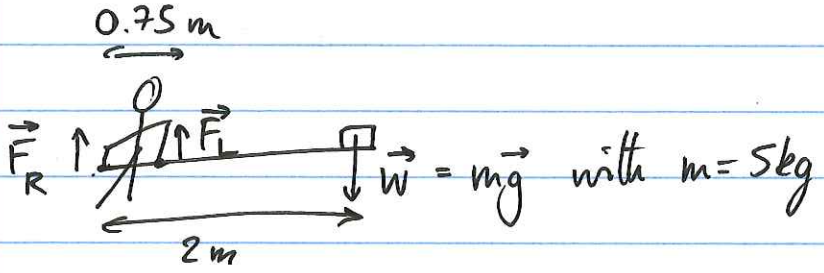
PHYS 107 – Week 08 – Friday

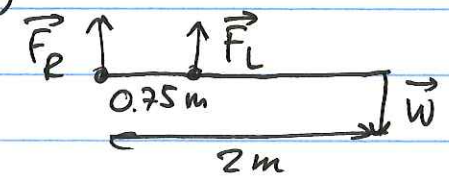
* Static equilibrium: $\vec{F}_{net} = 0$, $\tau_{net} = 0$

Q Equilibrium 3a-b

* Example: shovel with a mass of 5 kg
  (masken)



FBD



$\vec{F}_{net} = 0$ and $\tau_{net} = 0$

$$\begin{cases} F_{net} = F_R + F_L - W = 0 \\ \tau^R_{net} = (0.75m)F_L - (2m)W = 0 \quad \text{around pivot R} \end{cases}$$

$$\rightarrow F_L = \frac{2m}{0.75m} Mg = 131\,N$$

$$\hookrightarrow F_R = W - F_L = (5kg)(9.80\,m/s^2) - 131\,N = -82\,N$$

$\rightarrow$ pointing down

* What if pivot in L?

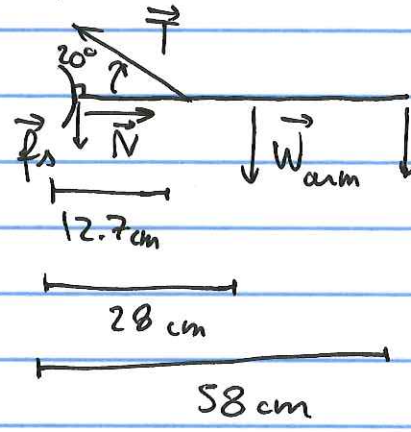
$$\tau^{L}_{net} = -(0.75m)\,F_R - (1.25m)\,Mg = 0$$

$$\hookrightarrow F_R = -Mg\,\frac{1.25m}{0.75m} = -81\,N$$

$$\hookrightarrow F_L = W - F_R = 131\,N$$

Pivot: doesn't matter where you pick it

* Example: Deltoid muscle



$W_{ball} = 22\,N$ for $m_{ball} = 2.25\,kg$

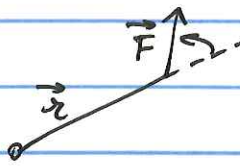
$W_{arm} = 31\,N$ for $m_{arm} = 3.15\,kg$

1) what is force T in deltoid?
2) what is force $\vec{F}$ in scapula/humerus contact point?

$$\begin{cases} \vec{N} + \vec{T} + \vec{W}_{arm} + \vec{W}_{ball} + \vec{f}_s = \vec{F}_{net} = 0 \\ \tau^{N}_{net} = 0 = \tau_T + \tau_{Warm} + \tau_{Wball} + \cancel{\tau_N} + \cancel{\tau_{f_s}} \end{cases}$$

1) $\tau^N_{net} = -(0.28\,m)(31N) - (0.58\,m)(22N) + (0.127\,m)\,F_{deltoid}\sin(180° - \theta) = 0$

↳ $F_{deltoid} = 781\,N$ (for lift of a 22 N weight)



$\rightarrow \tau = F\,r\sin\theta$

2) $\vec{N}$ and $\vec{f_s}$?

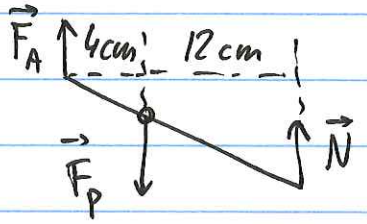
horizontal: $N - F_{deltoid}\cos 20° = 0$

↳ $N = 733\,N$ (large force)

vertical: $-f_s - W_{arm} - W_{wall} + F_{deltoid}\sin 20° = 0$

↳ $f_s = -214\,N$

* Achilles Tendon



$m = 75kg$

$N = mg$ upwards (force from floor on foot)

1) what is F_A?
2) what is force F_p of (upper) leg on foot

1) $\tau^P_{net} = 0 = -(4cm) F_A + (12cm) N$

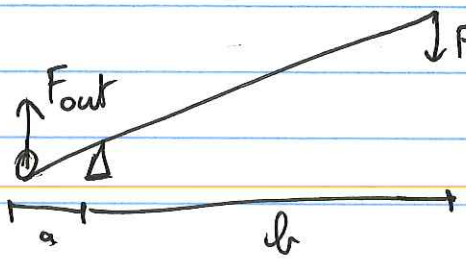
$\hookrightarrow F_A = \frac{(12cm)}{(4cm)}(75kg)(9.8 m/s^2) = 2205N$

$= 3x$ weight

2) $F_{net} = 0 = F_A + N - F_p \rightarrow F_p = F_A + N = 4x$ weight

* Mechanical advantage $= \frac{F_{out}}{F_{in}} = \frac{1}{3}$ in case of Achilles

Force is <u>not</u> a conserved quantity: can amplify forces with mechanical machines



$\rightarrow MA = \frac{b}{a}$

* Lifting with your back

1) $\tau_{net}^{hip} = (0.35\,m)(55\,kg)(9.8\,m/s^2)$ (weight upper body)
$+(0.50\,m)(30\,kg)(9.8\,m/s^2)$ (box)
$-(0.08\,m)F_B$ (back muscle)

↳ $F_B = 4200\,N \rightarrow \frac{F_B}{W_{55\,kg} + W_{30\,kg}} = 5.04$

2) Force on lower vertebrae

$F_{net,y} = 0 = F_{V,y} - W_{55\,kg} - W_{30\,kg} - F_B \sin 29°$

↳ $F_{V,y} = 2870\,N$

$F_{net,x} = 0 = F_{V,x} - F_B \cos 29°$

↳ $F_{V,x} = 3670\,N$

↳ $F_V = 4660\,N$ at angle of 38°