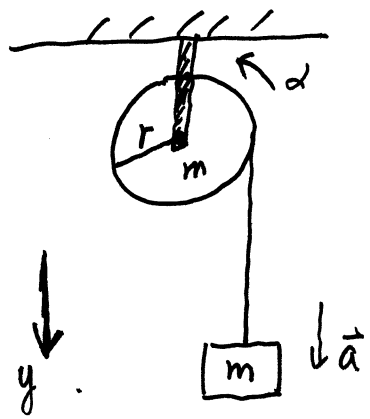
Phys 101. Lecture 21.

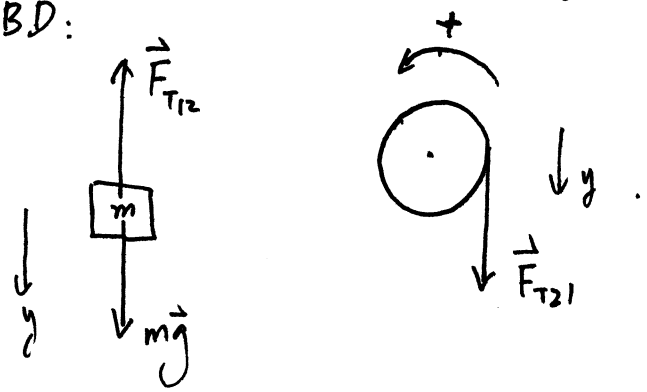
solid cylinder : $I = \frac{1}{2} m r^2$

e.g: Acceleration of a Pulley

Find: α in terms of (m), r, g.



FBD:



$F_{T12} = F_{T21}$ (magnitude) $= F_T$ (Newton's 3rd law)

$$\begin{cases} mg - F_T = m a_y & (\vec{F} = m\vec{a}) \\ -F_T r = I\alpha = \frac{1}{2} m r^2 \alpha & (\tau = I\alpha). \\ a_y = -\alpha \cdot r & \text{—— because } \downarrow y \text{ is opposite to ccw.} \end{cases}$$

$\therefore$ $mg - F_T = -mr\alpha$

$-F_T = \frac{1}{2} mr\alpha$

$mg + \frac{1}{2} mr\alpha = -mr\alpha$.

$mg = -\frac{3}{2} mr\alpha$.

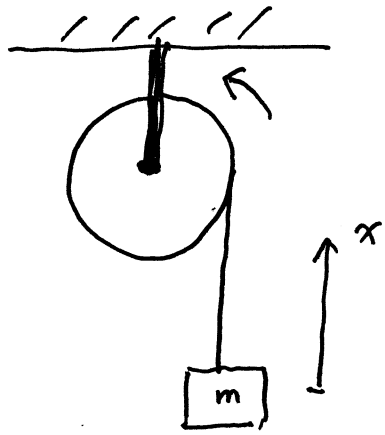
$\alpha = -\frac{2}{3}\frac{g}{r}$.

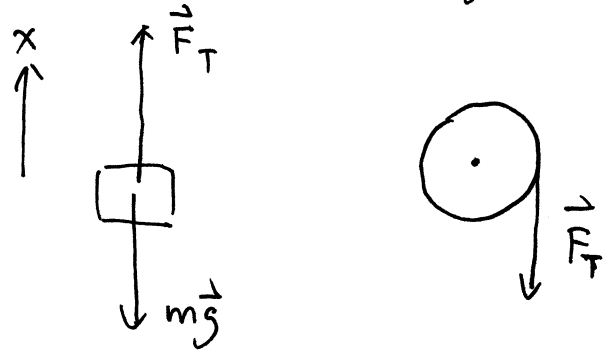
A better choice of the coordinate system.

positive x —— upward.

(Then $a_x = r\alpha$)

same sign





$$\begin{cases} F_T - mg = ma_x \\ -F_T r = \frac{1}{2} m r^2 \alpha \\ a_x = r\alpha \end{cases}$$

$$\therefore \quad F_T - mg = mr\alpha$$

$$(+) \quad -F_T = \frac{1}{2} mr\alpha$$

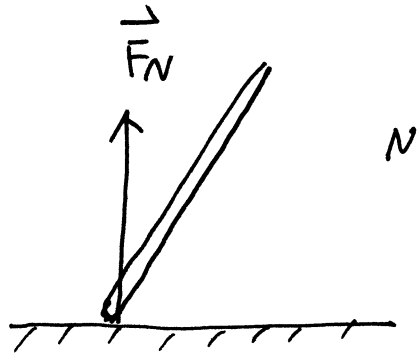
$$-mg = \frac{3}{2} mr\alpha.$$

$$\alpha = \frac{-2g}{3r}.$$

"$-$" —— CW.

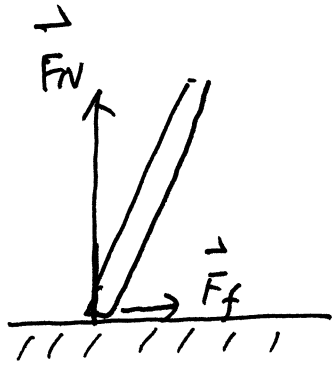
• Different kinds of supports in statics.

1. Rod on smooth ground.
   can slide,
   No friction.



Normal force only.

2. With friction. can slide.

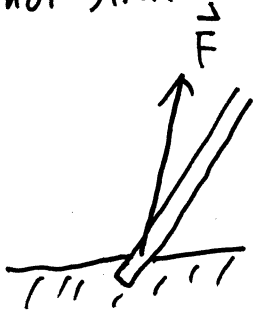


Normal force and friction.

$F_{f\,max} = \mu_s F_N$.

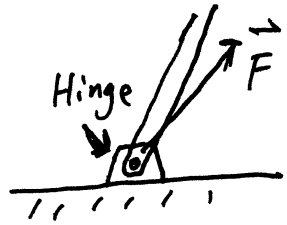
(when sliding. $F_f = \mu_k F_N$)

3. can not slide



(can't rotate)

OR.



(can rotate)

$\vec{F}$ — in an unknown direction!
(in general NOT along the rod).

4. Cable. (flexible)

Tension $\vec{T}$ is always along the cable.