Inertia

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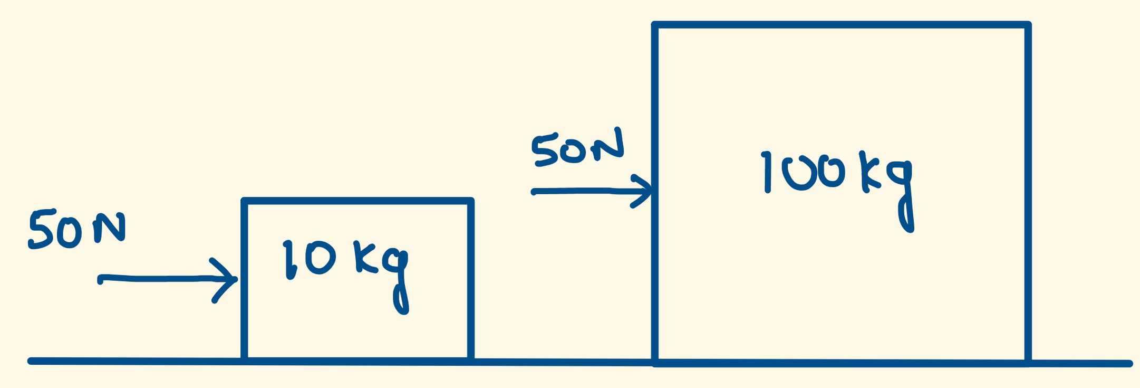
1. Introduction:

- INERTIA is the tendency of an object to resist changes in its state of motion.

So, if an object is at rest, inertia wants to keep that object in rest. If the object is in motion, inertia wants to keep that object in motion.



If we have two objects of masses 10 kg & 100 kg. We apply same amount of force (50 N) on both objects.

Which one do you think has more inertia?

Ofcource, it is difficult to move the heavier object. So, the object with 100 kg mass has more inertia.

So we can say [Inertia $\propto$ mass.] ↳ directly proportional

We can also justify this from Newton's 2nd law:-

$$a = \frac{F}{m} \Rightarrow a \propto \frac{1}{m}$$

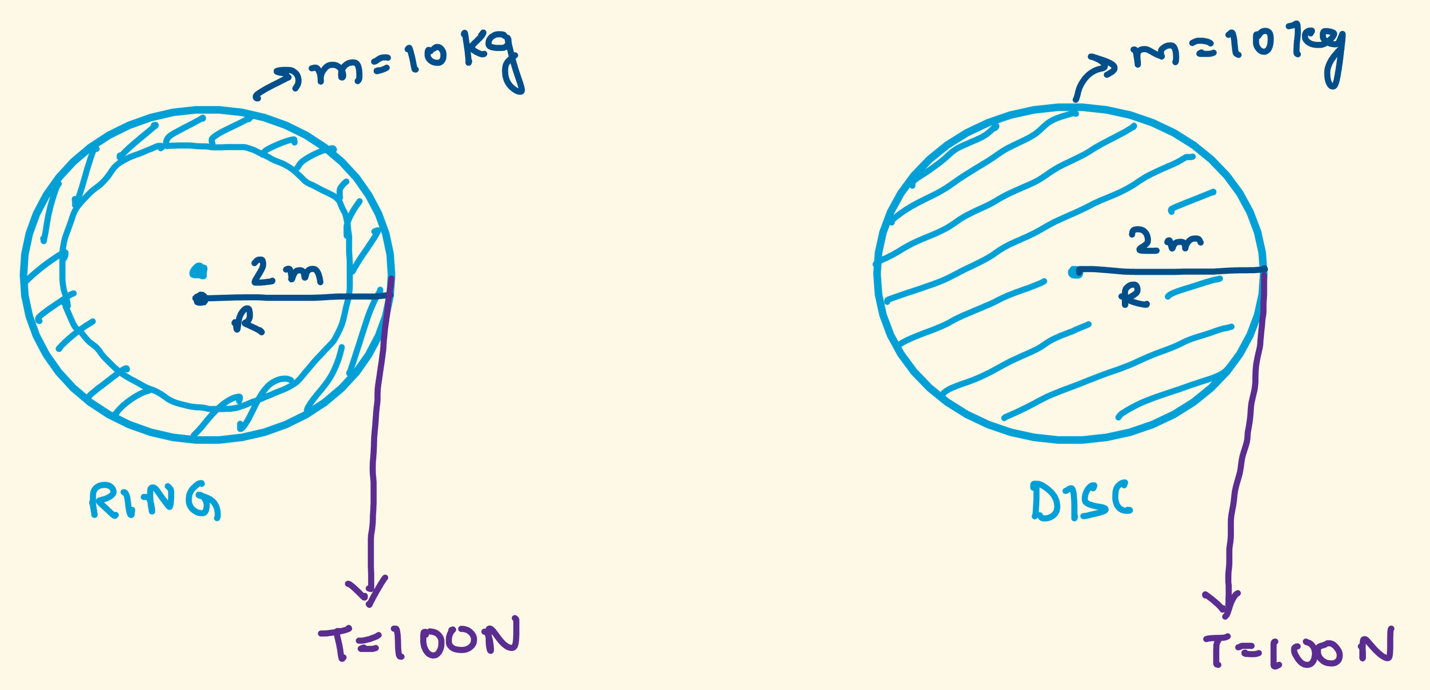
↳ If we keep the force same, then the object with lighter mass will have more acceleration.

And the object with heavier mass will have less acceleration. This means heavier object has more inertia.

mass ↑ inertia ↑
↳ if mass increases, inertia also increases.

This is about the role of inertia in translational motion.

Now, let's talk about its role in Rotational Motion



Let's say, we have a ring and a solid disc of same mass 10 kg. They both have same radius of 2m.

Now we apply a same amount of force (100N) on both objects.

Which one do you think has more inertia?

Ring will have more inertia as compared to disc. The reason is because of the distribution of the mass.

In solid disc, mass is distributed uniformly all over. However, in Ring, the mass is distributed away from the center.

$$I_{Ring} = mR^2 \qquad I_{disc} = \frac{1}{2} mR^2$$

Therefore, Ring has more resistance to rotation because it has more inertia as with respect to solid disc.

So, it is harder to spin the Ring than the solid disc.

Knowledge Point:

$$I_{sphere} = \frac{2}{5} mR^2$$

2. Important Expression:

In translational motion, from Newton's 2nd law:

$$F = m \cdot a$$

Taking it to rotational motion:

$$r \cdot F = m \cdot a \cdot r$$

$$\tau = m (\alpha r) \cdot r$$

$$\tau = mr^2 \cdot \alpha$$

$$\Sigma \tau = \Sigma mr^2 \cdot \alpha$$

$$\boxed{\tau = I \cdot \alpha}$$

→ $I = \Sigma mr^2$

3. References:

1. The Organic Chemistry Tutor

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