# Rotational Equilibrium

Torques tend to make objects rotate. If an object is subjected to a number of torques but does not rotate about some point then it is said to be in rotational Equilibrium

To ensure static equilibrium then, two conditions must be met by objects. They are

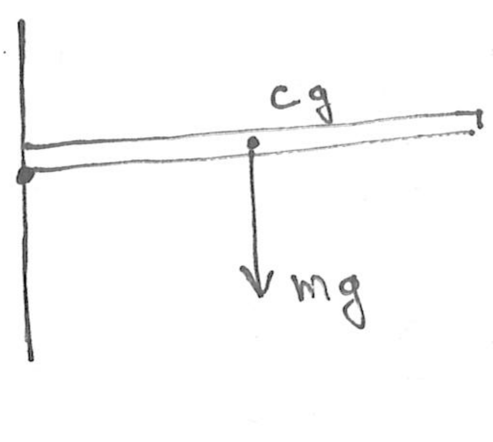
- the vector sum of all forces must be zero
- the vector sum of all torques must be zero

## Center of gravity

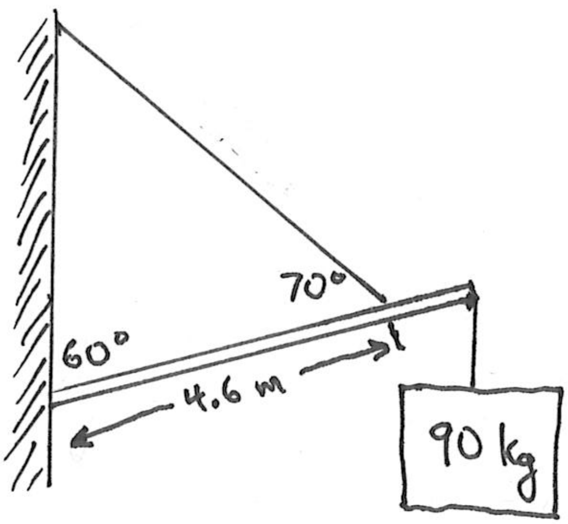
(a beams mass will produce torque in the presence of gravity)

the point in a rigid object where the force of gravity can be considered to act.

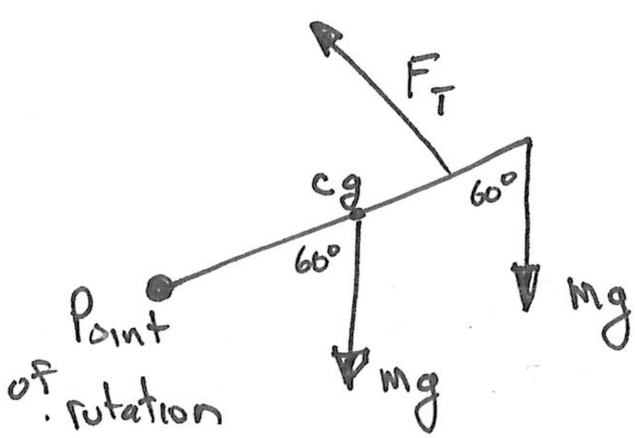
(Usually the center of the object)



Find the tension in the cable connected to the wall. Mass of beam is 30 kg, length = 7.0 m




Draw a free-body diagram and determine the direction of torques.




| | |
|---|---|
| $r_B$ | = 3.5 m |
| $r_M$ | = 7.0 m |
| $r_T$ | = 4.6 m |

Clockwise will be positive

Since the vector sum of the torques must equal zero then the two clockwise torques must equal the counter-clockwise torque

$$\tau_c = \tau_{cc}$$

(Torque from beam) + (Torque from mass) = (Torque from tension)

$$r_B F_B \sin\theta + r_M F_g \sin\theta = r_T F_T \sin\theta$$

$$\frac{r_B F_B \sin\theta + r_m F_g \sin\theta}{r_T \sin\theta} = F_T$$

$$F_T = \frac{(3.5)(30)(9.8)(\sin 60^\circ) + (7.0)(90)(9.8)(\sin 60^\circ)}{(4.6)(\sin 70^\circ)}$$

$$= \frac{6238 \text{ N}\cdot\text{m}}{4.322 \text{ m}}$$

$$F_T = 1443 \text{ N}$$

Tension in cable is 1400 N