T.C.

GEBZE TECHNICAL UNIVERSITY

PHYSICS DEPARTMENT

PHYSICS LABORATORY I

EXPERIMENT REPORT

THE NAME OF THE EXPERIMENT

Simple Pendulum

PREPARED BY

NAME AND SURNAME:

STUDENT NUMBER   :

DEPARTMENT   :

Signature:

Experimental Procedure:

Figure 9.2: Simple Pendulum Experimental Setup

1. Two steel balls of different size and mass will be used in the experiment.
2. Each balls are attached to a thin rope. The pendulum is created by pinching the rope to the clamps on the horizontal bar. The length of the pendulum is adjusted by changing the point of pinching on the rope. When the length is adjusted it is also necessary to change the height of the clamp to align the ball with the timer. Don't change the height of the timer.
3. Check the two small holes on the inner faces of the timer, those are the sensor eyes. Height of the clamp should be aligned such that the ball should be able to pass freely between the sensor eyes of the timer. The measurement mode of the timer is set with a switch on the timer. It should always be on the rightmost setting which corresponds to a "3-pass" measurement mode in which the timer starts when an object passes the first time between the sensor eyes, continues to measure in the second pass and stops only after the third pass. A typical measurement is performed by removing the ball from between the sensor eyes, pushing the reset button while holding the ball and then releasing the ball to swing between the sensor eyes. This way the timer measures a full period of the pendulum after 3 passes. The period is displayed in second units up to 4 significant figures. During your measurements always observe and count this 3 passes to be sure that the timer is measuring the correct time and not an erroneous measurement which might already be initiated by a passing object like your finger or the ball when setting up the measurement.
4. You are supposed to measure the periods of the pendulums of 20, 40, 60 and 80 cm approximate lengths. Those lengths might not be easy to adjust exactly so you are free to adjust to a nearby approximate value and measure the period. However don't forget to measure the exact length (ex. 78,1 cm) and record them to your tables. When measuring the length you should measure the horizontal distance between the pinching point and the center of the ball.

5. To cope with the random errors measure each period value 4 times. To stay in the "small-angle approximation" regime you should release the balls as close to the timer as possible. However also assure that the 3 passes should be possible.

6. Record your measurements to Table 9.1 and Table 9.2 which are for small and big balls respectively.

Table 9.1 Pendulum length vs. period table for the small ball

Pendulum length (cm)	Period (s) (1st measurement)	Period (s) (2nd measurement)	Period (s) (3rd measurement)	Period (s) (4th measurement)

Table 9.2 Pendulum length vs. period table for the big ball.

Pendulum length (cm)	Period (s) (1st measurement)	Period (s) (2nd measurement)	Period (s) (3rd measurement)	Period (s) (4th measurement)

Fill in the tables 9.3 and 9.4 by taking the average values of your four consecutive time measurements.

Table 9.3: Pendulum length vs. average period table for big ball

Pendulum length (cm)	Average Period (s)

Table 9.4: Pendulum length vs. average period table for small ball

Pendulum length (cm)	Average Period (s)

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You are asked to plot the length vs period (*l-T*) graph using Table 9.3. Choose the horizontal axis as *l* and the vertical axis as *T*. Represent the data in Table 9.3 as points on your plot. Under the small-angle approximation what type of a curve is expected to pass through those points?

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Plot that curve on your graph paper that fits best to your data points by crude eye estimation.

Graphic 9.1
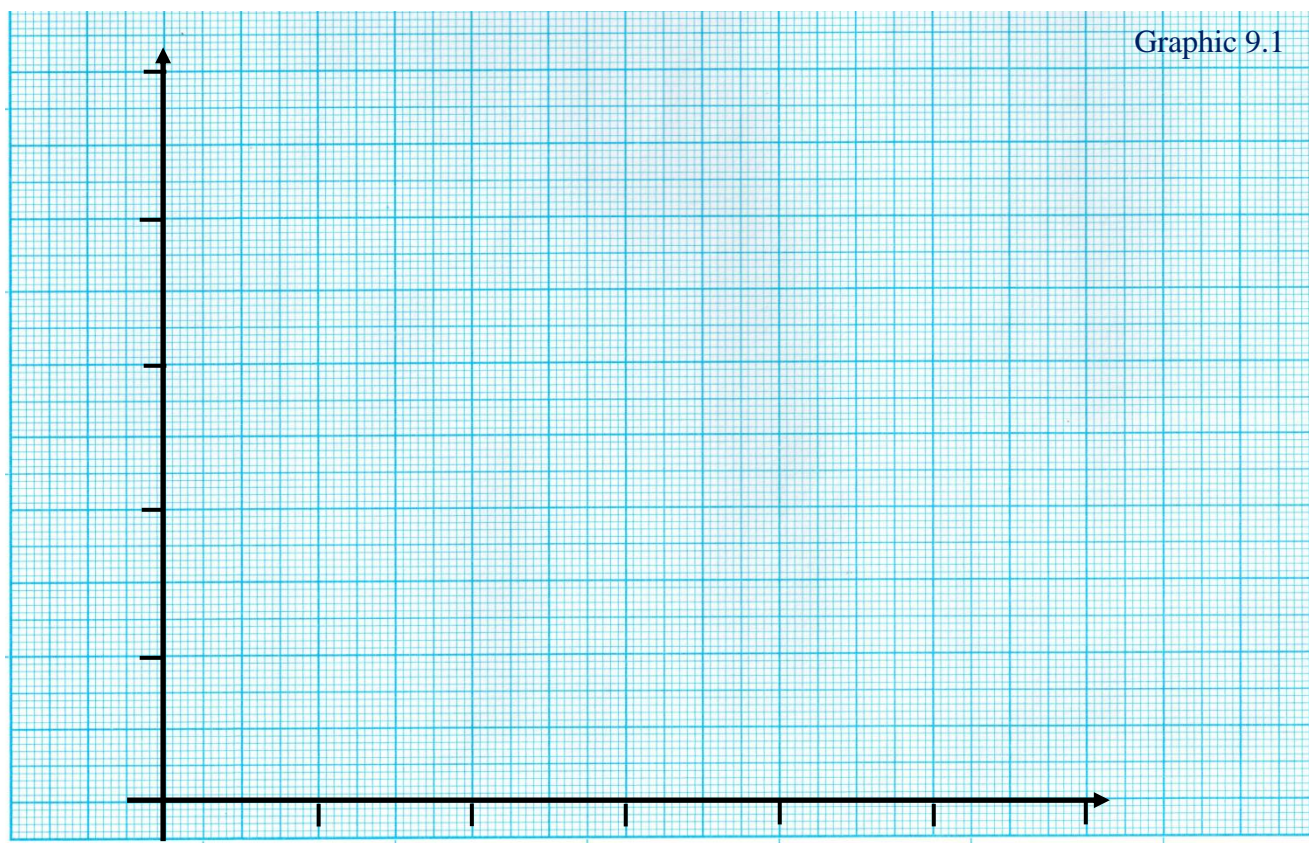
As it can be seen from your length vs. period graph, the relation between those quantities is not linear. However it can still be investigated using the linear fitting methods by manipulating the length-period relationship. We begin by assuming a relationship between period and length of the following form:

$$T = A.l^a \tag{9.10}$$

If we take the logarithm of Equation 9.10 we get equation 9.11

$$log(T) = log(A) + a.log(l) \tag{9.11}$$

Note that this is a linear relation of the form $y = n + mx$. So if we take $\log(l)$ and $\log(T)$ as our variables, we can determine the values of a and $log(A)$ by linear fitting techniques.
In this regard fill in Table 9.5 and Table 9.6 by taking the logarithms of the values of Table 9.3 and Table 9.4.

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Table 9.5: log(*l*)-log(*T*) table for the big ball			**Table 9.6**: log(*l*)-log(*T*) table for the small ball	
log(*l*)	log(*T*)		log(*l*)	log(*T*)

Plot log(*l*)-log(*T*) graph by taking log(*l*) as the horizontal axis and log(*T*) as the vertical axis. Represent the data in Table 9.5 on your plot as points. Since a line is expected to pass through these points calculate the slope (*a*) and the intercept (log(*A*)) of the line using the linear fitting formulae.

<u>Big ball;</u>

$$\sum_{i=1}^{4} log(l_i) =$$

$$\sum_{i=1}^{4} log(T_i) =$$

$$\sum_{i=1}^{4} log(l_i).\,log(T_i) =$$

$$\sum_{i=1}^{4} (log(l_i))^2 =$$

$$a = \frac{4.\sum_{i=1}^{4} log(l_i).\,log(T_i) - \sum_{i=1}^{4} log(T_i)\sum_{i=1}^{4} log(l_i)}{4.\sum_{i=1}^{4}(log(l_i))^2 - (\sum_{i=1}^{4} log(l_i))^2} =$$

$$log(A) = \frac{\sum_{i=1}^{4}(log(l_i))^2 \sum_{i=1}^{4} log(T_i) - \sum_{i=1}^{4} log(l_i).\,log(T_i)\sum_{i=1}^{4} log(l_i)}{4.\sum_{i=1}^{4}(log(l_i))^2 - (\sum_{i=1}^{4} log(l_i))^2} =$$

$a =$............; $log(A) =$.............

Small ball;

$$\sum_{i=1}^{4} log(l_i) =$$

$$\sum_{i=1}^{4} log(T_i) =$$

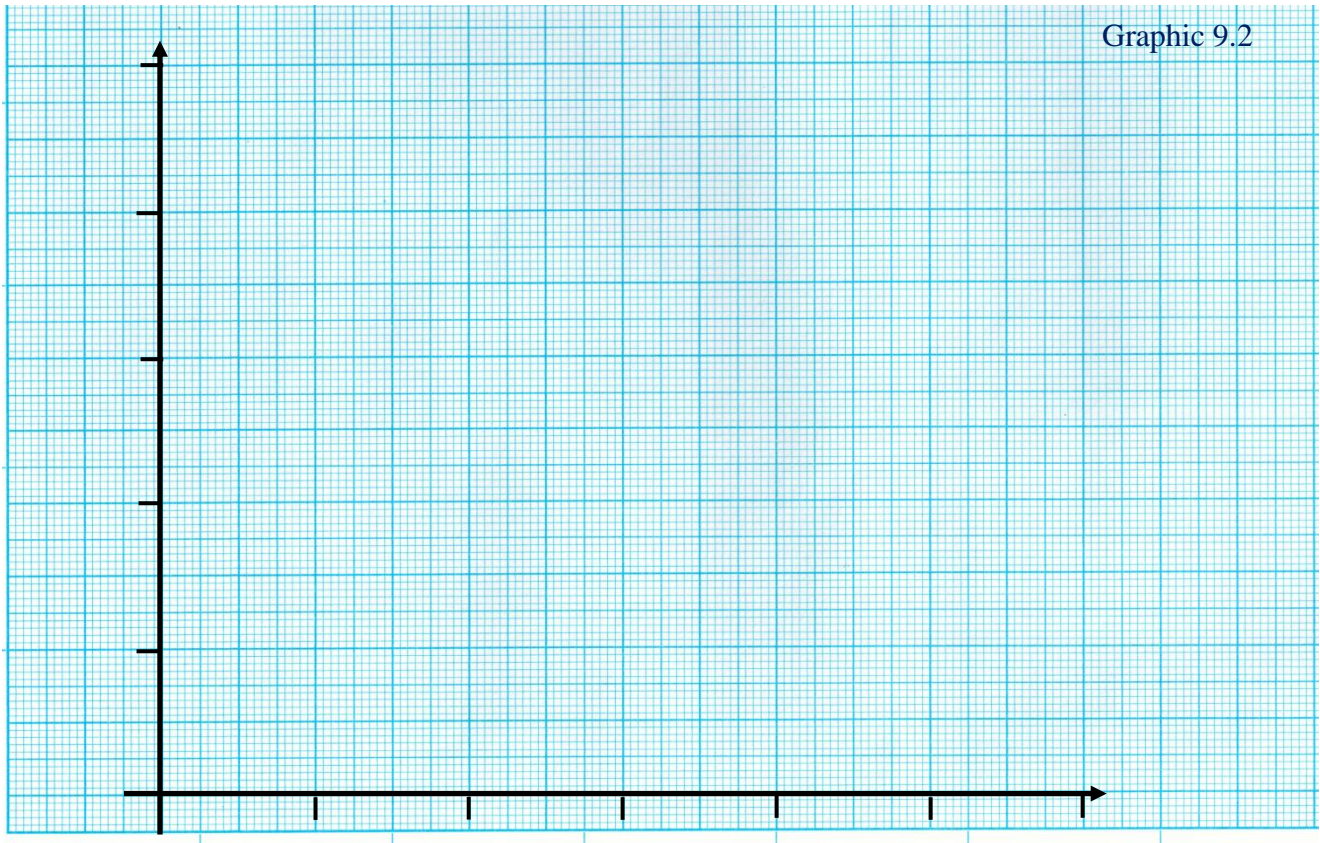$$\sum_{i=1}^{4} log(l_i) \cdot log(T_i) =$$

$$\sum_{i=1}^{4} (log(l_i))^2 =$$

$$\alpha = \frac{4 \cdot \sum_{i=1}^{4} log(l_i) \cdot log(T_i) - \sum_{i=1}^{4} log(T_i) \sum_{i=1}^{4} log(l_i)}{4 \cdot \sum_{i=1}^{4} (log(l_i))^2 - (\sum_{i=1}^{4} log(l_i))^2} =$$

$$log(A) = \frac{\sum_{i=1}^{4} (log(l_i))^2 \sum_{i=1}^{4} log(T_i) - \sum_{i=1}^{4} log(l_i) \cdot log(T_i) \sum_{i=1}^{4} log(l_i)}{4 \cdot \sum_{i=1}^{4} (log(l_i))^2 - (\sum_{i=1}^{4} log(l_i))^2} =$$

$a =$…………; $log(A) =$…………..

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Using these values plot the line which has the equation 9.11 on your graph.

Graphic 9.2

If we assume the small angle approximation is correct what do you expect to find the value for a?

Staying in the small-angle approximation use $\log(A)$ to calculate gravitational acceleration g:

Compare your α values for the small and big balls to the expected value of α under the small-angle approximation. Also compare your g values with the expected value of 980 cm/s^2.
Discuss the reasons for possible causes of differences.

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Conclusion, Comment and Discussion:

(**Tips:** Give detail explanation about what you've learned in the experiment and also explain the possible errors and their reasons.)

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Questions:

1) For a simple pendulum with a period of 2 s

    a) What length of rope is required?

    b) What length of rope is required for a person who wants to find the same period on the Moon?

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2) An hour of simple pendulum is slow. What changes should be made to the mass and length to correct the situation?

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