CH 8 Equilibrium & Elasticity

→ Static & Dynamic.

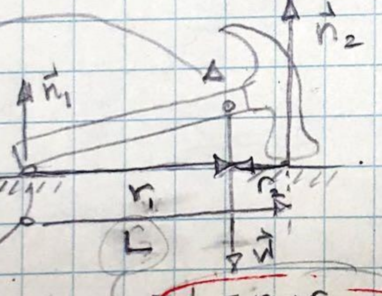
→ under what conditions does something **not** move?

Linear Equilibrium:

$$\sum \vec{F} = 0 \begin{cases} \sum F_x = 0 \\ \sum F_y = 0 \end{cases}$$ No Net Force

Rotational Equilibrium:

$$\sum \vec{\tau} = 0$$ No Net Torque



$$\sum F_y = n_1 + n_2 - w = 0$$

$$w = n_1 + n_2$$

$$L = r_1 + r_2$$

△ Pivot Point: $\sum \vec{\tau}_w + \vec{\tau}_{n_2} = -r_1 w + L\, n_2 = 0$

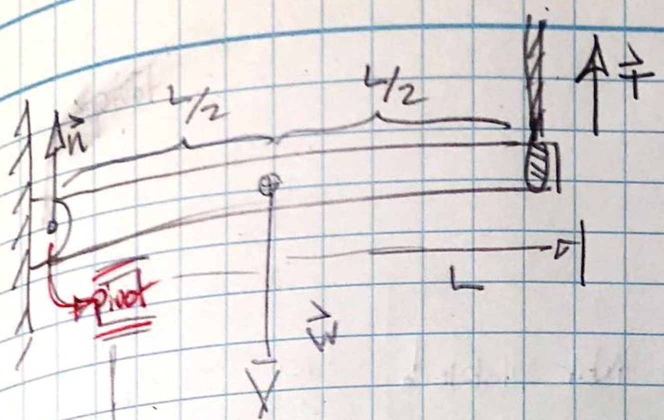
$$-r_1(n_1 + n_2) + (r_1 + r_2) n_2 = 0$$

$$(-r_1 n_1 + r_2 n_2) + r_1 n_2 - r_1 n_2 = 0$$

$= 0$!

Torque about pivot @ Center of Gravity $= 0$!

An Object In Static Eq: $\tau_{net} = F_{net} = 0$



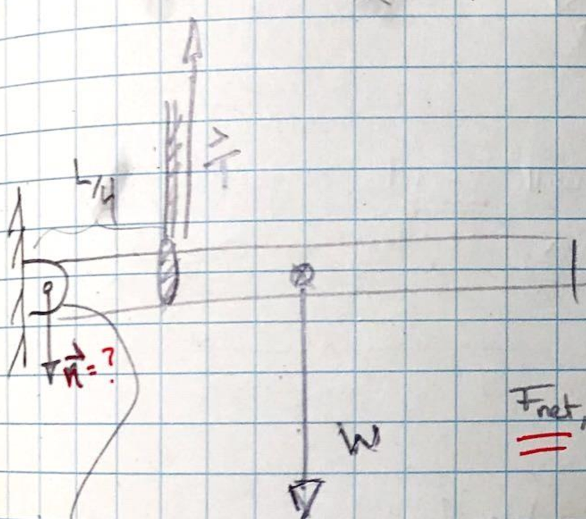
What is T? (So bar is static)

$F_{net,y} = -W + \vec{n} + \vec{T} = 0$

$n + T = W \Rightarrow n = W - T$

$\tau_{net} = -W\left(\frac{L}{2}\right) + TL = 0$

$T = \frac{W}{2} \rightarrow n = \frac{W}{2}$



What is $\vec{n}$? (Static Eq)

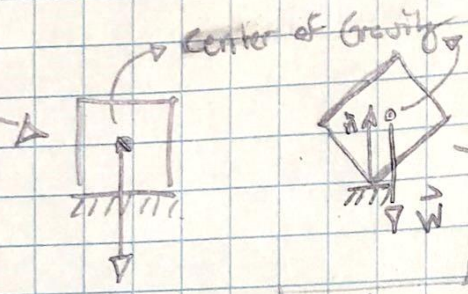
$F_{net,y} = -W + T - n = 0$

$n = T - W$ → still dont know T

$\tau_{net} = -W\left(\frac{L}{2}\right) + T\left(\frac{L}{4}\right) = 0$

$T = \frac{4W}{2} \rightarrow n = 2W - W = W$

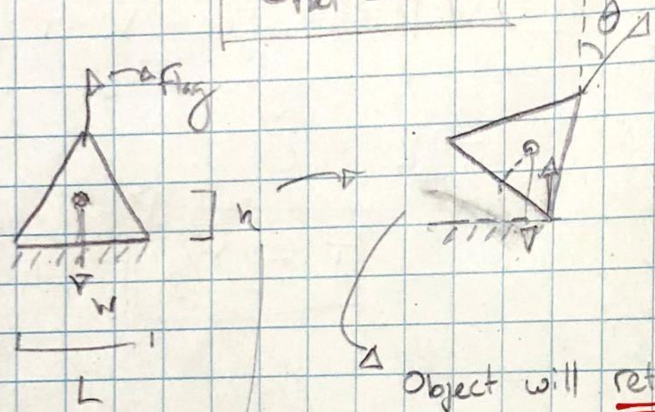
Stability + Balance:



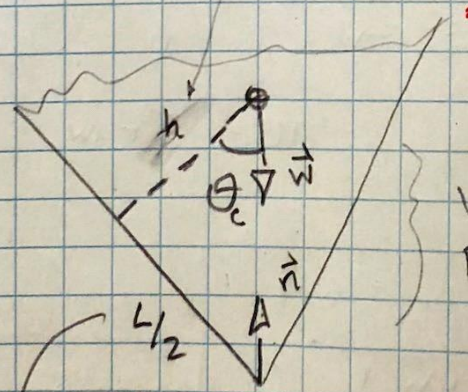
Not Stable!

$$F_{net} = 0$$
$$\tau_{net} \neq 0$$

$$\tau_{net} \geq 0$$



Object will return to original orientation, so long as $\theta \leq \theta_c$



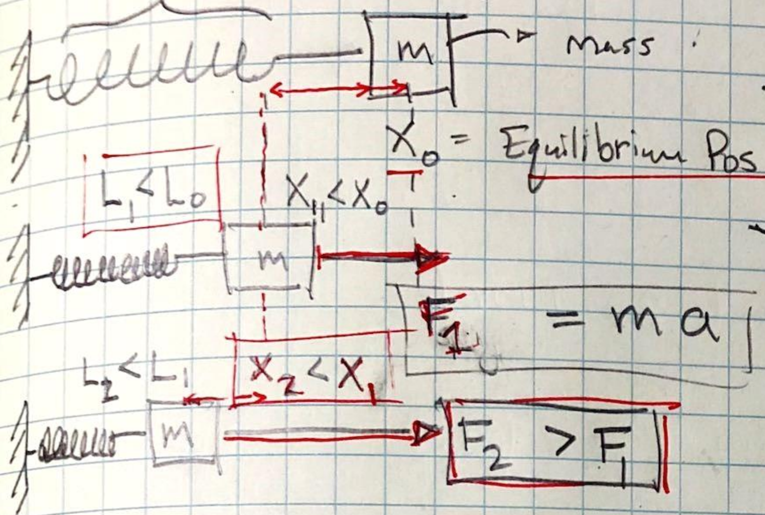
Unstable Eq:
When Center of Gravity is above pivot.

$$\tan \theta_c = \frac{L}{2h}$$

$$\theta_c = \tan^{-1}\left(\frac{L}{2h}\right)$$

Spring Force: restoring force that generally increases with distance from Equilibrium position (length)

L_0 = Equilibrium Length



$\Rightarrow F_{net,x} = 0$

$|F_s| \rightarrow$ increases w/ ΔX

direction of $(F_s) = -\Delta X$

Spring wants to return to Equilibrium Length

– it has an: **Elasticity**

Some Elastic materials are (modeled as) linear in ΔX (Hooke's Law):

$$F_s = -K \Delta X$$

$K \rightarrow$ spring constant (N/m)

Some materials have Elasticity that changes w/ ΔX, and are nonlinear:

$$F_s = -K(\Delta x) \cdot \Delta X$$

$K(\Delta x) \rightarrow$ restoring force changes w/ ΔX!

Stiff springs have large K
Pliant springs have small K
} Assuming same L_0 + diameter of coils

$$K \sim \frac{Y A}{L_0}$$

$A \rightarrow$ cross-sectional area

Y = Young's Modulus which varies for different materials.