Sec-15
Group-1

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Lab Report

Name of the Experiment	: Compound pendulum and simple harmonic motion
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Date	: 30-3-2024

Instructor's comments:

Table 1

Hole Number		Distance from COM d (cm)	Time for 10 oscillations (s)		Mean time t (s)	Time Period $T=\frac{t}{10}$ (s)	
Edge A	1	5.6	25.75	26.06	25.905	2.590	2.59
	2	11.4	19.15	18.90	19.025	1.902	1.90
	3	16.9	16.78	16.60	16.690	1.660	1.66
	4	22.6	15.75	15.78	15.765	1.586	1.58
	5	28.2	15.~~60~~47	15.31	15.~~455~~ 390	1.5~~45~~ 390	1.54
	6	33.7	15.69	15.50	15.595	1.559	1.56
	7	39.4	15.75	15.70	15.725	1.572	1.57
	8	45.0	16.~~87~~ 06	16.07	16.~~97~~ 065	1.~~59~~ 607	1.61
Edge B	1	5.6	24.62	24.93	24.775	2.477	2.48
	2	11.2	19.10	19.15	19.125	1.912	1.91
	3	16.3	16.60	16.56	16.580	1.658	1.66
	4	22.3	15.94	15.69	15.815	1.581	1.58
	5	28.0	15.38	15.47	15.425	1.542	1.54
	6	33.6	15.53	15.50	15.515	1.515	1.52
	7	39.3	15.79	15.81	15.800	1.580	1.58
	8	44.8	16.25	16.12	16.185	1.618	1.62

***Note : COM means Center Of Mass.*

For Edge A,

Mean time for 10 oscillations$(t) = \frac{19.15s + 18.90s}{2} = 19.025s.$

$\therefore$ Single time period, $T = \frac{t}{10} = \frac{19.025}{10}s = 1.90s.$

For Edge B,

Mean time for 10 oscillations$(t) = \frac{19.10s + 19.15s}{2} = 19.125s.$

$\therefore$ Single time period, $T = \frac{t}{10} = \frac{19.125s}{10} = 1.91s.$

$AC = AO + OC = 43.5cm + 21.5cm = 65cm = \frac{65}{100} m = 0.65m$

$BD = BO + OD = 20cm + 44cm = 64cm = \frac{64}{100} m = 0.64m$

$A'C' = A'O + OC' = 39cm + 25.5cm = 64.5cm = \frac{64.5}{100} m = 0.645m$

$B'D' = B'O + OD' = 26cm + 35cm = 61cm = \frac{61}{100} m = 0.61m$

For ABCD, $g = 4\pi^2 \frac{L}{T^2} = 4 \times (3.1416)^2 \times \frac{0.645m}{(1.60sec)^2} = 9.947 msec^{-2}$

TABLE 2 (From the graph)

Observations from the horizontal lines	L (m)	T (sec)	$g = 4\pi^2 \frac{L}{T^2}$ (m/s²)	Mean g (m/s²)	K (m)	Mean K (m)
1. ABCD	$L = \frac{AC+BD}{2}$ $= \frac{0.65m + 0.64m}{2}$ $= 0.645m$	1.60	9.947	10.133	0.305 ~~0.645~~	~~0.636~~ 0.31
2. A'B'C'D'	$L' = \frac{A'C'+B'D'}{2}$ $= \frac{0.645m + 0.61m}{2}$ $= 0.628m$	1.55	10.319		0.315 ~~0.627~~	

Calculations for L, g and K:

For A'B'C'D', $g' = 4\pi^2 \frac{L}{T^2} = 4 \times (3.1416)^2 \times \frac{0.628m}{(1.55sec)^2} = 10.319 msec^{-2}$

$\text{Mean } g = \frac{g+g'}{2} = \frac{9.947msec^{-2} + 10.319msec^{-2}}{2} = 10.133 msec^{-2}$

~~$K = \sqrt{AC \times BD} = \sqrt{(0.65m) \times (0.64m)} = 0.645m$~~

~~$K' = \sqrt{A'C' \times B'D'} = \sqrt{(0.645m) \times (0.61m)} = 0.627m.$~~

~~$\text{Mean } K = \frac{K+K'}{2} = \frac{0.645m + 0.627m}{2} = 0.636m.$~~

Results:

$L = 0.645m$

$L' = 0.628m$

$g = 9.947 msec^{-2}$

$g' = 10.319 msec^{-2}$

$\text{Mean}(g) = 10.133 msec^{-2}$

$K =$ ~~0.645m~~ $0.305m$

$K' =$ ~~0.627m~~ $0.315m$

$\text{Mean}(K) =$ ~~0.636m~~ $0.31m$

$\therefore \text{percentage error} = \left| \frac{\text{practical value} - \text{theoretical value}}{\text{theoretical value}} \right| \times 100\%$

$= \left| \frac{10.133 - 9.81}{9.81} \right| \times 100\%$

$= 3.29\%$

Here,

$OA = 43.5\,cm = \frac{43.5}{100}\,m = 0.435\,m$

$OC = 21.5\,cm = \frac{21.5}{100}\,m = 0.215\,m$

$$K = \sqrt{OA \times OC} = \sqrt{(0.435\,m) \times (0.215\,m)}$$
$$= 0.305\,m$$

Again,

$OA' = 39\,cm = \frac{39}{100}\,m = 0.39\,m$

$OC' = 25.5\,cm = \frac{25.5}{100}\,m = 0.255\,m$

$$K' = \sqrt{OA' \times OC'} = \sqrt{(0.39\,m) \times (0.255\,m)}$$
$$= 0.315\,m$$

$$\text{Mean } K = \frac{K + K'}{2} = \frac{0.305\,m + 0.315\,m}{2}$$
$$= 0.31\,m.$$

Questions:

1. According to your understanding and the data you have obtained in this experiment, explain the time variation with different suspension of the compound pendulum.

As per theory, we know $T = 2\pi\sqrt{\frac{I}{mgl}}$ and as per data we can see due to long distance from COM, there is first decrease in Time period then there is an increase. This is due to the increase in torque when there is more distance. For that reason, when torque $\uparrow$, then time period $\uparrow$.

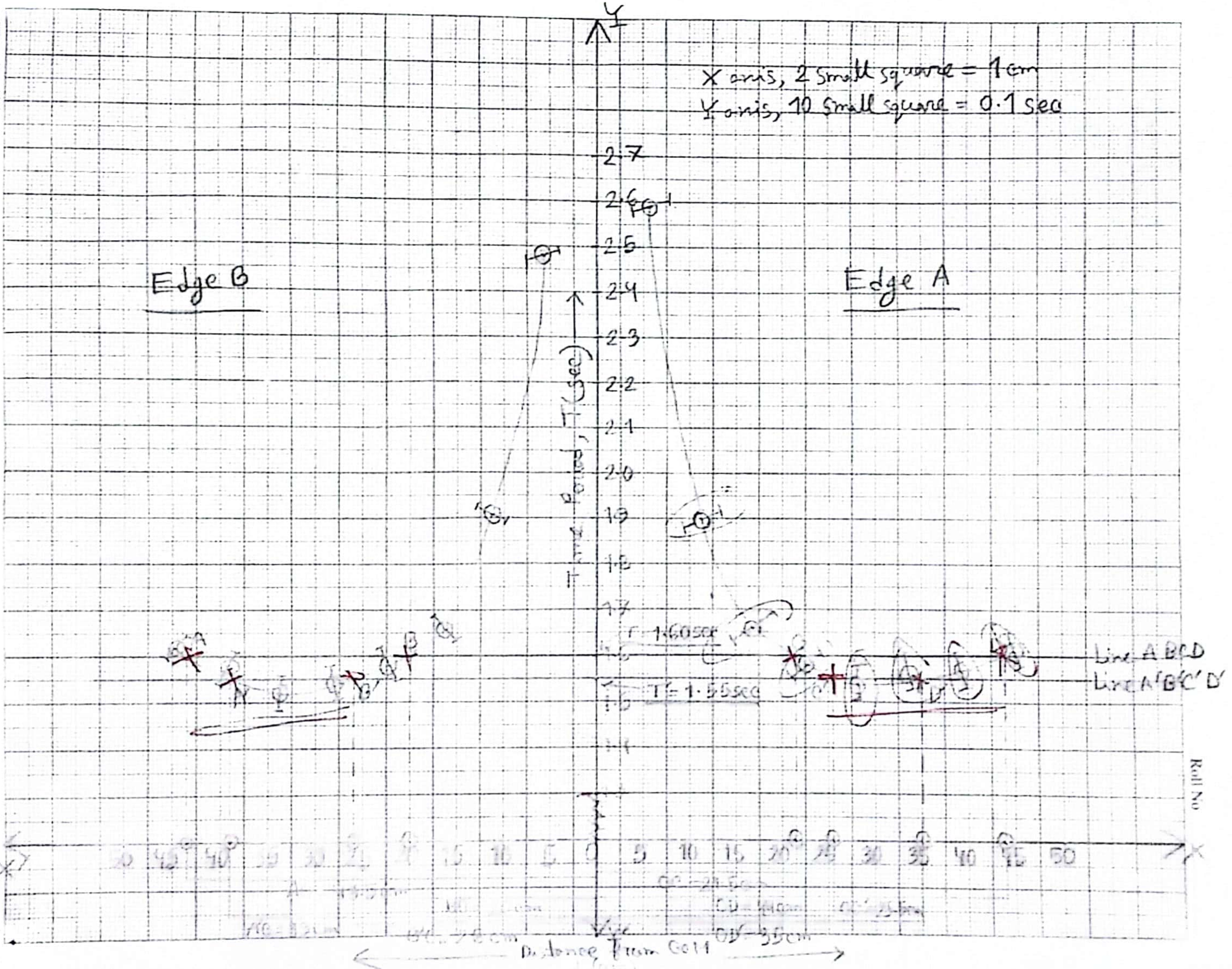
2. Do you think compound pendulum in comparison to simple pendulum would show better oscillatory motion in air for measurement of g? Why?

Drawbacks of simple pendulum, theoretically prove

No, I don't think compound pendulum gives better oscillatory motion in comparison with simple pendulum. Because we could only have $g > 10\,msec^{-2}$ in this experiment where as in simple pendulum we got close to $9.81\,msec^{-2}$. This is because of the extra weight distribution in the compound pendulum.

Discussion:

In the experiment, we tried to determine g and radius of gyration using a compound pendulum. We employed the compound pendulum in a pivot point with a screw in wall mount using knife edge. We chose eight points above and below of the center of mass and named the sides Edge A & Edge B. Later we found ten time period and then divided it by 10 to find single time period. We took two readings of 10 time period so that we could get less error when calculating mean 10 time period. We graphed Time period (sec) vs distance from CoM graph (cm) using graphical method. From the graph, we found Line ABCD and Line A'B'C'D' and calculated AC, BD, A'C', B'D' to get L & L' through AO, OC, BO, OD, A'O, OC', B'O and OD'. We also found T & T' from the two parallel Line ABCD & Line A'B'C'D'. Then we calculated g, g', K, K' and got the mean value of g and K. We observed the value of g is greater than 10 $msec^{-2}$ whereas in simple pendulum we got close to 9.81 $msec^{-2}$. For the extra weight distribution in the compound pendulum, it didn't give better oscillatory motion in comparison with simple pendulum. We faced some issues when we set the knife edge inside the points of the compound pendulum and employed it in the wall mount. Because it is important to set the pointed part of the knife edge perfectly to get a perfect oscillation. we got 3.29% percentage error of g. If ~~the~~ oscillation happened perfectly, then we could get less error value when calculating g. ~~and K.~~ Therefore, we completed the experiment smoothly.


X axis, 2 Small square = 1cm
Y axis, 10 Small square = 0.1 sec
Edge B
Edge A
Period, T (sec)
T = 1.60sec
T = 1.55sec
Line ABCD
Line A'B'C'D'
Distance from Cell
OD = 35cm