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EXP-2-TORSIONAL PENDULUM

Aim: To determine the moment of inertia of an irregular body and also to determine the rigidity modulus of the material of the wire by setting up a torsional pendulum.

Apparatus: Rectangular plate, circular disc, irregular plate, stands with clamp, stop clock and experimental material wire.

Formula:

$$I_o = \left(\frac{I}{T^2}\right)_{mean} T_o^2 \quad \text{kgm}^2$$

$$\eta = \frac{8\pi l}{r^4}\left(\frac{I}{T^2}\right)_{mean} \quad Nm^{-2}$$

where,

I_o is the Moment of inertia of irregular body (Kgm^2)

T_0 is the time period of oscillation of the irregular body about a given axis (sec).

I is the Moment of Inertia of the regular body on a given axis (Kgm^2).

T is the time period of oscillation of regular body on a given axis (sec).

η is the Rigidity Modulus of the material of the suspension wire (Nm^{-2}).

l is the length of the wire between the chuck nuts m.

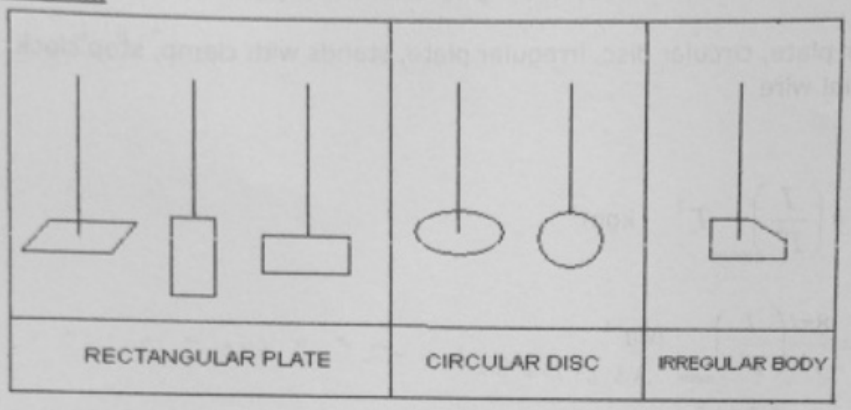
r is the Radius of the suspension wire in m.

Procedure: The masses of the given rectangular plate and circular plate are determined using weighing balance. The length L, breadth B of the rectangular plate and radius R of the circular plate are measured. The moment of inertia of these two bodies are calculated for different axes using the equations given in the table. The rectangular plate is suspended with the help of chuck nuts to the experimental wire with its axis perpendicular to the plane of the rectangular plate. Then the plate is set into torsional oscillations and its period for 10 oscillations is calculated. For the same rectangular plate, the time period is obtained in two other axes viz., an axis perpendicular to the length and an axis perpendicular to breadth. Then the experiment is repeated for circular disc with definite axis viz, perpendicular to its plane and along the diameter. Then the time period is noted for 10 oscillations. Then mean value of $\left(\frac{I}{T^2}\right)$ is calculated.

The time period is noted for 10 oscillations for the irregular body whose moment of inertia about an axis is calculated using the given formula.

The diameter of the wire is measured by using screw gauge and length of the wire between chuck nuts is measured using the scale. The rigidity modulus (η) of the wire is calculated using the given formula.

Observations
Diagram



Mass of the circular plate M = 0.63 Kg

Radius of the circular plate R = (Circumference/ 2π)= 0.058 m

Mass of the rectangular plate M = 0.655 Kg

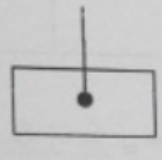
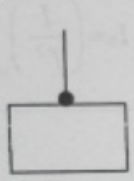
Length of the rectangular plate L = 0.12 m

Breadth of the rectangular plate B = 0.081 m

Length of the wire between the chuck nuts l = 0.327m

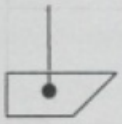
Radius of the given wire r = 0.00025m

Table: To find the time period (T)

Body	Axis	Moment of Inertia (I) Kg-m²	Time taken for 10 oscillations 't' sec			Period $T = t/10$ sec	T^2	I/T^2 Kg-m/s²
			t_1	t_2	$(t_1+t_2)/2$			
Rectangular plate	Perpendicular to its plane 	$I_1 = \frac{M(L^2+B^2)}{12}$ = 0.00114121	44.3	44.27	44.285	4.4285	19.61161	6E-05
	Perpendicular to its length 	$I_2 = \frac{ML^2}{12}$ = 0.000786	36.29	36.56	36.425	3.6425	13.268	6E-05
	Perpendicular to its breadth 	$I_3 = \frac{MB^2}{12}$ 0.0003581 21	24.38	24.53	24.455	2.4455	5.9805	6E-05
	Perpendicular to its plane 	$I_4 = \frac{MR^2}{2}$ = 0.00105906	40.5	40.3	40.4	4.04	16.322	6E-05

	Along the diameter 	$I_s = \frac{MR^2}{4}$ = 0.009529	28.57	28.25	28.41	2.841	8.0713	7E-05

Mean I/T^2 = 6.16E-05

Body	Axis	Time taken for 10 oscillations 't' sec			Period $T_0 = t/10$ sec	Moment of Inertia $I_o = \left(\frac{I}{T^2}\right)_{mean} \times T_o^2$
		t_1	t_2	$(t_1 + t_2)/2$		
Irregular body	Perpendicular to its plane 	53.75	54.25	54	5.4	0.0003

Calculations:

(1) Moment of Inertia of the irregular body (Perpendicular to the plane)

$$I_0 = \left(\frac{I}{T^2}\right)_{mean} \times T_o^2$$

= 0.00033 kgm^2

(2) Rigidity modulus of the given material wire

$$\eta = \frac{8\pi l}{r^4}\left(\frac{I}{T^2}\right)_{mean}$$

= 1.2963E+11 Nm^{-2}

Result:

The moment of inertia of an irregular body is = 0.00033 kgm^2

The rigidity modulus of the given wire is = 1.2963E+11 N/m^2

Note: Students can use the Microsoft excel sheet for calculations and paste the calculated values in the above table.