Torque + Static Equilibrium

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

$\tau = rF\sin\theta$

For there to be static equilibrium:

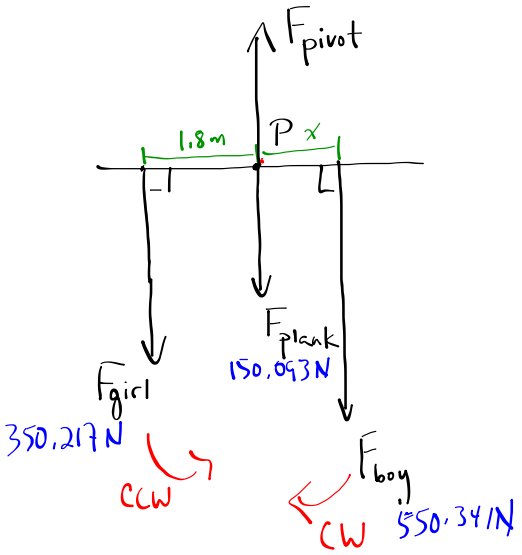
① $\vec{F}_{net} = 0$

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 there to be static equilibrium:

$\vec{\tau}_{net} = 0$ or $\sum \tau_{CCW} = \sum \tau_{CW}$

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

$r_{girl} F_{girl} = r_{boy} F_{boy}$

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

$x = 1.1\,m$

b) Recall $\vec{F}_{net} = 0$:

$F_{pivot} = F_{girl} + F_{plank} + F_{boy}$

$F_{pivot} = 350.217 + 150.093_N + 550.341$

$F_{pivot} = 1050.651\,N$

$F_{pivot} = 1051\,N$

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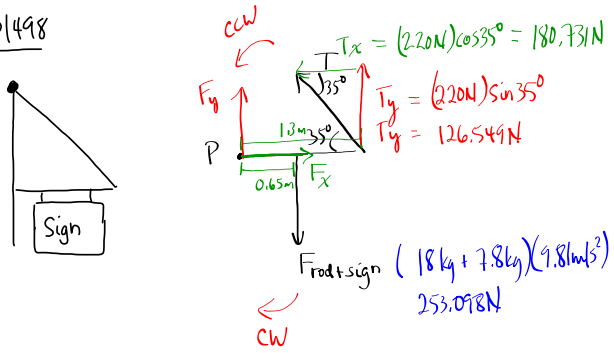


a) For there to be static Equilibrium:

$\tau = rF\sin\theta$

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

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

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

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

$$T = 2.2\times10^2 N$$

b) The force at the wall:

Horizontally

$F_x = T_x$

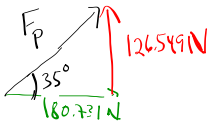
$F_x = 180.731N$

Vertically

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

$126.549 + F_y = 253.098N$

$F_y = 126.549N$



$\tan\theta = \frac{126.549N}{180.731N}$

$\theta = 35^\circ$

$c^2 = a^2 + b^2$

$c = 2.2\times10^2 N$

The force of the wall on the end of the rod is $2.2\times10^2 N$ [outward 35° above horiz]

(note this is the same as the tension due to the symmetry all the weight being in the centre)

TODO

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