

MOMENT OF INERTIA

- Remember: Motion problems do **NOT** depend on Mass, but Energy (eg. $K = \frac{1}{2} m v^2$) and Force ($\Sigma F = ma$) problems do.

- Mass is the **amount of resistance** to LINEAR acceleration, which we call (linear) _____:

- In ROTATION, the **amount of resistance** to ANGULAR acceleration depends on mass AND _____.

- This combination is called _____ (____), and it's the rotational equivalent of _____!

- You can think of it as (rotational) _____.

- There are two types of objects:

Point Masses

(_____)

$I = \underline{\hspace{2cm}}$, where $r = \underline{\hspace{2cm}}$

Rigid Bodies/Shapes

(_____)

I is found by Table Lookup →

General Form: $I = [\text{fraction}] mR^2$

(R = Radius)

EXAMPLE: A system is made of two point masses ($M_{\text{LEFT}} = 3 \text{ kg}$, $M_{\text{RIGHT}} = 4 \text{ kg}$) at the ends of a 2-m long massless rod, as shown. Calculate the moment of inertia of the system if it spins about a perpendicular axis through the center of the rod.



<u>Common Moments of Inertia</u>	
<u>Point Masses</u> 	$I = mr^2$
<u>Center of Rod</u> 	$I = \frac{1}{12} ML^2$

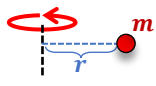
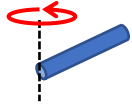
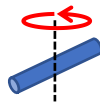
- The moment of inertia of a system of objects is the sum of each moment of inertia of the objects that make it up.

$I_{sys} = \underline{\hspace{2cm}}$

PRACTICE: MOMENT OF INERTIA / SIMPLE SYSTEM

PRACTICE: A system is made of two small masses ($M_{\text{LEFT}} = 3 \text{ kg}$, $M_{\text{RIGHT}} = 4 \text{ kg}$) attached to the ends of a 5 kg, 2-m long thin rod, as shown. Calculate the moment of inertia of the system if it spins about a perpendicular axis through the mass on the left.



Common Moments of Inertia	
<u>Point Masses</u> 	$I = mr^2$
<u>End of Rod</u> 	$I = \frac{1}{3}mL^2$
<u>Center of Rod</u> 	$I = \frac{1}{12}mL^2$

EXAMPLE: MOMENT OF INERTIA / EARTH

EXAMPLE: The Earth has mass and radius $5.97 \times 10^{24} \text{ kg}$ and $6.37 \times 10^6 \text{ m}$. The radial distance between the Earth and the Sun is $1.50 \times 10^{11} \text{ m}$. Calculate the Moment of Inertia of the Earth as it spins around:

- (a) itself -- treat the Earth as a solid sphere (solid spheres have moment of inertia given by $\frac{2}{5} mR^2$);
- (b) the Sun -- treat the Earth as a point mass.

PRACTICE: MOMENT OF INERTIA / FIND MASS

PRACTICE: A solid disc 4 m in diameter has a moment of inertia equal to 30 kg m^2 about an axis through the disc, perpendicular to its face. The disc spins at a constant 120 RPM. Calculate the mass of the disc.

EXAMPLE: MOMENT OF INERTIA / WITH DENSITY

EXAMPLE: A planet is nearly spherical with nearly continuous mass distribution, with $8 \times 10^7 \text{ m}$ in radius and $10,000 \text{ kg/m}^3$ in density. If the planet rotates around itself, calculate its moment of inertia around its central axis (Note: $V_{\text{SPHERE}} = \frac{4}{3} \pi R^3$).