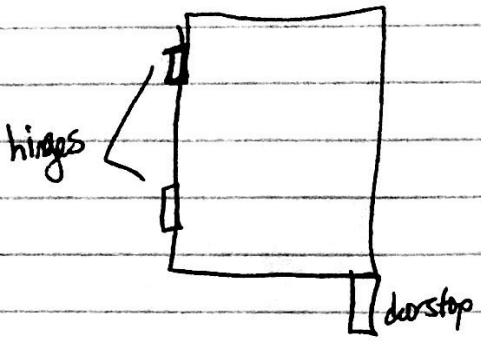
PH202 Recitation 2: Torque Solutions

Discussion Question 1:

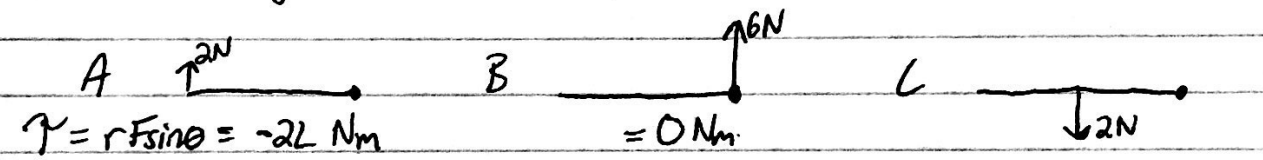
Where to put door stop on door?



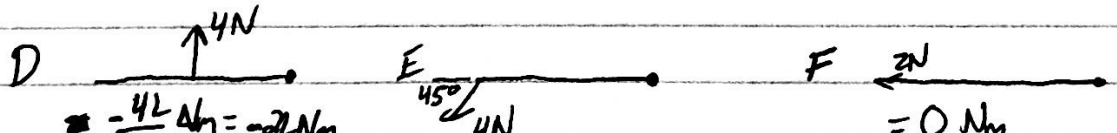
Place door stop furthest away from hinges. Torque $\Rightarrow \tau = rF\sin\theta$
so as $r\uparrow \Rightarrow \tau\uparrow$
which holds the door open easier/better

Discussion Question 2:

rank torques from most negative to most positive
negative = clockwise positive = counter clockwise



$\tau = rF\sin\theta = -2L$ Nm $= 0$ Nm $= +\frac{2L}{2}$ Nm $= L$ Nm



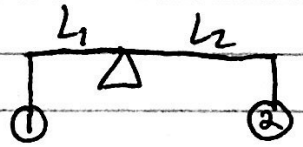
$= -\frac{4L}{2}$ Nm $= -2L$ Nm $= 0$ Nm

$= +4L\sin 45$ Nm

$= \frac{\sqrt{2}}{2} \cdot 4L = 2\sqrt{2}L$ Nm

So $\tau_A = \tau_D < \tau_B = \tau_F < \tau_C < \tau_E$

Discussion Question 3:



$m_1 = 8kg$ $L_1 = 2m$ $L_2 = 4m$
What is m_2?

Torque Problem: $\Sigma\tau = I\alpha$, in equilibrium $\Rightarrow \alpha = 0 \Rightarrow \Sigma\tau = 0$

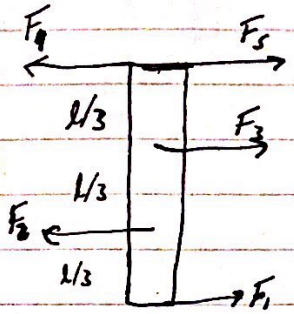
$\Rightarrow +L_1 \cdot m_1 g - L_2 \cdot m_2 g = 0$

$\Rightarrow L_1 m_1 g = L_2 m_2 g$

$\Rightarrow \frac{L_1 m_1}{L_2} = m_2 = \frac{2m}{4m} \cdot 8kg = 4kg$

proportional reasoning: $L_2 = 2L_1 \Rightarrow m_2 = \frac{1}{2}m_1 = 4kg$ ✓

POTD: Tuesday States



The massless rod of length ℓ is in equilibrium. $F_2 = 6N$ $F_3 = 3N$, $F_4 = 6N$
$F_1 = ?$ $F_5 = ?$

Equilibrium $\Rightarrow \Sigma F = 0$ and $\Sigma \tau = 0$

$\Sigma F = 0 \Rightarrow F_{left} = F_{right}$

$\Rightarrow F_2 + F_4 = F_1 + F_3 + F_5$

$\Rightarrow F_1 + F_5 = F_2 + F_4 - F_3$

$\Rightarrow F_1 + F_5 = 6N + 6N - 3N = 9N$

Still 2 unknowns 1 equation, so lets go to Torque:

$\Sigma \tau = 0 \Rightarrow \Sigma \tau_{ccw} = \Sigma \tau_{cw}$

Choose pivot point to get rid of an unknown and make problem easier.

Choose pivot point at top to get rid of F_4 and F_5 since $r_4 = r_5 = 0$

So $\Sigma \tau_{ccw} = \Sigma \tau_{cw}$ or $\Sigma \tau = 0$ just sum up positives and negatives

$\Rightarrow r_3 \times F_3 + r_1 \times F_1 = r_2 \times F_2$ $\Sigma \tau = +r_3 F_3 \sin\theta_3 + r_1 F_1 \sin\theta_1 + -r_2 F_2 \sin\theta_2 = 0$

$\Rightarrow r_3 F_3 \sin\theta_3 + r_1 F_1 \sin\theta_1 = r_2 F_2 \sin\theta_2$

$\sin\theta_3 = \sin\theta_1 = \sin\theta_2 = 1$

$\Rightarrow r_3 F_3 + r_1 F_1 = r_2 F_2$

$\Rightarrow r_1 F_1 = r_2 F_2 - r_3 F_3$

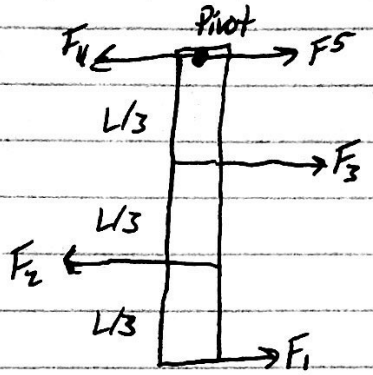
$\Rightarrow F_1 = \frac{r_2 F_2 - r_3 F_3}{r_1} = \frac{2(\ell/3)(6N) - (\ell/3)(3N)}{3(\ell/3)} = \frac{12N - 3N}{3} = 3N$

So $F_1 + F_5 = 9N$

$\Rightarrow F_5 = 9N - F_1 = 9N - 3N = 6N$

So $F_1 = 3N$ $F_5 = 6N$

POTD: Thursday Dynamics



From last problem and now the change in this problem we know that

$F_1 = 3N \quad F_2 = 10N \quad F_3 = 3N$

$F_4 = 6N \quad F_5 = 6N$

Looking for $\alpha \Rightarrow \Sigma\tau = I\alpha$ and $I = \frac{1}{3}ML^2$

$$\Sigma\tau = r_3F_3\sin\theta_3 + r_1F_1\sin\theta_1 - r_2F_2\sin\theta_2 = I\alpha$$

$$\sin\theta_1 = \sin\theta_3 = \sin\theta_2 = 1$$

$$\Rightarrow \frac{r_3F_3 + r_1F_1 - r_2F_2}{I} = \alpha$$

$$\frac{\frac{L}{3}\cdot 3Nm + L\cdot 3Nm - \frac{2L}{3}\cdot 10Nm}{\frac{1}{3}m_{Rod}L^2} = \alpha$$

$$\frac{LNm + 3LNm - \frac{20}{3}LNm}{\frac{1}{3}m_{rod}L^2} = \alpha$$

$$\frac{4L - \frac{20}{3}L}{\frac{1}{3}m_{rod}L^2} = \alpha$$

$$\Rightarrow \frac{-\frac{8}{3}L}{\frac{1}{3}m_{rod}L^2} = \alpha$$

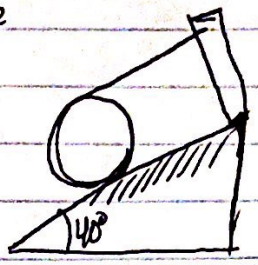
$$\Rightarrow \frac{-8}{m_{rod}L} = \alpha$$

Challenge Homework Orientation:

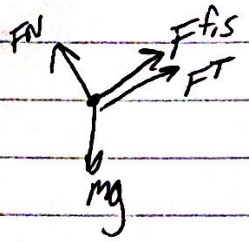
4kg disk in static equilibrium on 40° incline at max static friction

a) what is tension in rope

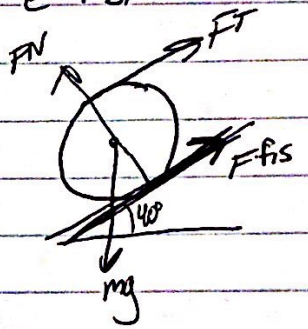
b) coefficient of static friction



draw an FBD



e-FBD



Static equilibrium => $a=0$ and $\alpha=0$

=> $\Sigma F=0$ and $\Sigma \tau=0$

probably need to solve simultaneously