

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 .

Find: Force on bar at the corner.

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

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

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

$$\Sigma \tau = 0. \quad (\text{about } O)$$

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

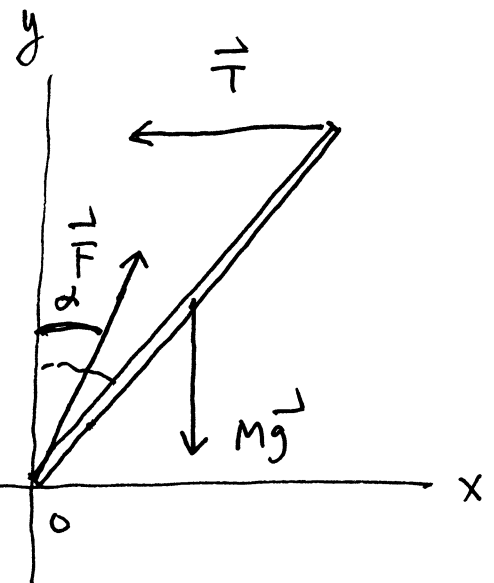
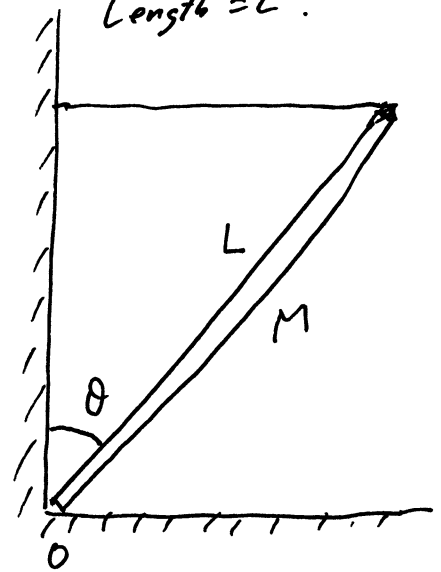
Solve (1), (2), (3) for T , F_x , F_y :

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

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

$$(2): \quad F_y = Mg$$

mass = M .
Length = L .



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

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

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

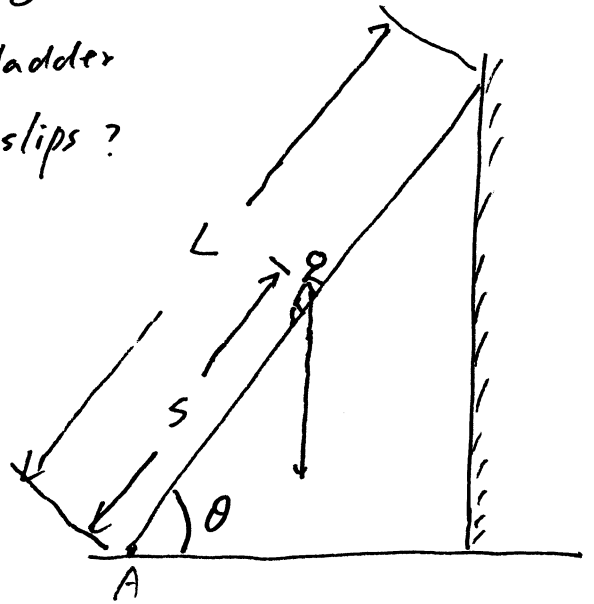
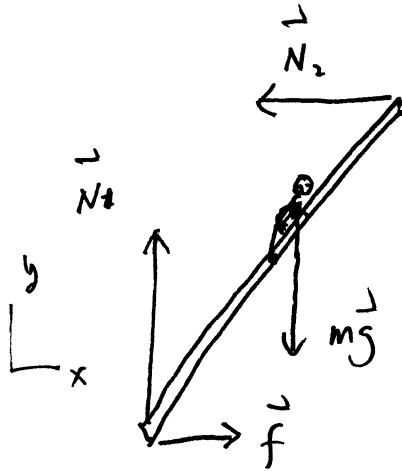
$$\alpha = \tan^{-1} \frac{F_x}{F_y} = \frac{\tan \theta}{2}$$

e.g. A man climbs a massless ladder against a frictionless wall. How far up the ladder can the man climb before the ladder slips?

Given: θ, L, μ_s

Find: $S = ?$

FBD for the ladder



$$f \leq \mu_s N_1$$

$$f = \mu_s N_1 \quad \text{when it's about to slip.}$$

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

$$y: \quad N_1 - mg = 0 \quad (2)$$

$$\Sigma \tau = 0 \quad (\text{about } A): \quad N_2 L \sin \theta - mg S \cos \theta = 0 \quad (3)$$

$$(2): \quad N_1 = mg \rightarrow (1): \quad \mu_s mg - N_2 = 0, \quad N_2 = \mu_s mg$$

$$(3): \quad S = \frac{N_2 L \sin \theta}{mg \cos \theta} = \frac{\mu_s mg L \sin \theta}{mg \cos \theta} = \mu_s L \tan \theta$$

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

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

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

[solution]. FBD:

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

$$R_y - mg = 0$$

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

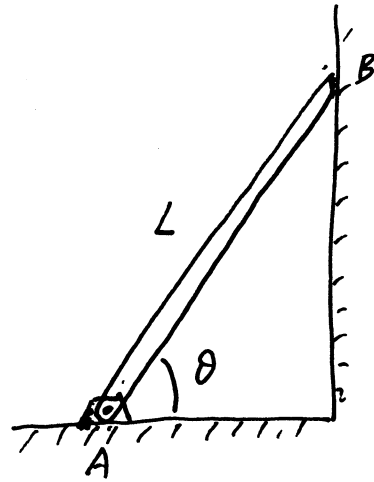
$$N = \frac{mg \cos \theta}{2 \sin \theta}$$

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

$$R_y = mg$$

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

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



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Given:

mass = \$m\$

length = \$L\$

angle = \$\theta\$

