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."

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

Modern interpretation: "there exists a reference frame called inertial, in which the above statement is correct."

- **Newton's 2nd Law:** $\vec{F} = m\vec{a}$

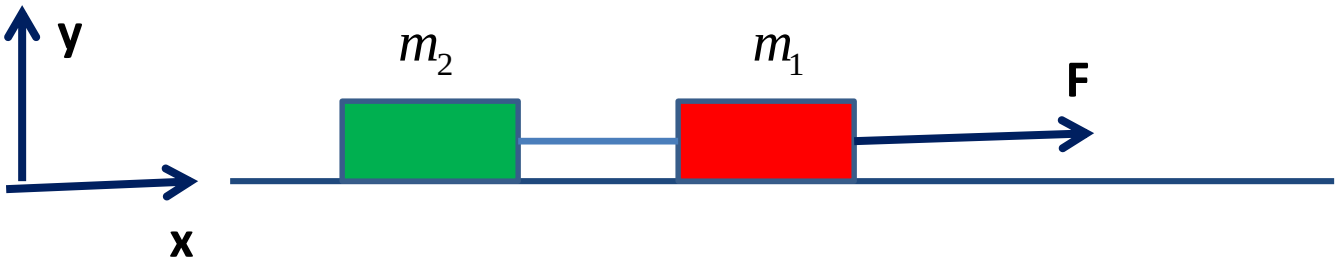
"Force equals mass times acceleration"

- **Newton's 3rd Law:** $\vec{F}_{B\to A} = -\vec{F}_{A\to B}$

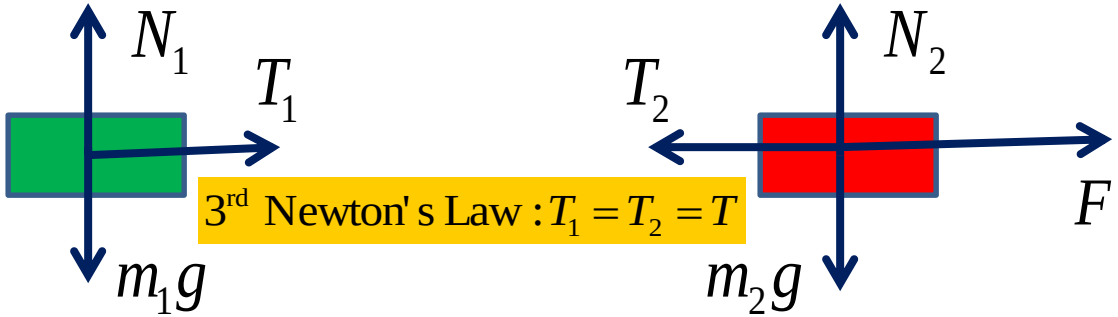
"Any Force of action has an equal and opposite Force of reaction "

Unit of force is called Newton (N) $1N = 1\frac{kg \cdot m}{s^2}$

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.



$$x-axis: \quad T = m_1 a \qquad F - T = m_2 a$$

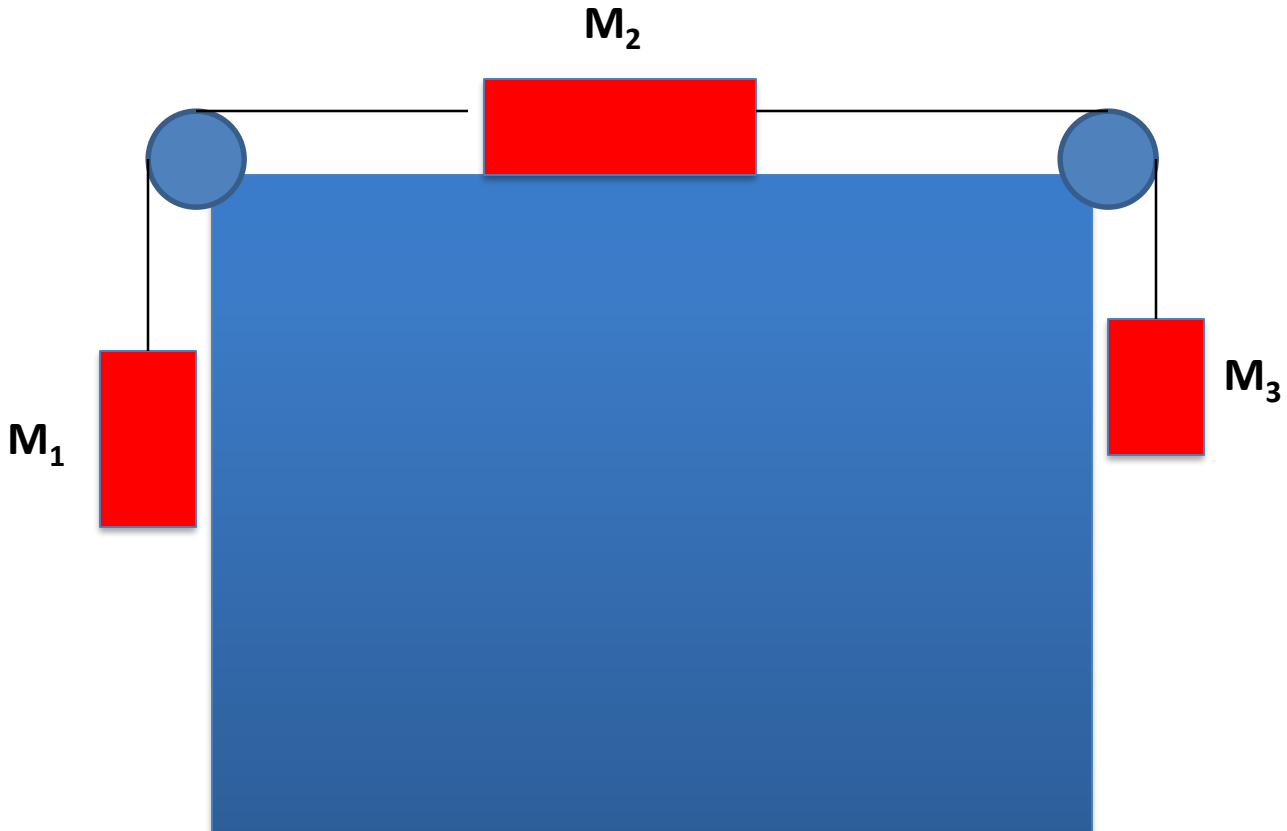
$$y-axis: \quad N_1 - m_1 g = 0 \qquad N_2 - m_2 g = 0$$

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

Homework

Problem 1.

Construct free body diagrams, and find accelerations of the blocks in the figure. Masses of the blocks are M_1=0.8kg; M_2=1kg and M_3=0.5kg.
Note that the tension is different between the two strings, but it does not change as a string goes around the pulley.



Problem2.

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

Important hint: *the accelerations of two blocks in the case (b) are not the same! Imagine that you move block “2” by distance x upward. How much did the block “1” moved? This consideration will allow you to find the relationship between the two accelerations.*