Static Equilibrium

An object is in static equilibrium if:

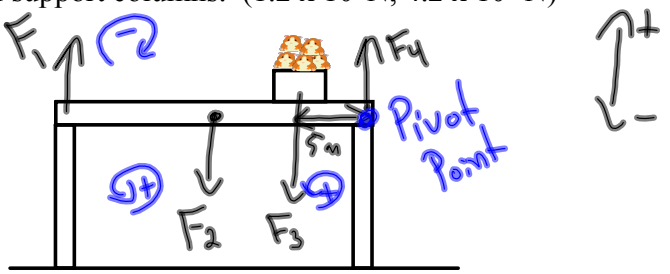
1. $\mathbf{v} = 0$ m/s
2. $\mathbf{F}_{net} = 0$ N
3. $\tau_{net} = 0$ Nm

Steps for Solving Static Equilibrium Problems

1. Draw a diagram.
2. Label all forces.
3. Choose a pivot point. It is helpful to place the pivot point where an unknown force exists.
4 Label distances from the pivot point to the forces. (r values)
5. Choose a coordinate system.
6. Resolve a force into its perpendicular components if the force doesn't fit into the chosen coordinate system.
7. Write F_{netx} and F_{nety} equations.
8. Write a τ_{net} equation.
9. Solve the equation(s) for the unknown.

* If a solid object has mass, treat the object as if all its mass were concentrated at a point - the center of mass.

Example: A uniform 1500 kg beam, 20.0 m long, supports a 15000 kg box of hamsters 5.0 m from the right support column. Calculate the magnitude of the forces on the beam exerted by each of the vertical support columns. (1.2×10^5 N, 4.2×10^4 N)



$$\sum \vec{F} = 0\ N$$

$$F_{net} = F_1 + F_2 + F_3 + F_4$$

$$\sum \tau = 0\ N_m$$

$$\tau_{net} = \tau_1 + \tau_2 + \tau_3 + \tau_4 \quad (=0 \text{ @ P.P.})$$

$$0 = -r_1F_1 + r_2F_2 + r_3F_3$$

$$0 = -(20)F_1 + (10)(1500)(9.81) + (5)(15000)(9.81)$$

$$0 = -20F_1 + 147150 + 735750$$

$$-882900 = -20F_1$$

$$44145\ N = F_1$$

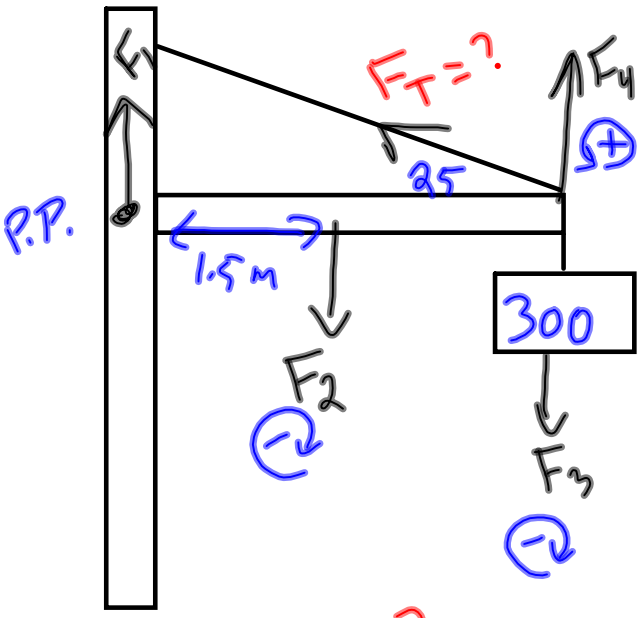
$$F_{net} = F_1 + F_2 + F_3 + F_4$$

$$0 = 44145 - (1500)(9.81) - (15000)(9.81) + F_4$$

$$0 = -117720 + F_4$$

$$117720 = F_4$$

Example: A uniform beam of mass 50.0 kg and length 3.00 m is attached to a wall with a hinge. The beam supports a sign of mass 300 kg which is suspended from its end. The beam is also supported by a wire that makes an angle of 25 ^{o} with the beam. Determine ~~the components of the force that the hinge exerts and~~ the tension in the wire. (6.8 x 10^{3} N, 2.5 x 10^{2} N, 7.5 x10^{3} N)



$\curvearrowright F_4 = F_T \sin\theta$

$\tau_{net} = \tau_1 + \tau_2 + \tau_3 + \tau_4$ ($\tau_1 = 0$)

$0 = -(1.5)(50)(9.81) - (3)(300)(9.81) + (3)F_4$

$0 = -735.75 - 8829 + (3)F_T \sin 25$

$0 = -9565 + 1.27F_T$

$\frac{9565}{1.27} = F_T$

$7544\ N = F_T$

$\curvearrowright rm(9.81)$