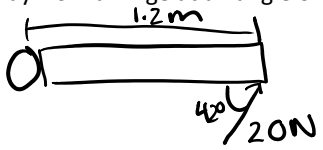
Torque Introduction

Monday, January 20, 2014 12:27 PM

Example
A 20 N force is applied to a door at a location 1.2 m away from a hinge at an angle of 42 degrees.

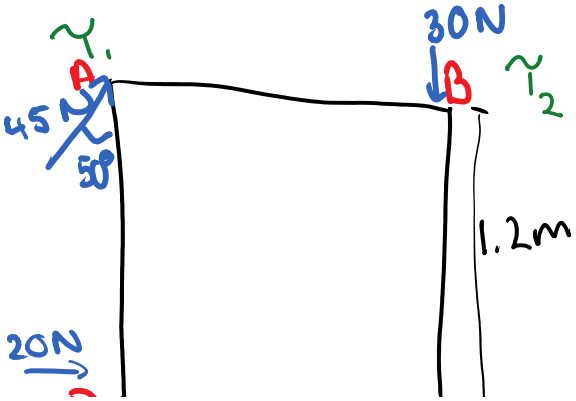


$\tau = F \times \sin\theta$
$= 20 \cdot 1.2 \cdot \sin 42 = +16$ N-m

Is our answer positive or negative?
+ = counterclockwise
− = clockwise

+ 16 N-m

Make it tougher



Note: remember force & displacement are ⊥ to eachother

$F_x \cdot y$ (force in x, distance in y)

$F_y \cdot x$ (force in y, distance in x)

$\tau_A = \tau_1 + \tau_2 + \tau_3$

$F_{ax} \cdot 4$

$\tau_A = \tau_1 + \tau_2 + \tau_3$

$F_{Ax} \cdot y \quad F_{Ay} \cdot x \quad F_B \cdot x \quad F_D \cdot y$

$45\sin 50 \cdot 0 + 45\cos 50 \cdot 0 - 30 \cdot 1.7 + 20 \cdot 1.2$

$\tau_1 \quad \tau_2 \quad \tau_3$

rotate clockwise

$= 0 + 0 - 51 + 24 = -27$ N-m clockwise

Find the torque at A and B (they will be different)

$\tau_B = \tau_1 + \tau_2 + \tau_3$

$F_{Ax} \cdot y + F_{Ay} \cdot x \quad F_x \cdot y$

$45\sin 50 \cdot 0 - 45\cos 50 \cdot 1.7 + 30 \cdot 0 + 20 \cdot 1.2$

$= 0 - 49.2 + 0 + 24 = -25.2$ N-m

For something like this, it is important to remember that force and displacement need to be perpendicular to each other so when calculating. . .

$F_x \cdot y$

F_x: force in x; y: distance in y

$F_y \cdot x$

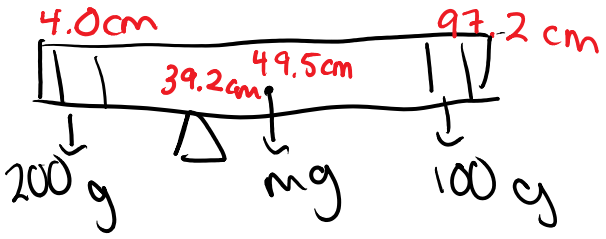
F_y: Force in y; x: distance in x

Words of warning
Pay attention to x and y components carefully as well as direction of rotation

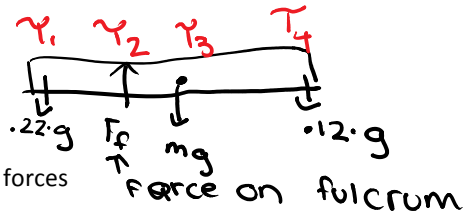
How to tell direction of rotation - think about pushing a ruler

Example of Rotational Equilibrium

A meter stick is balanced with weights on either side. What is mass of the meterstick?



The weight of the meter stick can be approximated at the center of mass
Where is the center of mass? Balance the meterstick on your finger



FBD of forces

1 eqn → careful where we pick

$\sum \tau_{fulcrum} = \tau_1 + \tau_2 + \tau_3 + \tau_4 = 0$

$F \cdot x \quad F_f \cdot x_2 \quad F \cdot x_3 \quad F \cdot x_4$

$+.22 \cdot 9.8 \cdot .352 + 0 - mg \cdot .103 - .12 \cdot 9.8 \cdot .58$

$0 = .76 + 0 - 1.01m - .68$

$0 = .08 - 1.01m$

$1.01m = .08$

$m = .079$ kg

Note: Don't forget to add in the masses of the hangers

Two unknowns (Force of fulcrum and mass of ruler)
Do we need two equations?

No! If we are careful about where we set our torque