Physics Practical Manual & Observation Note

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1. TORSIONAL PENDULUM

Expt. No. | Date:

AIM

To determine the moment of inertia of the metallic disc and the rigidity modulus of the material of the wire.

APPARATUS REQUIRED

Torsion pendulum, two equal masses, Stop-clock, Screw gauge and Meter scale

FORMULA

The moment of inertia of the metallic disc $I = \dfrac{2m(d_2^{\,2} - d_1^{\,2})T_0^{\,2}}{T_2^{\,2} - T_1^{\,2}} \; Kg\ m^2$

The Rigidity modulus of the material of the wire $n = \dfrac{8\pi I l}{T_0^{\,2} r^4} \; N m^{-2}$

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Symbol	Explanation	Unit
M	Mass of any one of the cylindrical masses	**Kg**
R	Radius of the suspended wire	**meter**
L	Length of the suspension wire	**meter**
$\mathbf{d_1}$	Minimum distance between the suspension wire and the centre of mass of the cylinder	**meter**
$\mathbf{d_2}$	Maximum distance between the suspension wire and the centre of mass of the cylinder	**meter**
$\mathbf{T_0}$	Time period when no masses are placed	**sec**
$\mathbf{T_1}$	Time period when two identical masses are placed at the maximum distance	**sec**
I	Moment of inertia of the disc	$\mathbf{kg\text{-}m^2}$

PROCEDURE

One end of the long uniform metallic wire whose rigidity modulus to be determined is clamped. On the other lower end, a heavy metallic disc is attached by means of a chuck. The length of the suspension wire is fixed to a particular value say, 60 or 70 cm. Now the disc is slightly twisted so that it executes torsional oscillations.

Care should be taken that the disc oscillates without wobbling. First few oscillations are omitted. A mark is made on the disc such that time taken for 10 oscillations (to and fro motion) are noted using stop-clock. Two trials are taken. The average of these two trials gives the time period T_0.

Now equal masses are placed on either side of the disc close to the suspension wire. The distance d_1 from the centre of one of mass and the suspension wire is noted. Now the disc with masses at the minimum distance is made to execute torsional oscillations. Time for 10 oscillations is noted. Two trials are taken. From this mean period T_1 is calculated.

Now the two masses are placed at the extreme ends of the disc and the distance d_2 from the centre of the one of the masses and the point of suspension wire is noted. The disc is now subjected to torsional oscillations. Time for 10 oscillations is noted. Two trials are taken. From this time period T_2 is calculated.

Now the masses of any one of the cylinders is found. The radius of the wire is measured by means of screw gauge and the length is measured using meter scale. From this data the moment of inertia and the rigidity modulus of the material of the wire are determined.

DIAGRAM

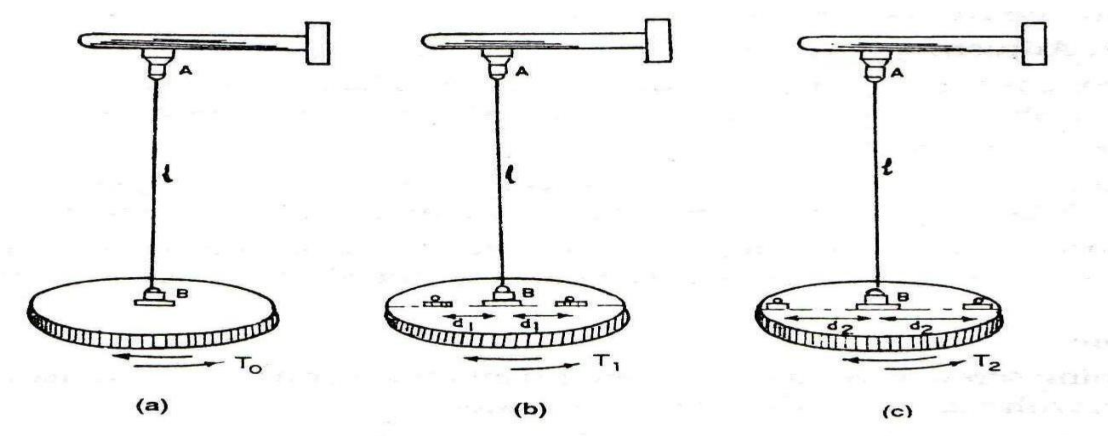


Fig. 1. Torsional Pendulum

Table: 1 - To determine the Time period:

Length of the suspension wire l = ……………… x 10^{-2}m

Position of the equal masses	Time for 10 oscillations			Time period (Time for one oscillation) Sec
	Trial-1 Sec	Trial-2 Sec	Mean Sec	
Without masses				T_0=
With mass at minimum distance d_1 = ------ x 10^{-2}m				T_1=
With mass at maximum distance d_2 = ------ x 10^{-2}m				T_2=

Table 2 - To find the radius (r) of the wire using screw gauge :

LC = 0.01 mm

ZE = ± div

ZE = ± div

ZC = ± (ZE x LC) = mm

ZC = ± (ZE x LC) = x 10^{-3}m

S.No.	Pitch Scale Reading (PSR) x 10^{-3} m	Head Scale Coincidence (HSC) div	Head Scale Reading (HSR) x 10^{-3} m	Observed Reading = (PSR + HSR) X 10^{-3} m	Correct Reading = (OR ± ZC) X 10^{-3} m
1.					
2.					
3.					
4.					
5.					

Mean d = **X 10^{-3} m**

r = d/2 = **X 10^{-3} m**

CALCULATION

Mass of any one of the cylindrical masses	m	=	$\times 10^{-3}$ kg.
Radius of the suspended wire	r	=	$\times 10^{-3}$ m
Minimum distance between the suspension wire and the centre of mass of the cylinder	d_1 =		$\times 10^{-2}$ m
Maximum distance between the suspension wire and the centre of mass of the cylinder	d_2 =		$\times 10^{-2}$ m
Length of the suspended wire	l =		$\times 10^{-2}$ m
Time period without masses	T_0 =		sec
Time period when two identical masses are placed at the minimum distance "d_1"	T_1 =		sec
Time period when two identical masses are placed at the maximum distance "d_2"	T_2 =		sec

RESULT

1. The moment of inertia of the metallic disc (I) = Kg m^2
2. The Rigidity modulus of the material of the wire (n) = Nm^{-2}

2. YOUNG'S MODULUS – NON-UNIFORM BENDING

Expt. No.	Date:

AIM

To determine the young's modulus of the material of a beam supported on two knife edges and loaded at the middle point.

APPARATUS REQUIRED:

A uniform rectangular beam, two equal knife edges, a weight hanger with slotted weight, vernier microscope, pin, screw gauge and vernier caliper.

FORMULA:

Young's modulus of the material of a beam $E = \dfrac{mgl^3}{4bd^3y} \quad Nm^{-2}$

Symbol	Explanation	Unit
y	Mean depression for a load	**meter**
g	Acceleration due to gravity	**m/s^2**
l	Distance between the two knife edges	**meter**
b	Breadth of the beam (meter scale)	**meter**
d	Thickness of the beam (meter scale)	**meter**
M	Load applied	**kg**

PROCEDURE

The given beam is symmetrically supported on two knife edges. A weight hanger is supported by means of a loop of thread from the point C, exactly midway between the knife edges. A pin is fixed vertically at C by some wax. The length of the beam (l) between the knife edges is set for 60 cm. A traveling microscope is focused on the tip of the pin such that the horizontal cross wire coincides with the tip of the pin. The reading in the vertical traverse scale is noted for dead load. In equal steps of m Kg added to the weight hanger, the corresponding readings for loading are noted. Similarly readings are noted while unloading. The breadth and the thickness of the beam are measured with a vernier calipers and screw gauge respectively. From the data Young's modulus of the beam is calculated.

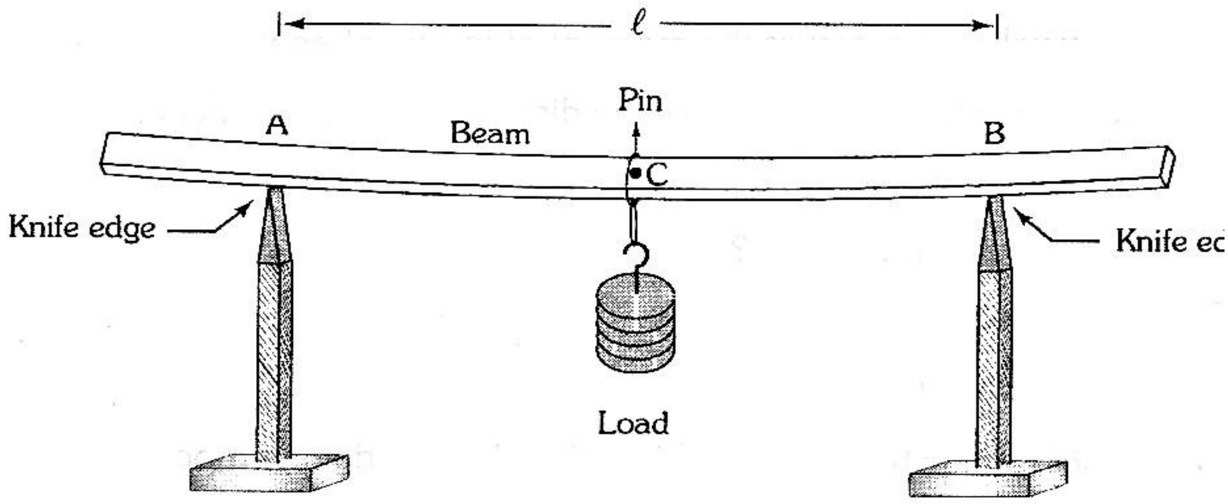


Fig. 2. Young's modulus by non-uniform bending

Table 1 - To find the depression (y) of the beam

LC = 0.001 cm   TR = MSR + (VSC x LC)

S.No.	Load x 10^{-3} kg	Traveling Microscope Reading						Mean cm	Depression "y" for M kg x10^{-2} m
		Loading			Unloading				
		MSR cm	VSC div	TR cm	MSR cm	VSC div	TR cm		
1.	W								
2.	W+50								
3.	W+100								
4.	W+150								
5.	W+200								
6.	W+250								
7.	W+300								

Mean (y) =   x10^{-2} m

Table 2 - To find the breadth (b) of the beam using vernier caliper

LC = 0.01cm VSR = VSC x LC

Zero Error = Nil Zero Correction = Nil

S.No	MSR $\times 10^{-2}$ m	VSC div	VSR $\times 10^{-2}$ m	TR (MSR + VSR) $\times 10^{-2}$ m
1.				
2.				
3.				
4.				
5.				

Mean (b) = $\times 10^{-2}$ m

Table 3 - To find the thickness (d) of the beam using Screw gauge

LC = 0.01 mm

ZE = ± div ZE = ± div

ZC = ± (ZE x LC) = mm

ZC = ± (ZE x LC) = $\times 10^{-3}$m

S. No	PSR $\times 10^{-3}$ m	HSC div	HSR $\times 10^{-3}$ m	OR = (PSR + HSR) $\times 10^{-3}$ m	CR = (OR ± ZC) $\times 10^{-3}$ m
1.					
2.					
3.					
4.					
5.					

Mean (d) = $\times 10^{-3}$ m

CALCULATION:

Load applied at mid point	m =		$\times 10^{-3}$ kg.
Acceleration due to gravity	g =	9.8 ms^{-2}	
Breadth of the beam	b =		$\times 10^{-2}$ m
Thickness of the beam	d =		$\times 10^{-3}$ m
Length of the beam between the knife edges	l =		$\times 10^{-2}$ m

Young's modulus of the material of a beam $E = \frac{mgl^3}{4bd^3y} \; Nm^{-2}$

RESULT:

Young's modulus of the material of the given beam E = ------------ Nm^{-2}

7.(b). COMPACT DISC – DETERMINATION OF WIDTH OF THE GROOVE USING LASER

Expt. No:

Date:

AIM

To determine groove width of CD using LASER.

APPARATUS REQUIRED

(i) CD (ii) Laser source (iii) Stand to hold CD and screen (iv) Ruler.

FORMULA

Width of the groove (or) track width is

$$\boxed{d = \frac{n\lambda}{\sin\theta_n}} \text{ metres}$$

n – Order of diffraction – metres

λ – Wavelength of Laser light – metres

θ_n – Angle of diffraction for n^{th} order

Procedure

The laser light source is placed firmly and horizontally using a stand. Another stand is used to position the CD in front of the laser for normal incident of laser light. The CD is placed close to the laser source. A blank wall or a white board can be used as a screen.

When a laser light is switched on, the diffraction pattern can be observed clearly on the screen. The diffraction pattern consists of a central bright spot and first order maxima on both sides of central bright spots. The second and third order spots may also be observed on the screen. If the diffraction spots are not in horizontal on the screen, the CD is rotated slightly until the images getting on a horizontal line.

The distances of the different orders of maxima from central bright on either sides can be measured and tabulated. Finally, the distance of the CD to the screen (D) is measured.

Using, D and X_n, the diffraction angle θ_n and hence, groove width d can be measured.

X_L, X_R distance between n^{th} order maximum and central bright spot in left side and right side respectively.

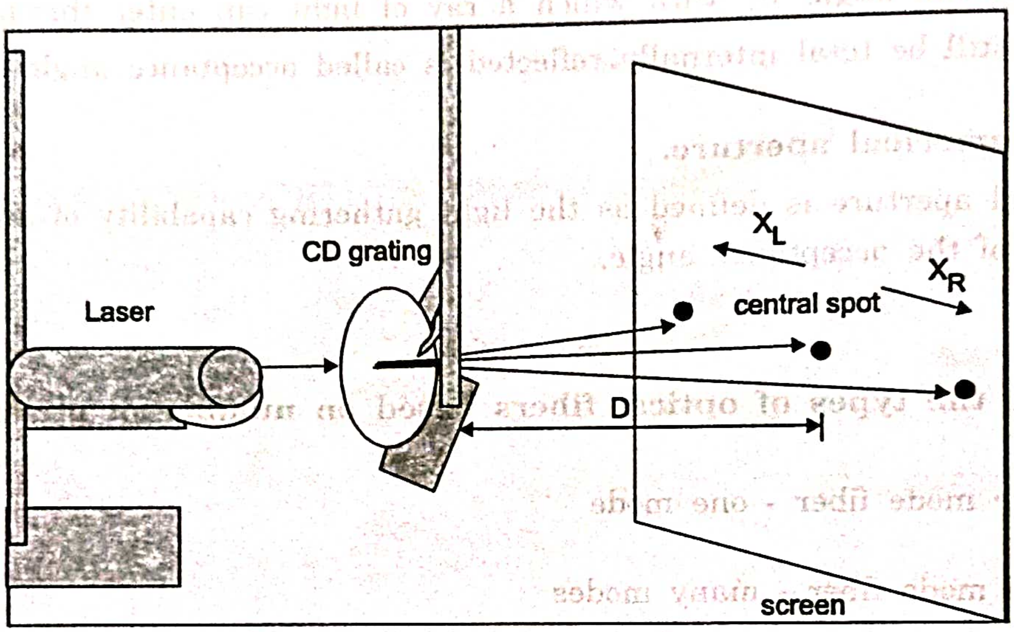


Fig. 7(b).1

Order (n)	Distance of maxima from central bright $\times 10^{-2}$ m			D $\times 10^{-2}$ m	θ_n degree $= \tan^{-1}\left(\frac{X}{D}\right)$	$d = \frac{n\lambda}{\sin \theta_n}$ $\times 10^{-6}$ m
	X_L	X_R	$X = \frac{X_L + X_R}{2}$			
1.						
2.						
					mean =	

Calculation

Result

The groove width of CD using Laser .... metres.

5. THICKNESS OF A WIRE – AIR-WEDGE METHOD

Expt. No:

Date:

AIM

To determine the thickness (diameter) of a thin wire by forming interference fringes using air-wedge arrangement.

APPARATUS REQUIRED

1. Travelling microscope 2. Sodium vapour lamp 3. Two optically plane rectangular glass plates 4. Condensing lens 5. Reading lens 6. Thin wire

FORMULA

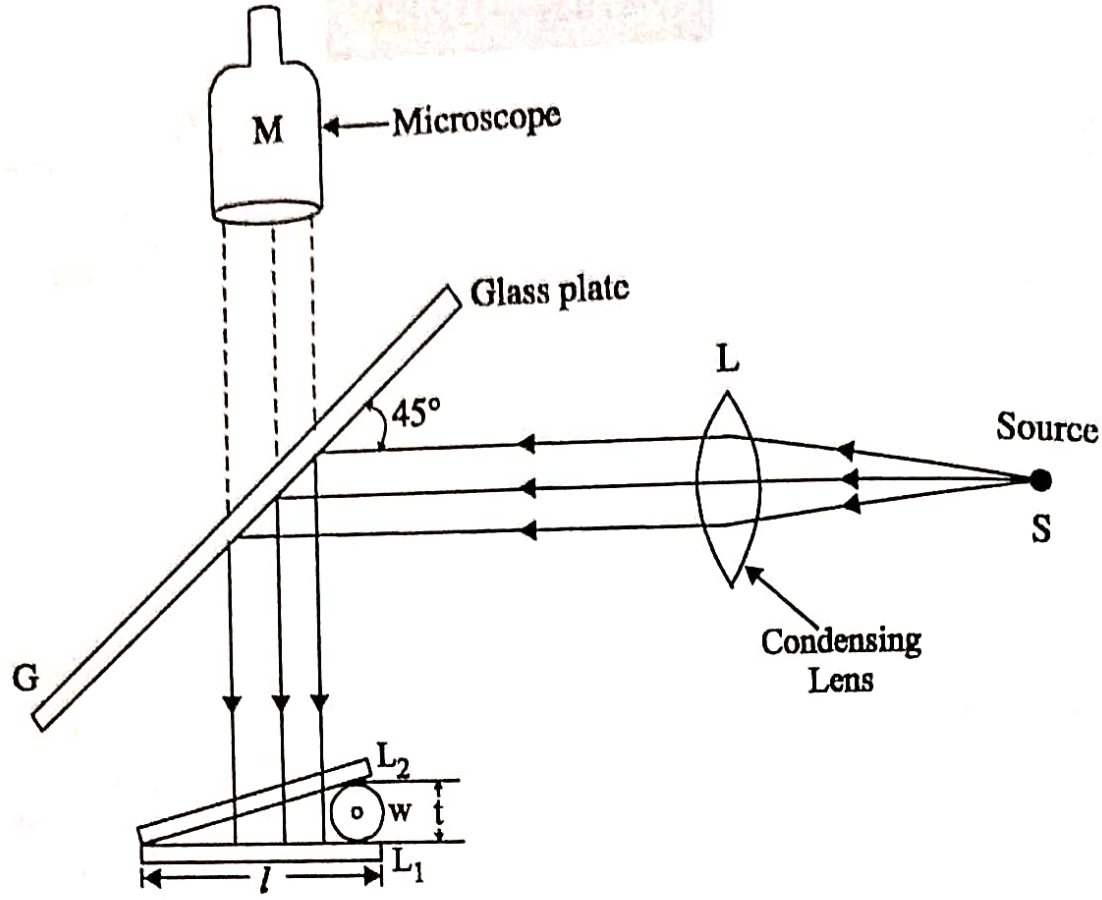
Thickness of the thin wire

$$\boxed{t = \frac{\lambda l}{2\beta}} \quad \text{metre}$$

Symbol	Explanation	Unit
λ	Wave length of sodium light	metre
l	Distance of the wire from the edge of contact	metre
β	Mean width of one fringe	metre

PROCEDURE

An air wedge is formed by keeping two optically plane glass plates in contact along one of their edges. At the other end, thin wire is introduced with its length perpendicular to the length of the plate. The glass plates are tied together in this position by means of rubber band. It is then placed on the horizontal bed plate of the travelling microscope.



L_1, L_2 - Transparent plane glass plates w - Specimen (wire)

Fig 5.1 Air - wedge arrangement

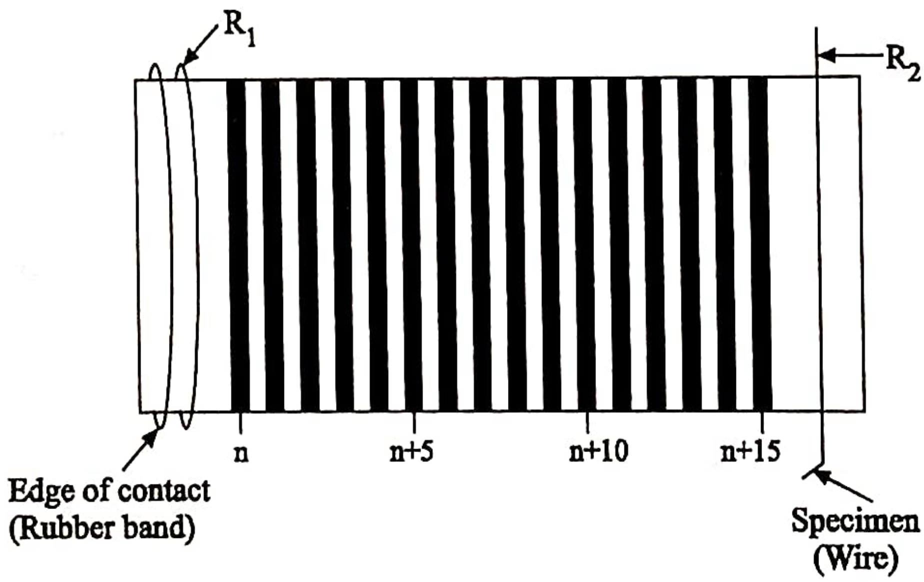


Fig. 5.2 Interference - Fringe pattern

Least Count of the Travelling microscope

$$\text{Least Count} = 1\ \text{MSD} - 1\ \text{VSD}$$

$$20\ \text{MSD} = 1\ \text{cm}$$

$$\text{Value of } 1\ \text{MSD} = \frac{1}{20}\ \text{cm} = 0.05\ \text{cm}$$

$$\text{Number of vernier scale division} = 50$$

$$50\ \text{VSD} = 49\ \text{MSD}$$

$$\therefore 1\ \text{VSD} = \frac{49}{50}\ \text{MSD} = \frac{49}{50} \times 0.05 = 0.049$$

$$\text{LC} = 0.05 - 0.049 = 0.001\ \text{cm}$$

Travelling microscope readings

(i) To find the fringe width (β):

LC = 0.001 cm

Order of the band	Microscope Readings			Width of 5 bands	Mean width of one fringe (β)
	MSR	VSC	TR = MSR + (VSC × LC)		
Unit	cm	div	cm	cm	cm
n					
$n+5$					
$n+10$					
$n+15$					
$n+20$					
$n+25$					
$n+30$					
$n+35$					
$n+40$					
$n+45$					
$n+50$					

Mean fringe width β = ______________ $\times 10^{-2}$ metre

The interference pattern can be obtained with the help of the glass plate inclined at an angle 45° to the horizontal plane and a condensing lens (Fig. 5.1). Light from the sodium vapour lamp is made to fall vertically on the air wedge. These interference fringes are viewed through the travelling microscope.

A system of equi-spaced straight alternately dark and bright bands are obtained (Fig.5.2).

The vertical cross wire of the microscope is adjusted to coincide with the centre of well defined dark band near the edge of contact of the glass plates. It is taken as the n^{th} dark fringe. The reading on the horizontal scale of the microscope is noted.

The microscope is then moved in the same direction by using the horizontal transverse screw and made to coincide with every successive 5^{th} dark fringe. The readings are noted. This is continued till about 50 fringes are covered. The readings are tabulated. From these readings, the mean width of one fringe (β) is calculated.

The distance 'l' between the edges of contact and the wire is measured with the help of the travelling microscope. (Fig.5.3). Assuming the wavelength of sodium light, the thickness of the thin wire is calculated by using the given formula.

RESULT

Thickness of the given thin wire (t) = ... metre.