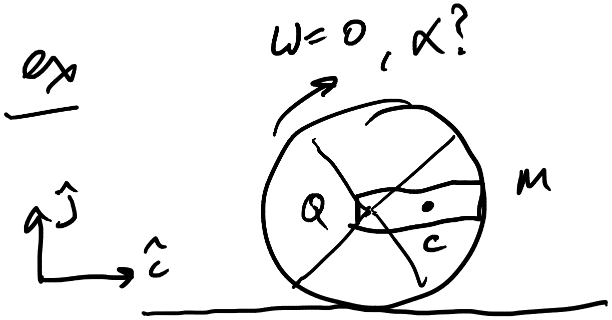
Euler's equs:

$$\begin{cases} \sum \vec{M} = 0 & \text{static.} \\ \sum \vec{M}_c = I_c \vec{\alpha} & C \text{ center of mass} \\ \sum \vec{M}_o = I_o \vec{\alpha} & O \text{ fixed} \end{cases}$$

① $\sum \vec{M}_p = I_c \vec{\alpha} + \vec{r}_{pc} \times m\vec{a}_c$

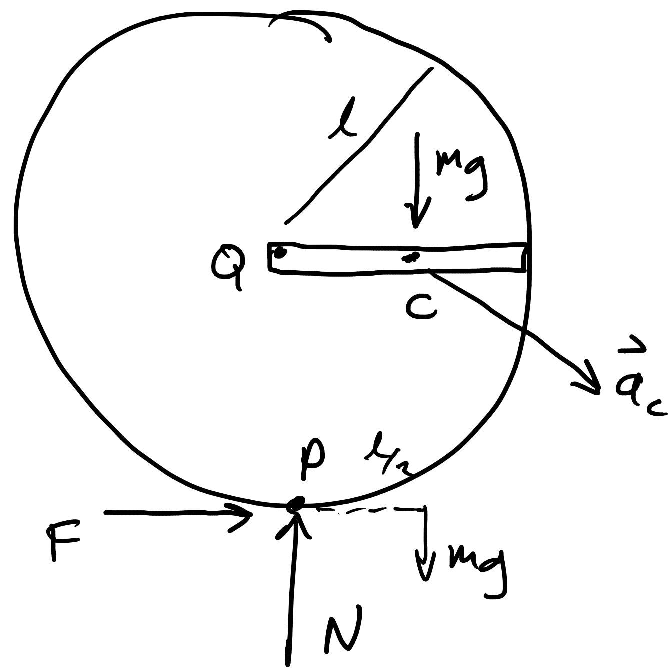
② $\sum \vec{M}_p = I_p \vec{\alpha} + \vec{r}_{pc} \times m\vec{a}_p$

ex



$\vec{\omega} = 0$

$\vec{\alpha} = -\alpha \hat{k}$



moments about P do not depend on F, N

① $\sum \vec{M}_P = I_C \vec{\alpha} + \vec{r}_{PC} \times m\vec{a}_C$

$$-\frac{mgl}{2}\hat{k} = -\frac{1}{12}ml^2\alpha\hat{k} + \left(\frac{l}{2}\hat{i} + l\hat{j}\right) \times m\vec{a}_C \quad \left(\alpha l\hat{i} - \frac{\alpha l}{2}\hat{j}\right)$$

k i j

$$\vec{a}_C = \vec{a}_Q + \vec{\alpha} \times \vec{r}_{QC} + \vec{\omega} \times (\vec{\omega} \times \vec{r}_{QC})$$

$$= \alpha l\hat{i} + (-\alpha\hat{k}) \times \frac{l}{2}\hat{i} + 0$$

$$= \alpha l\hat{i} - \frac{\alpha l}{2}\hat{j}$$

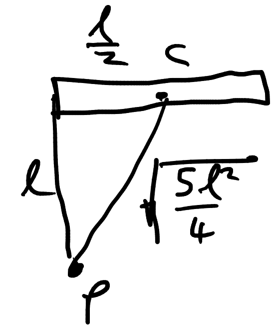
$$-\frac{mgl}{2}\hat{k} = -\frac{1}{12}ml^2\alpha\hat{k} - \frac{5}{4}m\alpha l^2\hat{k}$$

$$= -\frac{4}{3}ml^2\alpha\hat{k}$$

$$\frac{mgl}{2} = \frac{4}{3}ml^2\alpha$$

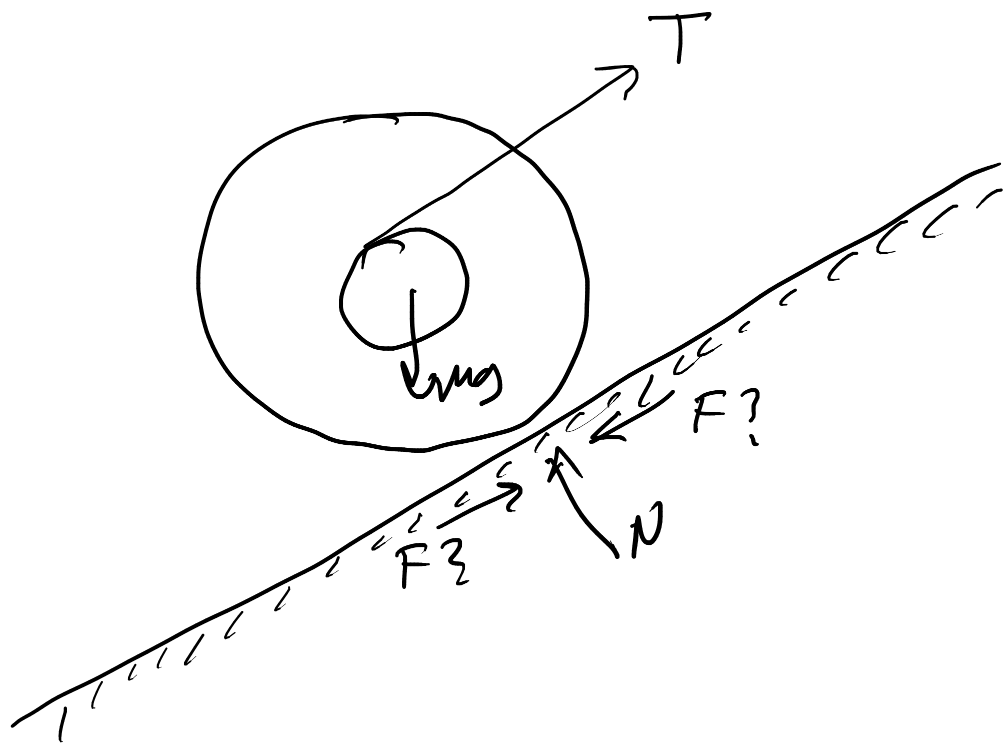
$$\boxed{\alpha = \frac{3}{8}\frac{g}{l}}$$

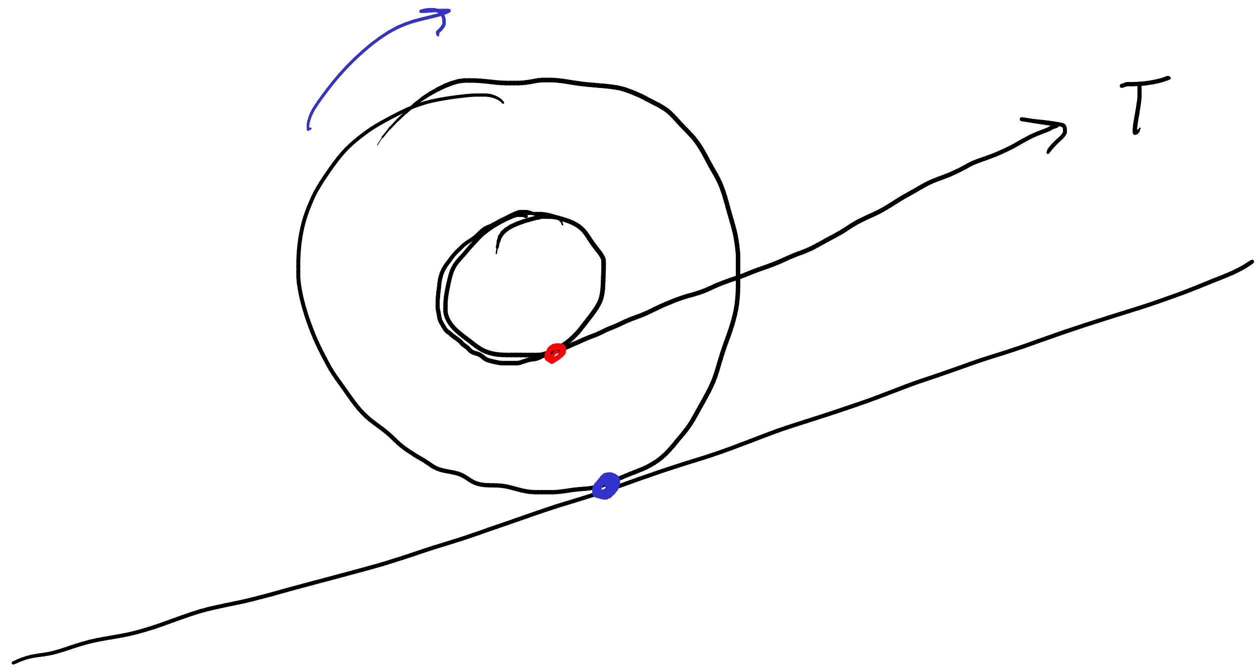
2 $\quad \sum \vec{M}_p = I_p \vec{\alpha} + \vec{r}_{pc} \times \cancel{\vec{a}_p} \to 0$



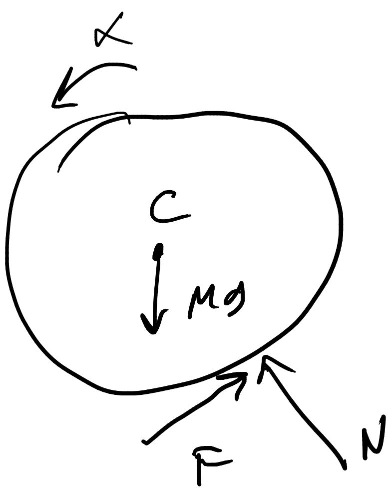
$$-\frac{mgl}{2}\hat{k} = -\left(I_c + m\frac{5}{4}l^2\right)\alpha\hat{k}$$

$$\Rightarrow \quad \alpha = \frac{3}{8}\frac{g}{l}$$





falling $T=0$



static