PHYSICS PRACTICAL SHEETS

Date: 26 Sept 2023 KU CAMPUS Experiment No. 2
Class: CE Group: T
Roll No.: 25 Subject: PHY102
Shift: Afternoon Set:

Object of the Experiment (Block Letter)

MEASUREMENT OF MOMENT OF INERTIA OF FLYWHEEL

x) Apparatus Required:

i) Thread
ii) Mass
iii) Vernier Calipers
iv) Scale
v) Marker
vi) Flywheel.

x) Theory

The mass 'm' attached to the axle of the wheel by a cord is allowed to fall through a height 'h'. The potential energy of the mass is partly converted into the kinetic energy, partly imparted to the flywheel as its kinetic energy and the rest is used up on overcoming the friction.

PE of mass = KE of m + KE of wheel + workdone against friction

or, $mgh = \frac{1}{2} mr^2\omega^2 + \frac{1}{2} I\omega^2 + nF$

where,

r = radius of the axle
I = moment of inertial flywheel
F = workdone against friction in one revolution.
ω = angular velocity of wheel
n = number of revolutions.

After the cord is detached, the flywheel begins to rotate with an angular velocity 'ω' and its final angular velocity is zero. So, the average velcity 'ω' is half the initial velocity. If n_1 is the number of revolutions made by the wheel before coming to rest in time t, the average angular velocity.

$\omega_{ave} = \dfrac{2\pi n_i}{t}$ or, $\omega = 2\omega_{ave}$

So, $\omega = 2 \times \dfrac{2\pi n_i}{t}$ and

$$n_1 F = \frac{1}{2} I \omega^2 \qquad \therefore F = \frac{I\omega^2}{2n_i}$$

Substituting the value of F in eq^n(i),

$$mgh = \frac{1}{2} m r^2 \omega^2 + \frac{1}{2} I\omega^2 + \frac{n}{2n_1} I\omega^2$$

$$\therefore I = \frac{2mgh - mr^2\omega^2}{\omega^2\left(1 + \frac{n}{n_1}\right)} \quad \text{— (3)}$$

OBSERVATIONS:

Vernier constant (V.C) = 0.1 cm/10 = 0.01 cm

Diameter of axle: (i) 2.1 + 4×0.01 = 2.14 cm

(ii) 2.1 + 5×0.01 = 2.15 cm

(iii) 2.2 + 0×0.01 = 2.20 cm

(iv) 2.2 + 0×0.01 = 2.20 cm

Mean diameter (d) = 2.18 cm

$\therefore$ Radius of axle (r) = 1.09 cm

Circumference of wheel = 60 cm

For 200 gm, height h = 70 cm

no of turns (n) = 10

For 250 gm, height h = 70.1 cm

no. of turns (n) = 10

For 300 gm, height h = 70.2 cm

no. of turns (n) = 10

Mass	No. of obs	No. of complete revs (x)	Fractions of revolution (y)	Total revs (n_1)	Mean (n_1)	Time	Mean time (t)
	1	32	0.57	32.57		43.28	
200gm	2	32	0.42	32.42	32.52	47.9	45.51
	3	32	0.57	32.57		45.35	
	1	38	0.69	38.69		48.40	
250gm	2	39	0.49	39.49	38.56	50.22	48.94
	3	40	0.51	40.51		48.22	
	1	48	0.58	48.58		51.56	
300gm	2	48	0.43	48.43	48.38	53.62	54.37
	3	47	0.35	47.35		57.94	

(i): For $m = 200gm$,

$$\omega = \frac{4\pi n_1}{t} = 8.97 \text{ rev/s}$$

$$I = \frac{2mgh - mr^2\omega^2}{\omega^2\left(1 + \frac{n}{n_1}\right)} = 260647 \text{ g cm}^2$$

ii) For $m = 250gm$

$$\omega = \frac{4\pi n_1}{t} = 9.9 \text{ rev/s}$$

$$I = \frac{2mgh - mr^2\omega^2}{\omega^2\left(1 + \frac{n}{n_1}\right)} = 278056 \text{ gcm}^2$$

iii) For $m = 300gm$

$$\omega = \frac{4\pi n_1}{t} = 11.18 \text{ rev/s}$$

$$I = \frac{2mgh - mr^2\omega^2}{\omega^2\left(1 + \frac{n}{n_1}\right)} = 273378 \text{ gcm}^2$$

Mean moment of Inertia $(I) = 270693\ gcm^2$

RESULT

The moment of inertia of the flywheel is found to be $270693\ gcm^2$.