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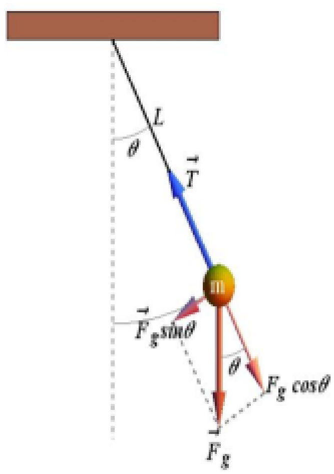
Objective: The study of the physical properties of the basic simple pendulum

Theory: A simple pendulum consists of a small bob suspended by a wire of length L (massless) fixed at its upper end. When pulled back and released, the mass swings through its equilibrium (center) point to a point equal in height to the release point, and back to the original release point over the same path. The force that keeps the pendulum bob constantly moving toward its equilibrium position is the force of gravity acting on the bob. The period, T, of an object in simple harmonic motion is defined as the time for one complete cycle. For small angles (θ < ~15°), it can be shown that the period of a simple pendulum is given by:

$$T = 2\pi\sqrt{\frac{l}{g}} \qquad (1)$$



Where g is the acceleration due to gravity, 9.8 m/s^2. Equation 1 indicates that the period and length of the pendulum are directly proportional; that is, as the length, L, of a pendulum is increased, so will its period, T, increase. However, it is not a linear relationship. The period increases as the square root of the length. Thus, if the length of a pendulum is increased by a factor of 4, the period is only doubled. The logarithmic relationship is given below:

$$T = kl^n \qquad (2)$$

Dependence of Period on Length

A mass is attached to the other end of the string and pulled back and let go, so that it executes (approximately) simple harmonic motion. The time required to complete 50 cycles (t) is measured with a stopwatch and recorded. To improve accuracy, three trials are completed for each measurement. The average of the recorded values of t for the three trials is then divided by 50 to obtain the period (T) of the motion. The mass (m) is held **constant at 100 g** and the length (L) is **varied from 30 cm to 100 cm, in 10**

cm increments. Times are measured and period calculated as in part I. As before, all times are in seconds. Lengths are measured in centimeters, then converted to m.

a) Complete the table below:

L(cm)	**L(m)**	$t_1(s)$	$t_2(s)$	$t_3(s)$	$t_{avg}(s)$	**T=** $t_{avg}/50$	**Log(L)**	**Log(T)**
30		54.90	54.90	54.90				
40		63.60	63.60	63.60				
50		70.90	70.90	70.90				
60		77.70	77.70	77.70				
70		83.90	83.90	83.90				
80		89.70	89.70	89.70				
90		95.15	95.15	95.15				
100		100.30	100.30	100.30				

Table 1: Period vs. Length for Simple Pendulum. (m = 100g)

b) Plot T vs. L.

c) From the graph (question b), is the relationship between T and L linear? deduce the value of n and k?

d) To determine the values of n and k, we utilize the equation (2) above.

E1) From the graph (question b), is the period of a simple pendulum dependent of mass? Explain your reason.

E2) Is energy conserved during the oscillation of a simple pendulum? Explain your reason

E3) What will be the time period of a simple pendulum in outer space? Discuss your claim.

e) Plot log(T) against log(L).

f) From (e), find the value of k. Explain whether this agrees with the value of k reported from estimating the period at a length of 1 m?

g) From the graph2. find the value of n.

List 3 precautions taken to avoid error.

Make a conclusion.