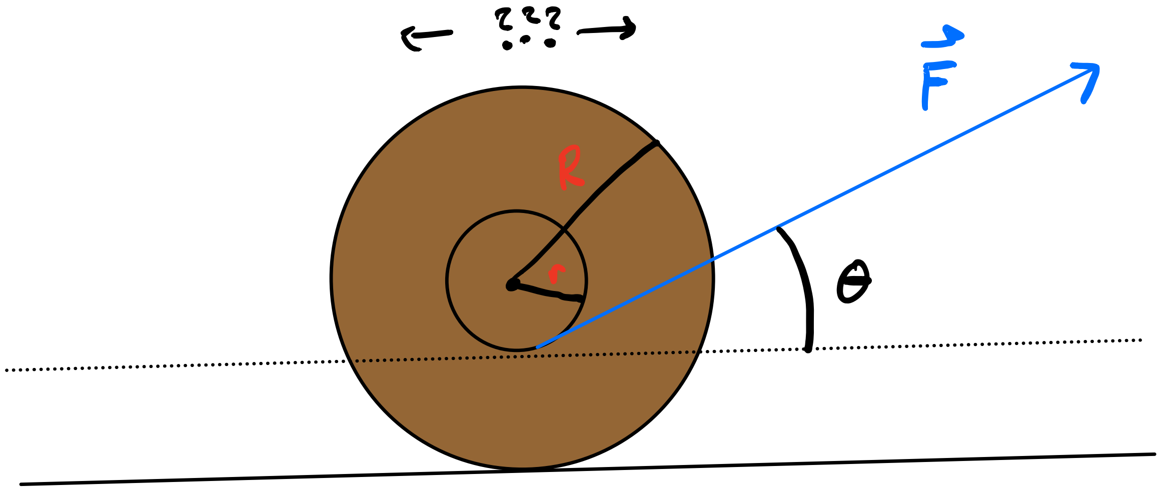
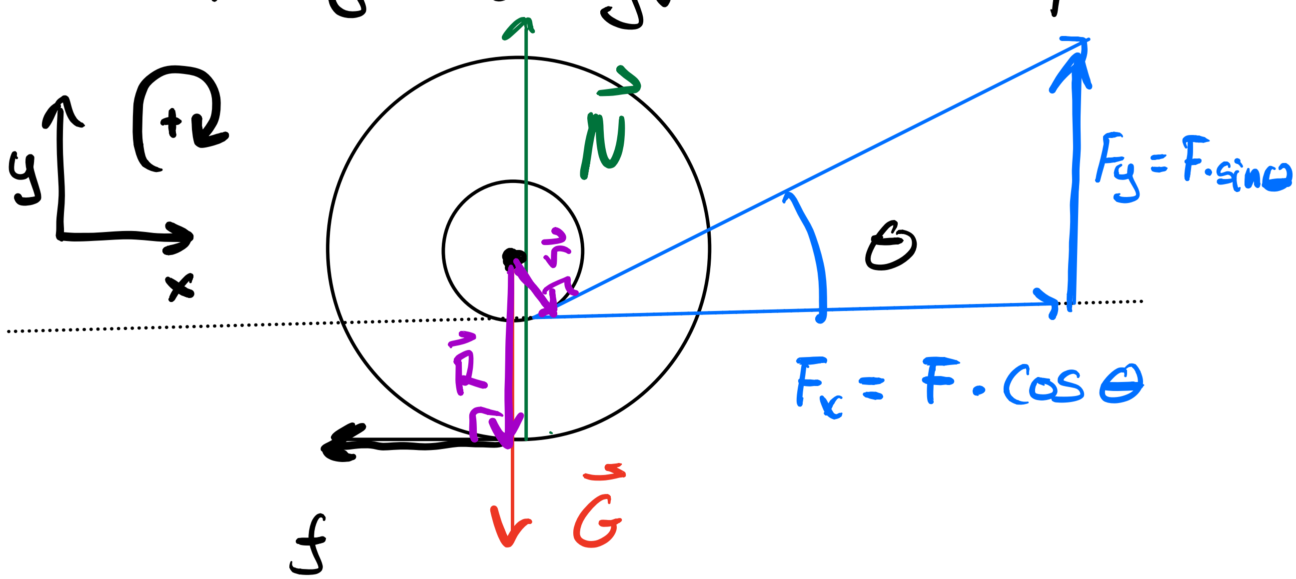
Hvilken vei ruller en Jo-jo.



Frilegemediagram:



N. 2. lov

$\sum \vec{F} = m\vec{a}$

x: $F \cdot \cos\theta - f = Ma$ (1)

y: $N - G + F \cdot \sin\theta = 0$ (2)

Spinnsats

$\sum \vec{\tau} = I\vec{\alpha}$

$\tau_F = -r \cdot F$ (+)

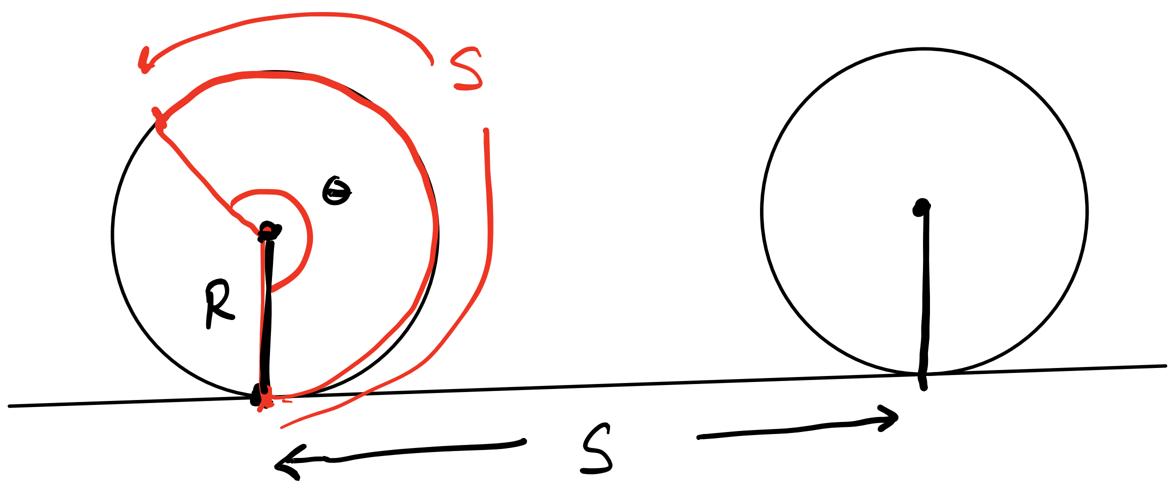
$\tau_f = R \cdot f$ (−)

$$R \cdot f - rF = I\alpha \quad (3)$$

Rullebetingelse: $\alpha \cdot R = a \quad (4)$

(Antar rulling uten å gli)

$$\boxed{\alpha = \frac{a}{R}}$$



$S = R \cdot \theta$ rullebeingelse

$$v = \frac{d}{dt}S = \frac{d}{dt}(R\cdot\theta) = R \cdot \frac{d\theta}{dt} = R\omega$$

$$a = \frac{d\omega}{dt} = \frac{d}{dt}(R\omega) = R \cdot \frac{d\omega}{dt} = R\alpha$$

Vi kjenner treghetsmoment $I = \frac{1}{2}MR^2$

③+④ $Rf - rF = \frac{1}{2}MR^{\cancel{2}} \cdot \frac{a}{\cancel{R}}$

$$Rf = \frac{1}{2}M \cdot R \cdot a + rF \quad \Big| \cdot \frac{1}{R}$$

$$\boxed{f = \frac{1}{2}Ma + \frac{r}{R}F}$$

innsat i ① $F \cdot \cos\theta - f = Ma$ ①

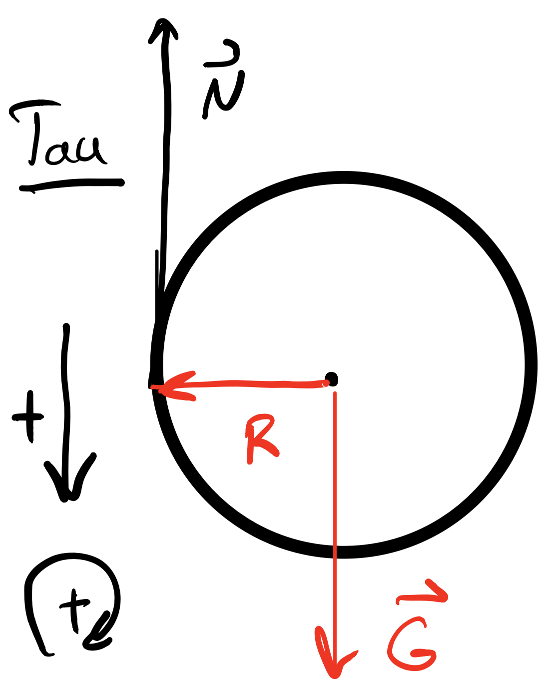
$$F \cdot \cos\theta - \left(\frac{1}{2}Ma + \frac{r}{R}F\right) = Ma$$

$$F \cdot \cos\theta - \frac{1}{2}Ma - \frac{r}{R}F = Ma$$

$$F \cdot \left(\cos\theta - \frac{r}{R}\right) = Ma + \frac{1}{2}Ma$$

$$a = \frac{F}{M}\left(\cos\theta - \frac{r}{R}\right)$$

Hvor raskt faller et sylinderskall?



$I_{cm} = MR^2$

M - massen

R - radius

$\boxed{\text{N. 2. lov} \\ \text{spinnsats} \\ \text{Rullebetingelse}}$

N. 2. lov $\quad G - N = Ma \quad (1)$

Spinnsats $\quad R \cdot N = I_{cm}\alpha \quad (2)$

rullebet. $\quad \alpha \cdot R = a \quad (3)$

α, a, N

③ $\alpha = \dfrac{a}{R}$

③+②: $R \cdot N = I_{cm} \dfrac{a}{R}$

$I_{cM} = MR^2$

$\cancel{R} \cdot N = MR^{\cancel{2}} \cdot \dfrac{a}{\cancel{R}}$

$\underline{N = M \cdot a}$

① $G - N = Ma$

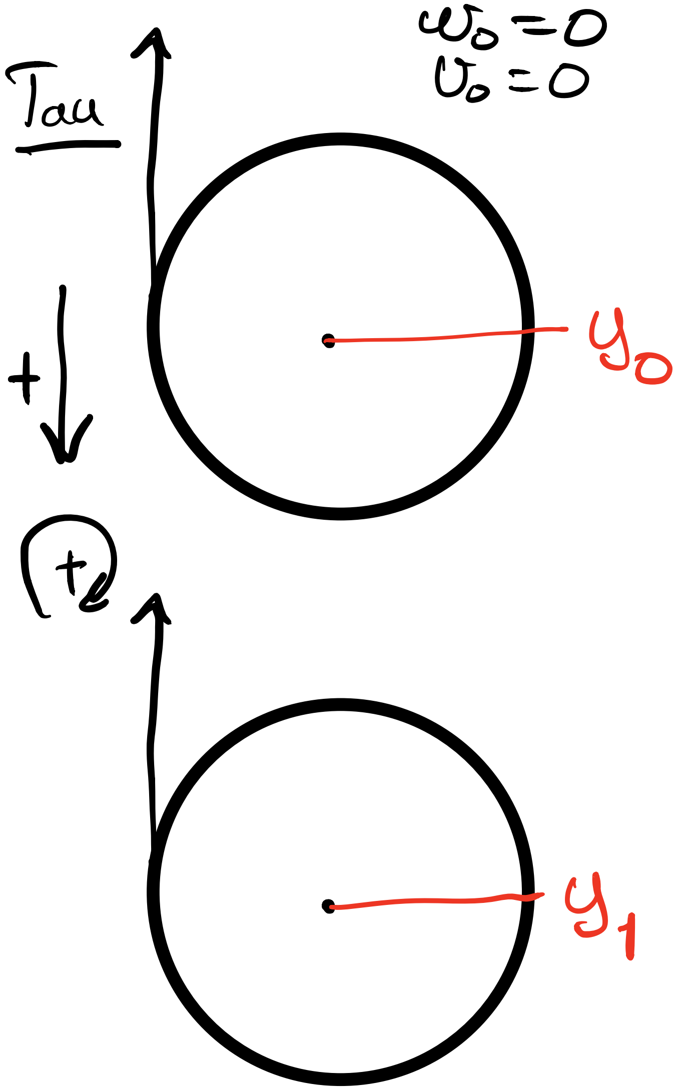
$Mg - Ma = Ma$

$\cancel{M}g = 2 \cdot \cancel{M}a$

$$\underline{\underline{a = \frac{1}{2} g}}$$

Energi

$\omega_0 = 0$
$v_0 = 0$



$$E = \underbrace{K_0}_{=0} + \underbrace{U_0}_{Mgy_0}$$

$$E = \underbrace{K_1}_{\frac{1}{2}Mv^2 + \frac{1}{2}I\omega^2} + \overbrace{U_1}^{Mgy_1}$$

$$Mgy_0 = \frac{1}{2}Mv^2 + \frac{1}{2}I\omega^2 + Mgy_1$$

$$\boxed{\text{rullebetingelse} \quad v = R\omega, \quad \omega = \frac{v}{R}}$$

$$Mg(y_0 - y_1) = \frac{1}{2} M v^2 + \frac{1}{2} I \left(\frac{v}{R}\right)^2$$

$$I = MR^2$$

$$Mg(y_0 - y_1) = \frac{1}{2} M v^2 + \frac{1}{2} M \cancel{R^2} \frac{v^2}{\cancel{R^2}}$$

$$Mg(y_0 - y_1) = \frac{1}{2} M v^2 + \frac{1}{2} M v^2$$

$$\cancel{M} g(y_0 - y_1) = \cancel{M} v^2$$

$$\underline{\underline{v = \sqrt{g(y_0 - y)}}}$$

$$v(0) = 0$$

$$x(0) = 0$$

$$a = g$$

$$v = \int a\,dt = gt$$

$$x = \int v\,dt = \underline{\frac{1}{2} g t^2}$$

h

$$h = \frac{1}{2} g t^2$$

$$\underline{t = \sqrt{\frac{2h}{g}}}$$

$$v = g \cdot t = g \cdot \sqrt{\frac{2h}{g}} = \underline{\underline{\sqrt{2gh}}}$$