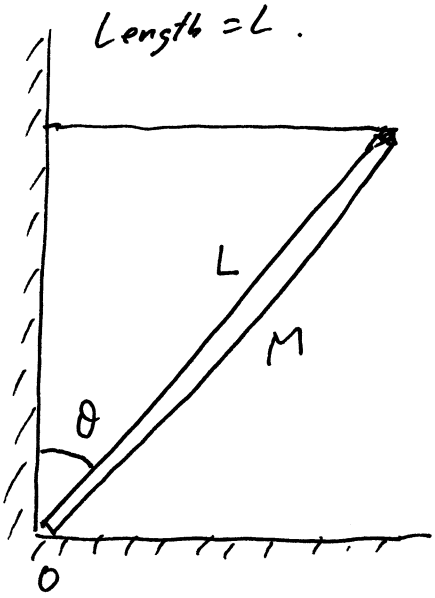
Phys 101 · Lecture 24.

Examples (statics and rotation)

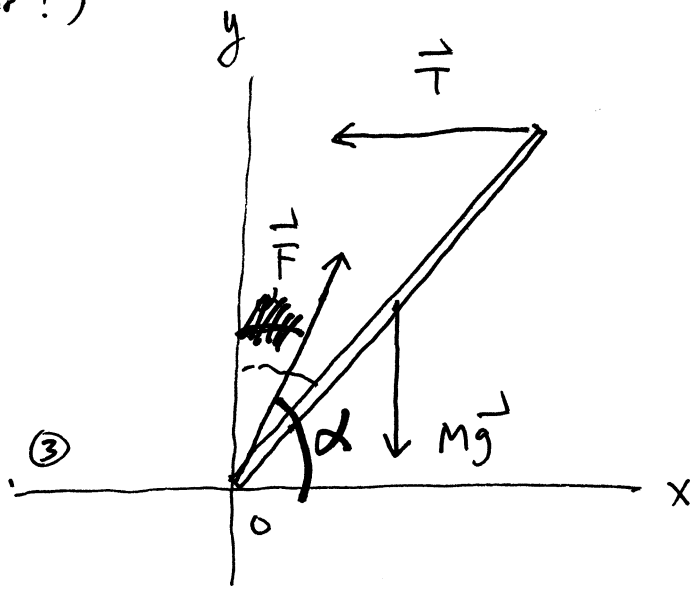
e.g.: A bar is held against a wall, by a horizontal wire. The bottom of the bar is wedged against the wall, with an angle θ.

mass = M.
Length = L.



Find: Force on bar at the corner.

FBD. ($\vec{F}$ is not along the bar!)



$\Sigma \vec{F} = 0$:

$$F_x - T = 0 \quad (1)$$

$$F_y - Mg = 0 \quad (2)$$

$\Sigma \tau = 0$: (about O)

$$TL\cos\theta - Mg\frac{L}{2}\sin\theta = 0 \quad (3)$$

Solve (1), (2), (3) for T, F_x, F_y:

(3): $T = \frac{Mg}{2}\frac{\sin\theta}{\cos\theta} = \frac{Mg}{2}\tan\theta$.

(1): $F_x = T = \frac{Mg}{2}\tan\theta$

(2): $F_y = Mg$.

$$F = \sqrt{F_x^2 + F_y^2}$$

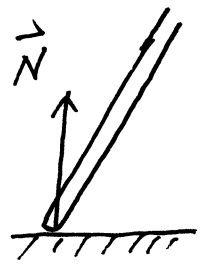
$$= \sqrt{\left(\frac{Mg}{2}\right)^2 \tan^2\theta + (Mg)^2}$$

$$= Mg\sqrt{1 + \left(\frac{\tan\theta}{2}\right)^2}$$

$$\alpha = \tan^{-1}\frac{F_y}{F_x} = \frac{\tan^{-1} 2}{\tan\theta}$$

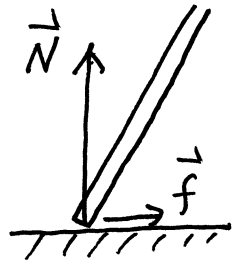
• Different kinds of supports in statics.

1. { Rigid body
   { can slide
   { No friction



Normal force only

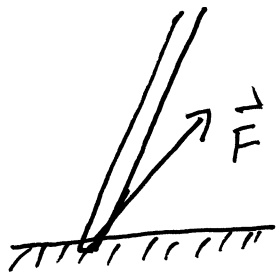
2. { Rigid body
   { can slide
   { with friction



Normal force and friction

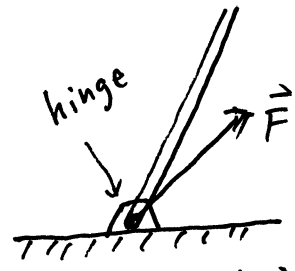
$f_{max} = \mu_s N$

3. { Rigid body
   { can not slide



(can't rotate).

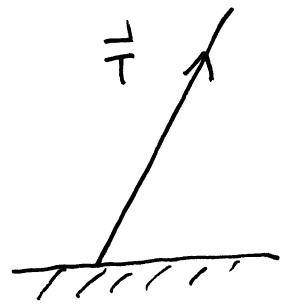
OR:



(can rotate)

$\vec{F}$ — with an unknow direction!
(In general, NOT along the beam)

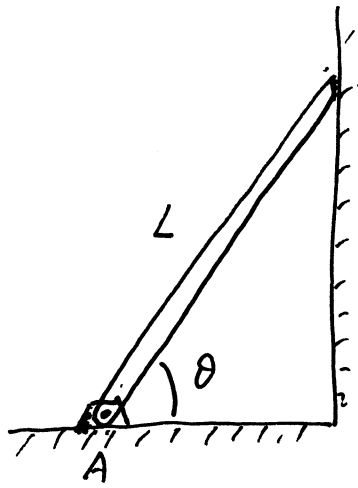
4. { Cable (flexible)



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

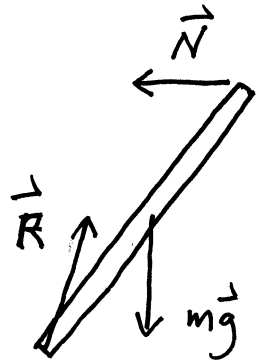
e.g. A bar leans against a smooth wall.

The bottom is held by a hinge. (can rotate, can't slide)



Given:
mass = m
Length = L
angle = θ.

Find the magnitude of the force that the hinge exerts on the bar.



[solution]. FBD:

$\Sigma \vec{F} = 0$: $R_x - N = 0$

$R_y - mg = 0$

$\Sigma \tau = 0$. (About point A): $NL\sin\theta - mg\frac{L}{2}\cos\theta = 0$

$$N = \frac{mg\cos\theta}{2\sin\theta}$$

$$R_x = N = \frac{mg\cos\theta}{2\sin\theta}$$

$$R_y = mg.$$

$$R = \sqrt{R_x^2 + R_y^2} = \sqrt{\frac{m^2g^2\cos^2\theta}{4\sin^2\theta} + m^2g^2}$$

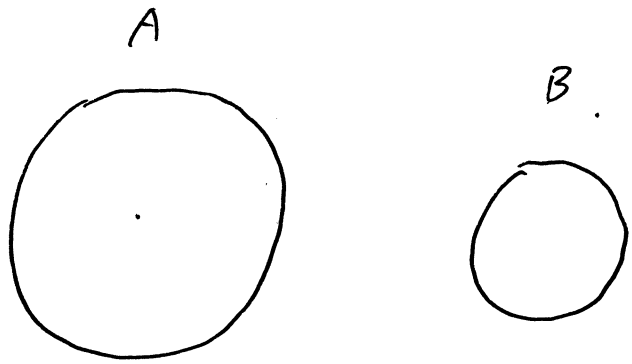
$$= mg\sqrt{\frac{\cos^2\theta}{4\sin^2\theta} + 1}.$$

e.g. Two thin disks, A. B.

Same thickness h,

same density ρ.

Disk A has a moment of inertia of I while disk B has $I/16$.



$R_A = R$ $\quad$ $R_B = ?$

$I_A = I$ $\quad$ $I_B = I/16$.

Question: If disk A has a radius of R, what is the radius of disk B?

A) R, B) $2R$, C) $R/2$, D) $4R$, E) $R/4$.

$I = \frac{1}{2} M R^2$. But. $M = \pi R^2 \cdot h \cdot \rho$.

$\therefore \quad I \propto R^4$

when R changes by a factor of 2.

I will change by a factor of 16.

$\therefore \quad R_B = R/2$. (so that $I_B = I/16$)

C) is the Answer.