Phys.101.

Lecture 23.

- static equilibrium of a rigid body. ch.12 (12-1 and 12-2, 12-3).

$$\Sigma \vec{F} = 0 . \quad (\because \vec{a}_{cm} = 0)$$

$$\Sigma \tau = 0 \quad (\because \alpha = 0 .)$$

It's important to choose the pivot point. (axis of rotation)

Try to make many torques = 0.

- Solving statics problems: (Need a lot of practice)

① . Free-body diagram (for each object). are important

— Draw the whole object (shape, size)

— where the forces act.

② coordinate system.

— easy to get components.

③ . $\Sigma \vec{F} = 0$

$\Sigma \tau = 0$ —— choose the axis of rotation (pivot point)

so that as many $\tau = 0$ as possible.

↑ unknown

(make use of $\tau = 0$).

④ solve.

e.g. : 12-3, 12-4, 12-5, 12-6. — you read. at least one will show up in midterm #2.

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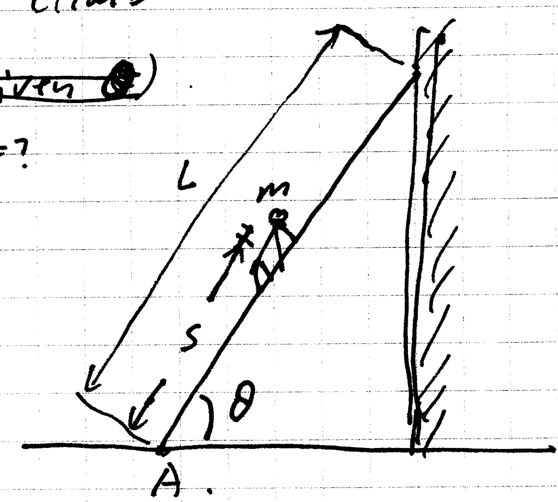
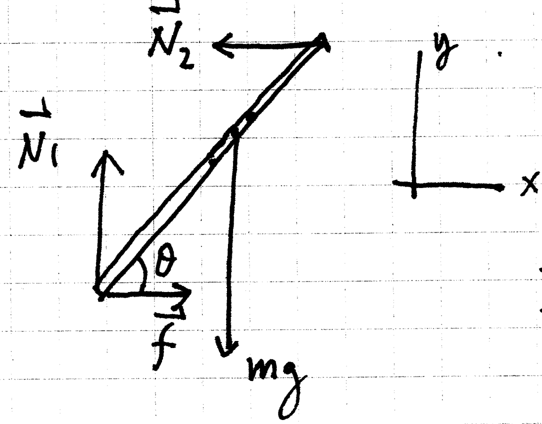
e.g. A man climbs a massless ladder against a frictionless wall. If the coefficient of friction between the ladder and the floor is μ_s, how far up the ladder can the man climb before the ladder slips? ~~given~~

given: θ, L, μ_s. find $s = ?$



① . FBD for the ladder.



$\vec{f}$: when it's about to slip,

$$f = f_{max} = \mu_s N_1$$

$\Sigma \vec{F} = 0$: x-comp: $\mu_s N_1 - N_2 = 0$ ①

y-comp: $N_1 - mg = 0$ ②

$\Sigma \tau = 0$: choose axis (pivot point) : . A. (because $\vec{f}$ and $\vec{N}_1$ go through A $\tau_f = 0$, $\tau_{N_1} = 0$)

$$N_2 \cdot L \sin\theta - mgs \cdot \cos\theta = 0 . \quad ③$$

Solve ①, ②, ③ for s : $s = \mu_s \cdot L \cdot \tan\theta$.

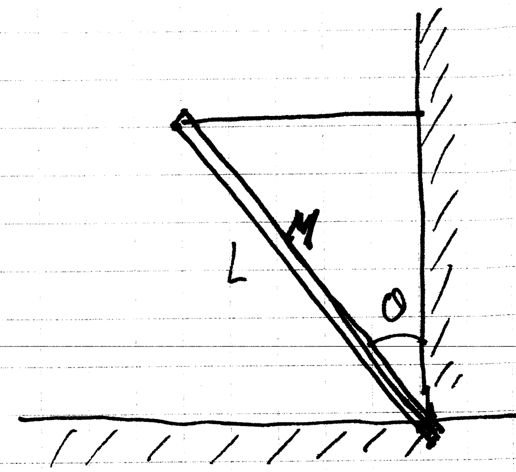
F.

$\tau = F \cdot r_\perp$

$\tau = F_\perp \cdot r$

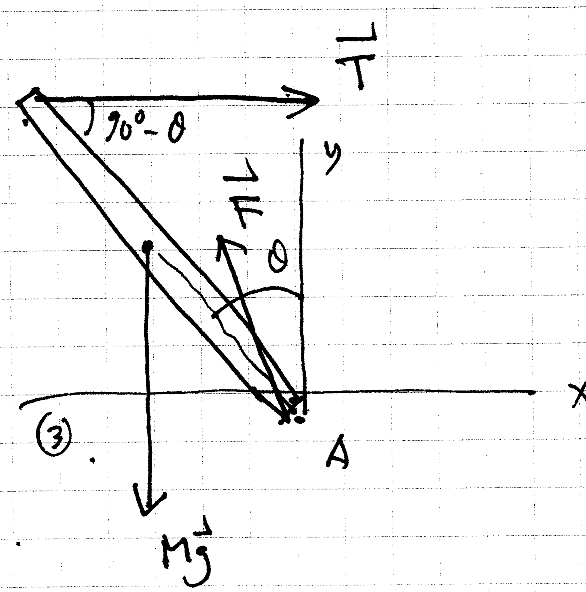
$\tau = F r \cdot \sin\theta$ — θ is angle between $\vec{F}$ and $\vec{r}$

e.g: A bar of mass M and length L is held against a wall by a horizontal wire. The bottom of the bar is wedged against the base of the wall, making an angle θ with respect to the wall. What is the magnitude of the force exerted on the bar at the corner?



given: M, θ, L.

FBD:



$\Sigma \vec{F} = 0 \quad T + F_x = 0 \quad (1)$

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

$\Sigma \tau = 0$. about the corner A

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

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

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

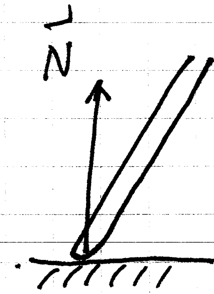
$$F_x = T = \frac{Mg}{2}\tan\theta .$$

$$F_y = Mg$$

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

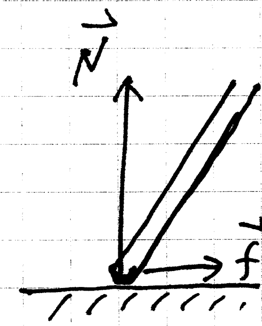
- Different kinds of supports.

1. Rigid body
   can slide.
   No friction



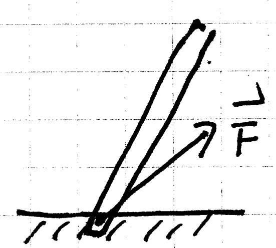
Normal force only.
(simplest).

2. Rigid body
   can slide.
   with friction

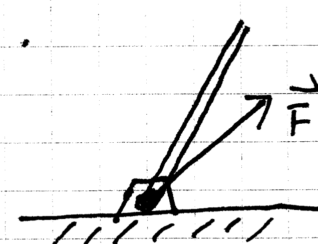


Normal force.
and friction.
(more complicated,
but : $f \leq \mu N$
or $f_{max} = \mu N$)

3. Rigid body.
   can not slide



OR :

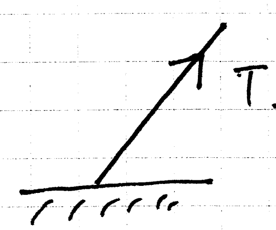


(can rotate)

$\vec{F}$ — with an unknown direction !

(usually, $\vec{F}$ is NOT along the beam !

4. Cable (flexible)



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

(flexible —— NOT transverse force)