PHYSICS LAB. 1

(31148)

Experiment No. 8

Moment of Inertia

Exp.no. 8 Moment of Inertia

In a rotational motion, there is a law which is similar to the Newton's second law in a transitional motion.

This law can be represented in the form

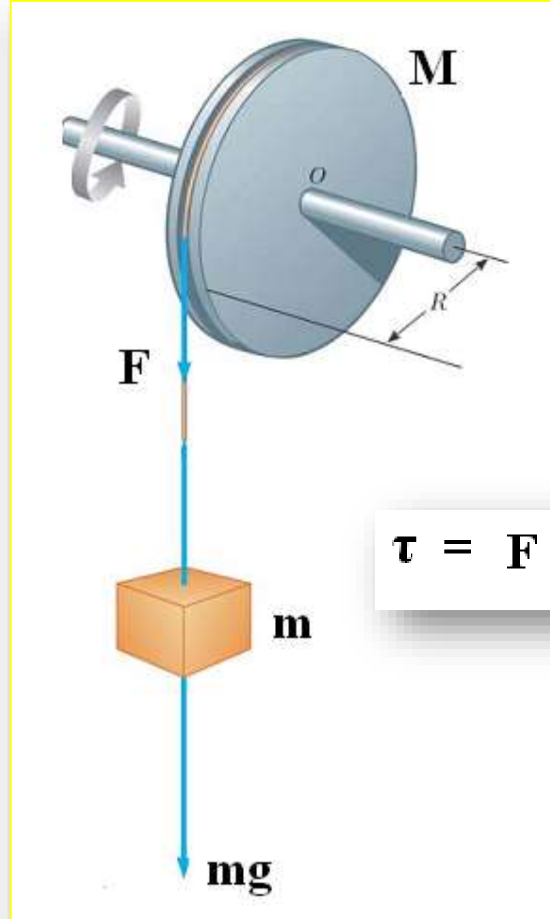
$$\tau = I\,\alpha$$

Where τ is the torque (moment) exerted on the body and caused it to rotate about a certain axis.

I is the moment of inertia of the body about that axis.

α is the angular acceleration of the body.

- The torque τ is positive if the rotation is counter clockwise.
- The torque τ is negative if the rotation is clockwise.



$$\tau = F * R$$

The moment of inertia I of a body depends on two factors:

1. The geometrical shape of the body.

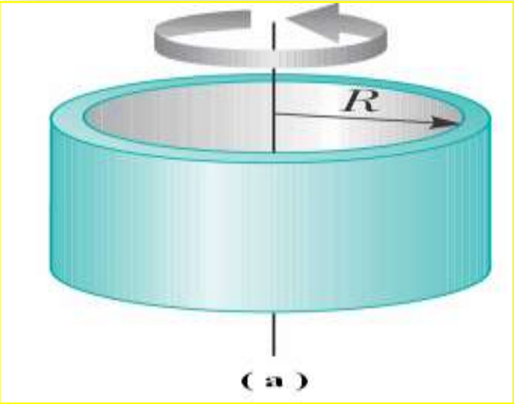
The shape of the body may be Disk, Ring, Cylinder, or Rod or any other shape.

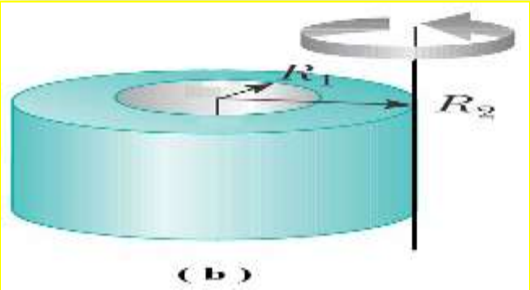
2. The position of the axis of rotation.

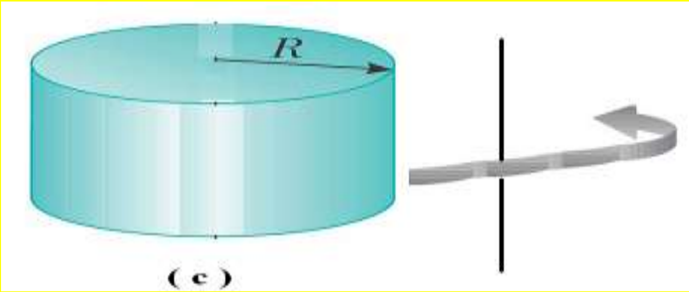
The axis of rotation may be at the center of the body as in fig. (a), or tangent to the surface of the body as in fig. (b), or may be any where out side the body as in fig. (c) .

We shall determine the movement of inertia by two methods :

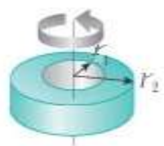
- By theoretical calculations.
- By experimental method.





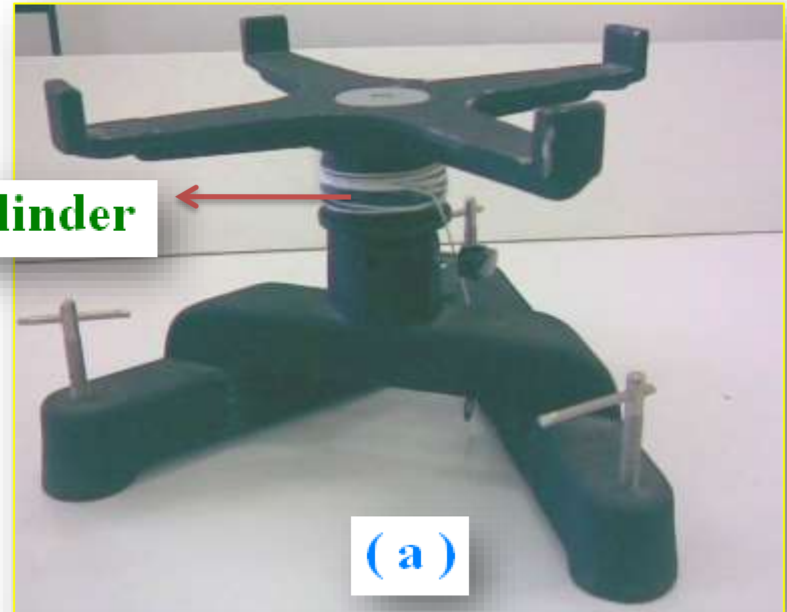


Theoretical calculation of moment of inertia

Body	Axis	Law of Moment of inertia (I)	Mass (gm)	Dimension (cm)		Value of I ($gm.cm^2$)
Disk		$1/2\ Mr^2$		$r =$		
Ring		$\frac{1}{2}M(r_1^2 + r_2^2)$		$r_1 =$		
				$r_2 =$		
Cylinder		$M\left(\frac{r^2}{4} + \frac{L^2}{12}\right)$		$r =$		
				$L =$		
Rod		$\frac{1}{12}M(a^2 + b^2)$		$a =$		
				$b =$		

Experimental determination of moment of inertia

- The apparatus used in this experiment is called the rotator, shown in fig. (a).
- The main part of the rotator is the cylinder where the string is wrapped.
- The diameter (2r) of the cylinder is measured by the Vernier as shown in fig. (b).



الأربعاء، 03 تشرين الثاني، 2021

Determination of moment of inertia of the rotator I_0

From the fig. when the mass m is fall down, the potential energy mgh is converted into kinetic energy of the mass $\frac{1}{2} m v^2$ and rotational kinetic energy of the cylinder $\frac{1}{2} I_0 \omega^2$, we can write

$$mgh = \frac{1}{2} mv^2 + \frac{1}{2} I_0 \omega^2 \quad \dots\dots\dots\dots\dots (1)$$

But

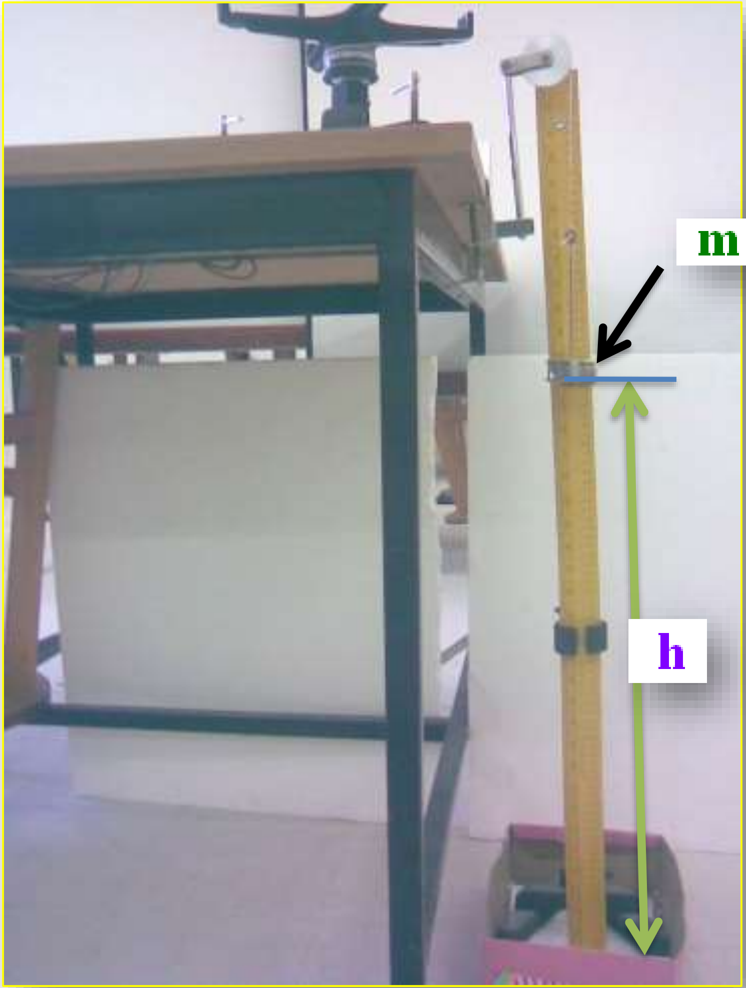
$$\omega = \frac{v}{r} \quad \dots\dots\dots\dots\dots\dots (2)$$

And

$$v = \frac{2h}{t} \quad \dots\dots\dots\dots\dots (3)$$

The we get

$$I_0 = m r^2 \left(\frac{gt^2}{2h} - 1 \right)$$



Determination of moment of inertia of any object I

If we put any object on the rotator such as a disk , and repeat the same experiment , we get the moment of inertia of both the rotator and the disk , we mean that

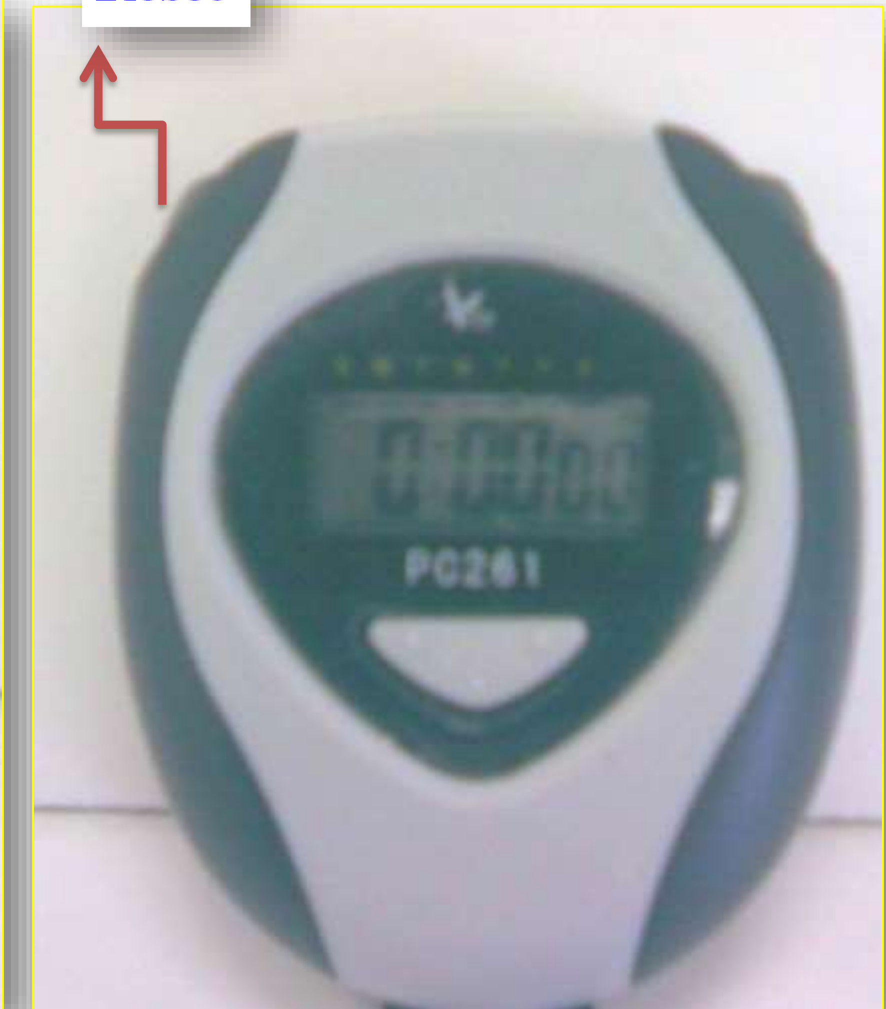
$$I + I_0 = m r^2 \left(\frac{g t^2}{2 h} - 1\right)$$

To find the moment of inertia of the disk only, we subtract I_0 from the above equation.

The same method is applied to any other object used with the rotator.

Determination of the falling time **t** by the stop watch


Stop
PC261
t = 2.56 sec.


Reset
PC261

B . moment of inertia of the rotator only

r = …………………… cm

Mass m (gm)	Height h (cm)	Time t (sec.)	Moment of inertia of the rotator I_0 ($gm.cm^2$)

C. Moment of inertia of the disk.

	Mass m (gm)	Height h (cm)	Time t (sec.)	Moment of inertia of the rotator and disk $(I + I_0)$ ($gm.cm^2$)	Moment of inertia of the disk I $(I + I_0) - I_0$ ($gm.cm^2$)