OBSERVATION

TABLE : 1

Knife edge	Time for 10 oscillation (sec) 1 (sec)	(2 s)	Mean time	Time period [illegible] in sec
K_1	18.13	18.00	18.07	1.81
K_2	17.31	17.12	17.22	1.72

TABLE : 2

Knife edge	Time for 10 oscillation (sec) 1 (s)	2 (s)	Mean time	Time period $T = t/10$ in sec
K_1	18.09	18.10	18.10	1.81
K_2	17.15	17.19	17.17	1.72

TABLE : 3

Knife edge	Time for 10 oscillation (sec) 1 (s)	2 (s)	Mean time	Time period $T = t/10$ in sec
K_1	17.65	18.06	17.86	1.79
K_2	16.87	16.72	16.80	1.68

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CALCULATION

Time period $T_1 = \frac{18.07}{10} = 1.807 = 1.81$ sec

Time period $T_2 = \frac{17.22}{10} = 1.722 = 1.72$ sec

$$\therefore g = \frac{8\pi^2}{\left[\frac{T_1^2 + T_2^2}{h_1 + h_2} + \frac{T_1^2 - T_2^2}{h_1 - h_2}\right]}$$

$$\Rightarrow g = \frac{8\pi^2}{\left[\frac{6.24}{0.93} + \frac{0.32}{0.27}\right]}$$

$$= \frac{8\pi^2}{6.71 + 01.19}$$

$$= \frac{8 \times 9.87}{7.90}$$

$$g = 9.99 \ m/s^2$$

RESULT : The acceleration due to gravity at a given place is found to be $9.99 \ m/s^2$

ERROR CALCULATION

$$g = 8\pi^2 \left[\frac{T_1^2 + T_2^2}{h_1 + h_2}\right]^{-1}$$

$T_1 \simeq T_2$

$$g = 8\pi^2 \left[\frac{2T_1^2}{h_1 + h_2}\right]^{-1}$$

$$g = 8\pi^2 \left(\frac{h_1 + h_2}{T_1^2} \right)$$

$$g \propto \frac{h_1 + h_2}{T_1^2}$$

$$\frac{\Delta g}{g} = \frac{\Delta (h_1 + h_2)}{h_1 + h_2} \pm 2 \frac{\Delta T_1}{T_1}$$

$$= \frac{0.001}{0.917} \pm 2 \times \frac{0.01}{1.81}$$

$$= 0.013$$

$$\Delta g = 0.013 \times 9.99$$

$$= 0.13$$

$$g' = g \pm \Delta g$$

$$= 9.99 \pm 0.13 \ m/s^2$$

Standard error in g:

$$\frac{\Delta g}{g} \times 100 = \frac{|g_{standard} - g_{calculated}|}{g_{standard}}$$

$$= \frac{|9.81 - 9.99|}{9.81} \times 100$$

$$= 1.8\ \%$$

CALCULATION :

Time period $T_1 = \frac{18.10}{10} = 1.81$ sec

Time period $T_2 = \frac{17.17}{10} = 1.717 = 1.72$ sec.

Now $g = 8\pi^2 \left[\frac{6.24}{0.90} + \frac{0.32}{0.24} \right]^{-1}$

$= \frac{8 \times 9.87}{8.16}$

$= 9.67 \ m/s^2$

RESULT : At that given place, accⁿ due to gravity is $9.67 \ m/s^2$

ERROR CALCULATION.

$g = 8\pi^2 \left[\frac{T_1^2 + T_2^2}{h_1 + h_2} + \frac{T_1^2 - T_2^2}{h_1 - h_2} \right]^{-1}$

As we derived eqⁿ: $\frac{\Delta g}{g} = \frac{\Delta(h_1 + h_2)}{h_1 + h_2} + \frac{2 \Delta T_1}{T_1}$

$\Delta g = 0.11$

$g' = g \pm \Delta g = 9.67 \pm 0.11 \ m/s^2$

Standard error in g is

$\frac{\Delta g}{g} \times 100 = \frac{9.81 - 9.67}{9.81} \times 100$

$= 1.4 \%$

PAGE NO.:

Distance of K_1 from C.G, h_1 = 0.57 cm
Distance of K_2 from C.G, h_2 = 0.31 cm

CALCULATION

Time period $T_1 = \frac{17.86}{10} = 1.786 = 1.79$ sec

Time period $T_2 = \frac{16.80}{10} = 1.68$ sec.

$$g = 8\pi^2 \left[\frac{T_1^2 + T_2^2}{h_1 + h_2} + \frac{T_1^2 - T_2^2}{h_1 - h_2} \right]^{-1}$$

$$= 8\pi^2 \left[\frac{6.02}{0.88} + \frac{0.38}{0.26} \right]^{-1}$$

$$= \frac{78.95}{8.30}$$

$$= 9.51 \ m/s^2$$

RESULT : Acceleration due to gravity at that place is found to be $9.51 \ m/s^2$

ERROR CALCULATION

$$g = 8\pi^2 \left[\frac{T_1^2 + T_2^2}{h_1 + h_2} + \frac{T_1^2 - T_2^2}{h_1 - h_2} \right]^{-1}$$

$T_1 = T_2$
similarly

$$\frac{\Delta g}{g} = \frac{\Delta (h_1 + h_2)}{h_1 + h_2} + \frac{2\Delta T_1}{T_1}$$

$$\frac{\Delta g}{g} = \frac{0.001}{0.88} + \frac{2 \times 0.11}{1.79}$$

$$\frac{\Delta g}{g} = 0.00114 + 0.12$$

$$\Delta g = 1.15$$

$$g' = 9.51 \pm 1.15 \ m/s^2$$

Standard error in g : $\frac{\Delta g}{g} \times 100 = \frac{9.81 - 9.51}{9.81} \times 100$

$= 3\%$

PRECAUTIONS

The two knife edges should be parallel to each other

The amplitude of vibration should be small so that pendulum satisfy the condition of simple harmonic motion

To avoid any irregularity of motion, the time period should be noted after the pendulum has made a few oscillations.

To avoid friction, there should be glass surface on the rigid support

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end than at the other end of the stretched wire one by one and if deflection in Galvano-meter is observed in two different direction in the two cases, then circuit is OK.

III Keeping K_2 open, balanced length L_1 is obtained by moving the jockey along the length of stretched wire.

IV Then K_2 is closed and resistance R is inserted through the Resistance Box (1Ω, 2Ω, 3Ω. -- 10Ω) again balanced Length L_2 is obtained

V L_2 is obtained for different values of variable resistance R.

OBSERVATION.

No of obs.	L_1 (cm) K_1 open	Mean of L_1 (cm)	R Ω	L_2 (cm) K_1 closed	Internal Resistance (Ω)	Mean Internal Resistance (Ω)
1	307.2		1	171.5	0.79	
2	308.2	307.4	2	189.0	1.25	1.34
3	306.8		3	204.6	1.51	≈ 1.3
4			4	211.9	1.80	

least count of Resistance box = 0.1 Ω

CALCULATION:

formula used $r = R\left(\frac{L_1 - L_2}{L_2}\right)$

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(1) for 1 Ω $r_1 = 1\left(\frac{307.4 - 171.5}{171.5}\right) = 0.79\ \Omega$

(2) for 2 Ω $r_2 = 2\left(\frac{307.4 - 189}{189}\right) = 1.25\ \Omega$

(3) for 3 Ω $r_3 = 3\left(\frac{307.4 - 204.6}{\cancel{1.51}\ 204.6}\right) = 1.51\ \Omega$

(4) for 4 Ω $r_4 = 4\left(\frac{307.4 - 211.9}{211.9}\right) = 1.8\ \Omega$

Mean Internal resistance $= \frac{r_1 + r_2 + r_3 + r_4}{4}$

$= \frac{1.25 + 0.79 + 1.51 + 1.80}{4}$

$= \frac{5.35}{4} = 1.337$

$= 1.3\ \Omega$

Result: The internal resistance of the cell is 1.3 Ω

ERROR CALCULATION

$r = R\left(\frac{L_1 - L_2}{L_2}\right) \Rightarrow \frac{\Delta r}{r}\Big|_{max} = \frac{\Delta R}{R} + \Delta\left(\frac{L_2 - L_1}{L_2 - L_1}\right) + \frac{\Delta L_2}{L_2}$

CLASSMATE
Date :
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$$\frac{\Delta r_1}{r} = \frac{0.1}{R} + \frac{0.001}{L_2 \cancel{1.715}} + \frac{\cancel{0.002}}{\cancel{1.989}} \quad \frac{0.002}{L_1 - L_2}$$

for $R = 1\Omega$ $\quad \frac{\Delta r_1}{r_1} = \frac{0.1}{1} + \frac{0.001}{1.715} + \frac{0.002}{1.989}$

$$= 1.3\,(0.1 + 0.001 + 0.001)$$

$$\Delta r_1 = 0.13\ \Omega$$

for $R = 2\Omega \Rightarrow$ $\quad \frac{\Delta r_2}{r_2} = \frac{0.1}{2} + \frac{0.001}{1.89} + \frac{0.002}{1.814}$

$$\Delta r_2 = 0.07\ \Omega$$

for $R = 3\Omega \Rightarrow$ $\quad \frac{\Delta r_3}{r_3} = \frac{0.1}{3} + \frac{0.001}{2.046} + \frac{0.002}{1.658}$

$$\Delta r_3 = 0.04\ \Omega$$

for $R = 4\Omega$ $\quad \frac{\Delta r_4}{r_4} = \frac{0.1}{4} + \frac{0.001}{2.119} + \frac{0.002}{1.585}$

$$\Delta r_4 = 0.03\ \Omega$$

Mean error $\Rightarrow \Delta r = \frac{0.13 + 0.07 + 0.04 + 0.03}{4} = 0.1\ \Omega$

Result: The Internal resistance of cell $= (1.3 \pm 0.1)\ \Omega$

Precaution :-

1. Connection should not be loose.
2. In Resistance box, the key should be very tight.
3. The positive terminal of both batteries should connected at same point.
4. Avoid pressing keys for large time otherwise cell will be discharged.

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Experiment No. 03 " ....

Title To find the moment of Inertia of a fly wheel.

Professor's Name Dr. Ram Narayan Chauhan

Performed on 25/01/2024 Submitted on 01/02/2024

Returned on .... Marks 100 ....

Remarks of Professor ....

....

....

Professor's Signature

end then at the other end of the stretched wire one by one and if deflection in Galvano-meter is observed in two different direction in the two cases, then circuit is OK.

III Keeping K_2 open, balanced length L_1 is obtained by moving the jockey along the length of stretched wire.

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V L_2 is obtained for different values of variable resistance R.

OBSERVATION.

No of obs.	L_1 (cm) K_1 open	Mean of L_1 (cm)	R Ω	L_2 (cm) K_1 closed	Internal Resistance (Ω)	Mean Internal Resistance (Ω)
1	307.2		1	171.5	0.79	
2	308.2	307.4	2	189.0	1.25	1.34
3	306.8		3	204.6	1.51	≈ 1.3
4			4	211.9	1.80	

Least count of Resistance box = $0.1\ \Omega$

CALCULATION:

formula used $r = R\left(\frac{L_1 - L_2}{L_2}\right)$

① for 1 Ω $\quad r_1 = 1\left(\frac{307.4 - 171.5}{171.5}\right) = 0.79\ \Omega$

② for 2 Ω $\quad r_2 = 2\left(\frac{307.4 - 189}{189}\right) = 1.25\ \Omega$

③ for 3 Ω $\quad r_3 = 3\left(\frac{307.4 - 204.6}{\cancel{1.51}\ 204.6}\right) = 1.51\ \Omega$

④ for 4 Ω $\quad r_4 = 4\left(\frac{307.4 - 211.9}{211.9}\right) = 1.8\ \Omega$

Mean Internal resistance $= \frac{r_1 + r_2 + r_3 + r_4}{4}$

$= \frac{1.25 + 0.79 + 1.51 + 1.80}{4}$

$= \frac{5.35}{4} = 1.337$

$= 1.3\ \Omega$

Result: The internal resistance of the cell is 1.3 Ω

ERROR CALCULATION

$r = R\left(\frac{L_1 - L_2}{L_2}\right) \Rightarrow \left.\frac{\Delta r}{r}\right|_{max} = \frac{\Delta R}{R} + \Delta\left(\frac{L_2 - L_1}{L_2 - L_1}\right) + \frac{\Delta L_2}{L_2}$

$$\frac{\Delta r_1}{r} = \frac{0.1}{R} + \frac{0.001}{L_2} + \frac{0.002}{1.989} \quad \frac{0.002}{L_1 - L_2}$$

for $R = 1\Omega$ $\quad \frac{\Delta r_1}{r_1} = \frac{0.1}{1} + \frac{0.001}{1.715} + \frac{0.002}{1.989}$

$$= 1.3\,(0.1 + 0.001 + 0.001)$$

$$\Delta r_1 = 0.13\ \Omega$$

for $R = 2\Omega \Rightarrow$ $\quad \frac{\Delta r_2}{r_2} = \frac{0.1}{2} + \frac{0.001}{1.89} + \frac{0.002}{1.814}$

$$\Delta r_2 = 0.07\ \Omega$$

for $R = 3\Omega \Rightarrow$ $\quad \frac{\Delta r_3}{r_3} = \frac{0.1}{3} + \frac{0.001}{2.046} + \frac{0.002}{1.658}$

$$\Delta r_3 = 0.04\ \Omega$$

for $R = 4\Omega$ $\quad \frac{\Delta r_4}{r_4} = \frac{0.1}{4} + \frac{0.001}{2.119} + \frac{0.002}{1.585}$

$$\Delta r_4 = 0.03\ \Omega$$

Mean error $\Rightarrow \Delta r = \frac{0.13 + 0.07 + 0.04 + 0.03}{4} = 0.1\ \Omega$

Result: The internal resistance of cell $= (1.3 \pm 0.1)\ \Omega$

Precaution:-

1. Connection should not be loose.
2. In Resistance box, the key should be very tight
3. The positive terminal of both batteries should connected at same point
4. Avoid pressing key for large time otherwise cell will be discharged

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Experiment No. 03

Title To find the moment of Inertia of a fly wheel.

Professor's Name Dr. Ram Narayan Chauhan

Performed on 25/01/2024 Submitted on 01/02/2024

Marks 100

Returned on

Remarks of Professor

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- In certain wheels, the peg is firmly attached to the axle. In such case, one end of string is loosely looped.
- 'm' is the sum of mass of wt hanger & the additional mass placed on it.

OBSERVATION AND TABULATION

To determine the radius of the axle using vernier calipers

Value of one main scale division (1 msd) = 0.1

Number of divisions on the VS, x = 10

Least count, $LC = \frac{\text{Value of 1 msd}}{\text{Number of division}} \cdot \frac{1\ msd}{x} = \frac{0.1}{10} = 0.01cm$

Trial No	MSR cm	VSR cm	D=MSR+VSR x LC cm	Mean Diameter cm
1	2	5	2.05	
2	2	5	2.05	2.05
3	2	6	2.06	

Diameter of the axle: D = 2.05 cm
= 0.0205 m

Radius of the axle, $r = \frac{D}{2}$ = 0.0102 m

DETERMINATION OF MOMENT OF INERTIA :

Mass suspended at one end of the string 'm' kg	Height from the floor to the bottom of wt hanger 'h' m	No of winding of string on the axle 'n'	No of rotations of the wheel after the detachment of the peg from the axle N			Time Interval in between the detatchment of the peg and when the wheel comes to stop, 't' (sec)			$\omega = \frac{4\pi N}{t}$ (rad/sec)	I ($kg\,m^2$)
			1	2	Mean N	1	2	Mean t (sec)		
0.3	0.825	3	19	17	18	28.38	25.78	27.08	8.35	0.060
0.3	0.895	4	22	24	23	29.22	29.43	29.32	9.86	0.045
0.3	0.974	5	32	33	32	38.97	36.60	37.78	10.64	0.044
0.3	1.042	6	39	46	42	41.94	47.90	44.92	11.74	0.038

RESULT : $I = \frac{I_1 + I_2 + I_3 + I_4}{4}$

$= 0.047\ kg\,m^2$

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CALCULATION

No of winding = 3.

$N_1 = 19$, $N_2 = 17$ Mean $N = \frac{19+17}{2} = 18$

No of winding = 4

$N_1 = 22$, $N_2 = 24$ Mean $N = \frac{22+24}{2} = 23$

Mean time taken $= \frac{29.22 + 29.43}{2} = 29.32$ sec

No of windings = 5

$N_1 = 33$, $N_2 = 32$ Mean $N = \frac{32+33}{2} = 32$

Mean time taken $= \frac{38.97 + 36.60}{2} = 37.78$ sec

No of winding = 6

$N_1 = 39$ $N_2 = 46$ Mean $N = \frac{39+46}{2} = 42$

Mean time taken $= \frac{42.94 + 47.90}{2} = 44.92$ sec.

for ω, I.

formula used: $\omega = \frac{4\pi N}{t}$, $I = \frac{Nm}{N+n}\left(\frac{2gh}{\omega^2} - r^2\right)$

for $n = 3$, $\omega = \frac{4 \times 3.14 \times 18}{27.08} = 0.35$ rad/sec

$I = \frac{18 \times 0.3}{18+3}\left[\left(\frac{2 \times 9.81 \times 0.825}{(8.35)^2}\right) - 0.0001\right]$

$= 0.060$ kg m^2

classmate

for $n = 4$.
$$\omega = \frac{4 \times 3.14 \times 23}{29.32} = 9.86 \text{ rad/sec}$$

$$I = \frac{23 \times 0.3}{23+4}\left(\frac{2 \times 9.81 \times 0.895}{(9.86)^2} - 0.0001\right)$$
$$= 0.045 \text{ kg m}^2$$

for $n = 5$
$$\omega = \frac{4 \times 3.14 \times 32}{37.78} = 10.64 \text{ rad/sec}$$

$$I = \frac{32 \times 0.3}{32+5}\left(\frac{2 \times 9.81 \times 0.974}{(10.64)^2} - 0.0001\right)$$
$$= 0.044 \text{ kg/m}^2$$

for $n = 6$
$$\omega = \frac{4\pi \times 42}{42+6} = 11.74 \text{ rad/sec}$$

$$I = \frac{42 \times 0.3}{42+6}\left(\frac{2 \times 9.81 \times 1.042}{(11.74)^2} - 0.0001\right)$$
$$= 0.038 \text{ kg/m}^2$$

$$\text{Mean } I = \frac{0.060 + 0.045 + 0.044 + 0.038}{4} = 0.047 \text{ kg/m}^2$$

RESULT: Moment of Inertia of flywheel is 0.047 kg/m².

ERROR CALCULATION

for $n = 3$
$$\frac{\Delta I_1}{0.060} = \frac{0.0001}{0.0102} + \frac{2 \times 0.01}{27.08}$$
$$= 0.000588 \text{ kg m}^2$$

for $n = 4$
$$\frac{\Delta I_2}{0.045} = \frac{0.0001}{0.0102} + \frac{2 \times 0.01}{29.32}$$
$$= 0.000441 \text{ kg m}^2$$

for $n=5$
$$\frac{\Delta I_3}{0.044} = \frac{0.0001}{0.0102} + \frac{2\times 0.01}{37.78}$$
$$= 0.000431 \ kg\,m^2$$

for $n=6$
$$\frac{\Delta I_6}{0.038} = \frac{0.0001}{0.0102} + \frac{2\times 0.01}{44.92}$$
$$= 0.000372 \ kg\,m^2$$

Mean error $\Rightarrow (0.000588 + 0.000441 + 0.000431 + 0.000372)/4$

$$\Delta I = 0.000458 \approx 0.001 \ kg\,m^2$$

RESULT : The moment of inertia of a fly wheel is $(0.047 \pm 0.001) \ kg\,m^2$

PRECAUTIONS :

- There should be least friction in flywheel.
- The length of the string should be less than the height of axle from floor.
- There should be no kink in string.
- The string should be thin and should be strong.
- The stopwatch should be started just after detaching the loaded string.

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Experiment No. 04 "

Title To determine the Young's modulus of a rectangular beam by bending beam method

Professor's Name Dr. Ram Narayan Chauhan

Performed on 01/02/2024 Submitted on 08/02/2024

Returned on Marks 100

Remarks of Professor

Professor's Signature

TABLE : A : Determination of breadth of the rectangular bar (b)

- Instrument used : Vernier Callipers
- Least count (LC) of the instrument : 0.01 cm

No of observⁿ	MSR : Main Scale reading (cm)	Ver. division overlapping (VC)	Total reading (cm) (MSR + VC×LC) [b]	Mean breadth (b) cm
1	2.3	2	2.32	
2	2.3	7	2.37	2.35
3	2.3	8	2.38	

TABLE : B : Determination of depth of rectangular bar (d)

- Least count (LC) of the Vernier callipers = 0.01 cm

No of obs.	MSR. main scale reading (cm)	Ver. division overlapping (VC)	Total reading (cm) (MSR + VC*LC) [d]	Mean depth (d) cm
1	0.4	0	0.40	
2	0.4	1	0.41	0.41
3	0.4	3	0.43	

TABLE : C : 1. For Load Increasing

- Instrument used : Spherometer, pitch = 1 mm.
- Least count : 0.01 mm.

No of obs.	Load (kg)	No of rotation × pitch = A	Initial Disc Reading I	Final Disc Reading F	Difference (I−F)	Diff × L.C. (B) mm	Depression (A+B) (mm)	Cumulative Depression δ (mm)
1	0.5	2.00	19	5	14	0.14	2.14	2.14
2	1.0	2.00	5	30	75	0.75	2.75	4.89
3	1.5	2.00	30	13	17	0.17	2.17	7.06
4	2.0	2.00	13	63	50	0.50	2.50	9.56
5	2.5	2.00	63	42	21	0.21	2.21	11.77

TABLE : C:2. for load decreasing

No of obs.	Load (kg)	No of rotation x Pitch = A	Initial Disc Reading I	Final Disc Reading F	Diff (I-F)	Diff x L.C (B) (mm)	Depression (A+B) (mm)	Cummulative Depression δ (mm)
1	2.5	2.00	42	64	78	0.78	2.78	13.24
2	2.0	2.00	64	10	54	0.54	2.54	10.46
3	1.5	2.00	10	54	56	0.56	2.56	7.92
4	1.0	2.00	54	7	47	0.47	2.47	5.36
5	0.5	2.00	7	18	89	0.89	2.89	2.89

TABLE : C:3. for mean depression for each load and Young's modulus calculation

$L = 0.80$ m $b = 2.35$ $d = 0.41$ cm

Load (kg)	Cummulative depression for load increasing	Cumulative depression for load decreasing	Mean Depression (δ mean)	Y (x 10¹¹) N/m²
0.5	2.14	2.89	2.52	1.62
1.0	4.89	5.36	5.13	1.60
1.5	7.06	7.92	7.49	1.62
2.0	9.56	10.46	10.01	1.63
2.5	11.77	13.24	12.51	1.64

CALCULATION:

formula used for rectangular bar : $Y = \frac{mgL^3}{4\delta bd^3}$

1 for 0.5 kg.

$$Y = \frac{0.5 \times 9.81 \times (0.800)^3}{4 \times 2.52 \times 10^{-3} \times 0.024 \times (0.004)^3}$$

Scanned with CamScanner

$$= \frac{0.5}{2.52} \times 8.18 \times 10^{11} = 1.62 \times 10^{11}\ N/m^2$$

2 for 1 kg,

$$Y = \frac{1.0 \times 9.81 \times (0.800)^3}{4 \times 5.12 \times 10^{-3} \times 0.024 \times (0.004)^3}$$

$$= \frac{1.0}{5.12} \times 8.18 \times 10^{11} = 1.60 \times 10^{11}\ N/m^2$$

3 for 1.5 kg,

$$Y = \frac{1.5 \times 9.81 \times (0.800)^3}{4 \times 7.49 \times 10^{-3} \times 0.024 \times (0.004)^3}$$

$$= \frac{7.5}{7.49} \times 8.18 \times 10^{11} = 1.62 \times 10^{11}\ N/m^2$$

4. for 2 kg,

$$Y = \frac{2 \times 9.81 \times (0.800)^3}{4 \times 10.01 \times 10^{-3} \times 0.024 \times (0.004)^3}$$

$$= \frac{2.0}{10.01} \times 8.18 \times 10^{11} = 1.63 \times 10^{11}\ N/m^2$$

5 for 2.5 kg,

$$Y = \frac{2.5 \times 9.81 \times (0.800)^3}{4 \times 12.50 \times 10^{-3} \times 0.024 \times (0.004)^3}$$

$$= \frac{2.5}{12.50} \times 10^{11} \times 8.18 = 1.64 \times 10^{11}\ N/m^2$$

Mean :

$$Y = \frac{1.62 \times 10^{11} + 1.60 \times 10^{11} + 1.62 \times 10^{11} + 1.63 \times 10^{11} + 10^{11} \times 1.64}{5}$$

$$= \frac{8.11}{5} \times 10^{11}$$

$$= 1.62 \times 10^{11}\ N/m^2$$

ERROR CALCULATION :

Young's modulus : $Y = \frac{mgL^3}{4\delta bd^3}$

for maximum error : $\frac{\Delta Y}{Y} = \frac{\Delta m}{m} + \frac{\Delta g}{g} + 3\frac{\Delta L}{L} + \frac{\Delta \delta}{\delta} + \frac{\Delta b}{b} + 3\frac{\Delta d}{d}$

Δm & $\Delta g = 0$; as they are not measured.

$\therefore \frac{\Delta Y}{Y} = \frac{3\Delta L}{L} + \frac{\Delta b}{b} + \frac{3\Delta d}{d} + \frac{\Delta \delta}{\delta}$

1 for 0.5 kg,

$\frac{\Delta Y}{1.62\times10^{11}} = \frac{3\times0.001}{0.800} + \frac{0.0001}{0.0235} + \frac{3\times0.0001}{0.0041} + \frac{0.00001}{0.00252}$

$\frac{\Delta Y}{1.62\times10^{11}} = 0.085$

$\Delta Y = 0.14 \times10^{11}\ N/m^2$

2. for 1.0 kg

$\frac{\Delta Y}{1.60\times10^{11}} = \frac{3\times0.001}{0.800} + \frac{0.0001}{0.0235} + \frac{3\times0.0001}{0.0041} + \frac{0.00001}{0.00512}$

$\frac{\Delta Y}{1.60\times10^{11}} = 0.083$

$\Delta Y = 0.13 \times10^{11}\ N/m^2$

3 for 1.5 kg

$\frac{\Delta Y}{1.62\times10^{11}} = \frac{3\times0.001}{0.800} + \frac{0.0001}{0.0235} + \frac{3\times0.0001}{0.0041} + \frac{0.00001}{0.00749}$

$\frac{\Delta Y}{1.62\times10^{11}} = 0.082$

$\Delta Y = 0.13 \times10^{11}\ N/m^2$

4. for 2.0 kg

$$\frac{\Delta Y}{1.63 \times 10^{11}} = \frac{3 \times 0.001}{0.800} + \frac{0.0001}{0.0235} + \frac{3 \times 0.0001}{0.0041} + \frac{0.00001}{0.01001}$$

$$\frac{\Delta Y}{1.63 \times 10^{11}} = 0.082$$

$$\Delta Y = 0.13 \times 10^{11} \ N/m^2$$

5 for 2.5 kg

$$\frac{\Delta Y}{1.64 \times 10^{11}} = \frac{3 \times 0.001}{0.800} + \frac{0.0001}{0.0235} + \frac{3 \times 0.0001}{0.0041} + \frac{0.00001}{0.01250}$$

$$\frac{\Delta Y}{1.64 \times 10^{11}} = 0.082$$

$$\Delta Y = 0.13 \times 10^{11} \ N/m^2$$

Mean error :

$$\Delta Y_{mean} = \frac{(0.14 + 0.13 + 0.13 + 0.13 + 0.13)}{5} \times 10^{11}$$

$$= 0.13 \times 10^{11} \ N/m^2$$

The Young's modulus of rectangular beam is $(1.62 \pm 0.13) \times 10^{11} \ N/m^2$

CACCULATION OF YOUNG's MODULUS FROM GRAPH

Plot a graph b/w load along x-axis and corresponding mean depression along y-axis

$$\text{slope} = \frac{\delta}{m} = \frac{12.50 - 2.52}{2.5 - 0.5} = 4.99 \ mm/kg$$

$$= 4.99 \times 10^{-3} \ m/kg$$

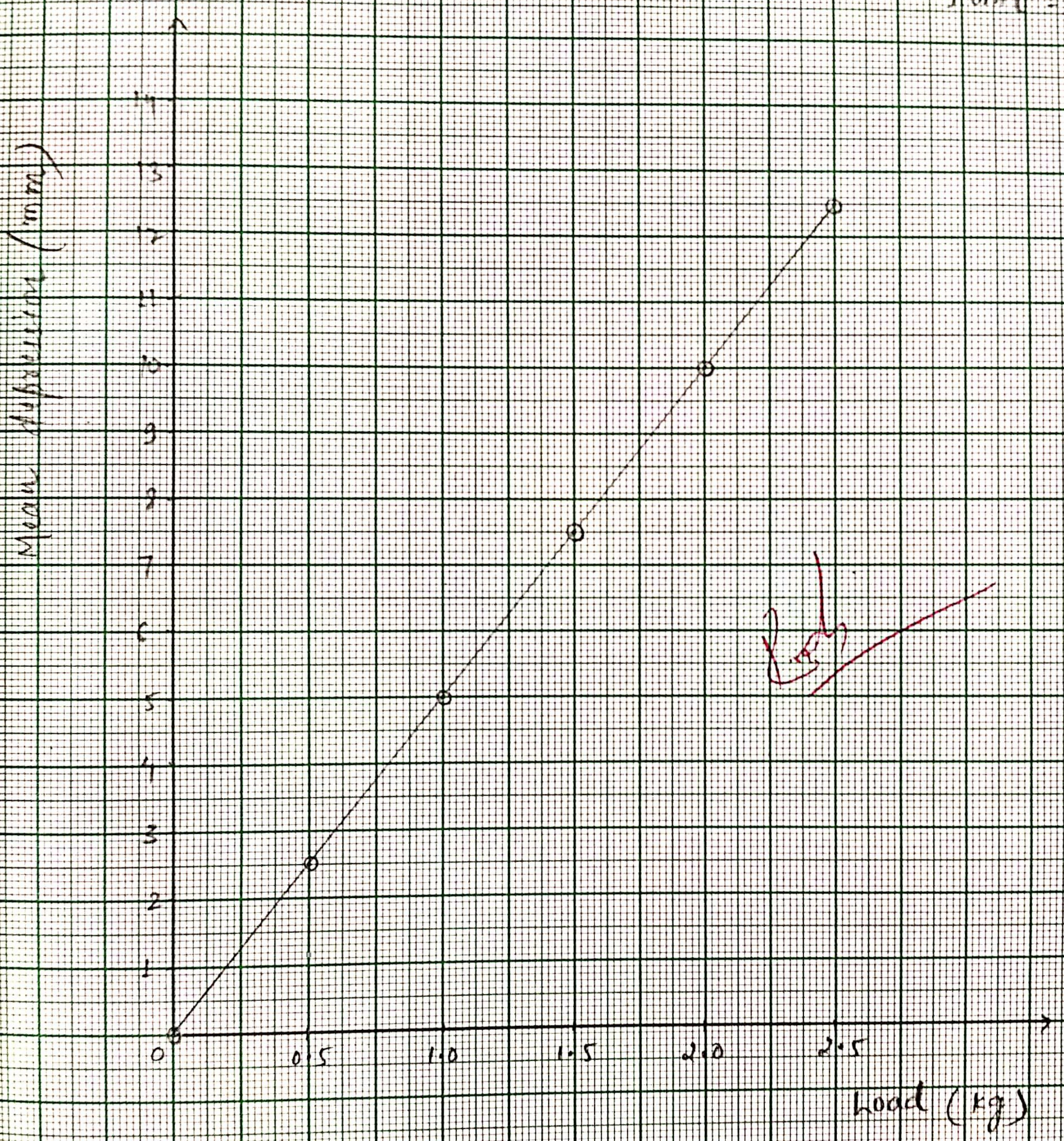
#

Y axis

1 unit = 1 mm

X axis

4 unit = 1 kg



Graph: B/w Load & corresponding mean depression

CALCULATION OF YOUNG'S MODULUS FROM GRAPH

plot a graph b/w load along x-axis and corresponding mean depression along Y-axis

$$\text{Slope} = \frac{\delta}{m} = \frac{12.50 - 0}{2.5 - 0} = 5\,mm/kg = 5 \times 10^{-3}\, m/kg$$

and $$Y = \frac{mgL^3}{4\delta bd^3}$$

$$= \frac{gL^3}{4bd^3} \times \frac{m}{\delta}$$

$$= \frac{gL^3}{4bd^3} \times \frac{1}{\text{slope}}$$

$$= \frac{9.81 \times (0.800)^3}{4 \times 0.024 \times (0.004)^3} \times \frac{1}{5 \times 10^{-3}}$$

$$= 1.64 \times 10^{11} \quad N/m^2$$

RESULT: The Young's Modulus of the rectangular bar is $(1.64 \pm 0.13) \times 10^{11}\ N/m^2$

Now,

$$Y = \frac{mgL^3}{4\delta bd^3}$$

$$Y = \frac{gL^3}{4bd^3} \times \frac{1}{slope} \qquad \therefore slope = \frac{\delta}{m}$$

$$Y = \frac{9.81 \times (0.800)^3}{4 \times 0.024 \times (0.004)^3} \times \frac{1}{4.99 \times 10^{-3}}$$

$$Y = \frac{8.18 \times 10^8 \times 10^3}{4.99}$$

$$Y = 1.64 \times 10^{11} \ N/m^2$$

RESULT : Young's modulus of the rectangular beam is $(1.64 \times 10^{11} \pm 0.13 \times 10^{11})$ N/m^2

PRECAUTIONS :

- Care must be taken to see that the beam doesn't slip on the knife edges. A little wax may be used to prevent slipping.
- The C.G. of the beam must be midway b/w the knife edges and weight hanger must be placed at this point.
- Excessive load must not be put on the beam.

Rsh
08-02-2024

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Experiment No. 05 "

Title To determine Young's Modulus of Material of wire by Searl's Apparatus

Professor's Name Dr. Ram Narayan Chauhan

Performed on 08/02/2024 Submitted on 15/02/2024

Returned on Marks 100

Remarks of Professor

Professor's Signature

find the pitch and the least count of the micrometer screw attached to the frame. Adjust it such that the bubble comes at center. Take the reading of the micrometer.

5. Placed a load on hanger attached to the experimental wire by increment of 0.5 kgs, bring bubble at center, not the reading in micrometer. Take precaution to avoid backlash error.

6. Take about 5 observation for increasing & decreasing load.

7. Decrease the load in steps of 0.5 kg, continue reading in micrometer.

OBSERVATIONS

- Length of wire : 106.8 cm
- pitch of the Screw Gauge : 1 mm
- No of the division on circular scale of the screw gauge : 100 divisions
- Least count (LC) of Screw Gauge : 0.01 mm
- Zero error of SC (if any) : No

TABLE : 1 : MEASURMENT OF DIAMETER OF WIRE (d)

pitch of screw Gauge : 1 mm

$LC : \frac{\text{Pitch}}{\text{Total no of div}} = \frac{1\text{ mm}}{100} = 0.01$ mm

No of observations	Main Scale Reading (MSR) (mm)	Circular Scale (CSR) Reading	d: Total Reading [MSR + CSR × LC] (mm)	Mean (d) Breadth (mm)
1	0	44	0.44	0.44
2	0	45	0.45	
3	0	44	0.44	

Mean diameter = 0.44 mm

Mean Radius = $\frac{\text{Mean diameter}}{2}$ = 0.22 mm

TABLE : C-1 FOR LOAD INCREASING.

No of obs.	load (kg)	No of Rotation x Pitch (A)	Initial disc Reading (I)	final disc Reading (F)	Diff (F−I)	Diff X LC (B) (mm)	Extension (A+B) (mm)	Cummulative Extension (l) (mm)
1	0.5	0	88	11	23	0.23	0.23	0.23
2	1.0	0	11	45	34	0.34	0.34	0.57
3	1.5	0	45	60	15	0.15	0.15	0.72
4	2.0	0	60	86	26	0.26	0.26	0.98
5	2.5	0	86	20	34	0.34	0.34	01.32

TABLE : C-2 FOR LOAD DECREASING

No of obs	load (kg)	No of Rotation x pitch = A	Initial disc Reading (I)	final disc Reading (F)	Diff (F−I)	Diff x LC (B) (mm)	Extension (A+B) (mm)	Cummulative Extension (l) (mm)
1	2.5	0	20	97	23	0.23	0.23	0.99
2	2.0	0	97	85	12	0.12	0.12	0.79
3	1.5	0	85	67	18	0.18	0.18	0.64
4	1.0	0	67	43	24	0.24	0.24	0.46
5	0.5	0	43	22	22	0.22	0.22	0.22

TABLE : C-3 for mean extension for each load & calculation of Youngs Modulus.

$$Y = \frac{mgL}{\pi r^2 l}$$

Load	Cummulative Extension for load Increasing	Cummulative extension for load decreasing	Mean Depression (l_{mean})	$Y (\times 10^{11})$ N/m²
0.5	0.23	0.22	0.22	1.56
1.0	0.57	0.46	0.52	1.32
1.5	0.72	0.64	0.68	1.52
2.0	0.98	0.76	0.87	1.58
2.5	1.32	0.99	1.15	1.49

CALCULATIONS :

formula used : $Y = \frac{mgL}{\pi r^2 l}$

for 0.5 kg,

$$Y = \frac{0.5 \times 9.81 \times 106.8 \times 10^{-2}}{3.14 \times (0.22 \times 10^{-3})^2 \times 10^{-3} \times 0.22}$$

$$Y = 1.56 \times 10^{11} \ N/m^2$$

for 1.0 kg,

$$Y = \frac{1.0 \times 9.81 \times 106.8 \times 10^{-2}}{3.14 \times (0.22 \times 10^{-3})^2 \times 0.52 \times 10^{-3}}$$

$$Y = 1.32 \times 10^{11} \ N/m^2$$

for 1.5 kg

$$Y = \frac{1.5 \times 9.81 \times 106.8 \times 10^{-2}}{3.14 \times (0.22 \times 10^{-3})^2 \times 0.68 \times 10^{-3}}$$

$$Y = 1.52 \times 10^{11} \ N/m^2$$

for 2.0 kg

$$Y = \frac{2.0 \times 9.81 \times 106.8 \times 10^{-2}}{3.14 \times (0.22 \times 10^{-3})^2 \times 0.87 \times 10^{-3}}$$

$$Y = 1.58 \times 10^{11} \ N/m^2$$

for 2.5 kg,
$$Y = \frac{2.5 \times 9.81 \times 106.8 \times 10^{-2}}{3.14 \times (0.22 \times 10^{-3})^2 \times 1.15 \times 10^{-3}}$$
$$Y = 1.49 \times 10^{11} \; N/m^2$$

Avg value of Young's Modulus : $\frac{(1.56 + 1.32 + 1.52 + 1.58 + 1.49)}{5} \times 10^{11} \frac{N}{m^2}$
$$= 1.49 \times 10^{11} \; N/m^2$$

ERROR CALCULATION
$$Y = \frac{MgL}{\pi r^2 l}$$
$$\therefore \frac{\Delta Y}{Y} = \underbrace{\boxed{\frac{\Delta M}{M} + \frac{\Delta g}{g}}}_{=0 \text{ due to constant value of } M \,\&\, g.} + \frac{\Delta L}{L} + 2 \cdot \frac{\Delta r}{r} + \frac{\Delta l}{l}$$
$$\Rightarrow \frac{\Delta Y}{Y} = \frac{\Delta L}{L} + 2 \cdot \frac{\Delta r}{r} + \frac{\Delta l}{l}$$

for 0.5 kg,
$$\frac{\Delta Y}{Y} = \frac{0.001}{106.8 \times 10^{-2}} + 2 \cdot \frac{0.01 \times 10^{-3}}{0.22 \times 10^{-3}} + \frac{0.01 \times 10^{-3}}{0.22 \times 10^{-3}}$$
$$\Delta Y = (0.0009 + 0.091 + 0.045) \; 1.56 \times 10^{11} \; N/m^2$$
$$\Delta Y = 0.20 \times 10^{11} \; N/m^2$$

for 1.0 kg
$$\frac{\Delta Y}{Y} = \frac{0.01 \times 10^{-3}}{0.52 \times 10^{-3}} + 2 \cdot \frac{0.01 \times 10^{-3}}{0.22 \times 10^{-3}} \times \frac{0.001}{106.8 \times 10^{-2}}$$
$$\Delta Y = (0.02 + 0 + 0.09) \times 1.32 \times 10^{11} \; N/m^2$$
$$\Delta Y = 0.14 \times 10^{11} \; N/m^2$$

for 1.5 kg

$$\frac{\Delta Y}{Y} = \frac{0.001}{106.8 \times 10^{-2}} + \frac{0.01 \times 10^{-3}}{0.68 \times 10^{-3}} + 2 \times \frac{0.01 \times 10^{-3}}{0.22 \times 10^{-3}}$$

$$\Delta Y = (0.10) \times 1.52 \times 10^{11} \ N/m^2$$

$$\Delta Y = 0.15 \times 10^{11} \ N/m^2$$

for 2.0 kg

$$\frac{\Delta Y}{Y} = \frac{0.001}{106.8 \times 10^{-2}} + \frac{0.01 \times 10^{-3}}{0.87 \times 10^{-3}} + 2 \times \frac{0.01 \times 10^{-3}}{0.22 \times 10^{-3}}$$

$$\Delta Y = (0.10) \times 1.58 \times 10^{11} \ N/m^2$$

$$\Delta Y = 0.16 \times 10^{11} \ N/m^2$$

for 2.5 kg

$$\frac{\Delta Y}{Y} = \frac{0.001}{106.8 \times 10^{-2}} + \frac{0.01 \times 10^{-3}}{1.15 \times 10^{-3}} + 2 \times \frac{0.01 \times 10^{-3}}{0.22 \times 10^{-3}}$$

$$\Delta Y = (0.10) \times 1.49 \times 10^{11} \ N/m^2$$

$$\Delta Y = 0.14 \times 10^{11} \ N/m^2$$

Mean Error :

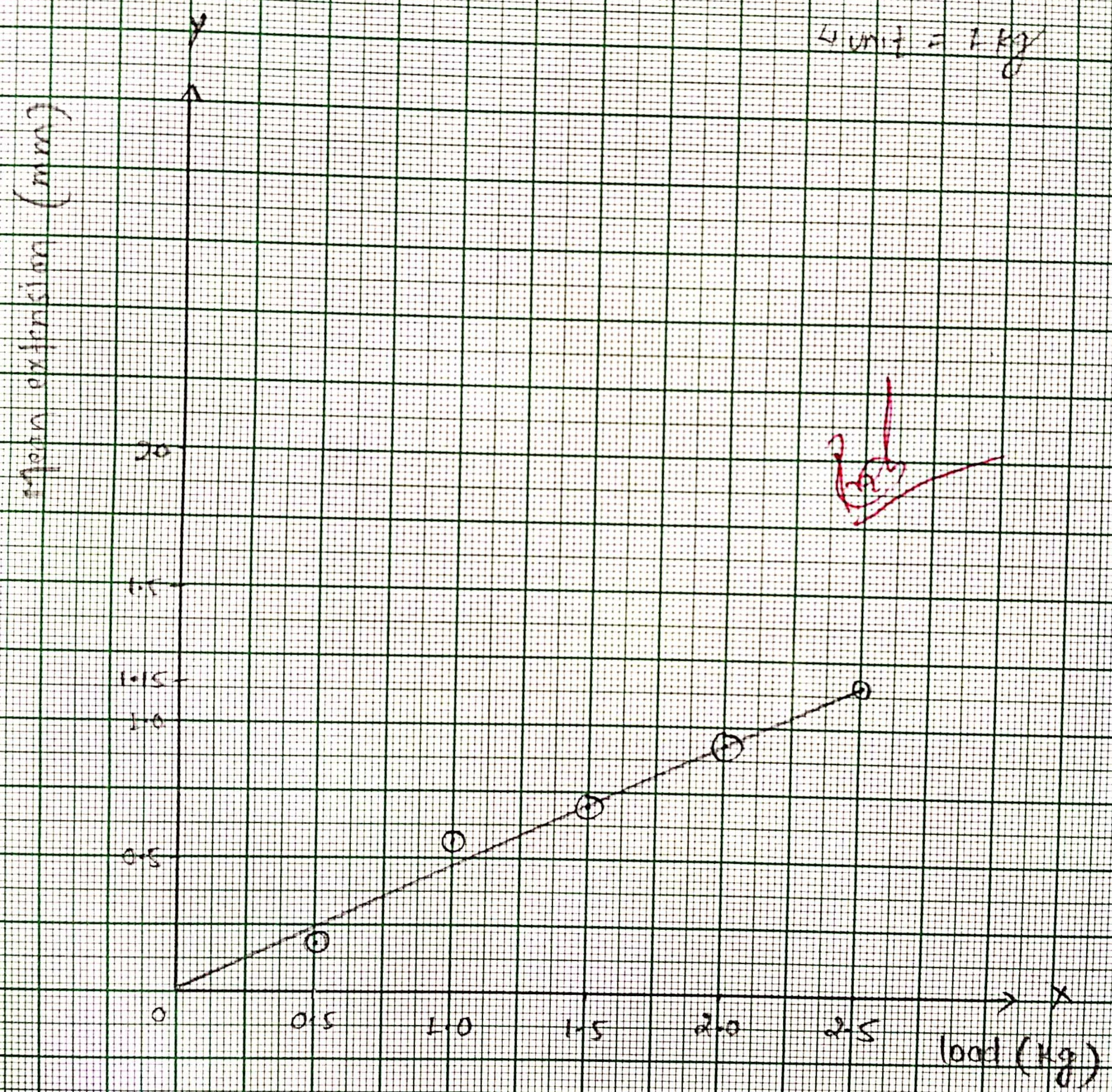
$$\Delta Y_{mean} = \frac{(0.20 + 0.14 + 0.15 + 0.16 + 0.14)}{5} \times 10^{11}$$

$$\Delta Y_{mean} = 0.16 \times 10^{11} \ N/m^2$$

RESULT : The Young's Modulus of the material of wire using table is $(1.49 \pm 0.16) \times 10^{11} \ N/m^2$

∴ Y axis
4 unit = 1 mm

∴ X-axis
4 unit = 1 kg



Graph: Between mean extension and Load

CALCULATION OF YOUNG's MODULUS FROM GRAPH

plot a graph b/w load along x-axis and corresponding mean extension along y-axis. It should be a straight line

$$\text{slope} = \frac{l}{m} = \frac{1.15-0}{2.5-0} = 0.46 \text{ mm/kg} = 0.46 \times 10^{-3} \frac{m}{kg}$$

Now, young's modulus:

$$Y = \frac{MgL}{\pi r^2 l} = \frac{gL}{\pi r^2}\left(\frac{m}{l}\right)$$

$$= \frac{gL}{\pi r^2} \times \left(\frac{1}{\text{slope}}\right) \qquad \because \text{slope} = \frac{l}{m}$$

$$= \frac{9.81 \times 106.8 \times 10^{-2}}{3.14 \times (0.22 \times 10^{-3})^2} \times \frac{1}{0.46 \times 10^{-3}}$$

$$= \frac{1047.71}{0.06} \times 10^{7}$$

$$= 17461.83 \times 10^{7}$$

$$= 1.74 \times 10^{11} \text{ N/m}^2$$

RESULT : The Young's modulus of the material of wire using graph is $(1.74 \pm 0.16) \times 10^{11}$ N/m^2.

→ PRECAUTIONS : Measure the diameter at diff position, for its uniformity.

→ Adjust the spirit level only after sufficient time gap following each loading/unloading.

15/02/2024

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Experiment No. 06 "

Title To measure the frequency of a tuning fork by Melde's exp.

Professor's Name Dr. Ram Narayan Chauhan

Performed on 15/02/2024 Submitted on 22/02/2024

Returned on Marks 100

Remarks of Professor

Professor's Signature

classmate

Date :

Page :

OBSERVATION

- Weight of pan (m_p) = 16.69 g
- Mass per unit length of the thread : $\mu = 0.26 \times 10^{-3}$ $\frac{kg}{m}$

TABLE : FOR TRANSVERSE MODE :

No of Obsⁿ	position of the fork	No of loops	Loop length (cm)	M (g)	$T \times (10^{-3})$ N $= (M+m_p)g$	n (Hz)	N = n (Hz)
1	T	6	24.0	5	212.77	59.59	59.59
2	T	6	23.3	10	261.82	68.09	68.09
3	T	5	26.3	15	310.87	61.09	61.09
4	T	5	27.8	20	359.92	66.91	66.91
5	T	5	29.6	25	408.97	66.99	66.99
6	T	4	32.5	30	458.02	64.57	64.57

$$\text{Avg frequency} = \frac{(59.59 + 68.09 + 61.09 + 66.91 + 66.99 + 64.57)}{6} \text{ Hz}$$

$$= \frac{387.24}{6} = 64.54 \text{ Hz}$$

TABLE : FOR LONGITUDINAL MODE :

No of Obsⁿ	position of the fork	No of loops	Loop length (cm)	M (g)	$T \times 10^{-3}$ (N) $=(M+m_p)g$	n (Hz)	N = 2n (Hz)
1	L	4	38.5	5	212.77	37.14	74.28
2	L	3	48.0	10	261.82	33.05	66.10
3	L	3	47.8	15	310.87	36.16	72.32
4	L	3	48.5	20	359.92	38.35	76.70
5	L	5	29	25	408.97	68.38	136.76
6	L	5	28.7	30	458.02	73.12	146.24

Avg frequency = $\frac{(74.28 + 66.10 + 72.32 + 76.70 + 136.76 + 146.24)}{6}$ Hz

$= \frac{572.40}{6} = 95.40$ Hz

CALCULATION

• for TRANSVERSE MODE

$$n = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$$

$$N = n$$

m = 5g

$$n = \frac{1}{2 \times 24 \times 10^{-2}}\sqrt{\frac{212.77 \times 10^{-3}}{0.26 \times 10^{-3}}}$$

$= 59.59$ Hz

Similarly

for m = 10g n = N = 68.09 Hz

m = 15g n = N = 61.09 Hz

m = 20g n = N = 66.91 Hz

m = 25g n = N = 66.99 Hz

m = 30g n = N = 64.57 Hz

Average value = $\frac{59.59 + 68.09 + 61.09 + 66.91 + 66.99 + 64.57}{\cancel{5}\ 6}$

$= 64.54$ Hz

for longitudinal mode

$$N = 2n$$

for 5g, $n = \frac{1}{2 \times 38.5 \times 10^{-2}}\sqrt{\frac{212.77 \times 10^{-3}}{0.26 \times 10^{-3}}} = 37.14$ Hz

Average frequency of the string : $\underline{95.40\ Hz}$
by longitudinal mode.

for 10g, $N = 2n = 66.10\ Hz$

Similarly from obs table,

Average value : $\frac{(74.28 + 66.10 + 72.32 + 76.70 + 136.76 + 146.24)}{6}$

$= 95.40\ Hz$

ERROR CALCULATION

for transverse mode ($n = N \Rightarrow \Delta n = \Delta N$)

$m = 5g \quad \frac{\Delta n}{n} = \frac{\Delta L}{L} \Rightarrow \frac{\Delta n}{59.59} = \frac{1 \times 10^{-3}}{24 \times 10^{-2}}$

$= 0.24\ Hz$

$m = 10g, \quad \frac{\Delta n}{n} = \frac{1 \times 10^{-3}}{23.3 \times 10^{-2}} = \Delta n = 0.29\ Hz$

$m = 15g \quad \frac{\Delta n}{61.09} = \frac{1 \times 10^{-3}}{283 \times 10^{-3}} \Rightarrow \Delta n = 0.21\ Hz$

$m = 20g \quad \frac{\Delta n}{66.91} = \frac{10^{-3}}{276 \times 10^{-3}} \Rightarrow \Delta n = 0.24\ Hz$

$m = 25g \quad \frac{\Delta n}{66.99} = \frac{10^{-3}}{296 \times 10^{-3}} \Rightarrow \Delta n = 0.23\ Hz$

$m = 30g \quad \frac{\Delta n}{64.57} = \frac{1 \times 10^{-3}}{325 \times 10^{-3}} \Rightarrow \Delta n = 0.20\ Hz$

Mean error in transverse frequency mode $= \frac{0.24 + 0.29 + 0.21 + 0.24 + 0.23 + 0.2}{6}$

$= 0.24$ Hz

→ for Longitudinal mode : ($\Delta n = 2^{-1} \Delta N$)

$m = 5g$ $\quad \frac{\Delta n}{37.14} = \frac{1 \times 10^{-3}}{385 \times 10^{-3}}$ → $\Delta n = 0.096$ Hz

$\Delta N = 0.19$ Hz

$m = 10g$ $\quad \frac{\Delta n}{33.05} = \frac{10^{-3}}{480 \times 10^{-3}}$ $\quad \Delta n = 0.069$ Hz

$\Delta N = 0.13$ Hz

$m = 15g$ $\quad \frac{\Delta n}{36.16} = \frac{10^{-3}}{478 \times 10^{-3}}$ $\quad \Delta n = 0.075$ Hz

$\Delta N = 0.15$ Hz

$m = 20g$ $\quad \frac{\Delta n}{38.35} = \frac{10^{-3}}{485 \times 10^{-3}}$ $\quad \Delta n = 0.079$ Hz

$\Delta N = 0.16$ Hz

$m = 25g$ $\quad \frac{\Delta n}{68.38} = \frac{10^{-3}}{290 \times 10^{-3}}$ $\quad \Delta n = 0.235$ Hz

$\Delta N = 0.47$ Hz

$m = 30g$ $\quad \frac{\Delta n}{73.12} = \frac{10^{-3}}{287 \times 10^{-3}}$ $\quad \Delta n = 0.254$ Hz

$\Delta N = 0.50$ Hz

Mean error in longitudinal frequency mode $= \frac{0.19 + 0.13 + 0.15 + 0.16 + 0.47 + 0.50}{6}$

$= 0.27$ Hz

RESULTS

- The average frequency of tuning fork by transverse mode (N) is

$$64.54 \pm 0.24 \ Hz$$

- The average frequency of tuning fork by longitudinal mode (N) is

$$95.40 \pm 0.27 \ Hz$$

PRECAUTIONS

- The thread should be uniform & inextensible
- Friction in pulley should be small.
- The loops in central part of thread should be counted for measurment. The nodes & pulley, and the tip of prong should be neglected as they have same motion.
- The longitudinal & transverse arrangement should be correct otherwise the length measured will be wrong.

22/02/2024

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Experiment No. 07 "

Title Compound pendulum - to find 'g', Moment of Inertia

Professor's Name Dr. Ram Narayan Chauhan

Performed on 22/02/2024 Submitted on 29/02/2024

Returned on Marks 100

Remarks of Professor

Professor's Signature

... and the radius of gyration k about the axis passing through the center of Gravity from the graph, draw lines $\parallel^r$ to the x-axis for particular values of T. Determine PR & QS and from these k is calculated. Also accⁿ due to gravity 'g' is calculated and the moment of Inertia of the bar about an axis through the COM (COG) using eqⁿ (5).

- Distance 'x' from the end 'A' depends upon how the knife edge is fixed at the holes. It may be the top end, bottom end or center of the hole. The inversion of the bar is taken into account in this case.

OBSERVATION AND TABULATION

- Mass of the Bar, M = 4 kg
- Posⁿ of COG from End A = 0.50 m

Distance 'x' from the end A in metre	Time for 20 oscillations in sec			Period T (sec)
	1	2	Mean	
0.05	32.00	31.97	31.99	1.60
0.10	31.22	31.25	31.24	1.56
0.15	30.72	30.72	30.72	1.54
0.20	30.56	30.47	30.52	1.53
0.25	30.47	30.47	30.56	1.53
0.30	31.47	31.22	31.35	1.57
0.35	33.66	33.56	33.61	1.68
0.40	38.87	37.10	37.84	1.89
0.45	55.10	55.38	55.24	2.76
0.50	-	-	-	-

Name :

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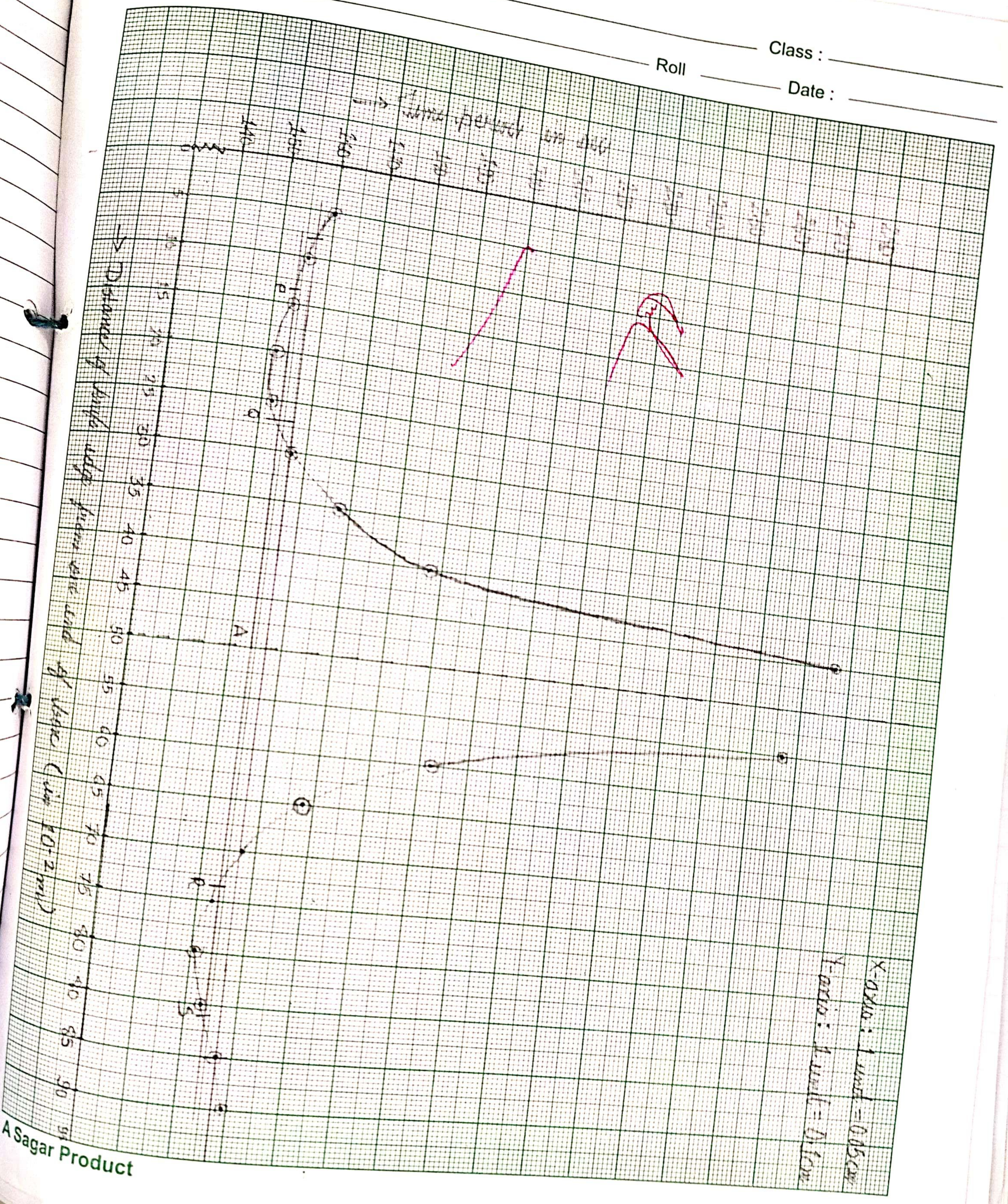
Class :

Roll

Date :



0.55	51.65	51.75	51.70	2.59
0.60	38.41	38.44	38.43	1.93
0.65	33.56	33.50	33.53	1.68
0.70	31.69	31.62	31.65	1.58
0.75	30.68	30.66	30.67	1.53
0.80	30.57	30.37	30.47	1.52
0.85	30.69	30.75	30.72	1.54
0.90	31.25	31.16	31.20	1.56
0.95	31.71	31.94	31.83	1.59

- To determine acc^n due to gravity (obs from Graph)

Sl. No.	T (sec)	PR (m)	QS (m)	$L = \frac{PR + QS}{2}$ (m)	$\frac{L}{T^2}$ m/s^2	Mean $\frac{L}{T^2}$ (m/s^2)	$g = 4\pi^2\left(\frac{L}{T^2}\right)$ m/s^2
1	1.54	0.62	0.59	0.61	0.26	0.26	10.25
2	1.57	0.63	0.62	0.63	0.25		

- To determine acc^n due to use the above table & for radius of Gyration & moment of Inertia (obs from Graph)

Sl. No	T (sec)	PA (m)	AR (m)	QA (m)	AS ~~(m)~~	$K = \frac{\sqrt{PA \times AR} + \sqrt{QA \times AS}}{2}$ (m)	Mean K m	$I_{cm} = MK^2$ kg. m^2
1	1.54	0.37	0.24	0.23	0.36	0.29	0.30	0.36
2	1.57	0.42	0.21	0.21	0.41	0.30		

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CALCULATION

for g, $g = 4\pi^2 \left(\frac{L}{T^2}\right)$ m/s²

$= 4 \times 3.14 \times 3.14 \times 0.26$ $\quad \therefore \frac{L}{T^2} = 0.26$ m/s²

$= 10.25$ m/s².

for K, I.

$I = MK^2$, $\quad \therefore K = 0.30$ m
$\therefore M = 4$ kg

$= 0.30 \times 0.30 \times 4$
$= 0.36$ kg m².

RESULT

- Accⁿ due to gravity at that place : 'g' = 10.25 m/s².
- Radius of gyration about an axis through the center of Mass : 'K' = 0.30 m.
- Moment of Inertia about an axis through the center of Mass : 'I' = 0.36 kg.m².

PRECAUTION

- The top support should be fixed.
- The amplitude of oscillation should be small
- Use a precise stopwatch and note time accurately measurement of length should be proper.

29/02/2024

National Institute of Technology

PATNA

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6. "

7. "

8. "

Experiment No. 08 "

Title To determine the wavelength of sod. light by Newton's Ring Exp.

Professor's Name Dr. Ram Narayan Chauhan

Performed on 29/02/2024 Submitted on 07/03/2024

Returned on Marks 100

Remarks of Professor

Professor's Signature

VIII Take any two diameter to perform calculation & finally calculate the value of wavelength of sodium light src.

OBSERVATION

$\mu_{(air)} = 1$

Table 1 : Measurment of the diameter of the ring

Sr. no.	Ring no.	Microscope Reading Left (L)			Right (R)			$D_n = L-R$	D_n^2	$D_n^2 - D_m^2$
		Main	Vernier	Total	Main	Vernier	Total	(cm)	(cm^2)	(cm^2)
1.	25	54	16	54·16	42	95	42·95	11·21	125·66	$D_{25}^2 - D_{15}^2 = 55.10$
2.	20	53	26	53·26	43	51	43·51	9·75	95·06	$D_{20}^2 - D_{10}^2 = 48.82$
3.	15	52	56	52·56	44	16	44·16	8·40	70·56	$D_{15}^2 - D_5^2 = 49.12$
4.	10	51	74	51·74	45	94	44·94	6·80	46·24	
5.	5	50	62	50·62	46	99	45·99	4·63	21·43	

Spherometer:

- pitch of the screw : 0·1 cm
- No of divisions on circular head : 100
- least count of spherometer : 0·001 cm
- Radius of curvature : R = 200 cm

Wavelength Calculation : Table 3

Sr no.	$\lambda = \frac{D_n^2 - D_m^2}{4R(n-m)}\mu$ (nm)
1.	614·0 for m=5, n=15
2.	610·2 for m=10, n=20
3.	688·7 for m=15 n=25

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CALCULATION.

$$\lambda = \frac{D_n^2 - D_m^2}{4R(n-m)} = \frac{(D_n + D_m)(D_n - D_m)}{4R\,(n-m)}$$

for $n=15$, $m=5$

$$\lambda = \frac{(8.40 + 4.63)(8.40 - 4.63)}{4 \times 0.2 \times 10} \text{ nm}$$

$$= 614 \text{ nm}$$

for $n=20$, $m=10$

$$\lambda = \frac{(9.75 + 6.80)(9.75 - 6.80)}{4 \times 0.2 \times 10} \text{ nm}$$

$$= 610.2 \text{ nm}$$

for $n=25$, $m=15$

$$\lambda = \frac{(11.21 + 8.40)(11.21 - 8.40)}{4 \times 0.2 \times 10} \text{ nm}$$

$$= 688.7 \text{ nm}$$

RESULT :

Avg. wavelength of sodium light : $(614 + 610.2 + 688.7)/3$ nm

$= 637.6$ nm

Actual wavelength : 589.3 nm

ERROR : $\left(\frac{637.6 - 589.3}{589.3}\right) \times 100 = 8.19\%$

PRECAUTION.

- The microscope should be ⊥ʳ to the edge of the glass plate.
- Mirror should be perfectly stable.
- Move the micrometer screw slowly to prevent backlash error
- Adjust crosswire in middle carefully while measuring diameters.

7/03/2024