Newton's Laws

- **Newton's 1st Law (Same as Galileo's law of inertia): No force => no acceleration.**

"An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by a force."

$$\vec{F} = 0 \quad \Rightarrow \quad \vec{v} = const$$

- **Newton's 2nd Law:**

"Force equals mass times acceleration"

$$\vec{F} = m\vec{a}$$

- **Newton's 3rd Law:**

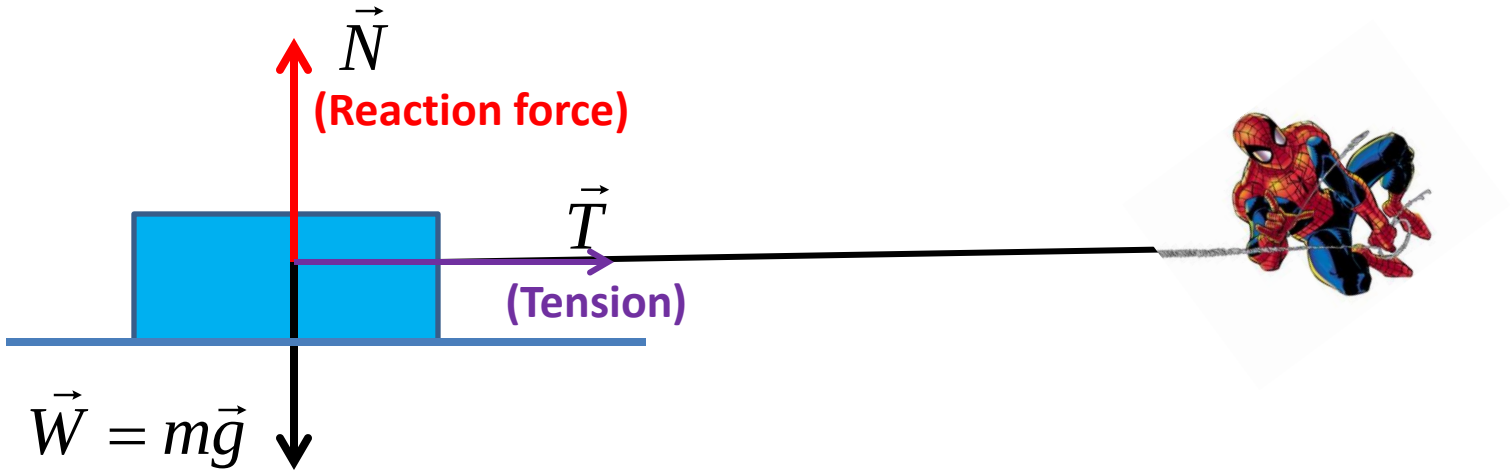
"Force of action is equal and opposite to Force of counter-action"

$$\vec{F}_{B\to A} = -\vec{F}_{A\to B}$$

Unit of force is called Newton (N)

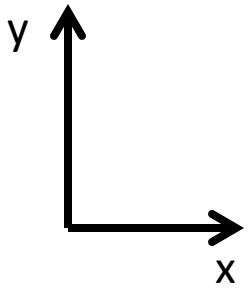
$$1N = 1\frac{kg \cdot m}{s^2}$$

Examples of Forces



(Gravitational force , or Weight)

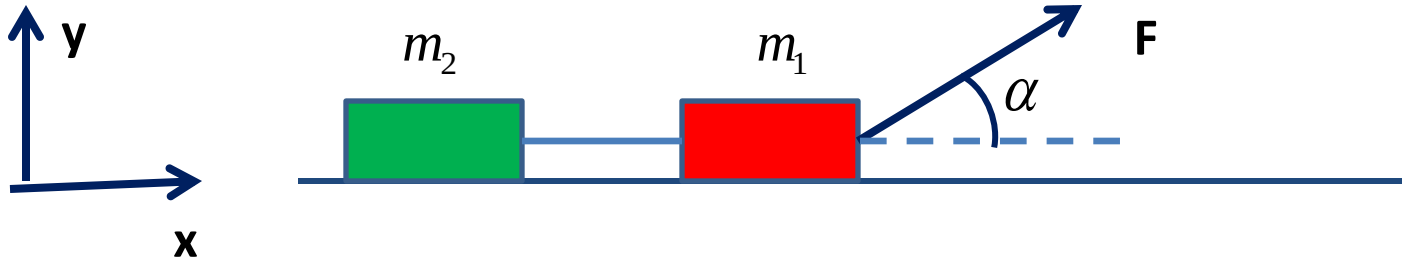
Forces a vectors! The total force is the *vector sum* of all applied forces:



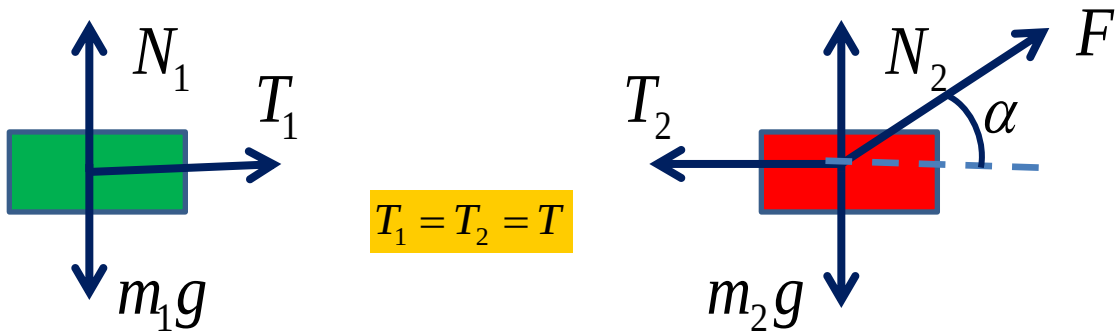
$$\vec{F}_{total} = \vec{N} + \vec{T} + \vec{W}$$

$$\vec{F}_{total} = (F_x, F_y) = (T, N - mg)$$

Free Body Diagram



1. Choose the coordinate system.
2. Show all forces applied to each object.
3. Write 2nd Newton's Law for each object, and each axis.
4. Solve equations to find acceleration.



$x-axis:$	$T = m_1 a$	$F\cos\alpha - T = m_2 a$
$y-axis:$	$N_1 - m_1 g = 0$	$N_2 + F\sin\alpha - m_2 g = 0$

$$a = \frac{F\cos\alpha}{m_1 + m_2}$$

Homework

Problem 1

Starting with Newton's Laws show that mass is additive. That is, mass of an object is equal to the sum of masses of its parts.

Problem 2

Find acceleration of block "1" in both cases in the Figure. All pulleys are weightless and rotate without friction.