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INSTRUCTION MANUAL

FLYWHEEL

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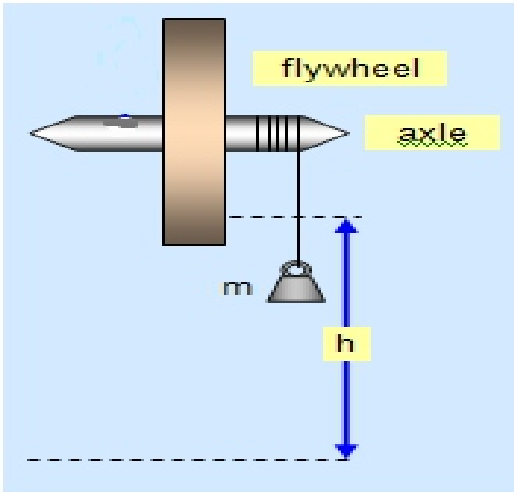
Experiment:- To determine the moment of inertia of flywheel about its own axis of rotation.

Apparatus :- 1. Flywheel, 2. Stop watch, 3. Thin cord, 4. 100g slotted weight, 5. Hanger, 6. Meter rod.

Theory :- If h = vertical distance through which the mass fall then
P.E = K.E Of falling mass + rotational K.E of wheel + work done by friction

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}Iw^2 + n_1 f \quad \text{------------- 1}$$

n_l = No of revolutions made by the winding of cord



$n_1 f$ = Total energy spent in over comming friction after the cord leaves the axle. Let n2 is the no of revolutions made by wheel before comming to rest . Hence K.E = 1/2 Iw2 of wheel is spent in over comming the friction in n_2 revolutions

$$\frac{1}{2}Iw^2 = n_2 f$$

or

$$f = \frac{I}{2}\frac{w^2}{n_2} \quad \text{-------------- 2}$$

putting 2 in 1 and rearranging we get

$$I = \frac{(2\text{mgh} - mr^2 w^2)}{w^2[1 + \frac{n_1}{n_2}]} \quad \text{----------------- 3}$$

Average angular velocity = $\frac{(w+o)}{2} = \frac{w}{2}$

If t = time teken by wheel before comming to rest , then average velocity,

$\frac{w}{2}$ = total angle described in n_2 revolution/t

= $\frac{(2\pi n_2)}{t}$

or

$$w = \frac{(4\pi n_2)}{t} \quad \text{-------------- 4}$$

if h = Height through which the mass m falls and is equal to length of cord wound on axle in n_1 windingS

i.e $h = 2\pi r n_1$ ------------- 5

put 4 and 5 in eq^n 3

on rearranging we get

$$I = \frac{(mgr n_1 t^2)}{(4\pi n_2 (n_1 + n_2))} - \frac{(mr^2 n_2)}{(n_1 + n_2)} \quad \text{----------- 6}$$

Procedure :-

1 :- A mass of about 300 gm is fastened to one end of thread. A loop is made at the other end which is. fastened to the peg of wheel axle . The length of cord should be sufficent for the mass to just touch the ground.
2:- Rotate the flywheel in reverse direction so that the load rises and remain at the table level.
3:- Allow the mass to fall , and count the no of revolutions , say n till the mass touches the ground.
4:-The moment the mass touches the ground and the thread get detached , start the stop watch and count the no. of rotation n_2 till the wheel stops. Record the time t.
5:- With the help of vernier calliper measure the diameter of the axel at several points , to find mean radius r.
6:- Repeat the exp with different weights.

OBSERVATION
Radius of axel r = cm
height h = cm
g = 981 cms^{-2}

TABLE FOR n_1, n_2 AND t

SR. NO	Total load m applied (g)	No of revolutions before the mass detached n_1	No of revolutions to come to rest n_2	Time for n_2 revolutions t	I by eq^n 6
1	300				
2	500				
3	700				

PRECAUTIONS:-
1:- The length of thread should be a little less than the height of the axel from the ground.
2:- The loop of cord slipped over the peg should be quite loose to prevent the rewinding of thread on axel in opposit direction , when the mass just reaches the floor.
3:- The thread should be wound uniformly on axel , ie neither the overlapping nor the gap between successive turns
4:- The cord should be thin enough. If not add half of it's half of its thickness to the radius of axel to get correct radius r .
5:- There should be whole no of turns of cord wound on axle. For this purpose, the windings of cord should be stopped at a point where the projection peg is horizontal.
6:- Start the stop watch when the cord just get detached from peg.
7:- The diameter of axel should be measured at different points in two mutually perpandicular directions.
8:- Before starting the experiment , put a little lubricant on the bearings of wheel.

ERROR:-
1:- n_1 ans n_2 may not be full numbers, this will introduce some error.
2:- Friction is not uniform for all speed as assumed.

TEST REPORT:

In equation (6) the value of 1st term is very very large as compared to the second term.

$\left(\frac{mr^2 n^2}{n_1 + n_2}\right)$ and so the 2nd term is neglected.

Hence, $$I = \frac{mgr\, n_1 t^2}{4\pi\, n_2 (n_1 + n_2)}$$

Practical value of moment of Inertia

Mass suspended m = 700 gm
Radius of axle r = 1 cm
n_1 (no. of round of thread) = 15
No. of revolutions before coming to rest n_2= 23.5
Time for n_2 revolutions t = 16.97 sec.

$$I = \frac{mgr\, n_1 t^2}{4\pi\, n_2 (n_1 + n_2)} = 260771.9 \text{ gcm}^2$$

Theoretical value:

Mass of flywheel, M = 3.7 kg = 3700 g (approx.)
Average radius of rim R = 9 cm
Theoretical value if whole mass were concentrated in rim I = MR^2 = 299700 g cm^2

Concept plus:

Deviation of practical value from theoretical value is because whole of mass of flywheel is not concentrated in the rim.