Torque and forces on rigid bodies

Torque is a measure of rotation that results from application of a force at some distance from a pivot point. τ = F *l* , the cross product of force x lever arm, the distance between where the force is applied and the pivot.

Objects can then be in two different types of equilibrium. If the net linear type forces on an object are = 0, Fnet = 0, then the object has an acceleration = 0 and the object moves at constant velocity or is at rest. (In a linear sense).

If the net amount of torque = 0, τ = 0, then the object will also be in rotation equilibrium, (rotating at constant velocity or at rest).

A 55 n force is applied to a door at 3 different points. *l = 0.80* m from the hinges, 0.60m from the hinges or on the hinges.

τ0.80 – 55(0.80) = 44 N●m τ0.60 = 55)(0.60) = 33 N●m τ0 = 0

If a body is in equilibrium, neither it’s linear or rotational motion changes.

∑Fx = 0, ∑Fy­ = 0 and ∑τ = 0. These will give the ability to resolve forces when we might need to involve torque, or using the net torque equation to solve for an unknown.

A woman 530 N stands on the end of a 3.90 m diving board that has a negligible weight, is bolted down at one end, and is supported by a fulcrum that is 1.40 m from the bolt. Determine the Fbolt and the Ffulcrum that must exist to balance the woman at the end of the board.

The axis is at the bolt, so that force produces a torque of zero

∑Fy= 0 = Fful – Fbolt = Fw ∑τ = 0 = Ffulcrum(1.40) - Fw (3.90) = 0

Ffulcrum = 530)(3.90)/1.40 m = 1476 N

Solving then for Fbolt yields 950 N (1476 – 530 = 950)

Firefighter on ladder:

An 870 N firefighter stands on a ladder that is 8.00 m long and has a weight of 355 N. The weight of the ladder acts at its center, and the ladder is leaning against a smooth wall at an angle of 50.0° between the ladder and the ground. The firefighter stands at a point 6.30 m from the base of the ladder. The ground is not smooth and exerts a force on the ladder to keep it from slipping. Determine the forces that the wall puts on the ladder and that the ground puts on the ladder.

∑Fx= 0 = Gx - Fwall (the normal force of the wall onto the ladder.)

∑Fy = 0 = Gy – Fw ladder – Fw fighter Gy = 870N + 355N = 1230 N We still have two unknowns and one equation, so we must use ∑ τ = 0 = Fwall *l* – WL*l* – Wf *l*

WL(sin 40)(4.00) = -WL *l=*

Wf (sin40)(6.30) = -Wf *l*=

Fwall (sin50)(8.00) = +Fwall (*l)*

Fwall = (WL*l ­*+ Wf*l)/*lp = 724 N now into ∑Fx t0 find Gx = 724 N.