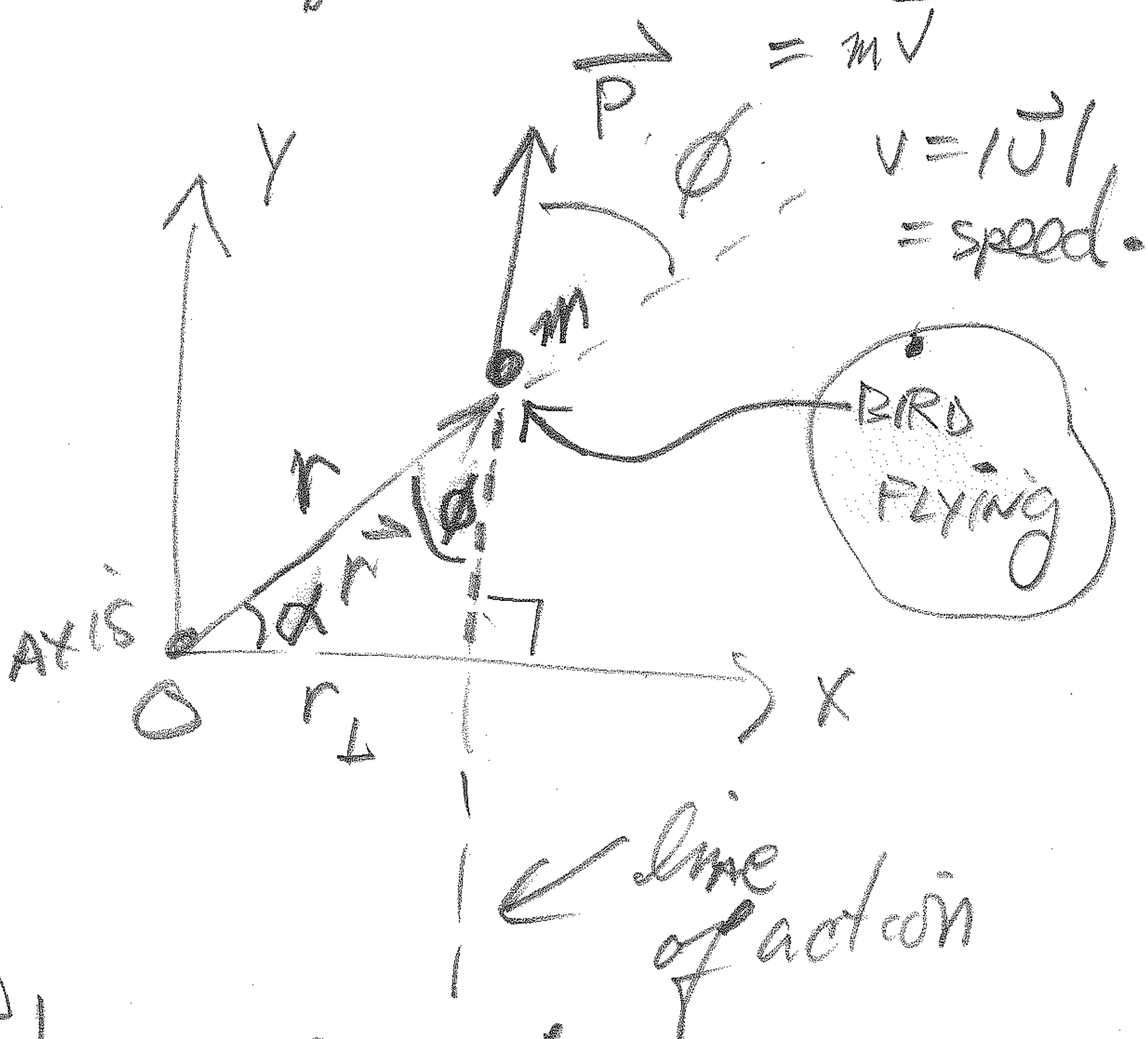
2A 10-31-13

CW10

angular momentum in detail:



$|\vec{L}| = r_\perp \cdot P$ like TORQUE:

$|\vec{L}| = \boxed{r \cdot \cos\alpha \cdot mv}$

$\alpha = 90 - \phi$

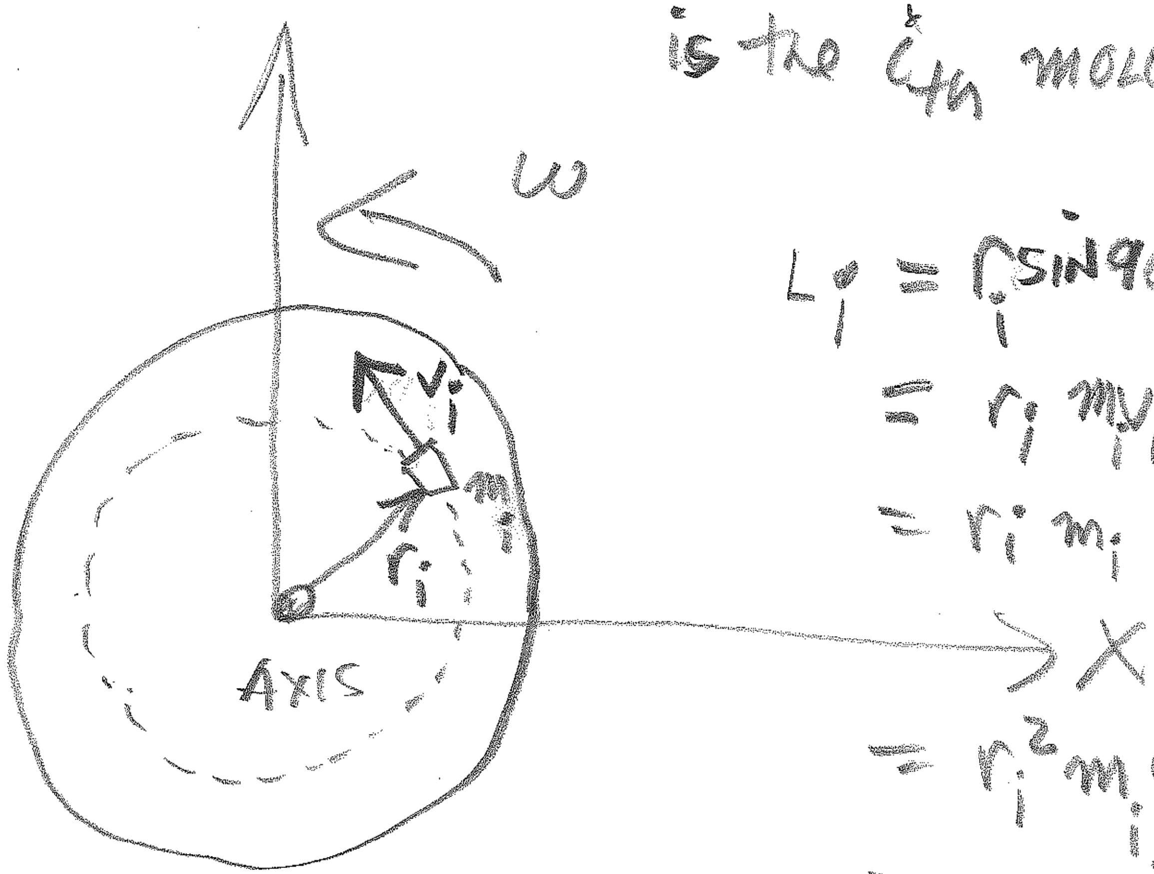
$\tau = r_\perp \cdot F$

NOTE: $|\vec{L}| = r\sin\phi \cdot mv$

$\cos\alpha = \sin\phi = \cos(90-\phi)$.

THEORETICAL TRICK:

pretend you have a solid CYLINDER (SOLID). SHOWN is the i_{th} MOLECULE.



$L_i = r_i \sin 90 \cdot m_i v_i$

$= r_i m_i v_i$

$= r_i m_i r_i \omega$

$= r_i^2 m_i \omega$

$= m_i r_i^2 \cdot \omega$

$$L_{TOTAL} = \sum_{i=1}^{N=6\times10^{25}} m_i r_i^2 \cdot \omega = I\omega$$

$$I = \sum_{i=1}^{N} m_i r_i^2$$

conservation of angular momentum

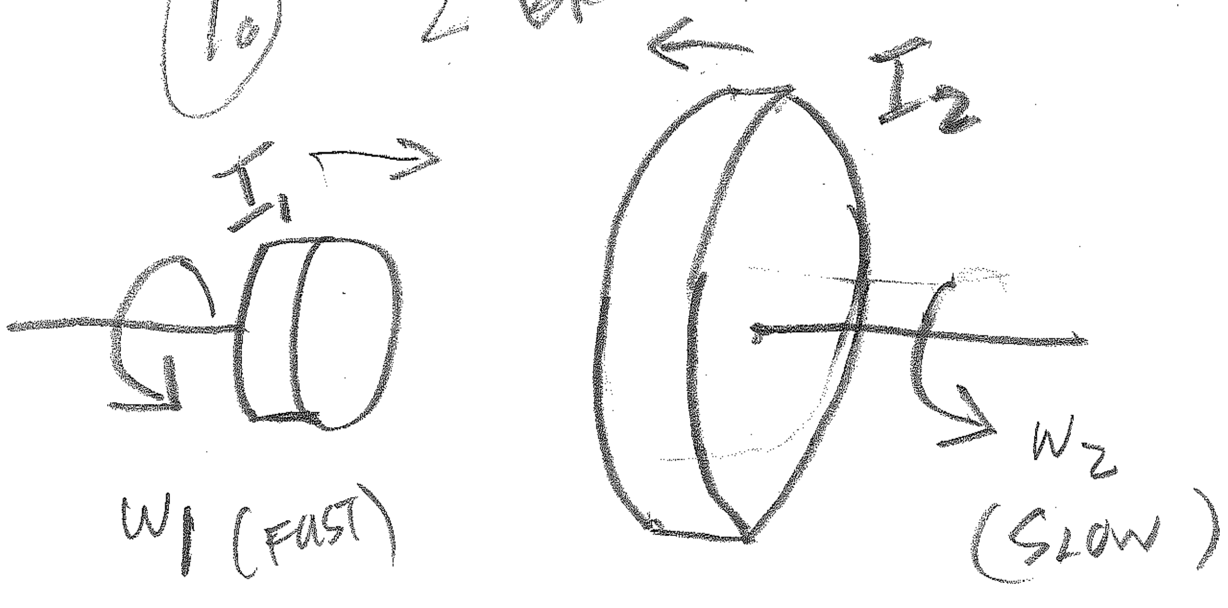
video: WORLD RECORD ice skate spinning:

Natalia Kanounnikova

~ 5 rev / second !

2 classical examples of conservation of angular momentum:

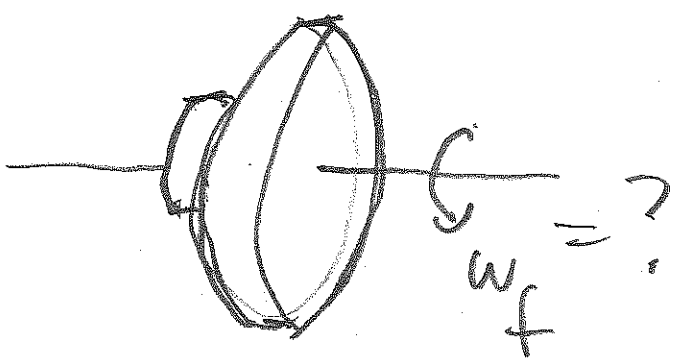
(1.) 2 brake shoes



(1.) 2 BRAKES COME INTO contact and STICK together.

what is final common angular speed?

contact (stuck); turn together.

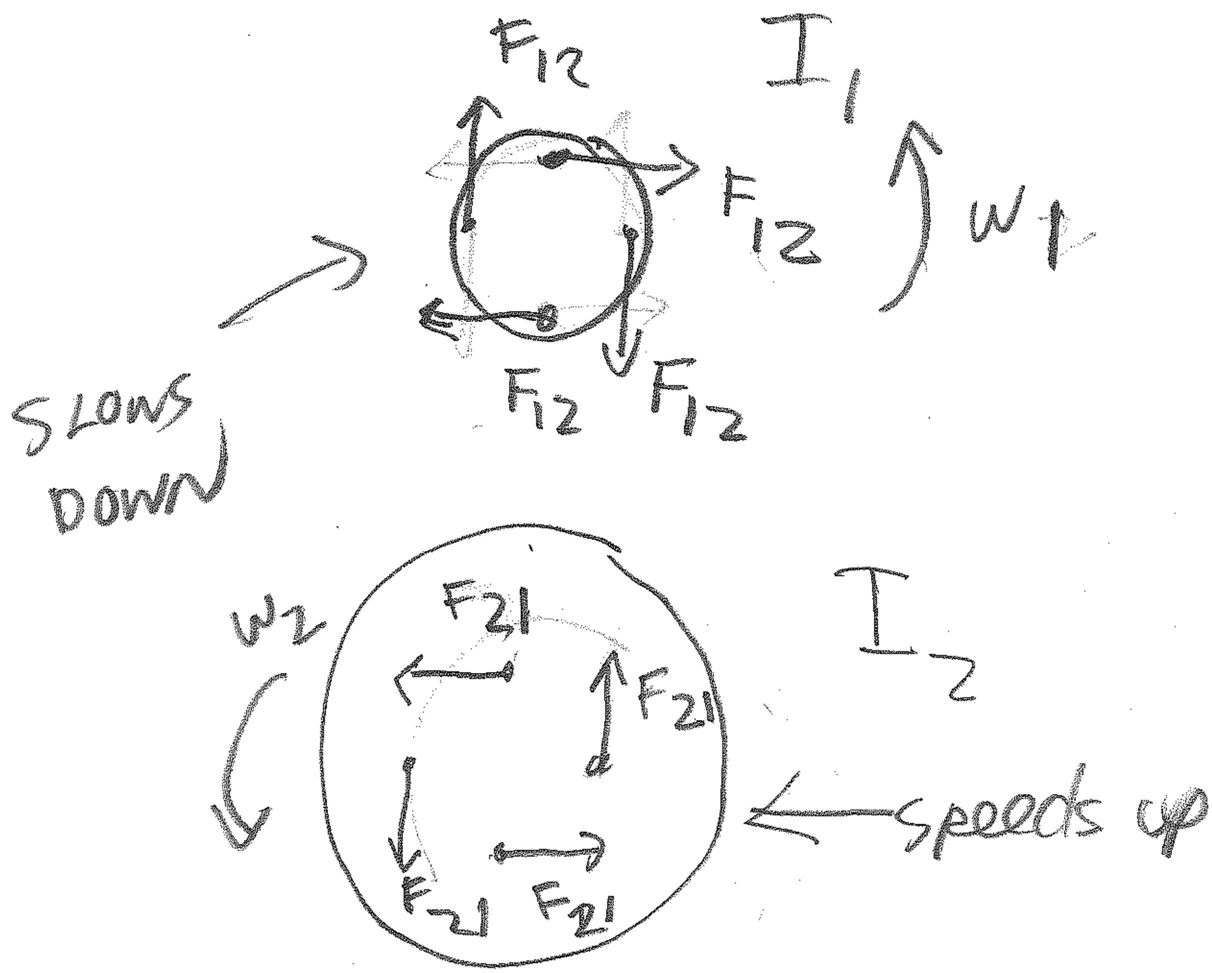


conservation of angular momentum

$$L_i = L_f$$

$$I_1 \omega_1 + I_2 \omega_2 = I_1 \omega_f + I_2 \omega_f$$

(1) NOTE: when they first come into contact:



N's 3RD LAW: $F_{21} = F_{12}$

Equal and opposite TORQUES

net TORQUE = 0 →

$$\Delta L_1 + \Delta L_2 = 0$$

$$\frac{\Delta L_1}{\Delta t} + \frac{\Delta L_2}{\Delta t} = 0$$

$$\hat{\tau}_{12} + \hat{\tau}_{21} = 0$$

$$\hat{\tau}_{12} = -\hat{\tau}_{21}$$

Thus ang. mom. is conserved

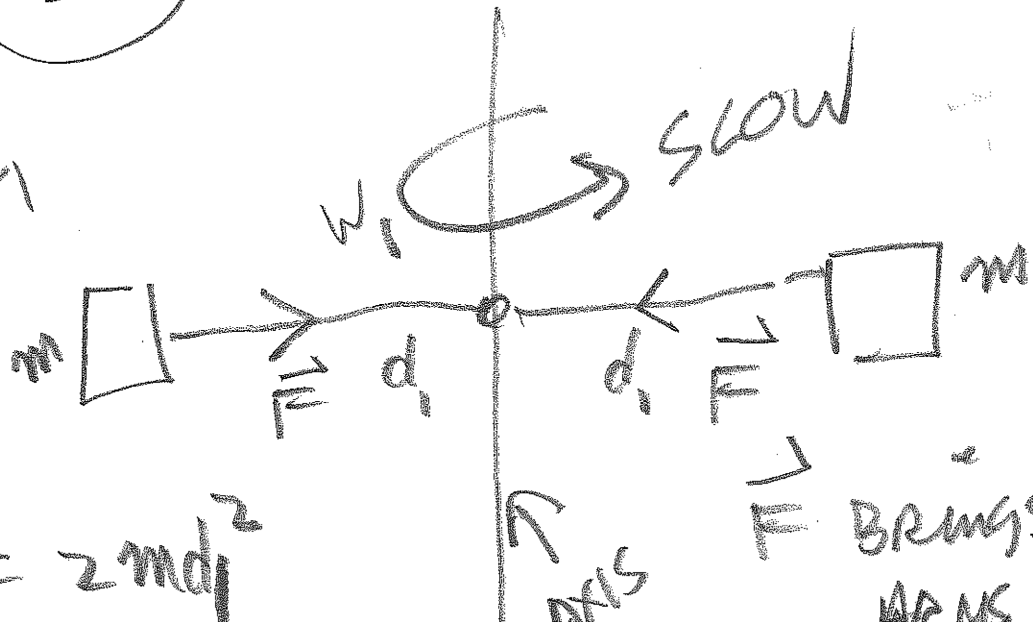
$$I_1 w_1 + I_2 w_2 = (I_1 + I_2) w_f$$

$$w_f = \frac{I_1 w_1 + I_2 w_2}{(I_1 + I_2)}$$

$$\boxed{w_2 < w_f < w_1}$$

(2.) ice skater pulls in arms

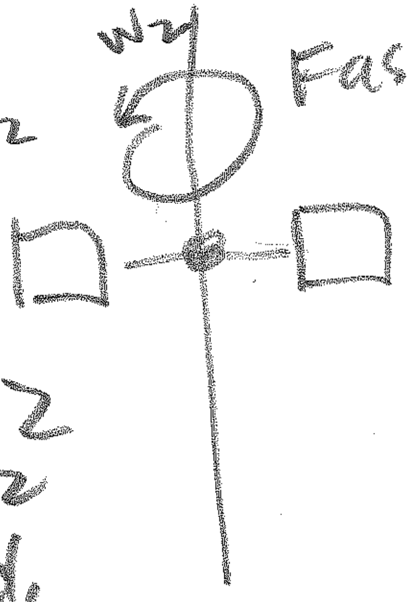
I_1



$I_1 = 2md_1^2$

$\vec{F}$ BRINGS ARMS INWARD

I_2



BUT $\vec{F}$ POINTS THROUGH AXIS OF ROTATION. THUS $\vec{F}$ CAUSES NO TORQUE.

$I_2 = 2md_2^2$

$d_2 < d_1$

$I_2 < I_1$

$L_i = L_f$

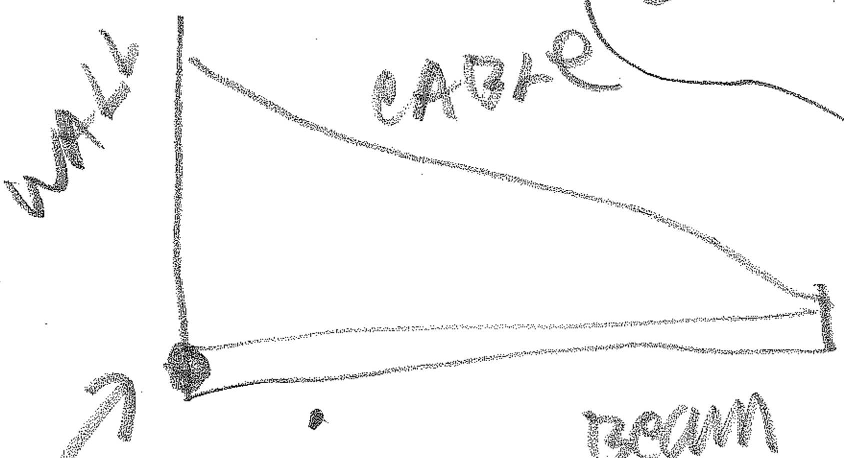
$I_1 w_1 = I_2 w_2 \Rightarrow w_2 = \frac{I_1}{I_2} w_1$

NOTE $w_2 > w_1$

STATICS 10.6

2 classical problems

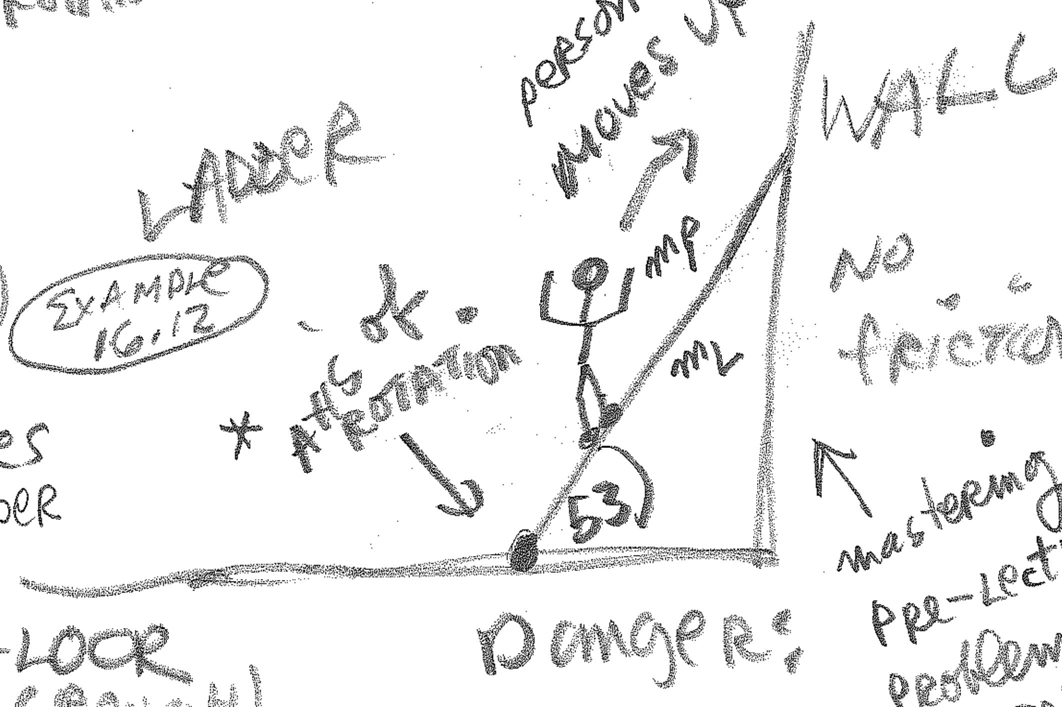
I.



construction beam held up by a cable

II. LADDER

(EXAMPLE 16.12)



* AXIS OF ROTATION

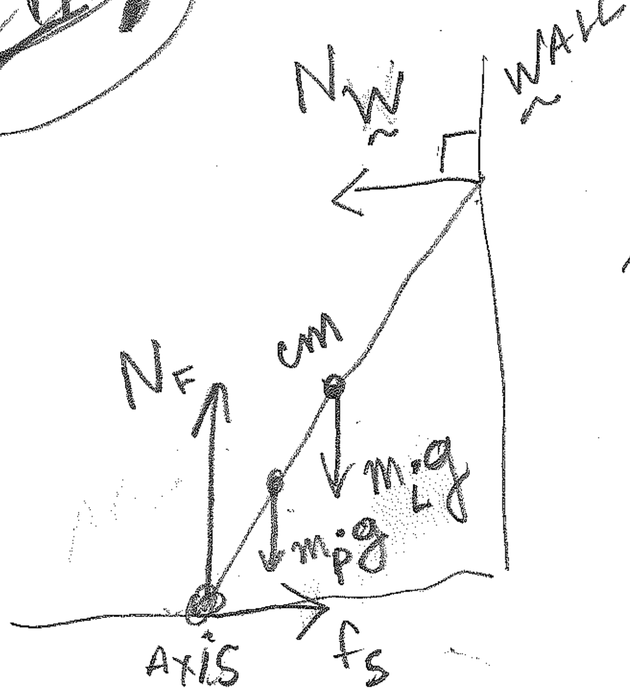
NO friction

* AXIS moves left if LADDER slips.

Danger:

mastering pre-lecture problem

(II.) Example 16.12



m_p = mass of person on ladder

$\sum F_x = 0$

$\sum F_y = 0$

$\sum \tau = \circlearrowleft - \circlearrowright = 0$

Axis

(a.) Find N_W, N_F, f_s

(b.) Find μ_s if $f_s = f_{s\,max}$

(c.) Find vector sum of $\vec{f_s}$ and $\vec{N_F}$

LADDER EXAMPLE 16.12

(II.) (a.)

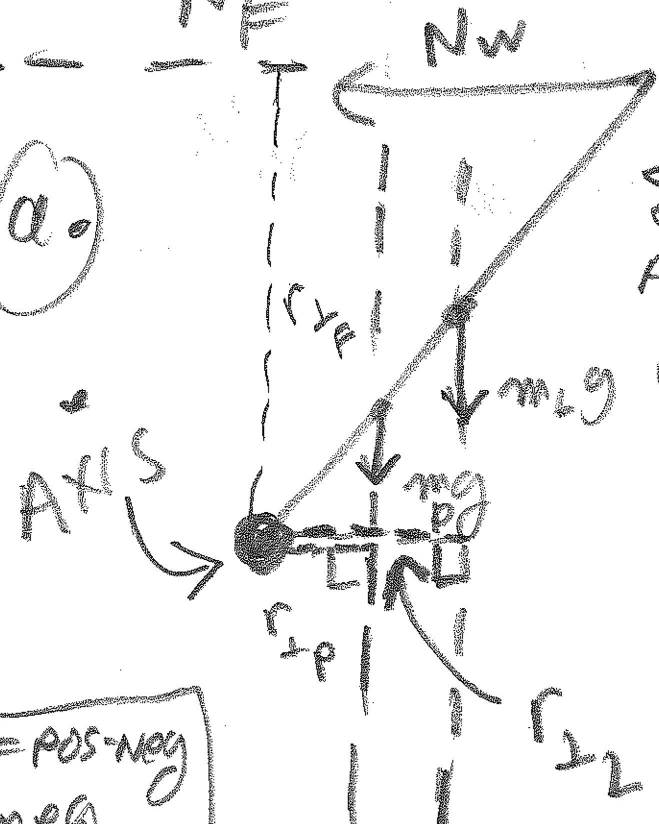
$$\sum F_y = 0 = N_F - m_p g - m_L g$$

$$N_F = m_p g + m_L g$$

$$N_F = 800(N) + 180(N)$$

$$N_F = 980(N)$$

(a.)



$$\sum_{Axis} \tau = ↺ - ↻$$

$$0 = r_{\perp F} N_W - r_{\perp L} m_L g - r_{\perp p} m_p g$$

$$N_W = \frac{r_{\perp L} m_L g + r_{\perp p} m_p g}{r_{\perp F}}$$

$$= \boxed{268(N)}$$

$\sum F_x = 0 = pos - neg$

$0 = pos - neg$

$0 = f_s - N_W$

$f_s = N_W = 268(N)$