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20XC18 - APPLIED PHYSICS LAB

EXP 1 : MOMENT OF INERTIA OF A FLYWHEEL

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AIM :

To find moment of inertia of flywheel.

APPARATUS :

Flywheel, weighted hanger, slotted ~~hanger~~ weights, stopwatch, ruler

FORMULA :

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

where,

I = Moment of inertia of flywheel assembly.

N = Number of rotations of flywheel before it stopped.

m = Mass of the slotted weights

n = Number of windings of the string on the axle.

g = Acceleration due to gravity of the environment.

h = Height of weight assembly from the ground.

r = Radius of axle.

t = Duration of time for N rotations.

To find the moment of inertia of the flywheel :

S.NO	Mass (m) of the slotted weight (10^{-3} kg)	Height (h) above the ground (10^{-2} m)	no. of revolution n	N	Time for N revolutions	Angular Velocity	M.I of flywheel

PROCEDURE :

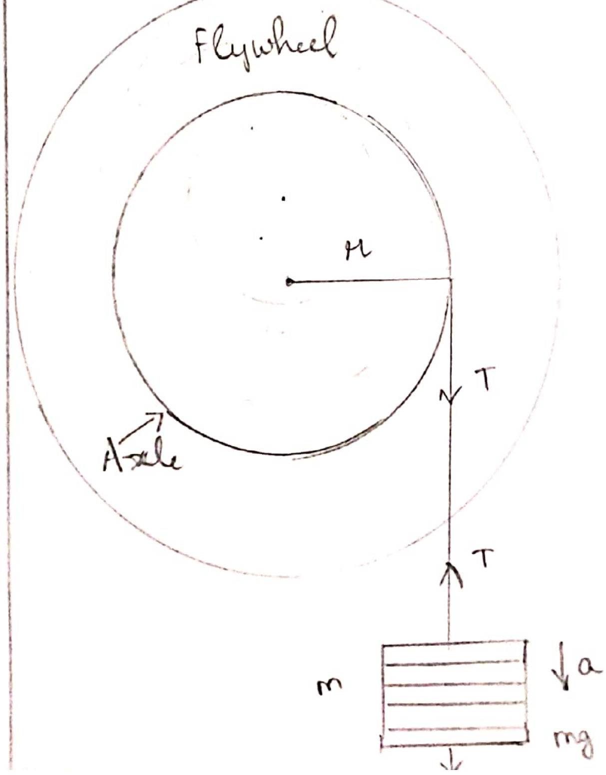
~~1. Flywheel is set with axle horizontally.~~

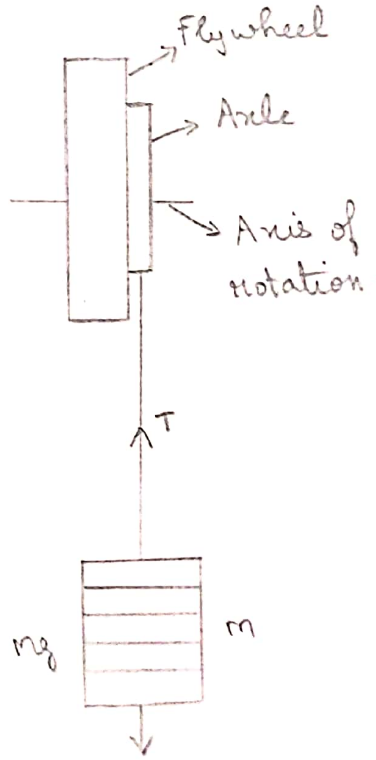
1. Find average radius of axle from 5 different positions on the axle using vernier callipers as recorded in table 2.
2. Note down the circumference of the flywheel by measuring using a thread.
3. Wind the thread using axle using weight hanger along with slotted weights tied around the thread.
4. Note the height of weight assembly from the ground.
5. Freely suspend the thread and count the number of rotations of the flywheel until it stops moving.
6. Calculate fractional rotation using the formula

$$F.R = \frac{\text{Length of thread}}{\text{circumference of flywheel}} \quad ; N = \text{no. of rotations} + F.R$$

7. Calculate time taken by flywheel to complete N rotations using a stopwatch.
8. Repeat the experiment using different values of m and n and tabulate the readings to find M.I of flywheel.

DIAGRAM :





OBSERVATION:

1. To find moment of inertia of flywheel:

S.NO	Mass(m) of slotted weights (10^{-2} kg)	Height(h) above the ground (10^{-2} m)	No. of revolutions n	N	Time(t) for N revolutions	Angular velocity	M.I of the flywheel (kgm^2)
1.	~~50~~0.5	145	15	43	17	31.785	0.01035
2.	~~50~~0.5	148	17	42	18	29.321	0.0119
3.	500.5	151	20	42	20	26.389	0.0142
4.	600.6	145	15	53	25	26.640	0.0186
5.	600.6	148	17	51	21	30.518	0.0139
6.	600.6	151	20	48	22	27.417	0.0164
7.	~~70~~0.7	145	15	58	24	30.368	0.0177
8.	~~70~~0.7	148	17	59	22	33.700	0.0137
9.	~~70~~0.7	151	20	60	22	34.271	0.0475

Mean Moment Of Inertia of Flywheel $= 0.01825\ kgm^2 = 1.825 \times 10^{-2}\ kg\,m^2$

2. To find radius of the axle:

Least count of vernier calliper = 0.02 mm

S.NO	MSR(10^{-2} m)	VSC (div)	VSR = VSC × LC (10^{-2} m)	OR = MSR + VSR (10^{-2} m)
1.	2.2	15	0.3	2.5
2.	2.2	17	0.34	2.54
3.	2.2	14	0.28	2.48
4.	2.2	17	0.34	2.54
5.	2.2	13	0.26	2.46
~~Mean radius =~~ ~~Mean dia~~			Mean dia	= 2.504

Mean radius of axle $= \dfrac{\text{Mean dia}}{2} = 1.252 \times 10^{-2}\,m.$

CALCULATIONS:

$$I_1 = \frac{43 \times \cancel{500}\,0.5}{58}\left(\frac{2 \times 9.8 \times 1.45}{(31.785)^2} - \left[(1.252)^2 \times 10^{-4}\right]\right)$$

$$= 0.01035\ \text{kg m}^2$$

$$I_2 = \frac{42 \times 0.5}{59}\left[\frac{2 \times 9.8 \times 1.48}{(29.321)^2} - \left((1.252)^2 \times 10^{-4}\right)\right] = 0.0119\ \text{kg m}^2$$

$$I_3 = \frac{42 \times 0.5}{62}\left[\frac{2 \times 9.8 \times 1.51}{(26.389)^2} - \left((1.252)^2 \times 10^{-4}\right)\right] = 0.0142\ \text{kg m}^2$$

$$I_4 = \frac{53 \times 0.6}{68}\left[\frac{2 \times 9.8 \times 1.45}{(26.640)^2} - \left((1.252)^2 \times 10^{-4}\right)\right] = 0.0186\ \text{kgm}^2$$

$$I_5 = \frac{51 \times 0.6}{68}\left[\frac{2 \times 9.8 \times 1.48}{(30.518)^2} - \left((1.252)^2 \times 10^{-4}\right)\right] = 0.0139\ \text{kgm}^2$$

$$I_6 = \frac{48 \times 0.6}{68}\left[\frac{2 \times 9.8 \times 1.51}{(27.417)^2} - \left((1.252)^2 \times 10^{-4}\right)\right] = 0.0164\ \text{kgm}^2$$

$$I_7 = \frac{58 \times 0.7}{73}\left[\frac{2 \times 9.8 \times 1.45}{(30.368)^2} - \left((1.252)^2 \times 10^{-4}\right)\right] = 0.0177\ \text{kgm}^2$$

$$I_8 = \frac{59 \times 0.7}{76}\left[\frac{2 \times 9.8 \times 1.48}{(33.7)^2} - \left((1.252)^2 \times 10^{-4}\right)\right] = 0.0137\ \text{kgm}^2$$

$$I_9 = \frac{60 \times 0.7}{80}\left[\frac{2 \times 9.8 \times 1.51}{(34.271)^2} - \left((1.252)^2 \times 10^{-4}\right)\right] = 0.0475\ \text{kgm}^2$$

RESULT :

The moment of inertia of the flywheel is 1.825×10^{-2} kg m^2

PRECAUTIONS :

1. Mark a point on the flywheel using a tape to count the number of revolutions.
2. Mark a point using a pen on the thread to measure circumference of the flywheel accurately.