NILE UNIVERSITY OF NIGERIA

Faculty of Natural and Applied Sciences

Department of Computer Science

Physics Unit

PHY 107: Experimental Physics I (Mechanics)

Experiment 5: SIMPLE PENDULUM

Student Name:

Student ID:

Department:

Date of the Experiment:

Group:

Purpose:

1. To determine the acceleration due to gravity .
2. To determine the oscillation period as a function of the deflection.

Equipment Needed:

- Light barrier with Counter
- Digital counter
- Power supply 5 V DC/2.4 A
- Steel ball with eyelet
- Vernier Caliper
- Meter scale, demo, $l = 1000$ mm
- Cursors, 1 pair
- Fish line, $l = 100$ m
- Right angle clamp
- Clamping pads on stem
- Support rod
- Tripod base

Theoretical Background:

A simple pendulum may be described ideally as a point mass suspended by a massless string from some point about which it is allowed to swing back and forth in a place. A simple pendulum can be approximated by a small metal sphere 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. If a pendulum is set in motion so that is swings back and forth, its motion will be periodic. The time that it takes to make one complete oscillation is defined as the period T. Another useful quantity used to describe periodic motion is the frequency of oscillation. The frequency f of the oscillations is the number of oscillations that occur per unit time and is the inverse of the period, $f = 1/T$. Similarly, the period is the inverse of the frequency, $T = 1/f$. The maximum distance that the mass is displaced from its equilibrium position is defined as the amplitude of the oscillation.

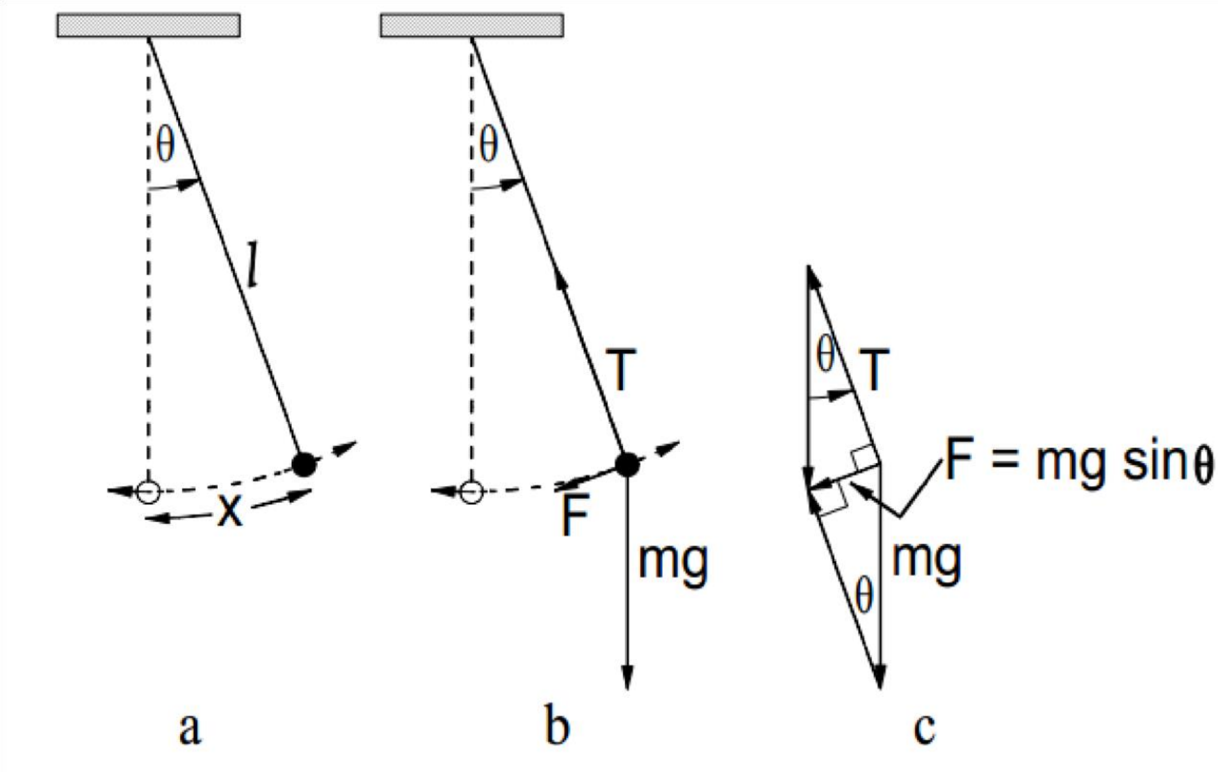

Figure 1: Diagram illustrating the restoring force for a simple pendulum

$$F = -mg\sin\theta \qquad (1)$$

where g is the acceleration of gravity, θ is the angle the pendulum is displaced, and the minus sign indicates that the force is opposite to the displacement. For small amplitudes where θ is small, $\sin\theta$ can be approximated by θ measured in radians so that Equation (1) can be written as

$$F = -mg\theta \qquad (2)$$

The angle θ in radians is $\frac{x}{l}$, the arc length divided by the length of the pendulum or the radius of the circle in which the mass moves. The restoring force is then given by

$$F = -mg\frac{x}{l} \qquad (3)$$

and is directly proportional to the displacement x and in the form of Hooke's law where

$F = -kx$ and $T = 2\pi\sqrt{\frac{m}{k}}$ and this satisfied the motion of a simple pendulum and also simple harmonic motion. Therefore,

$$T = 2\pi\sqrt{\frac{m}{mg/l}} \qquad (4)$$

and

$$T = 2\pi\sqrt{\frac{l}{g}} \qquad (5)$$

Therefore, for small amplitudes the period of a simple pendulum depends only on its length and the value of the acceleration due to gravity.

Set-up and procedure:

Figure 2: Experimental set up for determining the oscillation period of a simple pendulum

1. The experimental set up is as shown in Fig. 2. The steel ball is tied to the fishing line and the latter is fixed in the clamping pads on stem. With a new line, the ball should be allowed to hang for a few minutes, since the fishing line stretches slightly
2. Use a vernier caliper to measure the diameter d of the spherical ball. Record the values of the diameter in meters.
3. Set the length of the strings to 0.8m
4. Displace the pendulum about 5^0 from its equilibrium position and let it swing back and forth. Read and record the total time that it takes to make 20 complete oscillations.
5. Decrease the length of the string by 0.1m and repeat step 4 above.
6. Repeat the procedure for 0.6, 0.5, 0.4, 0.3 and 0.2 respectively.
7. Calculate the period of the oscillations for each length by dividing the total time by the number of oscillations, 20.

8. Record your respective data on the datasheet below.
9. Using your observations (data), plot the following graphs
   I. Plot the graph of T^2 against l.
   II. Plot the graph of LogT against LogL.
10. Evaluate the slope of each graph

Data Sheet: $d_{diameter\ of\ the\ ball}$ = ______**cm**

Length of String L(m)	Time for 20 oscillation t_1 (sec)	Time for 20 oscillation t_1 (sec)	Time for 20 oscillation t_{AV} (sec)	Period T (sec)	Period squared T^2(sec^2)	Log T	Log L
0.2							
0.3							
0.4							
0.5							
0.6							
0.7							
0.8							

Instructor Signature and Date: ____________________________________

Title: **Scale:**

Title: **Scale:**

Precaution:

State the precautions taken to ensure accurate result

Discursion of Result:

Question:

1. Evaluate the value of g (acceleration due to gravity) using your graph of T^2 against l,
2. Do error analysis of your evaluated g if the theoretical value of g is 9.81 m/s^2.
3. How would the period of a simple pendulum be affected if it were located on the moon instead of the earth?