Static Equilibrium + Torque

For static equilibrium:

① $\vec{\tau}_{net} = 0$

② $\vec{F}_{net} = 0$

Recall: $\tau = r_\perp F$

$\tau = rF\sin\theta$

This is the magnitude of the torque

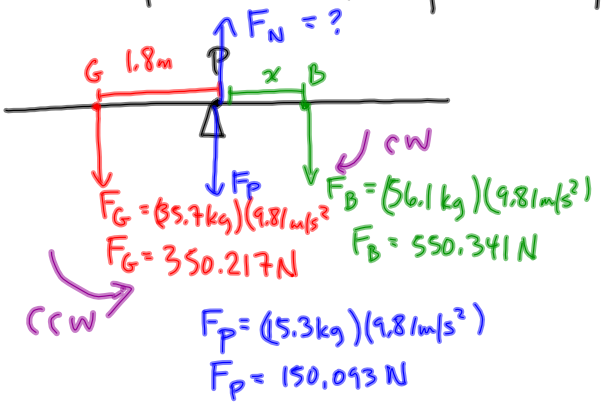
Example

Two children sit on a teeter-totter made from a uniform, 15.3 kg plank that rests on a frictionless pivot at its centre. A 35.7 kg girl sits at the left end, 1.8 m from the pivot of rotation. A 56.1 kg boy moves back and forth at the right end until the teeter-totter is balanced horizontally.

a) Where does the boy finally sit?

b) What is the upward force of the pivot on the plank?

FBD



a) For there to be static equilibrium, the net torque on the teeter-totter must be ZERO!

$\vec{\tau}_{net} = 0$ OR $\Sigma\tau_{CW} = \Sigma\tau_{CCW}$

Σ = sum of $\rightarrow \Sigma\tau_{CW} = \Sigma\tau_{CCW}$

$\tau_B = \tau_G$

Recall $\tau = r_\perp F$

$x(550.341\,N) = (1.8m)(350.217N)$

$x \doteq 1.1\,m$

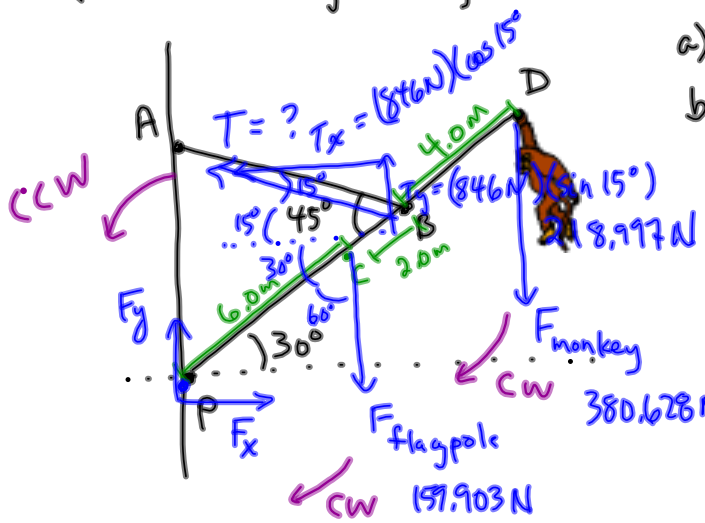
b) The net force must also be equal to ZERO!

So: $F_N = F_G + F_P + F_B$

$F_N = 350.217N + 150.093N + 550.341N$

$F_N \doteq 1051\,N$

Example - Monkey on flagpole



a) What is the tension in cable AB?

b) What are the horizontal and vertical forces exerted on the pole by the hinge?

Info:

$m_{flagpole} = 16.3\,kg$

$m_{monkey} = 38.8\,kg$

a) $\sum \tau_{cw} = \sum \tau_{ccw}$

$\tau_{flagpole} + \tau_{monkey} = \tau_T$

Recall: ~~$\tau = r_\perp F$~~ $\tau = rF\sin\theta$

$(6.0m)(159.903N)\sin 60° + (12.0m)(380.628N)\sin 60° = (8.0m)T(\sin 45°)$

$830.880\,N\cdot m + 3955.602\,N\cdot m = (8.0m)T(\sin 45°)$

$4786.482\,N\cdot m = (8.0m)T(\sin 45°)$

$T \doteq 846\,N$ $\quad 8.5\times10^2\,N$ (sd)

b) The net force must also be ZERO:

$F_x = T_x$ (the horizontal force at the pivot)

and:

$F_y + T_y = F_{flagpole} + F_{monkey}$