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Lab Report

Name of the Experiment	: Period of Oscillation for a simple Pendulum
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Date	: 23-3-2024

Instructor's comments:

$$T_{avg_1} = \frac{T_1+T_2+T_3}{3} = \frac{1.491+1.481+1.487}{3} sec = \cancel{1.4863 sec}\ 1.486\ sec$$

$$T_{avg_2} = \frac{T_1+T_2+T_3}{3} = \frac{1.474+1.466+1.478}{3} sec = 1.473 sec$$

$$T_{avg_3} = \frac{T_1+T_2+T_3}{3} = \frac{1.457+1.469+1.471}{3} sec = 1.466 sec.$$

$$T^2_{avg} = (1.486 sec)^2 = 2.21 sec^2$$

Table 1. Mass Dependence of the Period

Length of Pendulum, L = 0.52 m $\theta \leq 10$ degree

Mass (grams)	A Single Period (sec)			T_{avg} (sec)	T_{avg^2} (sec²)
82.6	1.491	1.481	1.487	1.486	~~2.208~~ 2.21
18	1.474	1.466	1.478	1.473	2.17
14.6	1.457	1.469	1.471	1.466	~~2.15~~ 2.15

Table 2. Angle Dependence of the Period

Mass of Pendulum = 14.6 grams

$l = 0.52 m.$

Angle (degrees)	A Single Period (sec)			T_{avg} (sec)	T_{avg^2} (sec²)
10	1.457	1.469	1.471	1.466	2.15
15	1.485	1.484	1.488	1.486	2.21
20	1.491	1.500	1.503	1.498	2.24
30	1.505	1.510	1.504	1.506	2.27
40	1.509	1.513	1.520	1.514	2.29

$$T_{avg_{15}} = \frac{T_1+T_2+T_3}{3} = \frac{1.485+1.484+1.488}{3} sec = 1.486 sec.$$

$$T_{avg_{20}} = \frac{T_1+T_2+T_3}{3} = \frac{1.491+1.500+1.503}{3} sec = 1.498 sec.$$

$$T_{avg_{30}} = \frac{T_1+T_2+T_3}{3} = \frac{1.505+1.510+1.504}{3} sec = 1.506 sec.$$

$$T_{avg_{40}} = \frac{T_1+T_2+T_3}{3} = \frac{1.509+1.513+1.520}{3} sec = 1.514 sec.$$

$$T^2_{avg} = (1.466 sec)^2 = 2.15 sec^2$$

$$T_{avg\,0.40m} = \frac{T_1+T_2+T_3}{3} = \frac{1.312+1.308+1.306}{3}\,sec = 1.309\,sec.$$

$$T_{avg\,0.45m} = \frac{T_1+T_2+T_3}{3} = \frac{1.388+1.381+1.393}{3}\,sec = 1.387\,sec$$

$$T_{avg\,0.50m} = \frac{T_1+T_2+T_3}{3} = \frac{1.455+1.465+1.461}{3}\,sec = 1.460\,sec.$$

$$T_{avg\,0.55m} = \frac{T_1+T_2+T_3}{3} = \frac{1.518+1.515+1.520}{3}\,sec = 1.518\,sec.$$

$$T^2_{avg} = (1.309\,sec)^2 = 1.71\,sec^2$$

Table 3. Length Dependence of the Period

$\theta \leq 10$ degree

$m = 14.6$ grams

Length l (m)	A Single Period (sec)			T_{avg} (sec)	T_{avg}^2 (sec²)
0.40	1.312	1.308	1.306	1.309	1.71
0.45	1.388	1.381	1.393	1.387	1.92
0.50	1.455	1.465	1.461	1.460	2.13
0.55	1.518	1.515	1.520	1.518	2.30
0.60	1.575	1.588	1.580	1.581	2.50

$$T_{avg\,0.60m} = \frac{T_1+T_2+T_3}{3} = \frac{1.575+1.588+1.580}{3}\,sec = 1.581\,sec.$$

Slope of the best fit line = ________ s²/m.

g_{exp} = ________ m/s².

Percent error = ________

Calculation:

$$Slope = \frac{\Delta y}{\Delta x} = \frac{y_2-y_1}{x_2-x_1} = \frac{1.3-1.0}{0.30-0.23} = 4.29\,sec^2/m.$$

$$g_{experimental} = \frac{4\pi^2}{Slope} = \frac{4\times(3.1416)^2}{4.29} = 9.20\,m\,sec^{-2}$$

$$\text{percentage error} = \left|\frac{g_{theoretical} - g_{experimental}}{g_{theoretical}}\right| \times 100\%$$

$$= \left|\frac{9.81-9.20}{9.81}\right| \times 100\% = 6.22\%$$

Result:

$g_{experimental} = 9.20\,m\,sec^{-2}$

percentage error = 6.22%

Questions:

1. Does the period of a simple pendulum depend on the mass?

No, because as per the equation $T = 2\pi\sqrt{\frac{L}{g}}$, there is no mass(m). As well as we can see that from graph of T^2_{avg}(sec²) vs mass(gram), there is no correlation.

2. Is the period constant over small angles? Does it vary when one reaches larger angles?

Yes, the period is constant over small angles. Yes, time period varies greatly in large angles because as per theory $\sin\theta \simeq \theta$ when θ is smaller.

3. Does the period depend on the length of the pendulum?

Yes, the time period depends on the length of the pendulum as we know that $T = 2\pi\sqrt{\frac{L}{g}}$ where L is length. In the graph of T^2_{avg} vs length, we can also see a linear correlation. Therefore, the period depends on the length of the pendulum.

4. Of the three parameters explored in this experiment, which has the strongest influence?

Length has the strongest influence on time period as its graph has the most correlation than the other graphs.

5. Is your best-fit line in form Table-3 goes through the origin? Explain why or explain not?

No, the best-fit line doesn't go through the origin. We know,

$$T = 2\pi\sqrt{\frac{L}{g}} \Rightarrow T^2 = 4\pi^2\frac{L}{g} \Rightarrow T^2 = 4\pi^2\frac{l+r}{g} \Rightarrow T^2 = \frac{4\pi^2}{g}l + \frac{4\pi^2}{g}r$$

Therefore, $y = mx + c$

The relation $L = l + R$ where l = length of the string and r = radius of the spherical mass. If there are the case $r = 0$, then it will be $T^2 = \frac{4\pi^2}{g} l$ or, $y = mx$. So, then the best-fit line will go through the origin. Therefore, if $r = 0$, then the best-fit line in form Table-3 ~~goes~~ will go through the origin.

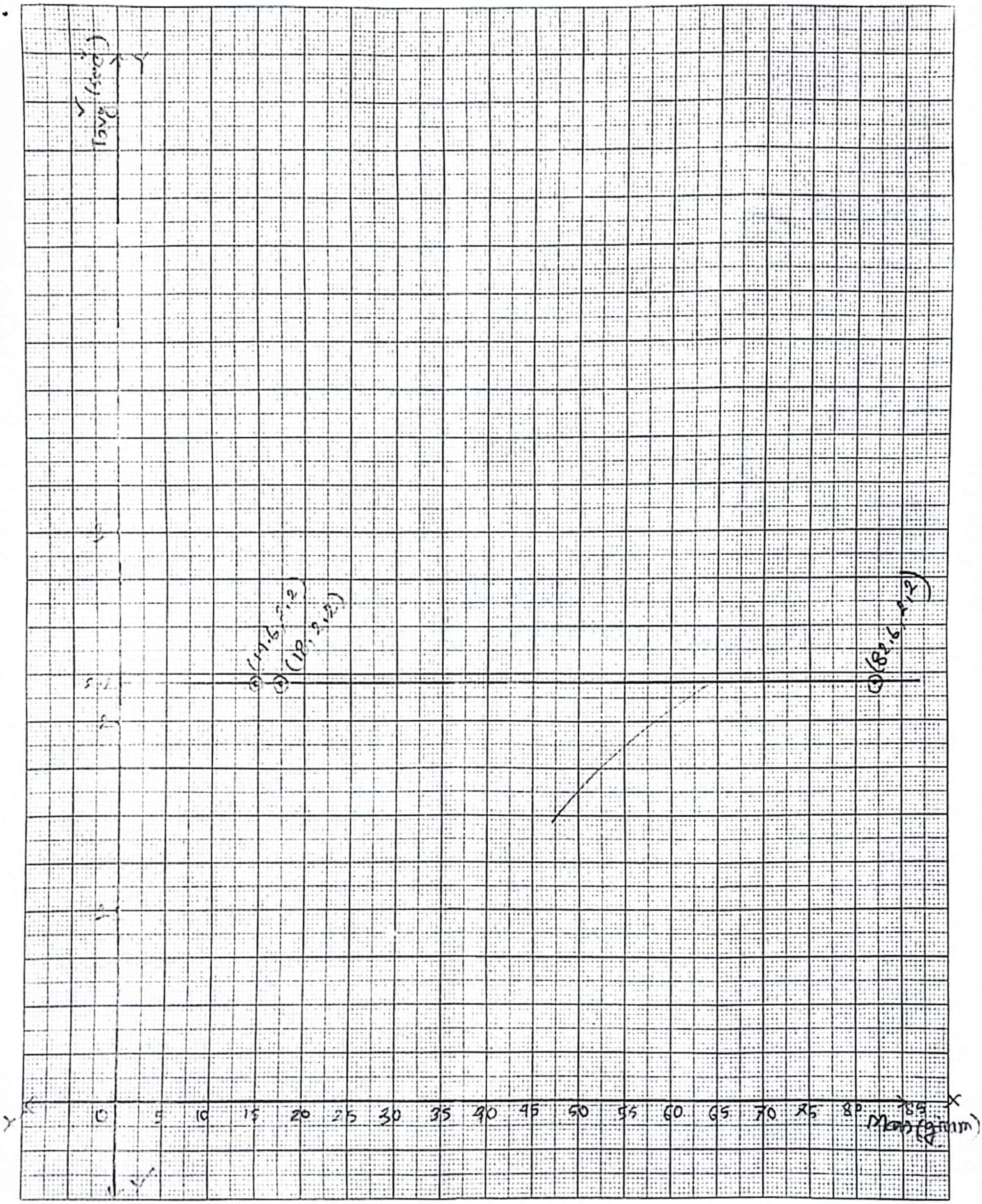
Discussion :

5.1

In this experiment, we tried to find the time period of a pendulum step created with wires, stand and spherical mass. The mass was tied with the wire and the wire was tied to the stand with pendulum harmonic motion. we evaluated three criteria, Time period's dependence on mass, time period's dependence on angle and time period's dependence on the length of the wire. We tried to do the experiment with three times where only one variable was changed and the others were kept same. Then we graphed the T^2_{avg} vs mass, T^2_{avg} vs angle and T^2_{avg} vs length to find and visualize the ~~dependency~~ dependency and correlation between the dependent variable (time period) with respect to independent variable (mass, angle and length). Then we found that length gave the greater dependency in correlation. Then we found the T^2_{avg} vs length graph using that we calculated $g_{experimental}$ and compared $g_{experimental}$ value with ~~$g_{theoretical}$~~ $g_{theoretical}$ which is $9.81\ m\,sec^{-2}$. we found 6.22% percentage error, which is negligible. To reduce that percentage errors, we had to measure the length of the wire precisely and the oscillation times to calculate the average time period perfectly. Therefore, the experiment was successful and everything went smoothly without any problem.

In x axis, 10 square = 5 unit
In y axis, 10 square = 1 unit

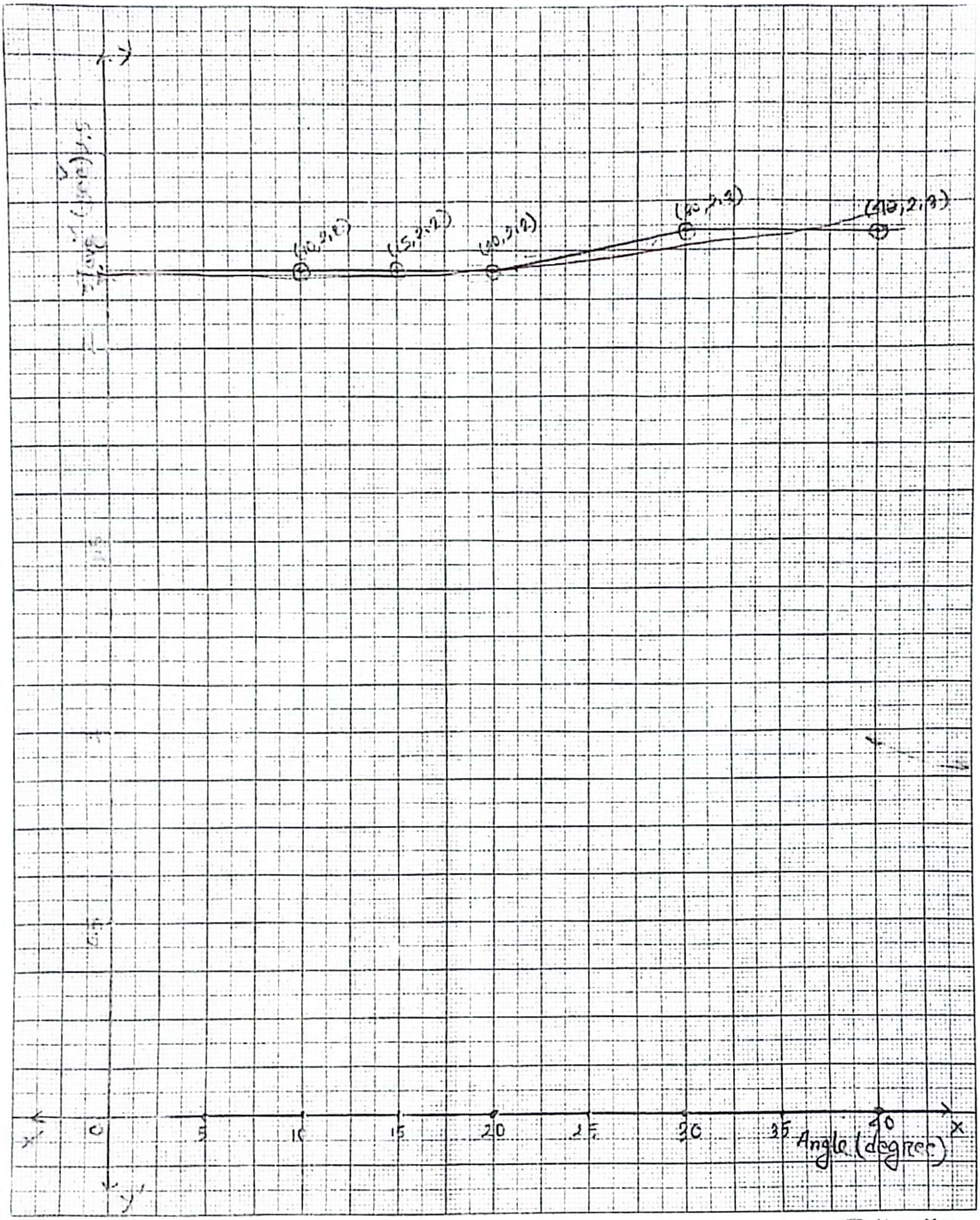
Roll No. ....



In x axis, 20 square = 5 unit

• In y axis, 80 square = 0.5 unit

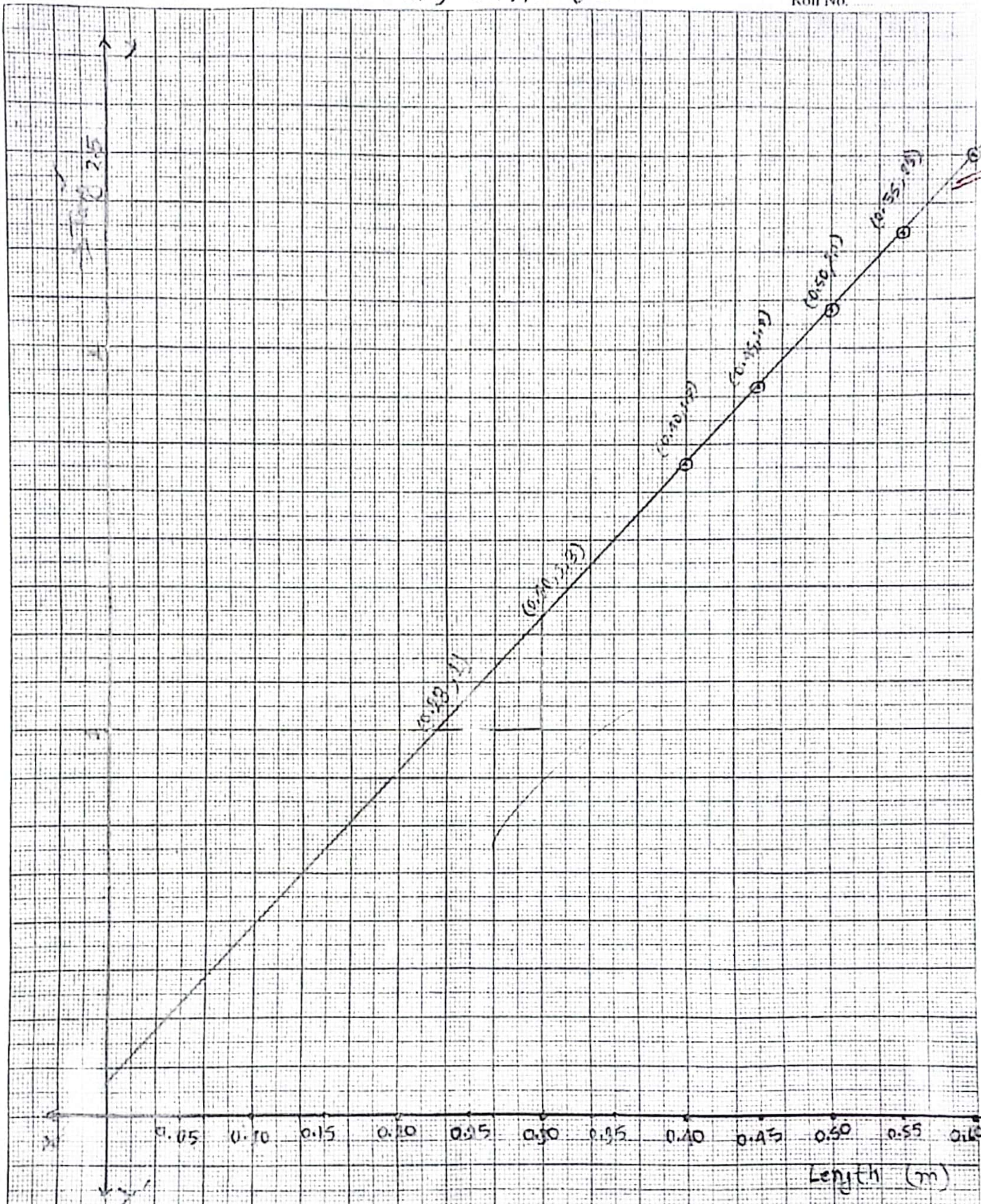
Roll No.



In X· Axis, 15 square = 0.05 unit

In y. Axis; 50 square = 1 unit

Roll No.



MICRO

20 cm x 25 cm