Newtonian Gravitation

- Attraction

$$F = G\, m_1 m_2 / r^2$$

Constant of universal gravitation

$$G = 6.673 * 10^{-11}\, kg^{-1} m^3 s^{-2}$$

Rotational Motion

- Particles
  - moving in 3-D space
- Sizable objects
  - moving in 3-D space
  - rotation

Kinetic Energy

Motion	Energy
Translation	$KE = \frac{1}{2} mv^2$
Rotation	$KE = \frac{1}{2} I\omega^2$
Vibration	

Equilibrium

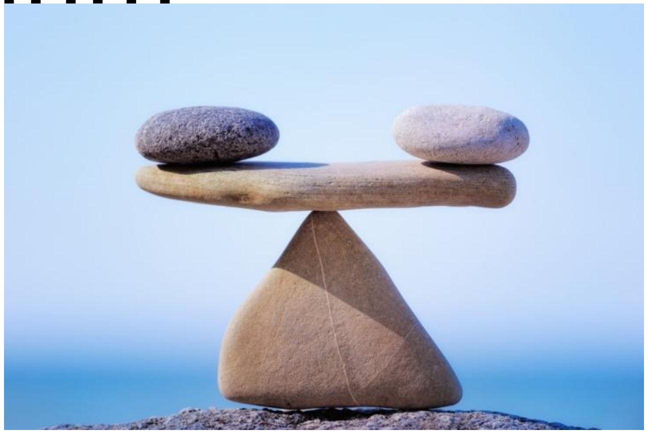


image source: shutter stock

Torque

- Is the door knob always at the far end from the hinge?

- Torque

$$\tau = rF\sin\theta$$

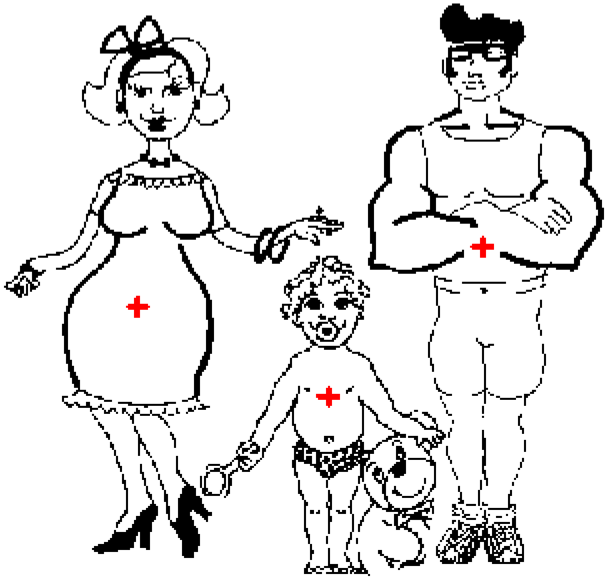
- SI Units:

Newton meter (N m)

Is this crib safe?

Center of Gravity

- The gravitational force on a body effectively act on a single point.



http://spot.pcc.edu/

Equilibrium Conditions

- Force

$$F_{net,x} = 0$$

$$F_{net,y} = 0$$

$$F_{net,z} = 0$$

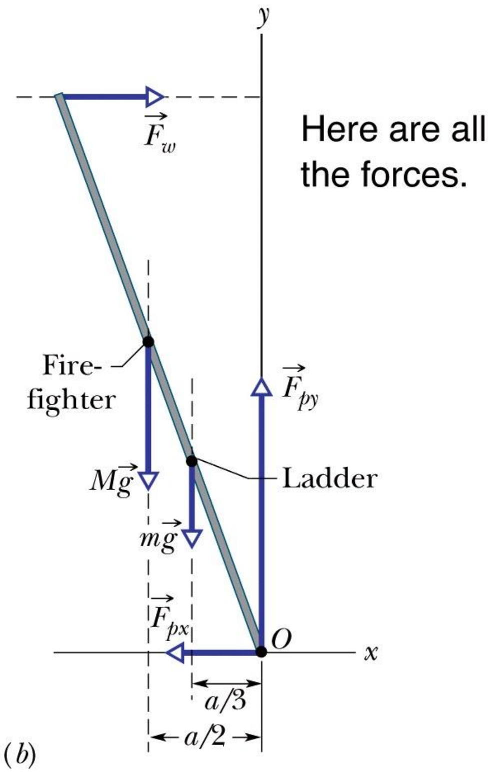
$$\tau_{net,x} = 0$$

- Torque

$$\tau_{net,y} = 0$$

$$\tau_{net,z} = 0$$

Force Analysis



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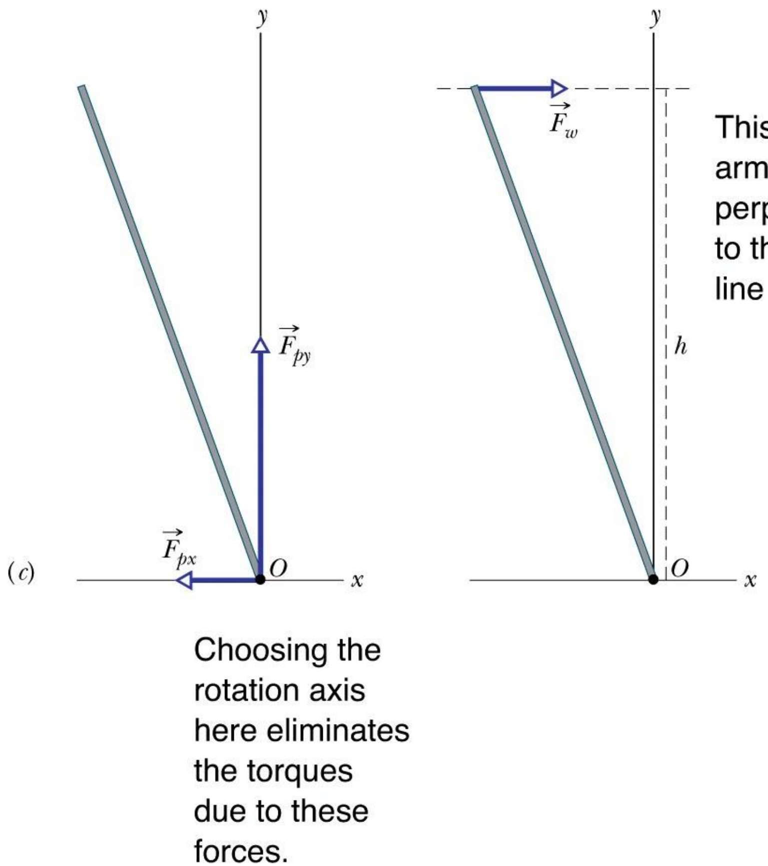
O is for rotational axis



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I is for Moment of Inertia

$$I = \sum mr^2$$

$$\tau = I\alpha$$

$$KE_r = \frac{1}{2} I\omega^2$$

$$L = I\omega$$

Conservation of Anglular Momentum

- Condition

$$\tau = 0$$

- Angular Momentum remains constant

$$I_i \omega_i = I_f \omega_f$$