

EXPERIMENT - 5

AIM: Determination of modulus of rigidity of the material of a wire by dynamic method.

APPARATUS REQUIRED: Torsional pendulum, stop watch, screw-gauge, slide calipers balance.

THEORY: If a solid cylinder be suspended by a long wire from a torsion head, forming a torsional pendulum and if the pendulum be set into torsional oscillation, the time period of such oscillation is given by $T = 2\pi\sqrt{I/\tau}$ or $\tau = (4\pi^2 I)/T^2$ where I is the moment of inertia of the cylinder about the suspension wire as axis and τ = shearing couple for one radian.

Now, if the axis of the cylinder coincides with axis of rotation, then $I = MR^2$ where M = mass of the cylinder and R = radius of the cylinder. Again, for the suspension wire, $\tau = \frac{\pi \cdot n \cdot r^4}{2l}$ where l = length, n = modulus of rigidity of the material of the suspension wire,

$$\therefore \frac{\pi \cdot n \cdot r^4}{2l} = \frac{4\pi^2 \cdot I}{T^2}$$

$$= \frac{8\pi \cdot l}{r^4 \cdot T^2} \times \frac{1}{2} MR^2$$

$$n = \frac{8\pi I l}{M r^4 T^2} \quad \text{--- (A)}$$

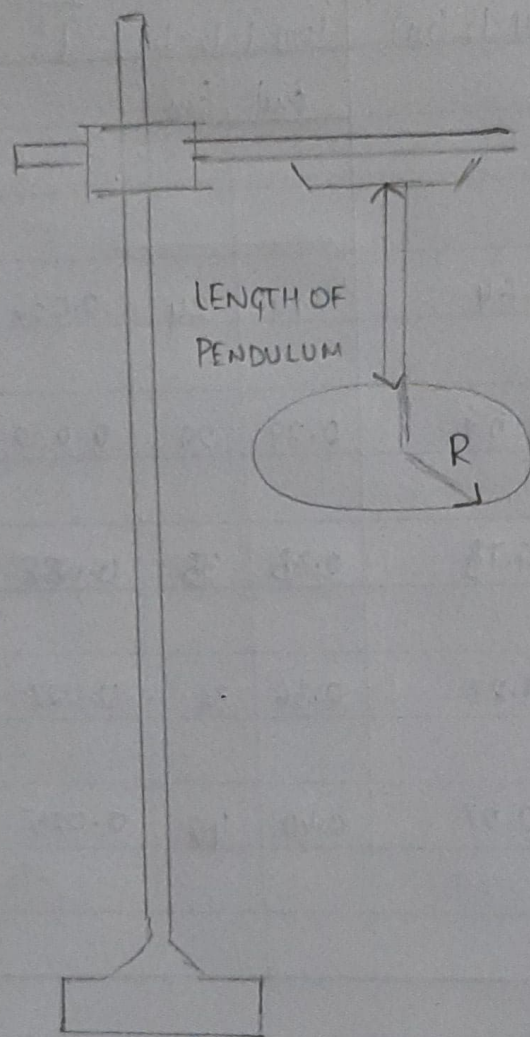


DIAGRAM OF TORSION PENDULUM

OBSERVATIONS:-

Mass of disk = $1.5 \text{ kg} = 1500 \text{ gm}$

Radius of disk = 5 cm

Radius of wire = 0.04 cm

length of wire = 100 cm

| MATERIAL | NO OF OBS | TIME PERIOD FOR 20 OSCILATION (Sec) | MEANTIME PERIOD FOR 20 OSCILATIONS (Sec) | MEANTIME PERIOD (Sec) | RIGIDITY MODULUS (dyne/cm^2) |
|-----------|-----------|-------------------------------------|--|-----------------------|---|
| COPPER | 1 | 122 | 122.6 12 | 6.13 | 4.8×10^{11} |
| | 2 | 123.3 | | | |
| BRASS | 3 | 126.8 | 126.9 | 6.34 | 4.6×10^{11} |
| | 4 | 127 | | | |
| BRONZE | 5 | 123.4 | 123.6 | 6.18 | 4.7×10^{11} |
| | 6 | 123.8 | | | |
| CAST IRON | 7 | 129.6 | 130 | 6.5 | 4.5×10^{11} |
| | 8 | 130.4 | | | |
| ZINC | 9 | 126.7 | 125.8 | 6.29 | 4.6×10^{11} |
| | 10 | 124.9 | | | |

CONCLUSION: We understood that the rigidity modulus is the coefficient of the elasticity for a shearing force. It will measure the stiffness of a particular material. Therefore, the higher the value of torsion stiffness

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of a material ; the higher the modulus of rigidity . So therefore the rigidity modulus increases for copper, the decreases for brass, the increases for bronze again, then again decreases for cast iron and again increases for zinc..