TAM 212

MOMENT OF INERTIA → resistance to rotation $I_{c,\hat{a}}$

axis of rotation

inertia

about the center of mass

mass m

mass m

Which one undergoes a larger angular acceleration? Disk

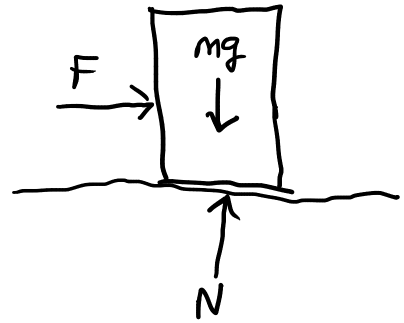
Formally, $I_{c,\hat{a}}$. For us, we'll consider 2D rotations taking place on a plane. $\hat{a} = \hat{k}$

drop subscript: I_c

$$\boxed{I_c = \sum m_i r_i^2 = \int_V \rho r^2 \, dV}$$

mass density

Newton's Laws for Rigid Bodies:



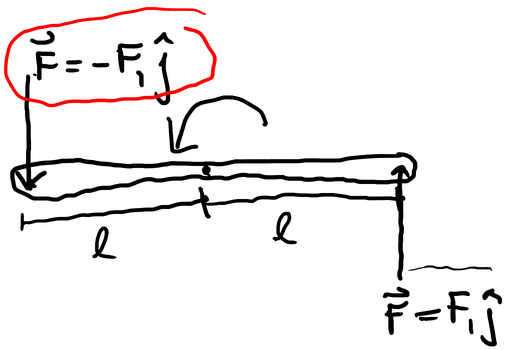
① linear momentum

$$\sum \vec{F} = \hat{m}\,\vec{a}_c = m\,\frac{d\vec{v}_c}{dt}$$

② angular momentum

$$\sum \vec{M}_c = I_c\,\vec{\alpha} = I_c\,\frac{d\vec{\omega}}{dt}$$

Ex)



$\vec{M} = \vec{r} \times \vec{F}$

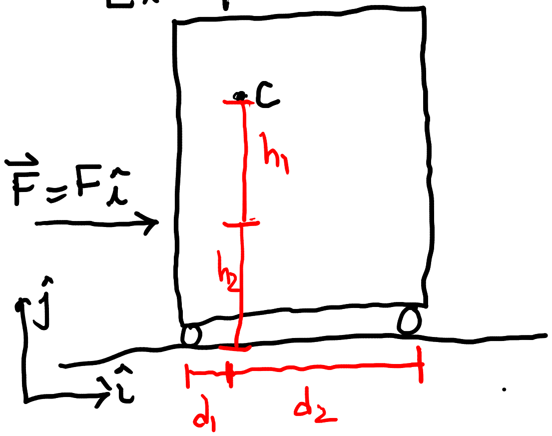
Question 1: A - yes B - no

① Is $m\vec{v}_c$ changing at the instant shown? No, $\Sigma\vec{F} = 0$.

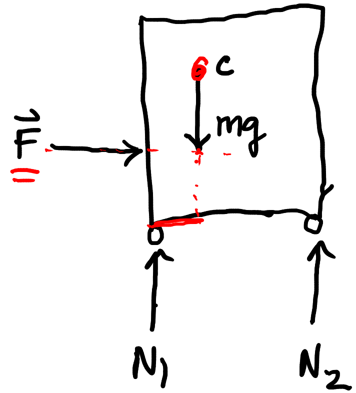
② Is $\vec{\omega}$ changing at the instant shown?

$$\Sigma\vec{M}_c = \ell F_1 + \ell F_1 = 2\ell F_2$$

Example: Block of Mass m. Find $\vec{a}_c$, normal forces.



FBD



linear momentum: $\sum \vec{F} = m\vec{a}_c = m a_{cx}\hat{\imath}$

$$\sum F_x = m a_{cx}$$
$$F = m a_{cx}$$
$$a_{cx} = \frac{F}{m}$$
$$\boxed{\vec{a}_c = \frac{F}{m}\hat{\imath}}$$

$$\sum F_y = m a_{cy} = 0$$
$$N_1 + N_2 - mg = 0$$
$$mg = N_1 + N_2$$

angular momentum: $\sum \vec{M}_c = I_c \vec{\alpha} = 0$

$$F h_1 + N_2 d_2 - N_1 d_1 = 0$$

$$N_1 = (F_1 h_1 + mg d_2)/(d_1 + d_2)$$