L15_Rotational Kinematics and Moment of Inertia

- [x] ~~SP check~~

Rotational Kinematics

Formulas

1. Note the comparisons between linear motion (translation motion) and angular motion

Linear	Angular
$d = vt$	$\theta = \omega t$
$v_F = v_0 + at$	$\omega_F = \omega_0 + \alpha t$
$v_F^2 = v_0^2 + 2ad$	$\omega_F^2 = \omega_0^2 + 2\alpha\theta$
$d = v_0 t + \frac{1}{2}at^2$	$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$
$d = \frac{1}{2}[v_0 + v_F]t$	$\theta = \frac{1}{2}[\omega_0 + \omega_F]t$

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2. Related linear parameters to angular ones

$$d = \theta R$$

$$v = \omega R$$

$$a = \alpha R$$

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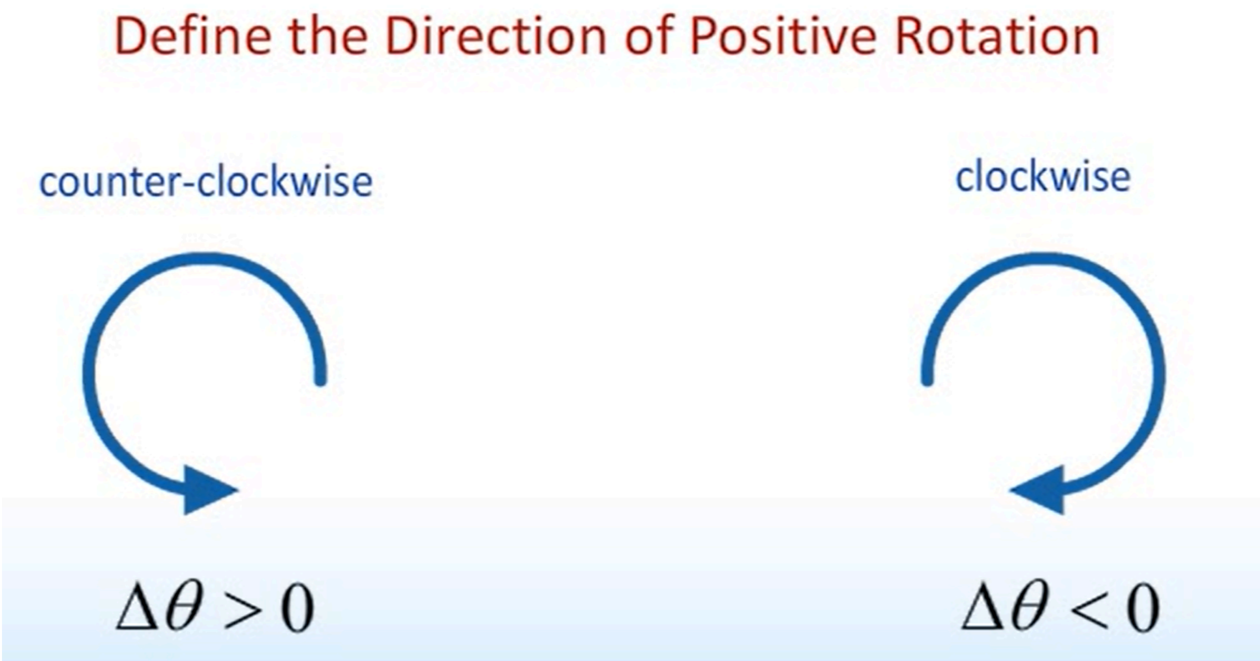
3. Direction:



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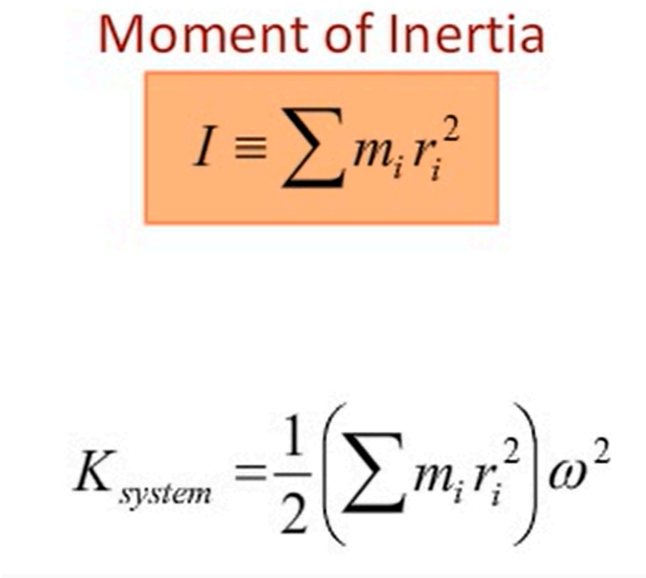
Rotational Energy

- Derivation



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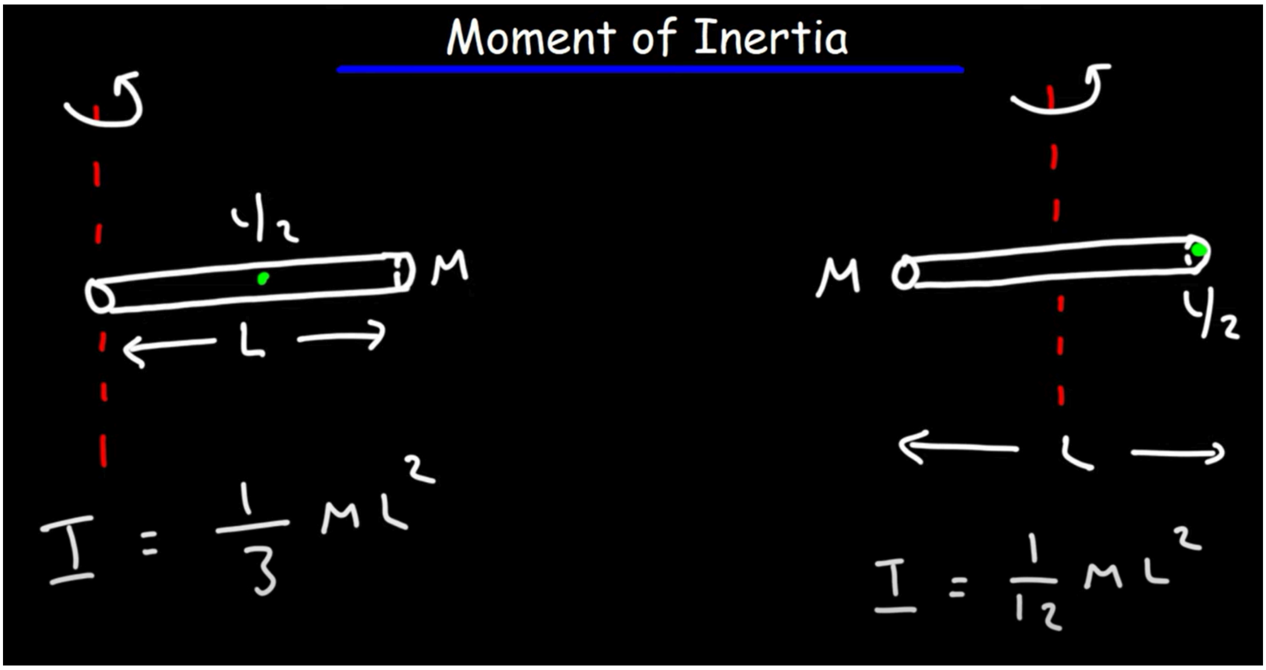
- $$E_{rot} = \frac{1}{2}mv^2 = \frac{1}{2}m(\omega r)^2 = \frac{1}{2}mr^2(\omega)^2 = \frac{1}{2}I\omega^2$$
- Note that the definition of I is different for different object

Moment of inertia

Slender Rod

1. Special cases



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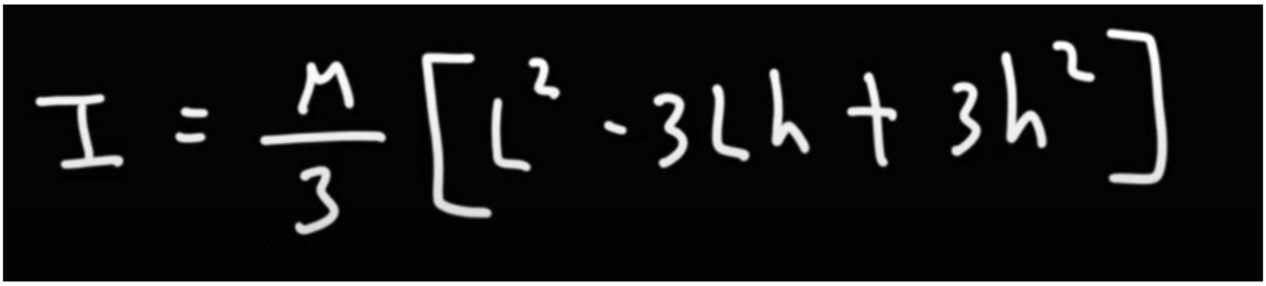
2. Here h is the distance from the axis to the left and L is the length of the rod



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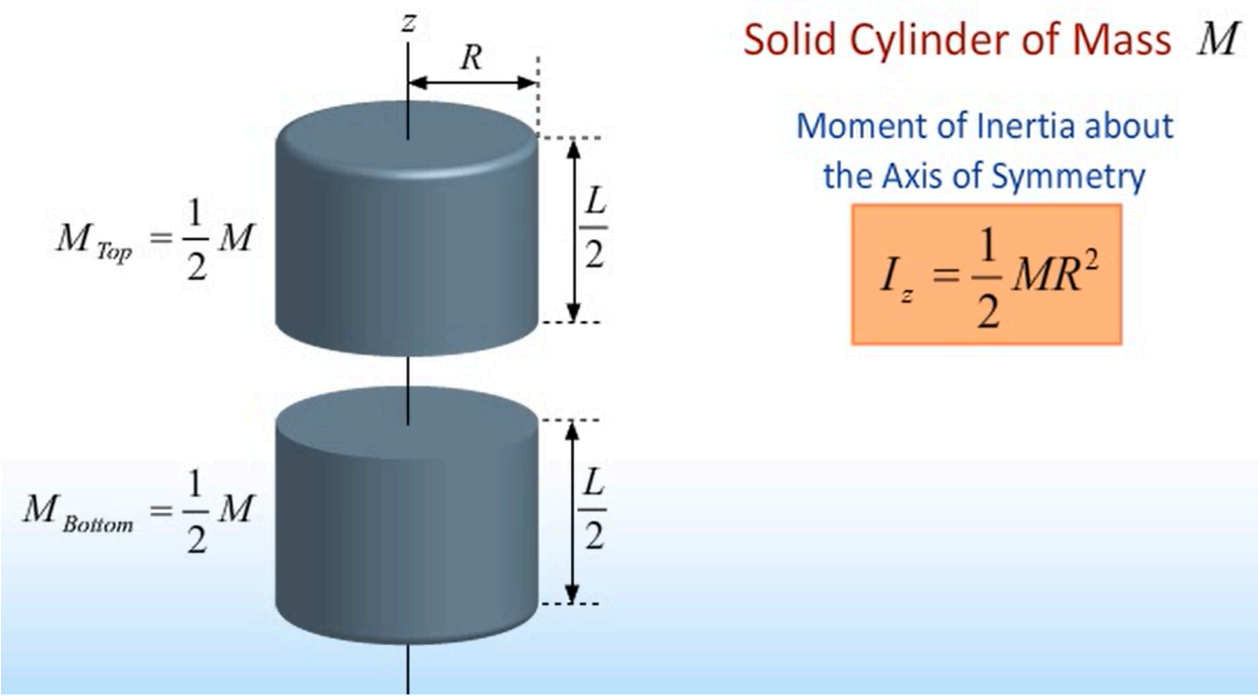
Disk/Solid Cylinder/Puck

- 

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- $$I = \frac{1}{2}mR^2$$

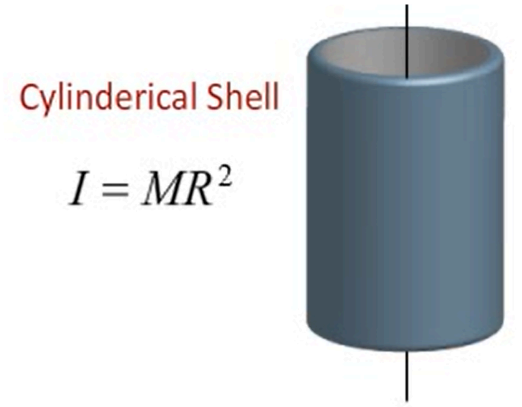
Hoop/Block

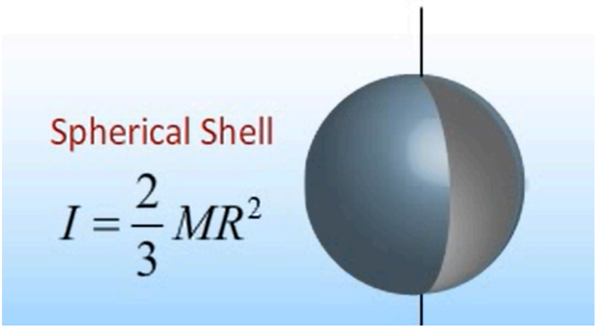
- $$I = mR^2$$

Sphere

$$I = \frac{2}{5}mR^2$$

Shell



- 

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System

- Add every component's moment of inertia up