

**AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH**

**FACULTY OF SCIENCE & TECHNOLOGY**

**DEPARTMENT OF PHYSICS**

**PHYSICS 1 LAB**

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**Section: B21 , Group: 08**

**LAB REPORT ON**

To determine the acceleration due to gravity applying linear least square regreession method by using a simple pendulum.

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**Submitted By**

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**1. Theory**

The time period of small-angle oscillation of a simple pendulum (a mental bob attached by a light string and suspended vertically from a fixed support) can be shown to be

T=

where L is the effective length (length from the point of suspension to the center of the bob) and time period (time of one complete oscillation) of a simple pendulum, respectively in a place where the acceleration due to gravity is g.

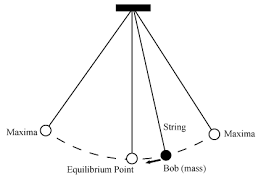


Figure1.1: A swinging simple pendulum with an effective length L and amplitude .

The time period equation of a simple pendulum can be rearranged as

T2=L

Comparing this equation with the state line equation that goes through the origin (y=mx) the value of acceleration due to gravity can be determined by

g=

where m is the slope of the T2 vs L graph.

For two types (independent and dependent) of variables x and y = f(x) the linear least square regression method can be used for N number of data points to find the best fitted line (regression line) as the fig. 1.2 shows.

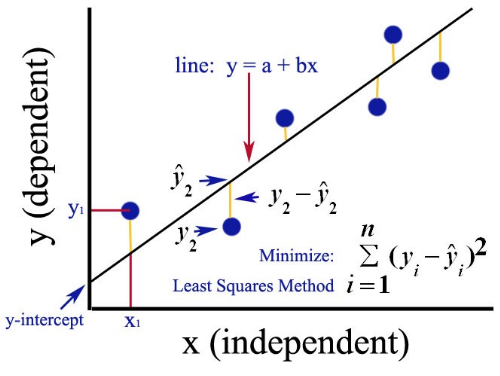


Figure 1.2: Way to get the best fitted line by finding the minimum value of D = d12 + d22 + d32 + d42 + d52 + d62 + d72 according to the least square regression method. The equation for the best fitted line is y = mx + c, where m is the slope and c is the interception in the y axis. Here the number of data points is taken as N=7.

The formula for determining the slope of the regression line

m =

and intercept c = , where and are mean value of x and y.

In the slope equation:

= x1 + x2 + x3 + x4 + x5 + x6 + x7

= y1 + y2 + y3 + y4 + y5 + y6 + y7

= x1 y1 + x2 y2 + x3 y3 + x4 y4 + x5 y5 + x6 y6 + x7 y7

= (x1 + x2 + x3 + x4 + x5 + x6 + x7 )2

= x12 + x22 + x32 + x42 + x52 + x62 + x72

**2. Apparatus**

* Metal bob
* A piece of string
* Stand
* Clamp
* Meter scale
* Stop watch

**3. Procedure**

* We attach a light piece of string with the hook of the metal bob and find the length L of the pendulum with a meter scale from the point of suspension to the mid-point of the bob.
* We give a small angle (less than 10 degrees) swing to the pendulum. We find the time period, to do it, measure the total time for 20 oscillations and divide it by 20. We repeat the procedure for different lengths and record the data in table 1.1.
* We are using the Linear Least Square Regression Method (LLSRM) find the regression line and from the value of slope find g from the relation: slope = 4/g.
* We plot the same graph in Excel and also find the value of g from the equation of the graph.

**4. Experimental Data**

Table 1.1: Time periods T for different lengths L of the simple pendulum.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| No  of  Obs. | Effective  Length  L  (cm) | Time for 20  Oscillations  t  (s) | Time  Period  T = t/20  (s) | T2  (s2) | L2  (cm2) | L. T2  (cm. s2) |
| 1 | 150 | 48.77 | 2.4385 | 5.9463 | 22500 | 891.945 |
| 2 | 140 | 46.66 | 2.333 | 5.4429 | 19600 | 762.006 |
| 3 | 130 | 45.88 | 2.294 | 5.2624 | 16900 | 684.112 |
| 4 | 120 | 43.99 | 2.1995 | 4.8378 | 14400 | 580.536 |
| 5 | 110 | 42.87 | 2.1435 | 4.5946 | 12100 | 505.406 |
| 6 | 100 | 39.79 | 1.9895 | 3.9581 | 10000 | 395.81 |
| 7 | 90 | 38.17 | 1.9085 | 3.6424 | 8100 | 327.816 |
| ∑ | 840 | 306.13 | 15.3065 | 33.6845 | 103600 | 4147.631 |

**5. Analysis and Calculations**

Table 1.2: Finding the slope, m and intercept , c by using the linear least

square regression method.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| N |  |  |  |  |  | M | c |
| 7 | 840 | 33.6845 | 4147.631 | 705600 | 103600 | 0.03768 | 0.2905 |

Equation: m =

**A. The value of g using the LLSRM:**

m = = = 0.03768

= = = 120

= = 4.8121

Intercept, c = = 4.8121 – 0.03768 = 0.2905

Acceleration due to gravity by LLSRM, = = = 1047.7287 cm. s2

**B. The value of g from the graph of excel:**

Slope of the regression line, m = 0.037

Acceleration due to gravity by Excel, = = 1066.9843 cm.s2

**C. Percentage of difference in g between Excel and LLSRM:**

1.8047%

**6. Result**

|  |  |  |
| --- | --- | --- |
| Method | Value of g (m/s2) | Comment |
| LLSRM  Excel | 1047.7287  1066.9843 | Percent of error is 1.8047% |

**7. Discussion**

a) There may be some instrumental error in slide calipers so that there is some difficulties

while measuring the bob.

b) While measuring the oscillation of the bob, there may be some error. The bob isn’t

moving freely because of some frictional problem.

c) There may be some error while measuring the thread.

d) We may be acehive the exact value by using wire instead of using rope.

e) The string stand is not properly straight.

**8. References**

* **Fundamentals of Physics:** Acceleration due to gravity (Chapter 13, page 360), Simple pendulum (Chapter 15, page 425-426)
* **Video Link:**
* Simple pendulum: 1. https://www.youtube.com/watch?v=02w9lSii\_Hs

2. https://www.youtube.com/watch?v=bJKEN43695k

* LLSRM: 1. https://www.youtube.com/watch?v=0T0z8d0\_aY4

2. https://www.youtube.com/watch?v=1C3olrs1CUw