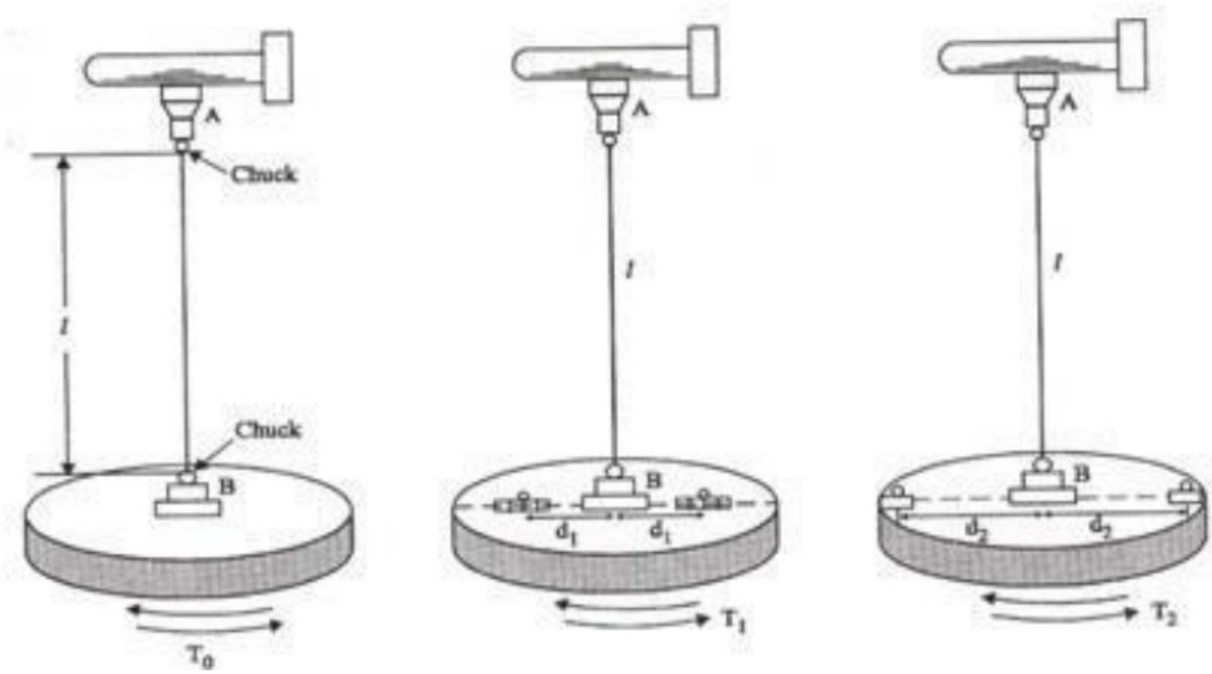

Fig. 1 TORSIONAL PENDULUM

(i) Measurement of the suspension wire using Screw gauge(r)

Least Count= 0.01mm

Zero error = ……div………mm

Zero correction = ……div………mm

Sl.No.	PSR	HSC	OR	Correct Reading = OR ± ZC
Unit	**10^{-3}m**	**div**	**10^{-3}m**	**10^{-3}m**
1				
2				
3				
4				
			Mean	

Torsional Pendulum-Determination of Moment of Inertia of a disc and the Rigidity Modulus of a wire

Aim

To determine **(i)** the moment of inertia of the given disc and **(ii)** the rigidity modulus of the material of a wire by torsional oscillations.

Apparatus required

A meter scale, Circular metal disc, suspension wire, biscuit balance, slotted weights, stop watch, vernier calipers, screw gauge, etc.

Formula

(i) Moment of inertia of the disc $I = \frac{2m(d_2^2 - d_1^2)T_0^2}{T_2^2 - T_1^2}$ kg.m^2

(ii)Rigidity modulus of the material of the wire $\eta = \frac{8\pi I l}{r^4 T_0^2}$ N/m^2

Explanation of Symbols

Symbol	Explanation	Unit
M	Mass of circular disc	Kg
R	Radius of the circular disc	Metre
r	Radius of the given wire	Metre
l	Length of the suspension wire	Metre
T	Time period for various lengths	Second

THEORY

The circular disc is rotated in a horizontal plane so that a twist is given to the wire which holds the disc. Hence the various elements of the wire undergo shearing strains. The restoring couples, which tend to restore the unstrained conditions, are called into action. Now when the disc is released it starts executing torsional oscillations. The couple which acts on the disc produces in it an angular acceleration which is proportional to the angular displacement and is always directed towards its mean position. Hence the motion of the disc is a simple harmonic motion.

(ii) To find the time periods of the disc at different stages

Length of the suspension wire (l): --------------- cm = ----------- $\times 10^{-2}$ m.

Position of the equalmasses	Time for 10 oscillations			Time period one oscillation
	Trial – 1	Trial – 2	Mean	
Unit	Seconds	Seconds	Seconds	Seconds
Without any masses				T_0 =
With masses at closest distance, d_1 = $\times 10^{-2}$m				T_1 =
With masses at farthest distance, d_2 = $\times 10^{-2}$m				T_2 =

PROCEDURE

One end of a long, uniform wire whose rigidity modulus is to be determined is clamped by a vertical chuck. To the lower end, a heavy uniform circular disc is attached by another chuck. The length of the suspension '*l*' is fixed to a particular value (say 60 cm or 70 cm). The suspended disc is slightly twisted so that it executes torsional oscillations. Care is taken to see that the disc oscillates without wobbling. The first few oscillations are omitted. By using the pointer, (a mark made in the disc) the time taken for 10 complete oscillations are noted. Two trials are taken. The mean time period T (time for one oscillation) is found.

Two equal masses are placed on the disc symmetrically on either side, close to the suspension wire (at the minimum distance). The closest distance 'd_1' from the centre of the mass of the cylindrical and the centre of the suspension wire is found. The disc with masses at distance 'd_1' is made to executive torsional oscillations by twisting the disc. The time taken for 10 oscillations is noted. Two trials are taken. The mean time period 'T_1' is determined.

Two equal masses are now moved to the extreme ends so that the edges of masses coincide with the edge of the disc and the centers are equi – distant. The distance 'd_2' from the centre of the mass of the cylinder and the centre of the suspension wire is noted. The disc with masses at distance 'd_2' is allowed to execute torsional oscillations by twisting the disc. The time taken for 10 oscillations is noted and time period 'T_2' is calculated

The mass of one of the cylinders placed on the disc is found. The diameter of the wire is accurately measured at various places along its length with screw gauge. From this, the radius of the wire is calculated. The moment of inertia of the disc and the rigidity modulus of the wire are calculated using the given formulas.

Calculation:

1. **Moment of inertia of the disc** $I = \frac{2m(d_2^2 - d_1^2)T_0^2}{T_2^2 - T_1^2}$ kg.m^2

Mass of one of the cylinder (m)	=	(Kg)
Closest distance between suspension wire and the centre of mass of the cylinder (d_1)	=	(meter)
Farthest distance between suspension wire and the centre of mass of the cylinder (d_2)	=	(meter)
Time period without any mass placed on the disc (T_0)	=	(seconds
Time period when equal masses are placed at a distance d_1 (T_1)	=	(seconds
Time period when equal masses are placed at a distance d_2 (T_2)	=	(seconds
Length of the suspension wire (l)	=	(meter)
Radius of the wire (r)	=	(meter)

2. Rigidity modulus of the material of the wire $\eta = \frac{8\pi I l}{r^4 T_0^2}$ N/m^2

Result

(i) Moment of Inertia of the disc **I** =............... Kg m^2

(ii) Rigidity modulus of the material of given the wire η =...........Nm^{-2}

Marks Distribution		**Marks Obtained (25)**
Preparation & Understanding	**5**	
Experimental setup & Execution	**5**	
Calculation	**5**	
Result	**5**	
Viva-voce	**5**	
Total	**25**	