Name: _____ Phys 12

3.5 Torque (part 1)

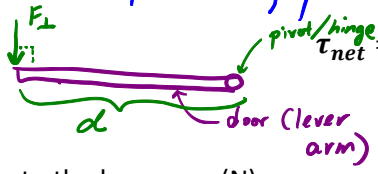
Last class we dealt with translational equilibrium. Today we will look into rotational equilibrium.

For rotational equilibrium: $\sum \tau_{clockwise} = \sum \tau_{counterclockwise}$ (cw) (ccw)

What is τ (tau) or torque?

Please check out the youtube video: https://www.youtube.com/watch?v=b-HZ1SZPaQw up to 2:45

Torque is a perpendicular force applied some distance away from a pivot



Where:

τ_{net} is the net torque (N·m)

$F_\perp$ is the force perpendicular to the lever arm (N)

d is the length of the lever arm measured in (m) (distance between the pivot/axis to where the force is applied)

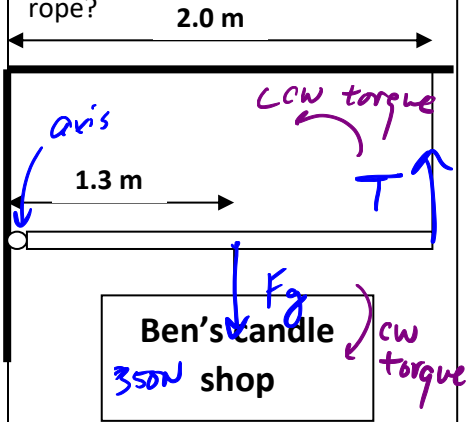
A few more terms we need to learn before we go on…

Centre of Gravity: the position where the average weight of the object acts for a uniform beam, F_g acts @ the very middle of the beam

Uniform Beam: a beam of uniform shape and density

Arbitrary Position of Rotation: we can choose any point on an object and treat it as the point of rotation

Ex 1: A 350 N store sign hangs from a pole of negligible mass. The pole is attached to a wall by a hinge and supported by a vertical rope. What is the tension in the rope?



* draw FBD or the lever arm

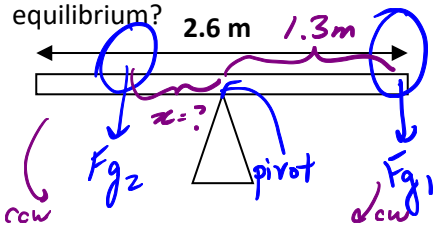
$\tau_{cw} = \tau_{ccw} = F_\perp d$

$F_g(1.3m) = T(2.0m)$

$T = \frac{F_g(1.3m)}{2.0m} = \frac{350(1.3)}{2.0} = 230N$

Extension: What are the vertical and horizontal components of the supporting force provided by the hinge in the last question?

Ex 2: Two students sit on opposite sides of an 800 N teeter-totter. Student 1 has a mass of 65 kg and sits at the very end of the teeter-totter. Student 2 has a mass of 90 kg. How far from the pivot should he sit in order to achieve equilibrium?



$m_1 = 65kg$

$m_2 = 90kg$

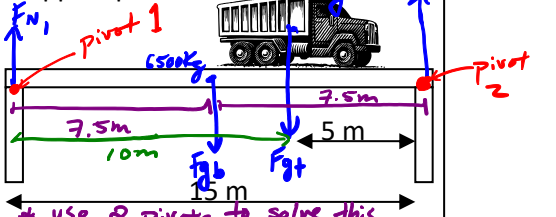
$\tau_{cw} = \tau_{ccw}$

$F_{g1}(1.3m) = F_{g2}\,x$

$x = \frac{F_{g1}(1.3m)}{F_{g2}} = \frac{m_1 g(1.3m)}{m_2 g}$

$= \frac{65kg\,(1.3)}{90kg} = 0.9m$ from the pivot

Ex 3: A 3500 kg truck is parked on a uniform bridge as shown. If the bridge deck itself has a mass of 6500 kg find the supporting force provided by each of the two support posts.



* F_{N_2} probs bigger...

* use 2 pivots to solve this problem ∴ 2 $\tau_{cw} = \tau_{ccw}$ equations

pivot 1: $\tau_{ccw} = \tau_{cw}$

$F_{N_2}(15m) = F_{g_t}(10m) + F_{g_b}(7.5m)$

* F_{N_1} doesn't affect torque on pivot 1 b/c distance = 0m

$F_{N_2} = \frac{m_t g(10m) + m_b g(7.5m)}{15m}$

$= \frac{3500g(10) + 6500g(7.5)}{15} = 55000N$

pivot 2: $\tau_{ccw} = \tau_{cw}$

$F_{g_t}(5m) + F_{g_b}(7.5) = F_{N_1}(15m)$

* different pivot, distance may change.

$F_{N_1} = \frac{F_{g_t}(5) + F_{g_b}(7.5)}{15}$

$= \frac{3500\,g(5) + 6500g(7.5)}{15}$

$= 43000N$

HW: Worksheet 3.5 ALL