be accurately described as a mass that is suspended by a massless string from a specific some point about which it is allowed to swing back and forth in a place. A simple pendulum can be approximated by a small weight which has a small radius and a large mass when compared relatively to the length and mass of the light string from which it is suspended. Objects that exhibit this type of motion follow sinusoidal paths and experience oscillations between their maximum values of position. The period of a pendulum is the time for one complete swing. The period of pendulum's equation: $T = 2\pi\sqrt{\frac{L}{g}}$

The units we used were to measure period of period of motion is ***m/s²*** for ***g***, and **metres** for length **L**, thus, the period units were ***seconds.***

Another simple device besides the spring-mass that can produce simple harmonic motion is the **simple pendulum**. A simple pendulum consists merely of a point-mass (*m*) suspended from a fixed point by a rod or string of length (*L*). The mass of the rod or string is assumed to be so much less than the suspended mass that it can be ignored. If the suspended mass is displaced to the left or right, while the rod or string is kept taut, and then released, the mass will swing freely back and forth under the gravity's influence.



In these experiments, the **dependent** variable will always be the time for one full swing, or the period.
The three tested **independent variables** will be the mass, the angle, and the length of string. The **controlled variables** will be the attachment point of the string, the string itself, the method used to time the pendulum.

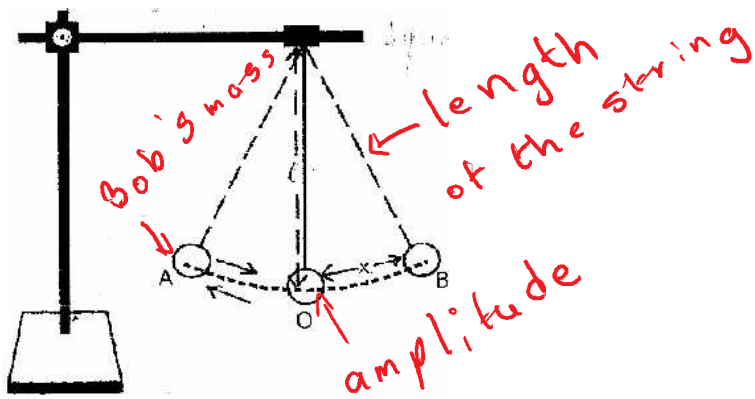
Procedure:

1. The end piece of the string was tied to a rigid support in such a way that insures that the point of suspension remains fixed throughout a complete (but small-angle) cycle.

2. Attach the bob to the other end of the thread. The bob was dragged 6 cm to one side (the amplitude), the bob was released so that it swung parallel to the board. Another observer used a stopwatch to measure the time for 20 complete swings. One swing was the time the bob takes to go out from its release position and return. Repeat this procedure using three other bobs of different masses. In each case we used the same length of string and amplitude.

3. The effect on the period of the pendulum when the amplitude is altered and the mass was determined. The lengths of string were kept constant. Time was measured for 20 complete swings when the bob is given amplitude of 4 cm, 6 cm, 8 cm, and 10 cm respectively.

4. The effect on the period of the pendulum when the length of string is altered was determined. The mass of the bob constant, and give the bob the same amplitude of 6 cm in each case are kept constant, but the length of the string changed progressively so that results are obtained for lengths of 10 cm, 20 cm, 30 cm, and 40 cm.



Simple Pendulum

Results:

Table 1: The effect of the mass of the bob in the period of motion

Length = 20 cm, amplitude = 6 cm

Mass of bob	Time for 20 swings	Period of motion (s)
1)350	20.65	0.897
2)300	22.12	0.897
3)250	22.41	0.897
4)200	22.0	0.897
5)150	21.88	0.897
6)100	22.16	0.897

Table 2:The effect of the amplitude in the period of motion

Length = 20 cm, amplitude = 6 cm

Mass of bob	Time for 20 swings	Period of motion (s)
1)350	20.65	0.897
2)300	22.12	0.897
3)250	22.41	0.897
4)200	22.0	0.897
5)150	21.88	0.897

6)100	22.16	0.897

Table 3A: The effect of the length of the string in the period of motion

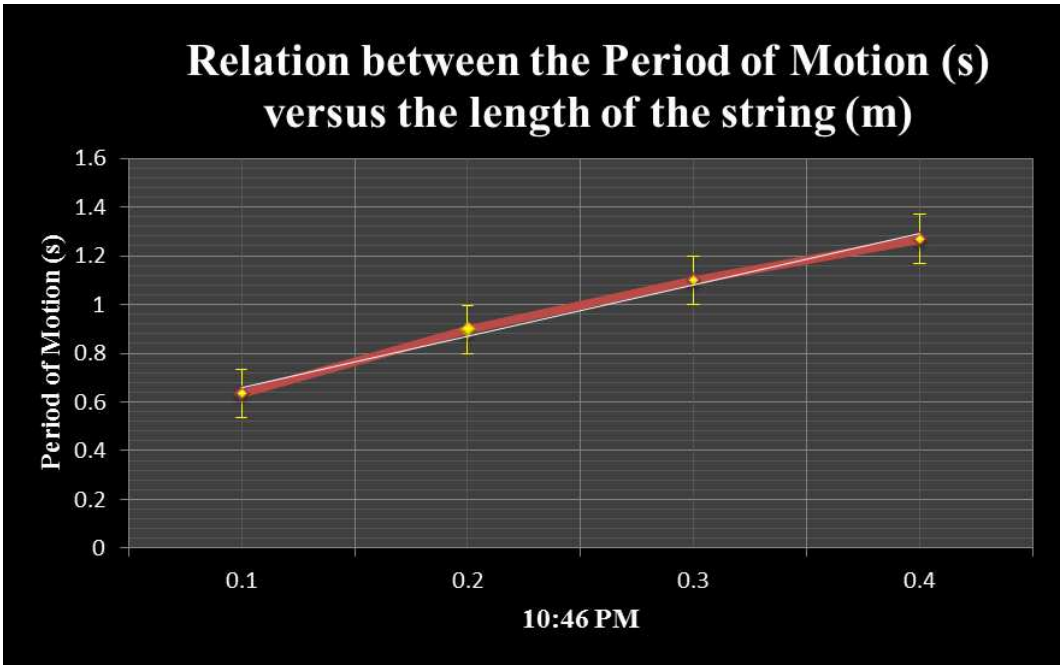
Mass of bob constant, amplitude of swing = 6 cm

Length of string	**Time for 20 swings**	**Period of motion (s)**
10 cm	17.79	0.634
20 cm	21.72	0.897
30 cm	25.25	1.098
40 cm	28.35	1.268

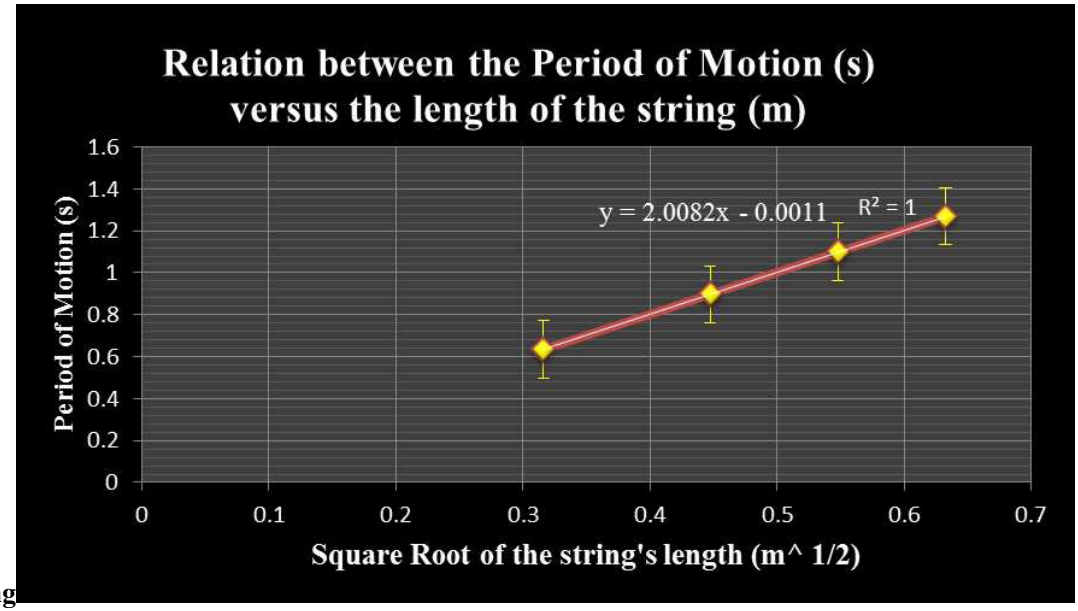
Table 3B: The average oscillations of pendulum with error time

Length (m) ±0.0005	Time Trials (sec) ±0.001	Average Time (20 oscillations) (sec)	Average Time (1 oscillation) (sec)	Error In Time (sec)	% Error Time
0.1	17.67	17.79	1.779	0.017	0.955
	17.96				
	17.74				
0.2	20.32	21.72	2.172	0.107	4.926
	21.87				
	22.79				
0.3	25.79	25.25	2.525	0.054	2.138
	25.32				
	24.64				
0.4	28.35	28.35	2.835	0.034	1.199

Graph 1: Relationship between the period of motion (s) versus the length of the string (m)



Graph 2:Relation between the Period of Motion (s) versus the length of string



Discussion:

In Graph 1 above the variables are the string's length (m) and the Period of Motion (s).Both of the graphs have same mass. In the first, graph there is no constant progression. The line curves out a bit which means there is no relation. In Graph 2, when the string's length is square rooted then there is a linear equation. There is a constant progression between the (m^1/2) and (s). As the string is lengthened, the period of the pendulum is increased. This illustrates that the length of the string is the factor that affects the period of motion.

Other factors that could be investigated the shape of the bob and how it would affect the period of motion. Also using the same mass with liquids and the height of the mass could also be investigated

There were two types of errors involved in this experiment. One was systematic error and the other one was random error. Systematic error included the accuracy of stop watch or the accuracy of a metre ruler. Random error like rough estimation of data, human errors, air friction and equipment defaults.

In future, to deal with these errors we should use more precise and calibrated instruments to measure time and maybe use a tape measure rather than a metre rule. A random error like

rough estimation needs to be more decimal places. A human error like calibration needs to be focused on. Other stuff like air friction needs to be reduced to minimum when it is being experimented. And also the equipment defaults can be prevented by repairing or replacing equipment now and then.

In future, we also would need more time to be accurate about the graphs. This will be done by experimenting 5 trials or more to be more precise.

Conclusion:

The aim was to investigate what factors affected the period of oscillation. The results and the experimentation led us to conclude that the length of the string is factor that affects the period of oscillation. This supports and proves the hypothesis stated above. Other two did not have an effect on the period of oscillation.

Bibliography: