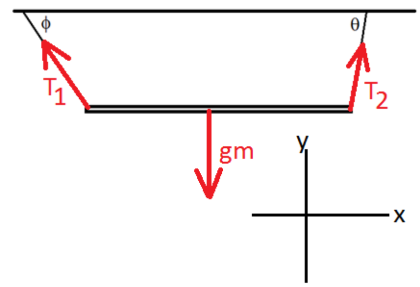
9-1)

For static equilibrium, the sums of the torques and the sums of the forces in each direction must be zero.

$\Sigma_i \mathbf{F}_i = 0$,
$\Sigma_i \ \tau_i = 0$.

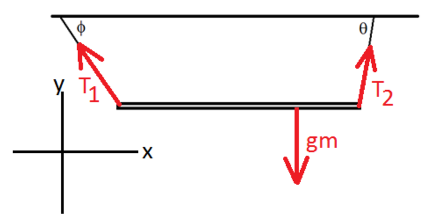


x: $T_2\cos\theta - T_1\cos\phi = ma_x = 0 \ \rightarrow \ T_2\cos\theta = T_1\cos\phi$
y: $T_1\sin\phi + T_2\sin\theta - gm = ma_y = 0$

For the torques, put the pivot at the center of the bar. Let CCW be positive.
τ: $-T_1[L/2]\sin\phi + T_2[L/2]\sin\theta + 0*gm*\sin? = 0 \ \rightarrow$
$T_2\sin\theta \ = T_1\sin\phi$

Divide the torque equation by the x equation to get
$T_2\sin\theta/T_2\cos\theta \ = T_1\sin\phi/T_1\cos\phi$
$\tan\theta \ = \tan\phi$
So if both angles are under 90°, they are equal.
$\theta \ = \phi$
Note that with this choice of pivot, we did not need the y equation.

b)



Move the center of mass to 3L/4 from the left end of the beam. Put the pivot there too. The x and y equations are still valid. The torque equation becomes:

τ: $-T_1[3L/4]\sin\phi + T_2[L/4]\sin\theta + 0*gm*\sin? = 0 \ \rightarrow$
$T_2\sin\theta \ = 3T_1\sin\phi$

Again, divide the torque equation by the x equation to obtain:

$T_2\sin\theta/T_2\cos\theta \ = 3T_1\sin\phi/T_1\cos\phi$

$\tan\theta \ = 3\tan\phi$