Torque + Static Equilibrium

Torque: $\tau = r_\perp F$ (units: N·m)

$\tau = rF\sin\theta$

For there to be static equilibrium:

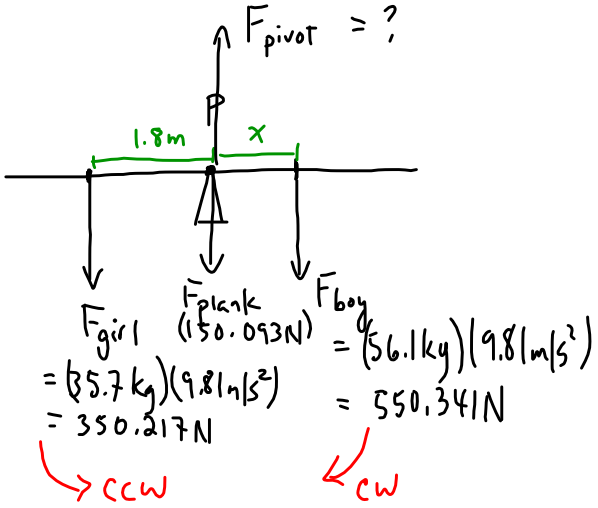
① $\vec{F}_{net} = 0$

② $\vec{\tau}_{net} = 0 \Rightarrow \sum\tau_{ccw} = \sum\tau_{cw}$

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 point of rotation. A 56.1 kg boy moves back and forth at the right end until the teeter-totter balances horizontally.

a) Where does he finally sit?

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



a) For the teeter-totter to be balanced horizontally, $\vec{\tau}_{net} = 0$. (i.e. $\Sigma\tau_{ccw} = \Sigma\tau_{cw}$)

$\tau = rF\sin\theta$

$\tau = r_\perp F$

$\Sigma\tau_{ccw} = \Sigma\tau_{cw}$

$\tau_{girl} = \tau_{boy}$

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

$x = 1.1\text{ m}$

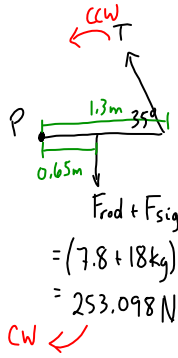
The boy is sitting 1.1 m to the right of the point of rotation.

b) Since $\vec{F}_{net} = 0$, $F_{pivot} = F_{girl} + F_{plank} + F_{boy}$

$F_{pivot} = 350.217\text{ N} + 150.093\text{ N} + 550.341\text{ N}$

$F_{pivot} = 1051\text{ N}$

MP1498



a) T = ?

b) F at the end of rod

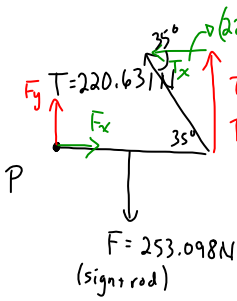
a) $\Sigma \tau_{ccw} = \Sigma \tau_{cw}$

$\tau_T = \tau_{rod+sign}$

$(1.3m)T(\sin 35^\circ) = (0.65m)(253.098N)$

$T = \dfrac{(0.65m)(253.098N)}{(1.3m)(\sin 35^\circ)}$

$T = 2.2 \times 10^2 N$



$(220.631N)\cos 35^\circ = 180.730N$

$T_y = (220.631N)\sin 35^\circ$

$T_y = 126.549N$

Horizontally

$F_x = T_x$

$F_x = 180.730N$

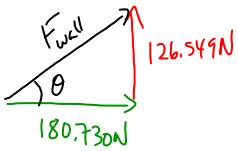
Vertically

$F_{sign+rod} = T_y + F_y$

$253.098N = 126.549N + F_y$

$F_y = 126.549N$

(F_y is equal to T_y in this case due to symmetry)



$\theta = 35^\circ$

$F_{wall} = 220 N$

↑ same as the tension due to the symmetry

TO DO: FOP|§6-3|2-4