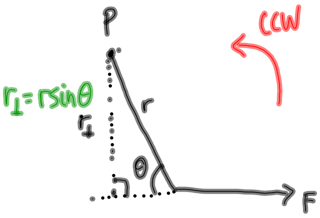
Torque

When a force acts on an object in such a way that it does not act through the object's centre of mass then a twisting action occurs. This is called torque.



A force, F, is acting on the object at a distance, r, from the pivot point, P.

$$\tau = r_\perp F$$

where τ is the torque (N·m)

$r_\perp$ is the perpendicular distance from the pivot point to the line of action of the force (m)

F is the force acting on the object (N)

Torque is actually a vector that is perpendicular to the plane that r and F make. If r and F are in the plane of this board, then the torque vector is either into the board or out of the board

If F causes a CCW rotation then the torque is out of the board ⇒ + (positive)

If F causes a CW rotation then the torque is in to the board ⇒ − (negative)

$$\tau = r_\perp F$$

$$\tau = (r\sin\theta) F$$

$$\tau = rF\sin\theta$$

always will sin θ as long as θ is the angle between r and F.

If $\theta = 90°$, τ is max

$\theta = 0°$, $\tau = 0$

$\theta = 180°$, $\tau = 0$

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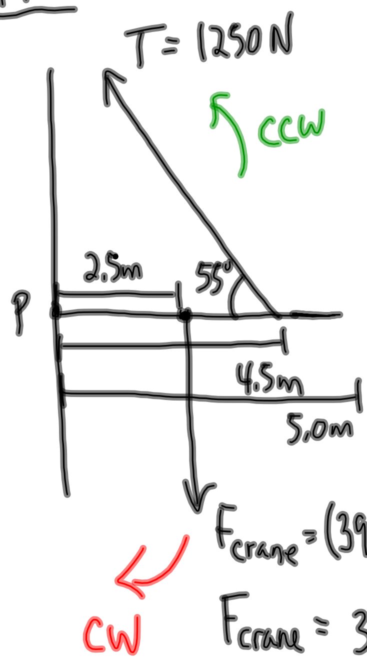

$F_{crane} = (395kg)(9.81m/s^2)$

$F_{crane} = 3874.95N$

a) torque from cable:

$\tau = rF\sin\theta$

$\tau = (4.5m)(1250N)\sin 55^\circ$

$\tau = 4607.73\ N\cdot m$

$\tau \doteq 4.6\times 10^3\ N\cdot m$

(+) torque

T causes CCW rotation

b) torque from the crane's weight:

$\tau = rF\sin\theta$

$\tau = (2.5m)(3874.95N)\sin 90^\circ$

$\tau \doteq 9.7\times 10^3\ N\cdot m$

(−) torque, F_{crane} causes CW rotation

Since the (+) torque is not balanced with the (−) torque, this object (crane) is NOT in static equilibrium. The net rotation would be CW.

PP|495 * 30 → assume the end of the ladder at the ground is the pivot.