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Lab Report-6

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Name of the Experiment	: Experiment with compound pendulum and determination of value of 'g'
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Date	: 04/11/25

Instructor's comments:

Data 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	24.40	24.37	24.385	2.4385
	2	10	18.75	19.03	18.89	1.889
	3	15	16.38	16.80	16.59	1.659
	4	20	15.50	15.75	15.625	1.5625
	5	25	15.40	15.22	15.31	1.531
	6	30	15.50	15.56	15.53	1.553
	7	35	15.62	15.72	15.67	1.567
	8	40	15.91	15.89	15.9	1.59
Edge B	1	5	24.63	24.76	24.695	2.4695
	2	10	18.84	19.01	18.925	1.8925
	3	15	16.50	16.75	16.625	1.6625
	4	20	15.67	15.73	15.7	1.57
	5	25	15.39	15.21	15.3	1.53
	6	30	15.37	15.39	15.38	1.538
	7	35	15.71	15.66	15.685	1.5685
	8	40	15.99	15.87	15.93	1.593

Note: COM means Center of Mass

$AC = (40.5 + 17.5) = 58 cm$
$BD = (18 + 40.5) = 58.5 cm$
$AO = 40.5 cm$; $OC = 17.5 cm$

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	$L = \frac{AC+BD}{2}$ $= \frac{58+58.5}{2}$ cm $= 58.25\times10^{-2}$ m	1.6	8.98 m/s²	9.13 m/s²	0.2662	0.2678
2. A'B'C'D'	$L' = \frac{A'C'+B'D'}{2}$ $= \frac{55.5+57.5}{2}$ cm $= 56.5\times10^{-2}$ m	1.55	9.28 m/s²		0.2691	

Calculations for L, g and K: (Edge A)

$L = \frac{AC+BD}{2}$
$= \frac{58 + 58.5}{2}$ cm
$= 58.25 cm = 58.25\times10^{-2}$ m
$T = 1.6$ sec
$g = 4\pi^2 \times \frac{58.25\times10^{-2}}{1.6^2}$
$= 8.98$ m/s²

$L' = \frac{A'C' + B'D'}{2}$ (Edge B)
$= \frac{55.5 + 57.5}{2}$ cm
$= 56.5$ cm $= 56.5\times10^{-2}$ m
$T' = 1.55$ sec
$g' = 4\pi^2 \frac{56.5\times10^{-2}}{1.55^2}$
$= 9.28$ m/s²

Results:

Mean $g = (8.98 + 9.28)/2 = 9.13$ m/s²

$K = \sqrt{AO \times OC} = \sqrt{40.5 \times 17.5} = 26.62$ cm $= 0.2662$ m

$K' = \sqrt{OA' \times OC'} = \sqrt{34.5 \times 21} = 26.91$ cm $= 0.2691$ m

Mean, $K = (0.2662 + 0.2691)/2 = 0.2678$ m

$$\% \text{ Error} = \frac{|g_{theo} - g_{paral}|}{g_{theo}} \times 100\%$$

$$= \frac{|9.81 - 9.13|}{9.81} \times 100\%$$

$$= 6.93\%$$

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.

In a compound pendulum, the time period of oscillation varies depending on the point of suspension, because the distance from the (com) to the pivot changes. which affects the moment of inertia and the effective length of the pendulum. firstly, at the near point it goes up, then gradually go down, far from pivot, then again goes up when more far. We know, $T = 2\pi\sqrt{I/mgl}$, show that both depend on I and ~~g~~ l; resulting parabollic shape curve.

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

Yes, the compound pendulum provide more accurate oscillatory motion in air compare to simple Pendulum which provide better measurement of g.

Because -

① It is less affected by air resistance and string flexibility

② The center of mass and dimensions remain fixed, which replaces the uncertainities caused by string length and bob mass in simple pendulum.

③ Oscillations are more stable because of the rigid structure

④ Clean calculation and higher precision gives more accurate result.

Discussion:

Today our experiment goal was to determine the value of 'g' - the acceleration due to gravity using a compound pendulum, and also calculate the radius of gyration K. to further determine moment of inertia. Firstly, we were introduced with simple pendulum where the mass was at the center of bob, but in compound pendulum, our main challange was to determine different different moment of inertia, as the body is rigid and mass distribution vary as the distance from center of mass to pivot point change. Then we calculate the different time periods for different point on the compound pendulum. But as the hole are not perfectly homogeneous, there was some error while calculating time period for two different edges. But one thing about compound pendulum, it is much reliable than the simple pendulum and it gives more accurate reading due to its rigid structure and its nature. Finally, after finding 'g' by ~~tr-plo~~ taking help from the ploting graph by using the data collection, we got $g =$ ~~9.082~~ $9.13\,ms^{-2}$, which is a 6.93% error of theoratical g. but agaig as we use our own eye to take the data of time period, there was obviously some error, to overcome this error, we could use slo-mo technology to calculate ~~ω~~(T) more precisely and using a homogenous distance hole's compound pendulum. We can see its less error than pendulum. Also we measure the 'g' by using parallel axis theorem of moment of inertia.

It is, $I = I_{com} + Mh^2$

where 'h' is the parallel distance from the I_{com}'s radius.

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