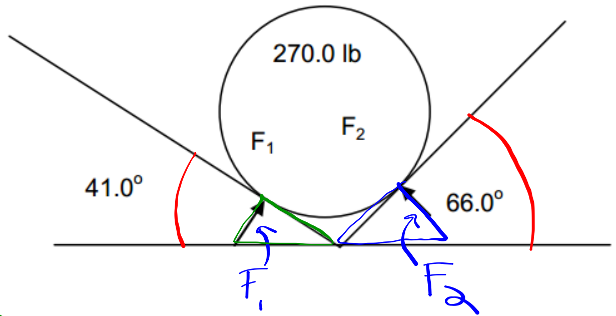
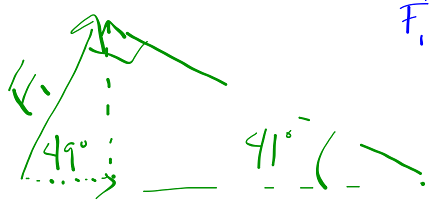
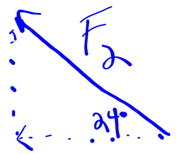
6. The 270.0 lb ball rests in a V-shaped, frictionless crevice. Find F_1 and F_2. [F_1 = 258 lb, F_2 = 185 lb]

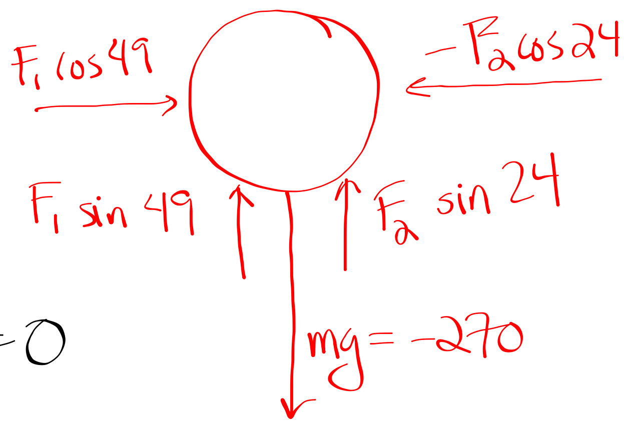






x comp: $F_1 \cos 49$
y comp: $F_1 \sin 49$

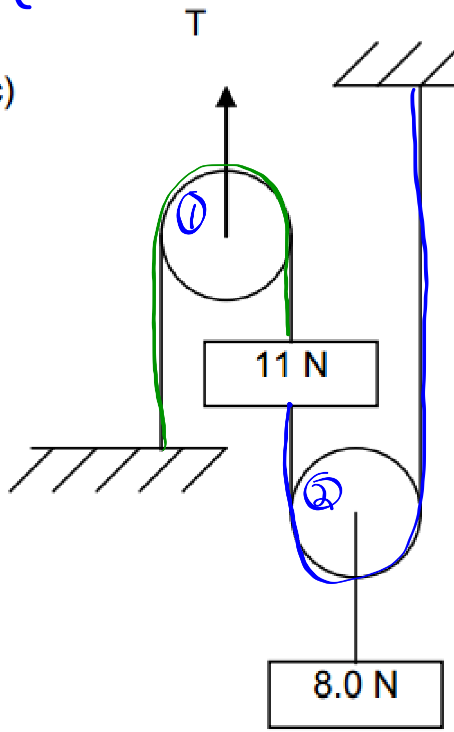
x comp = $-F_2 \cos 24$
y comp = $F_2 \sin 24$

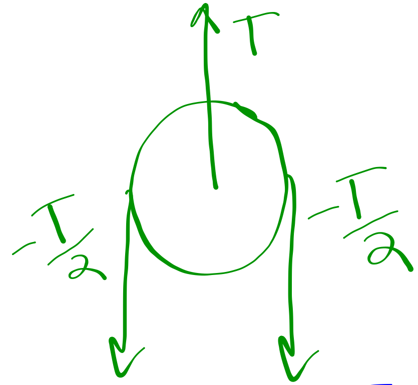


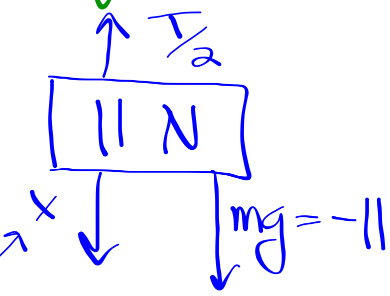
$\Sigma F_x = 0$
$\Sigma F_y = 0$

(30N)

c)



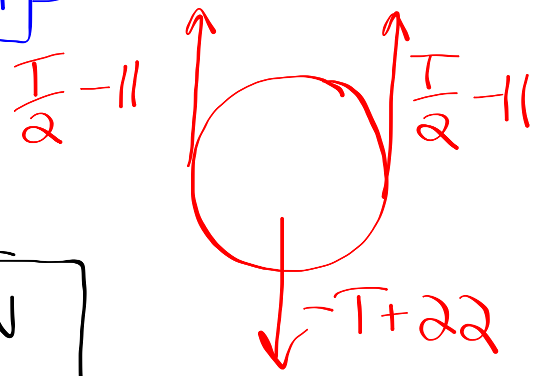


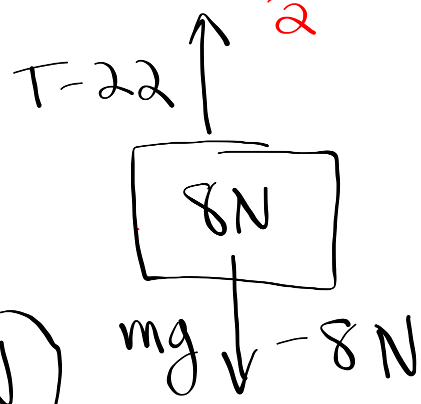


$\Sigma F_y = 0$

$\frac{T}{2} + x + {}^-11 = 0$

$x = \boxed{\frac{-T}{2} + 11}$



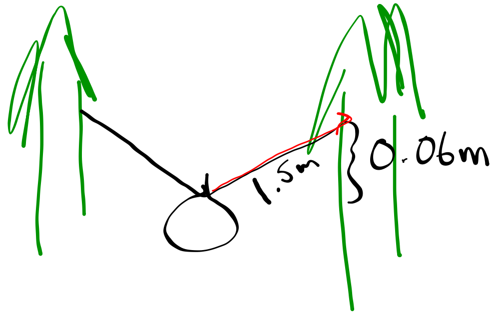


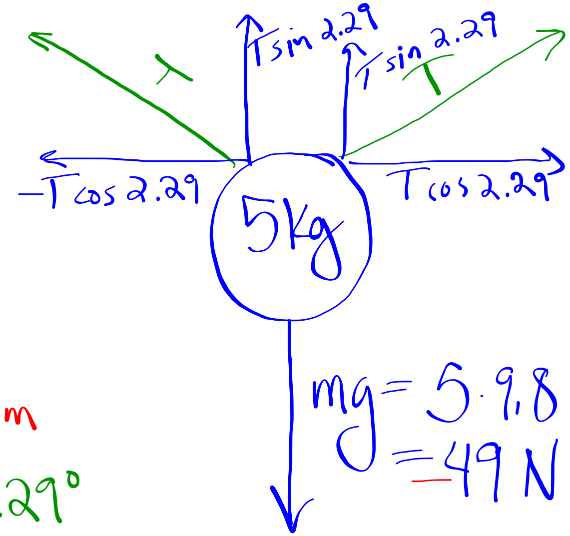
$\Sigma F_y = 0$

$T - 22 - 8 = 0$

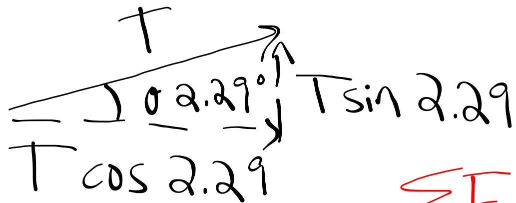
$T = 30\text{ N}$

3. While camping in Denali National Park in Alaska, a wise camper hangs his pack of food from a rope tied between two trees, to keep the food away from the bears. If the 5.000-kg bag of food hangs from the center of a rope that is 3.000 m long, and the rope sags 6.000 cm in the middle, what is the tension in the rope? [610.5 N]





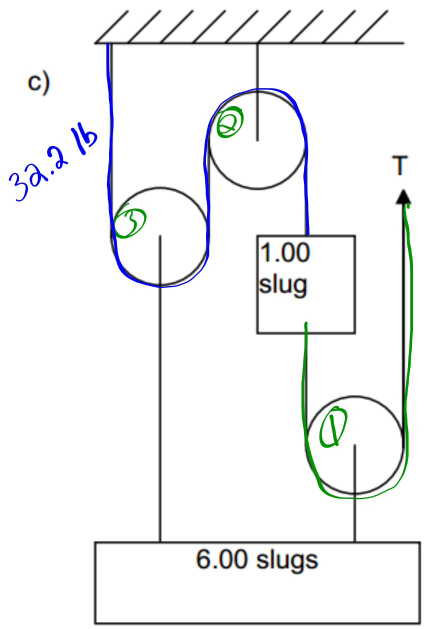
$\sin^{-1} \frac{0.06}{1.5} = 2.29°$

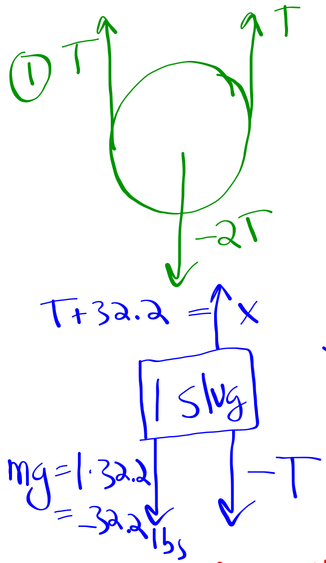


$\Sigma F_y = 0$

$-49 + T \sin 2.29 + T \sin 2.29 = 0$

$T = \frac{49}{(2)(\sin 2.29)} = 613N$

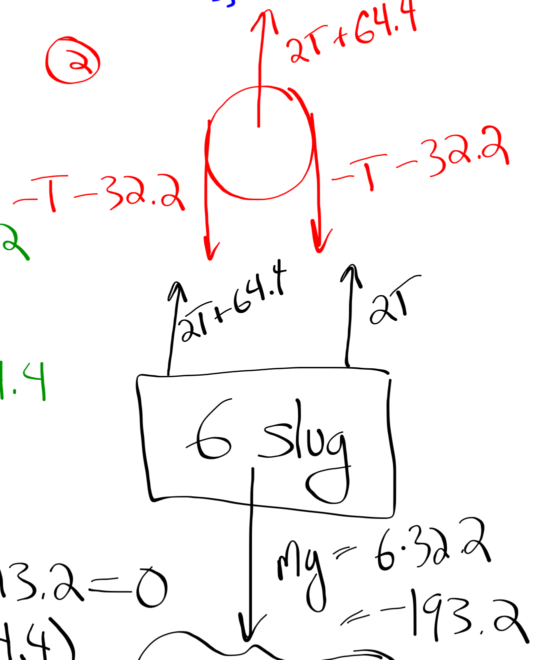


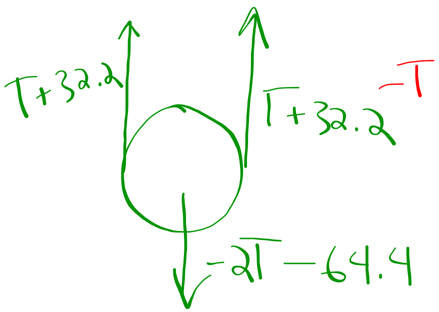


$\Sigma F_y = 0$

$x + -32.2 + -T = 0$

$x = T + 32.2$





$\Sigma F_y = 0$

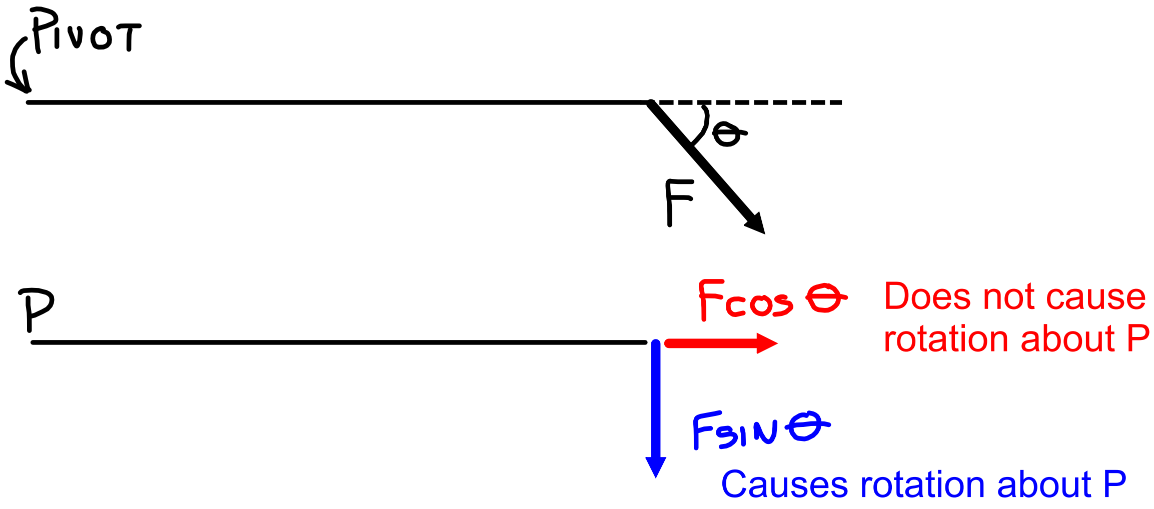
$2T + 64.4 + 2T - 193.2 = 0$

$T = \frac{(193.2 - 64.4)}{4} = 32.2 \text{ lbs}$

Torque
and
Rotational Equilibrium

Torque:

A torque is required to cause something to rotate.



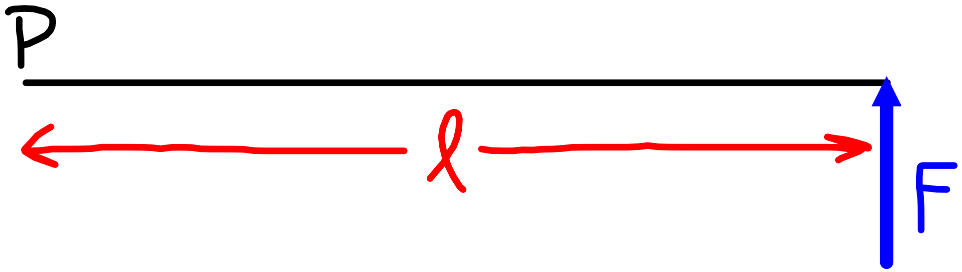
In general:

$$\boxed{\text{Torque} = \boxed{\tau = F \times \ell}}$$

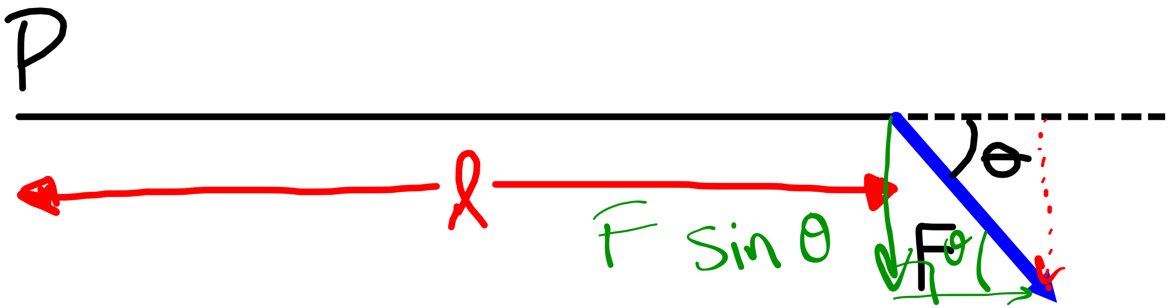
F = A Force $\perp$ to ℓ

ℓ = Lever Arm (The displacement between the "pivot" and the location where the force is being applied)

Examples of determining torque:



$$\tau = F \times \ell$$



$$\tau = F\sin\theta \times \ell$$

Rotational Equilibrium

When considering cases of **translational** equilibrium, the location on a body at which a force acts is not important.

$$\Sigma F_x = 0$$

$$\Sigma F_y = 0$$

When considering cases of **rotational** equilibrium, the location at which a force acts is important.

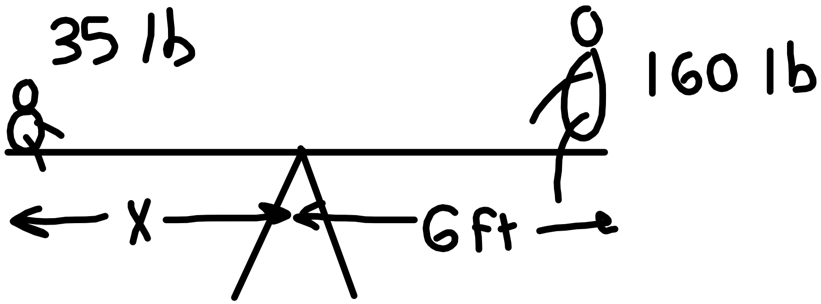
$$\Sigma F_x = 0$$

$$\Sigma F_y = 0$$

$$\Sigma \tau = 0$$

(No matter what point is taken to be the pivot. Rotational equilibrium exists only when the sum of the torques about ALL points on an object is zero).

EXAMPLE 1:



WHAT MUST X BE TO ACHIEVE EQUILIBRIUM?

$$X \cdot 35 = 6 \cdot 160$$

$$\boxed{X = 27.xx'}$$

$$\cancel{\frac{X}{35} = \frac{160}{6}}$$

$$\cancel{X = 933.3'}$$

$$\cancel{\frac{X}{35} = \frac{6}{160}}$$

$$\cancel{X = 1.3}$$

Using Rotational Equilibrium as a problem-solving tool:

1. Draw a FBD. → of the object that would be rotating

2. Identify a point to serve as a pivot. (Note: if in equilibrium, the object will NOT be pivoting. Also, ANY point could serve as a reference for lever arms).

3. Establish a reference rotation (+/-). +

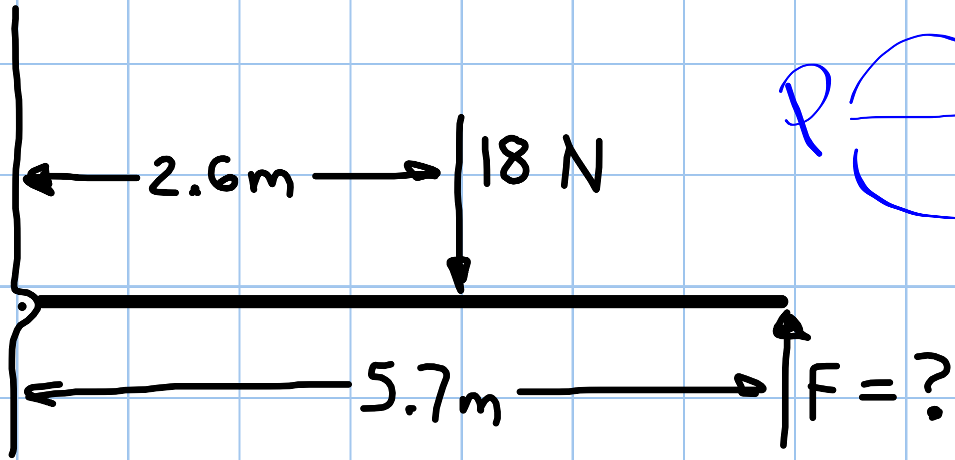
4. Resolve all forces into components:
- One perpendicular to the lever arm
- One parallel to the lever arm

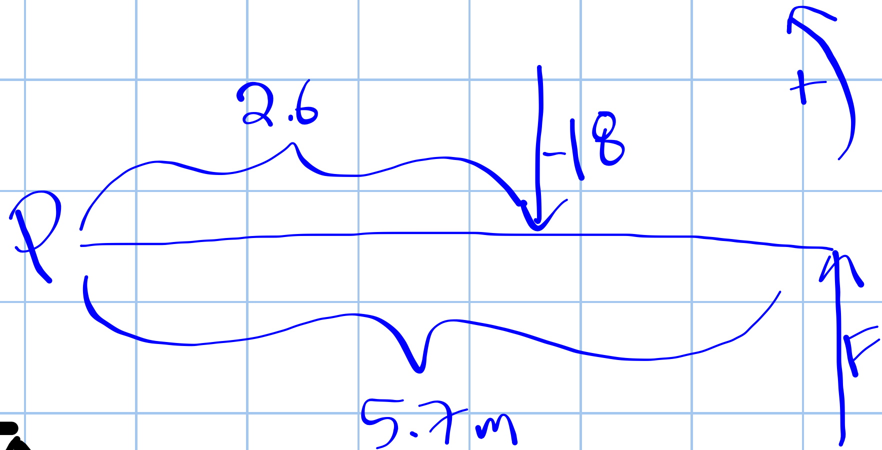
$\Sigma\tau = 0$

5. The sum of all torques about any (and every) point on the object must equal zero.

6. Solve for unknowns.

EXAMPLE 2



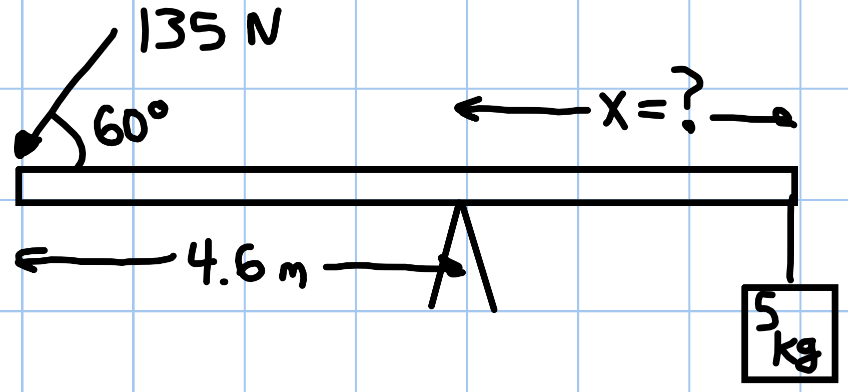


$$\Sigma \tau = 0$$

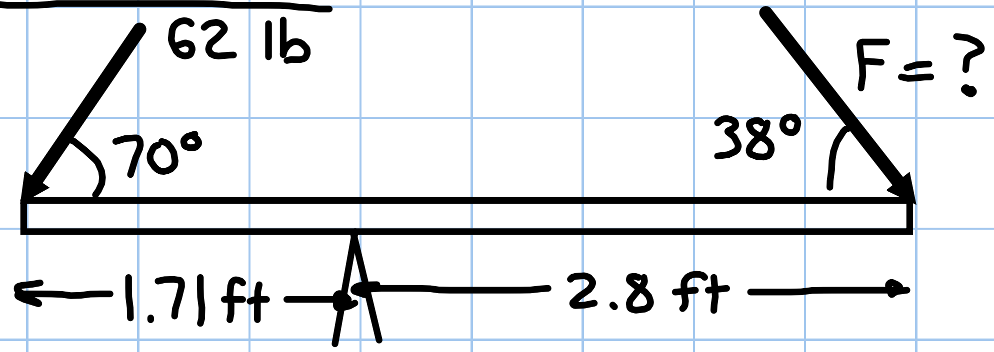
$$-(18)(2.6) + (5.7)F = 0$$

$$F = \frac{(18)(2.6)}{5.7} = 8.2\,N$$

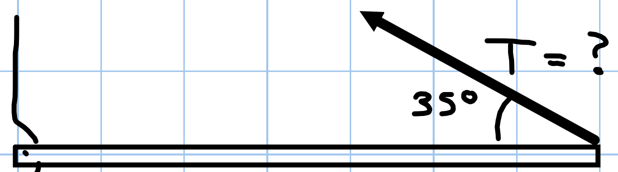
Example 3



EXAMPLE 4

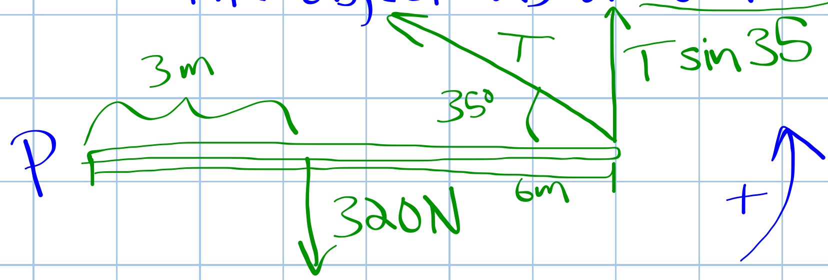


EXAMPLE 5



BAR WEIGHS $\boxed{320\text{ N}}$ & IS 6.0m LONG

(center of mass) C.O.M. mass creates weight that acts in the center of the object as a downward force

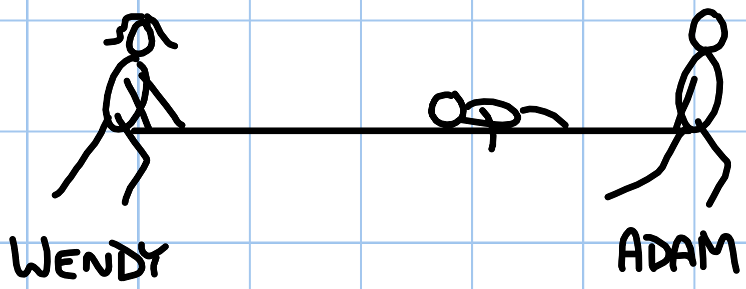


$$\Sigma\tau = 0$$

$$-(320)(3) + (T\sin 35)(6) = 0$$

$$T = \frac{(320)(3)}{(\sin 35)(6)} = 279\text{N}$$

EXAMPLE 6



- STRETCHER (1.3 SLUGS) IS 7.0 ft LONG
- FOSTER'S (35 lb) C.O.M. IS 2.0 ft FROM ADAM
- WHAT FORCES MUST WENDY & ADAM APPLY?