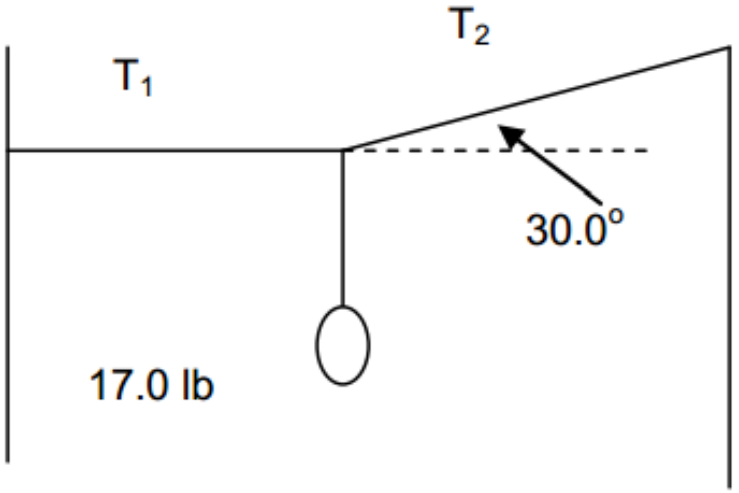
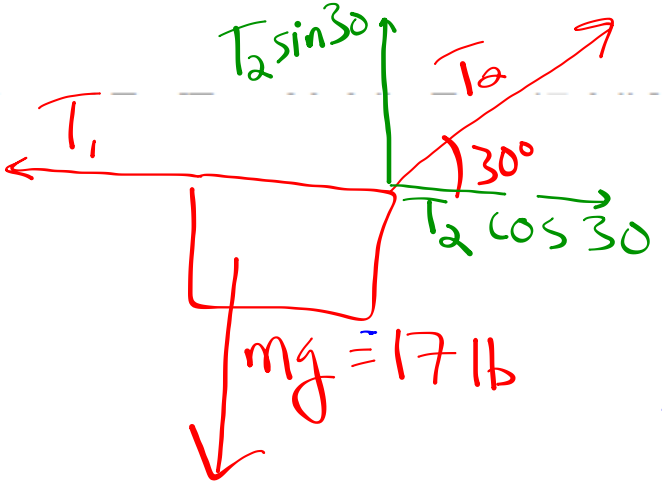
To keep fresh veggies cool on summer nights, two adjacent apartment occupants set up the system shown, suspending the goodies between the two apartment buildings. What tension will be in the two ropes when the weight of vegetables is 17.0 pounds? [T_1 = 29.4 lb; T_2 = 34.0 lb]





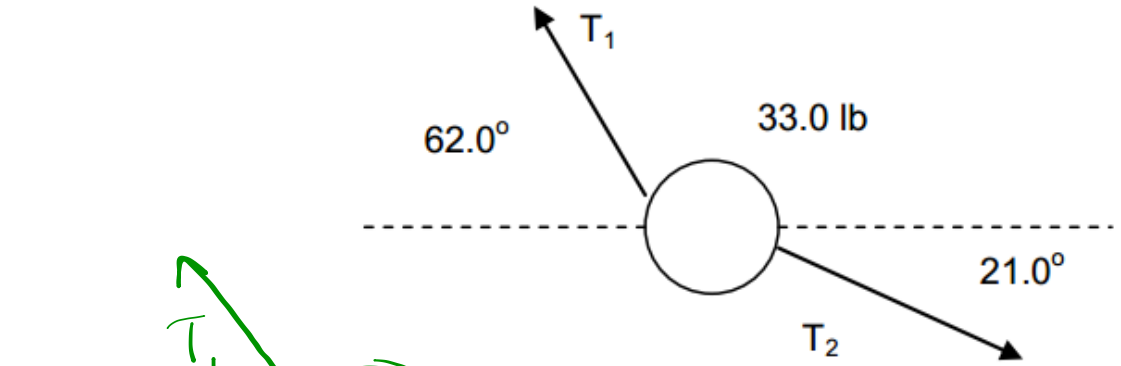
$$\Sigma_x = T_1 + T_2 \cos 30 = 0$$

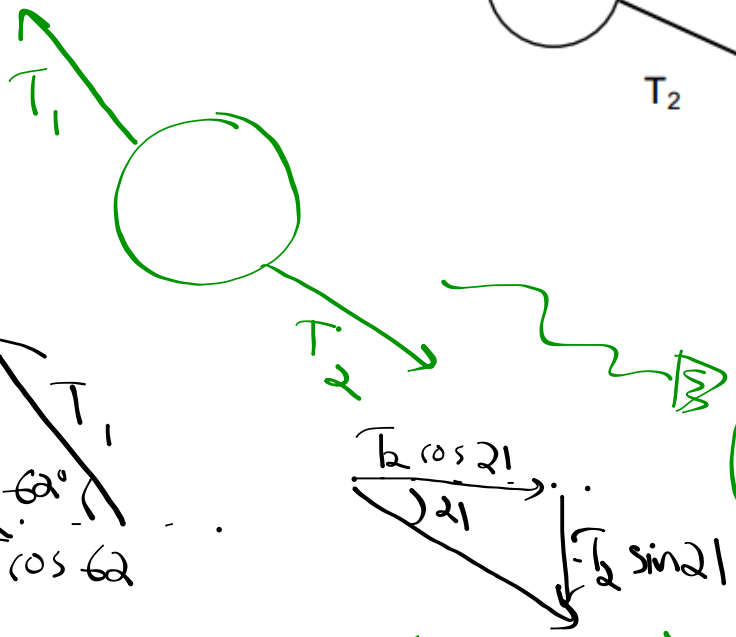
$$T_1 = -T_2 \cos 30$$

$$\Sigma_y = T_2 \sin 30 - 17 = 0$$

$$T_2 = \frac{17}{\sin 30} = 34 \text{ lbs}$$

5. Find T_1 and T_2. [$T_2 = 23.6$ lb, $T_1 = 47.0$ lb]





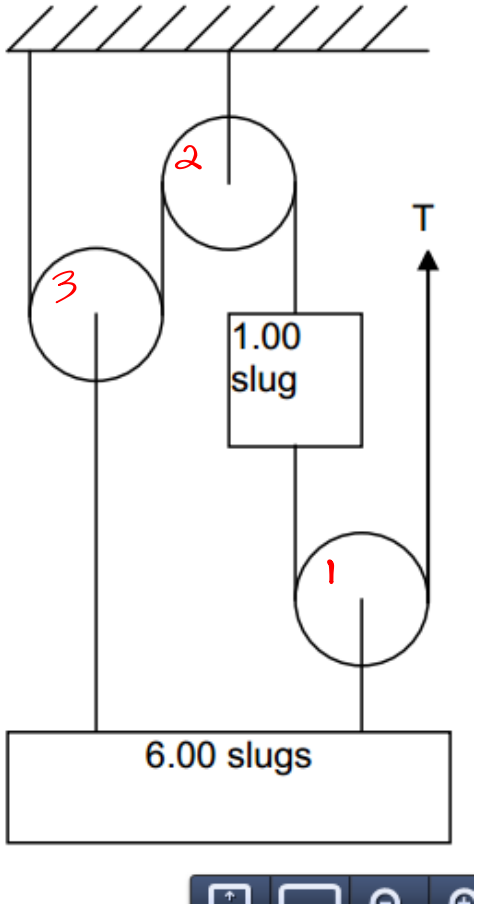
$\Sigma x = -T_1 \cos 62 + T_2 \cos 21 = 0$

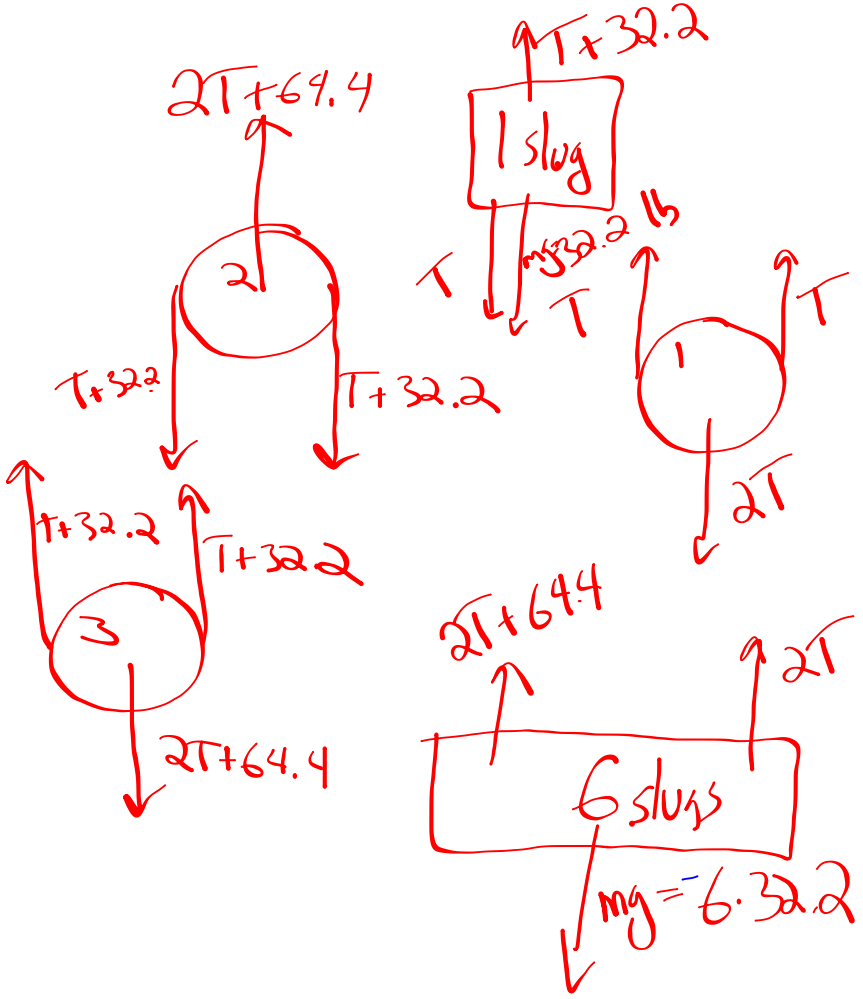
$T_2 = \frac{T_1 \cos 62}{\cos 21}$

$\Sigma y = T_1 \sin 62 - T_2 \sin 21 = 0$

$T_1 = \frac{T_2 \sin 21}{\sin 62}$

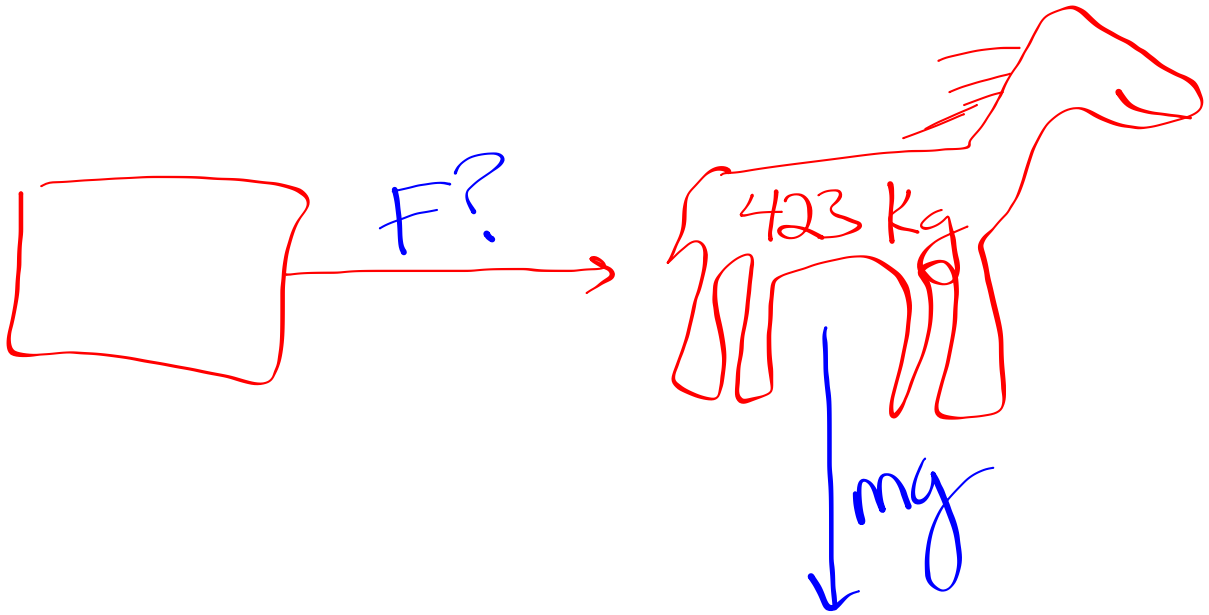
$T_2 = \frac{\left(\frac{T_2 \sin 21}{\sin 62}\right)(\cos 62)}{\cos 21}$

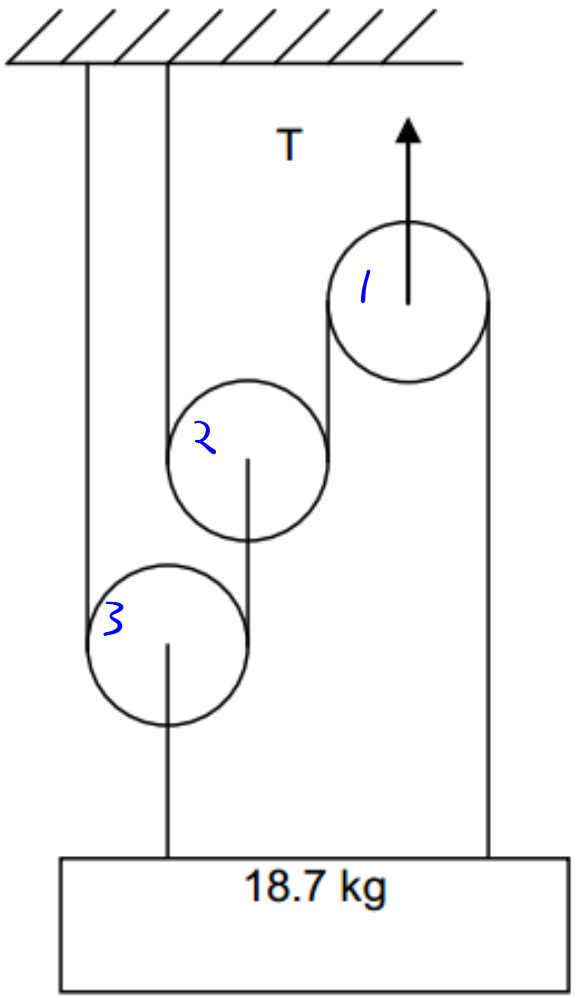


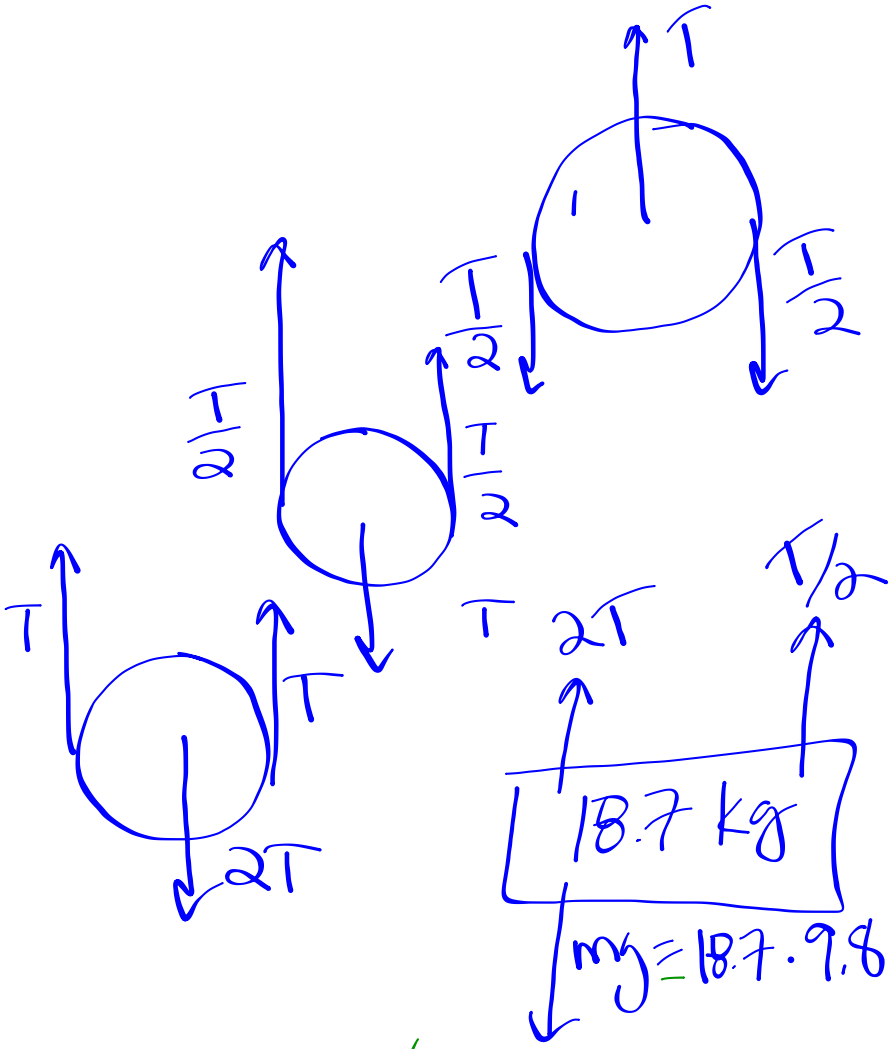


$$\Sigma_y = 2T + 64.4 + 2T - (6 \cdot 32.2) = 0$$

$$T = \ldots$$


F?
423 kg
mg



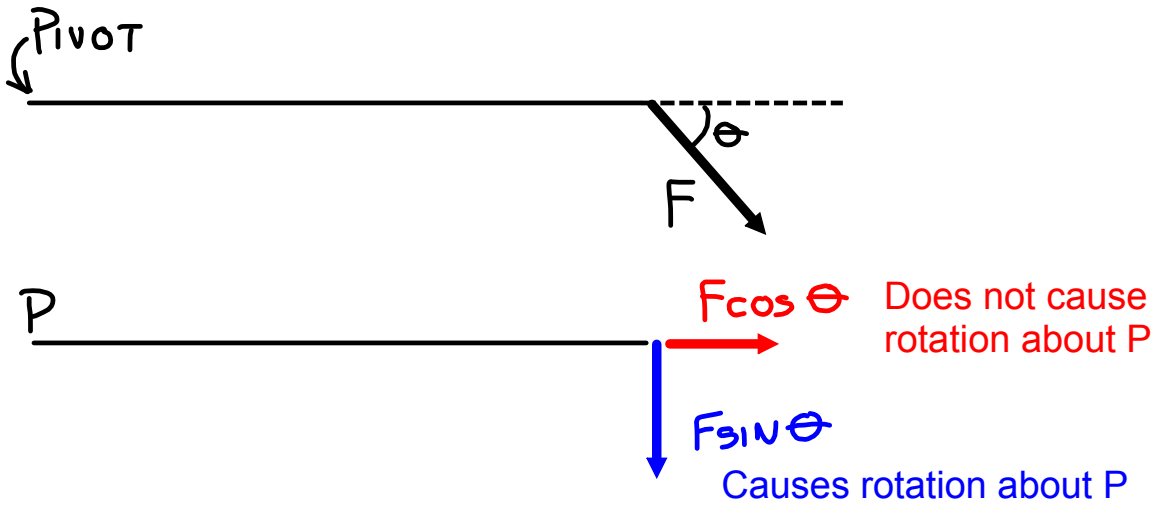


$$\Sigma_y = 2T + \frac{T}{2} - (18.7 \cdot 9.8) = 0$$

Torque and Rotational Equilibrium

Torque:

A torque is required to cause something to rotate.



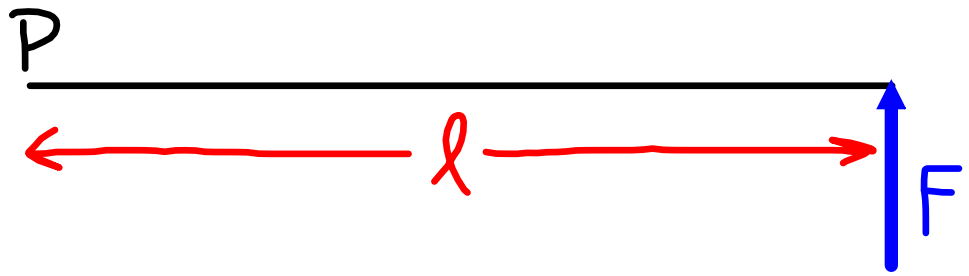
In general:

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

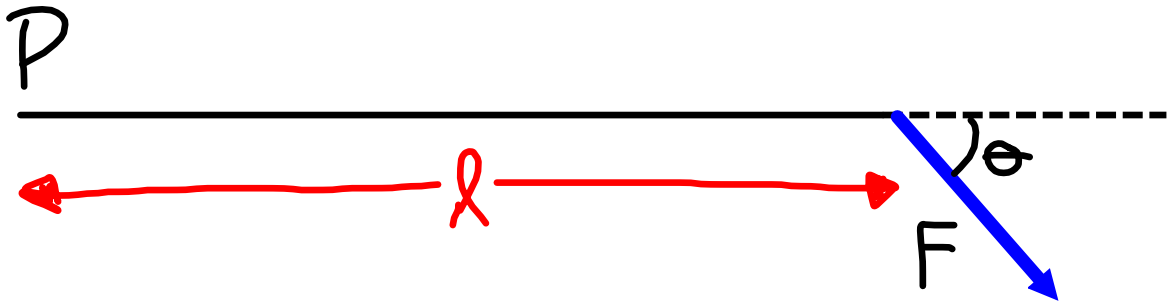
F = A Force $\perp$ To ℓ

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.

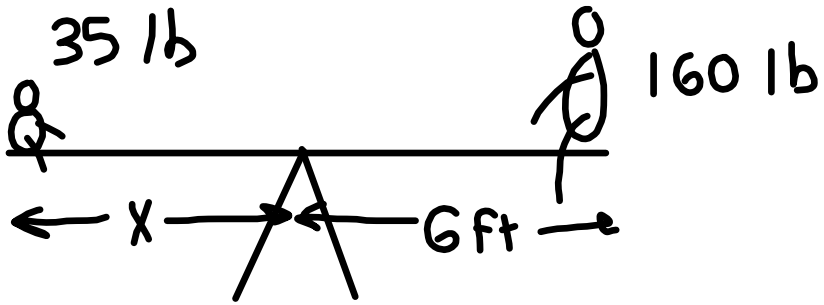
$$\Sigma F_x = 0$$

$$\Sigma F_y = 0$$

$$\Sigma \tau = 0$$

(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?

$160 \cdot 6 = 35 \cdot x$

$x = 27.4$ ft

Using Rotational Equilibrium as a problem-solving tool:

1. Draw a FBD.

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).

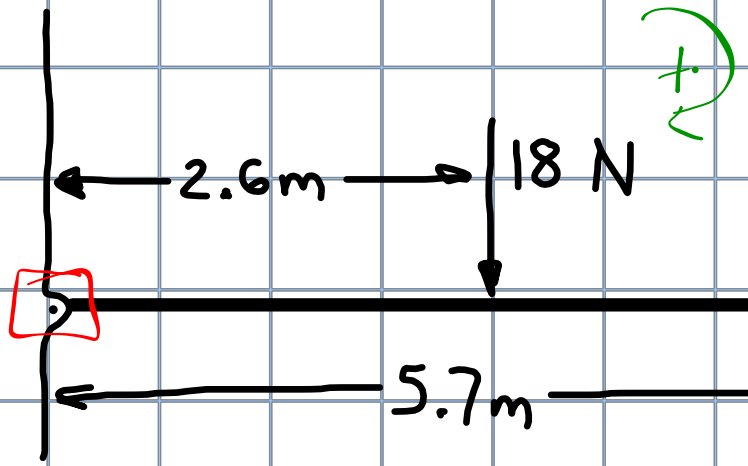
3. Establish a reference rotation (+/-).

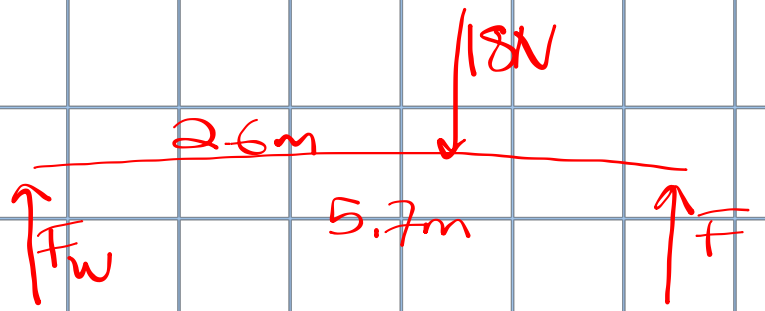
4. Resolve all forces into components:
- One perpendicular to the lever arm
- One parallel to the lever arm

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

6. Solve for unknowns.

EXAMPLE 2

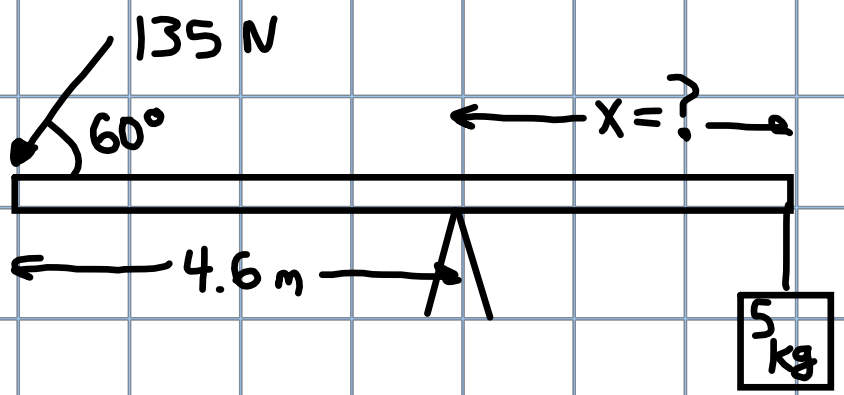




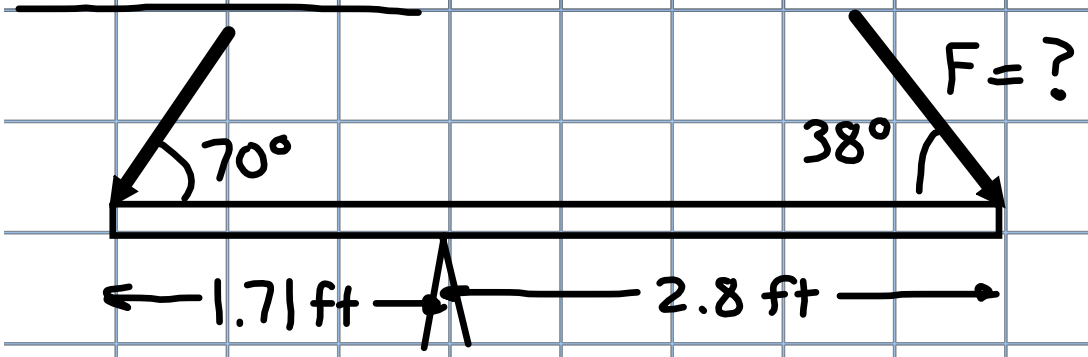
$$\sum \tau = F_w \cdot 0 + 18N(2.6m) + F \cdot 5.7 = 0$$

$$F = \frac{-18 \cdot 2.6}{5.7} = -8.2\,N$$

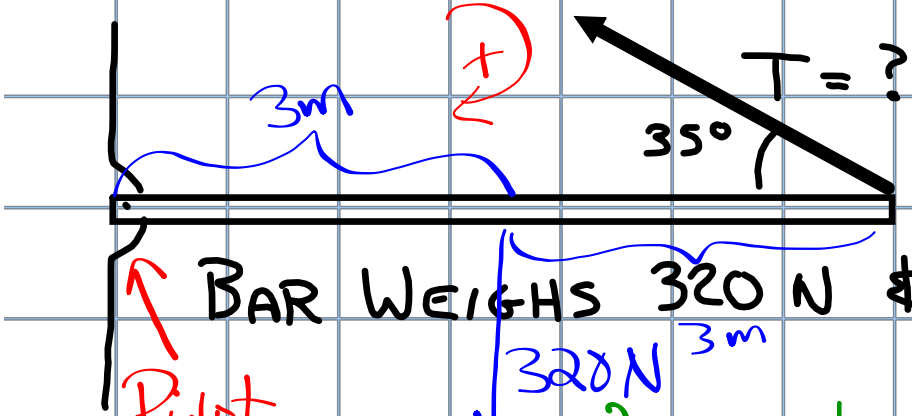
Example 3



Example 4



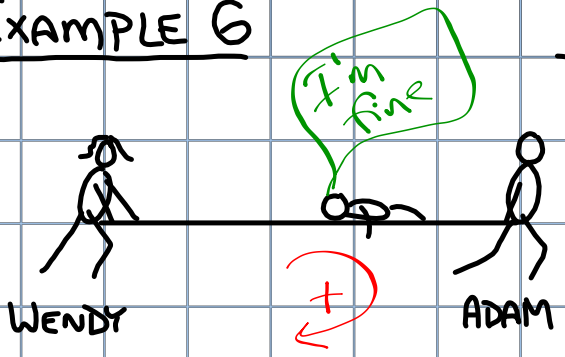
EXAMPLE 5



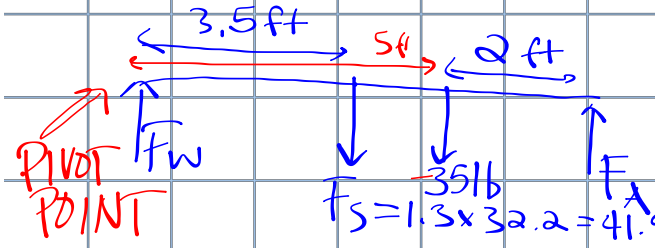
BAR WEIGHS 320 N & IS 6.0m LONG

↳ Center of mass

Example 6



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



$F_S = 1.3 \times 32.2 = 41.9$ lb

$$\Sigma\tau = F_W \cdot 0 + (3.5)(41.9) + 35(5) + F_A(7) = 0$$

$$F_A = -45.95 \text{ lb}$$

Find F_W two ways:

1. Rotational equilibrium
2. Translational equilibrium