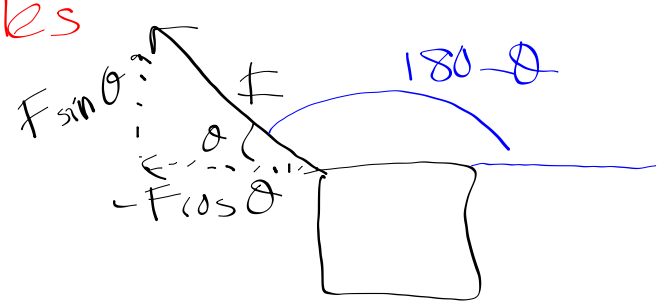
Show work:

(,)(,)(,)

→ System of variables

→ Diagrams



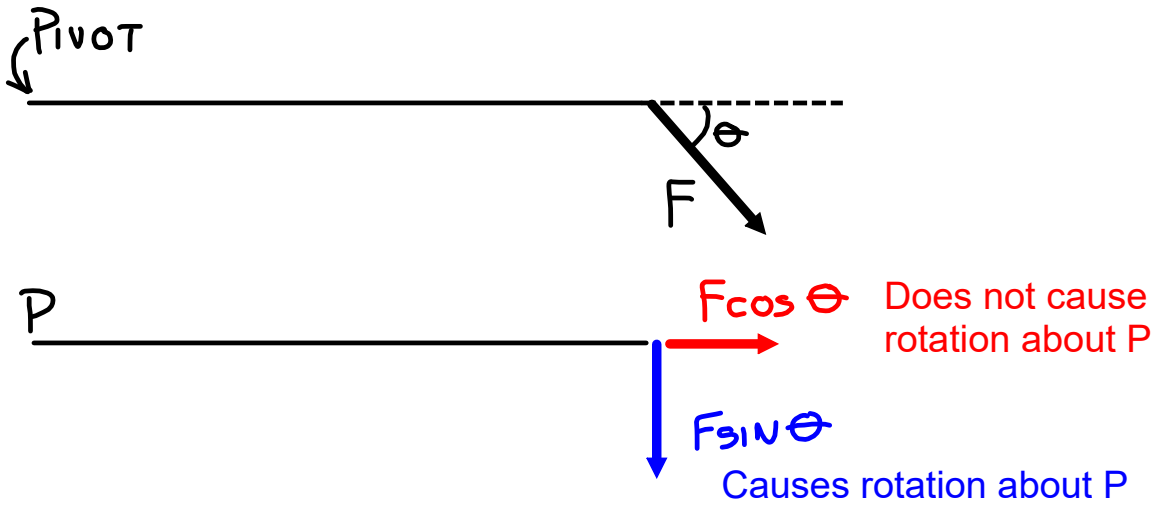
→ Equations $\Sigma F_x = 0$

→ Use words, arrows, etc.

Torque and Rotational Equilibrium

Torque:

A torque is required to cause something to rotate.



In general:

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

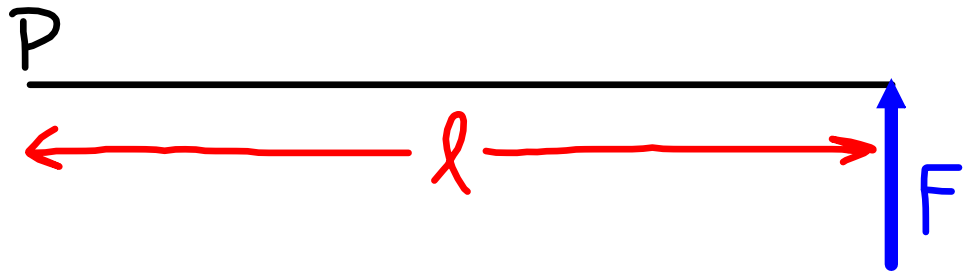
N ⨉ m : N·m

lbs ⨉ ft : lb·ft

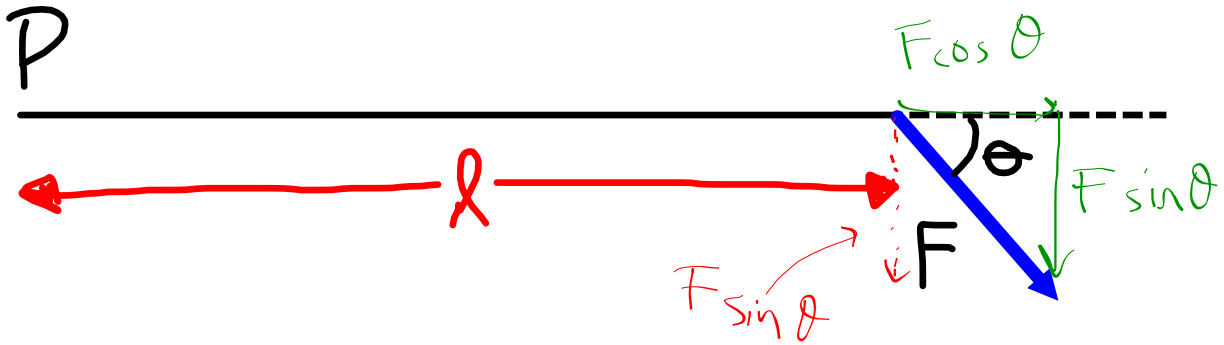
F = A Force ⊥ To ℓ

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.

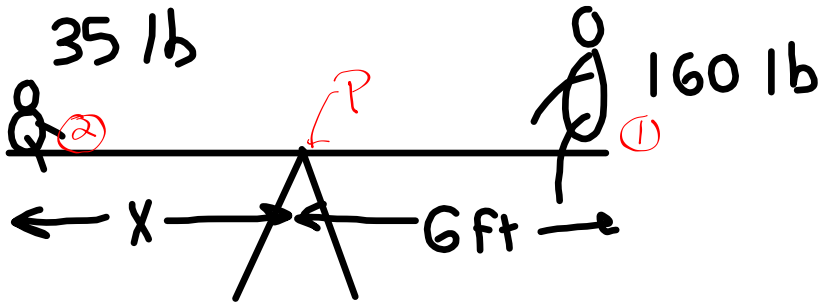
$$\Sigma F_x = 0$$

$$\Sigma F_y = 0$$

$$\Sigma \tau = 0$$

(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:



$\tau_1 = 160\ lb \cdot 6\ ft$

$= 960\ lb \cdot ft$

$\tau_2 = 35 lb \cdot x$

WHAT MUST X BE TO ACHIEVE EQUILIBRIUM?

$35x = 960$

$x = 27.4\ ft$

Using Rotational Equilibrium as a problem-solving tool:

1. Draw a FBD. → try to locate forces correctly

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).

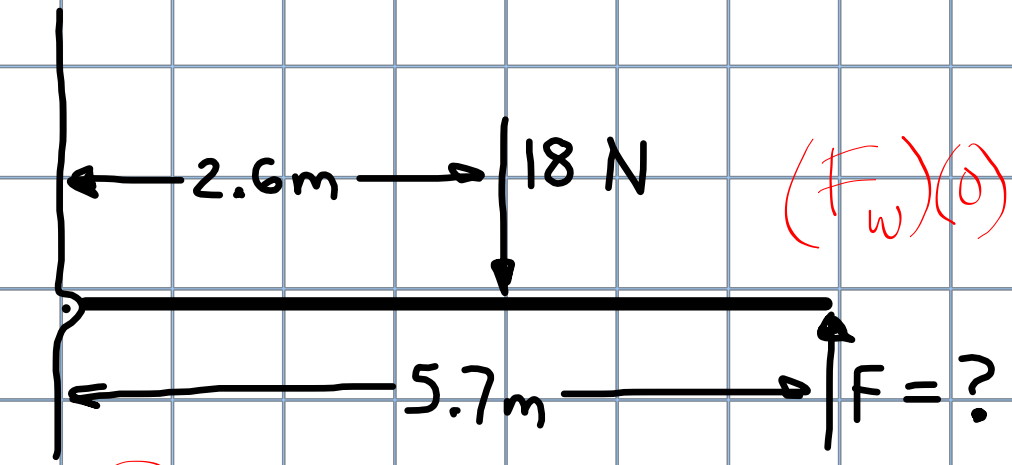
3. Establish a reference rotation (+/-). 

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

5. The sum of all torques about any (and every) point on the object must equal zero. $\Sigma \tau = 0$

6. Solve for unknowns.

EXAMPLE 2

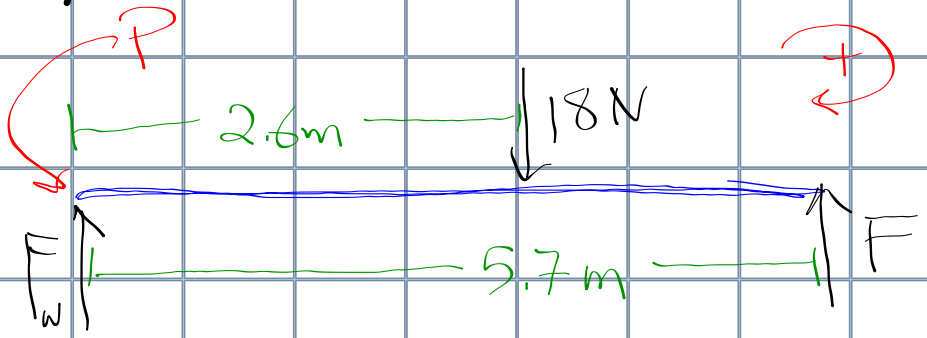


$$\sum \tau = 0$$

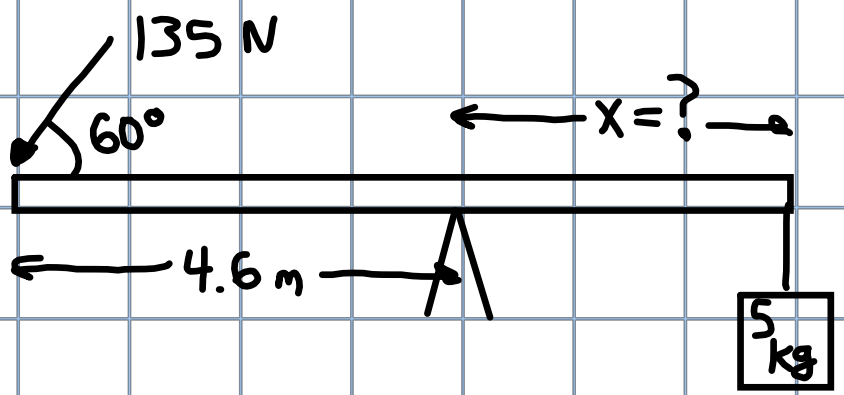
$$(F_w)(0) + (18)(2.6) + -(F)(5.7) = 0$$

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

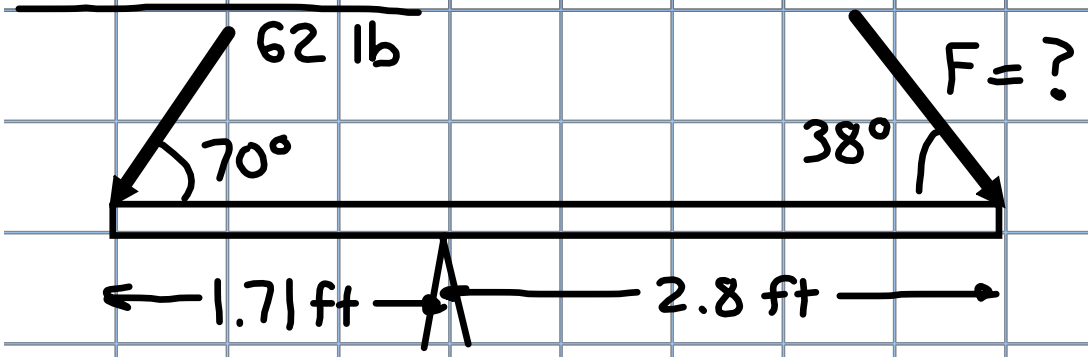
$$= 8.21\ N$$



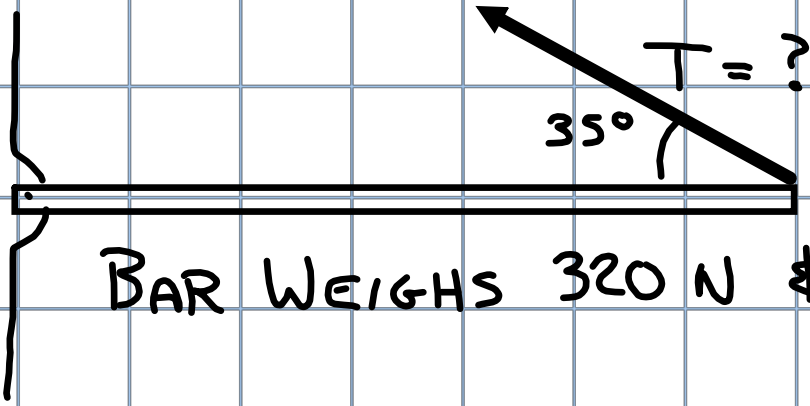
Example 3



Example 4

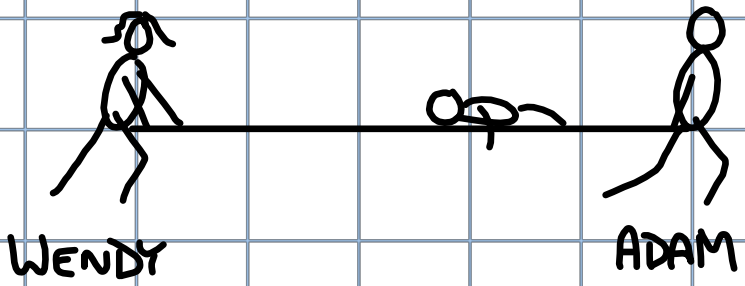


EXAMPLE 5



BAR WEIGHS 320 N & IS 6.0 m LONG

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?