

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."

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

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

"Force equals mass times acceleration"

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

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

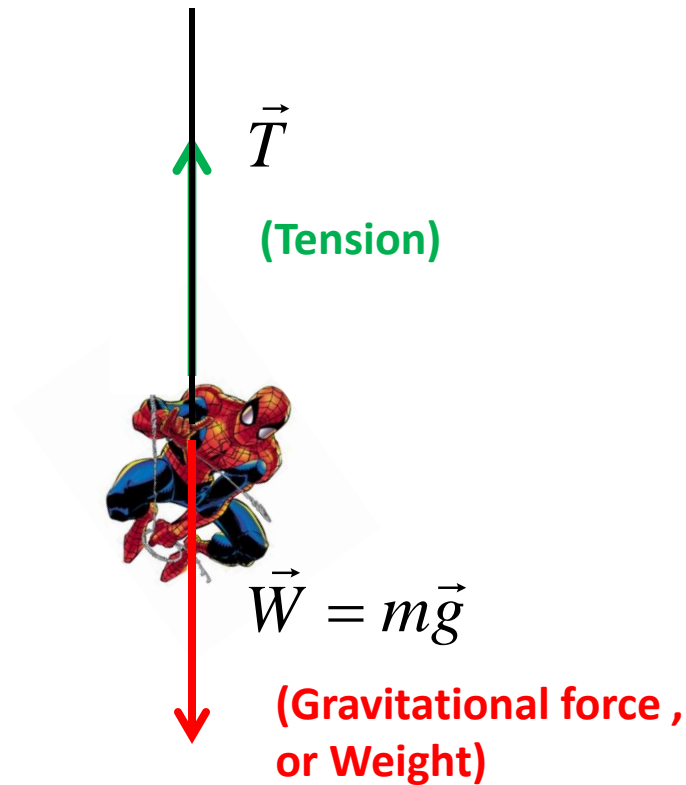
"Any Force of action has an equal and opposite Force of reaction"

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

Unit of force is called Newton (N)

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

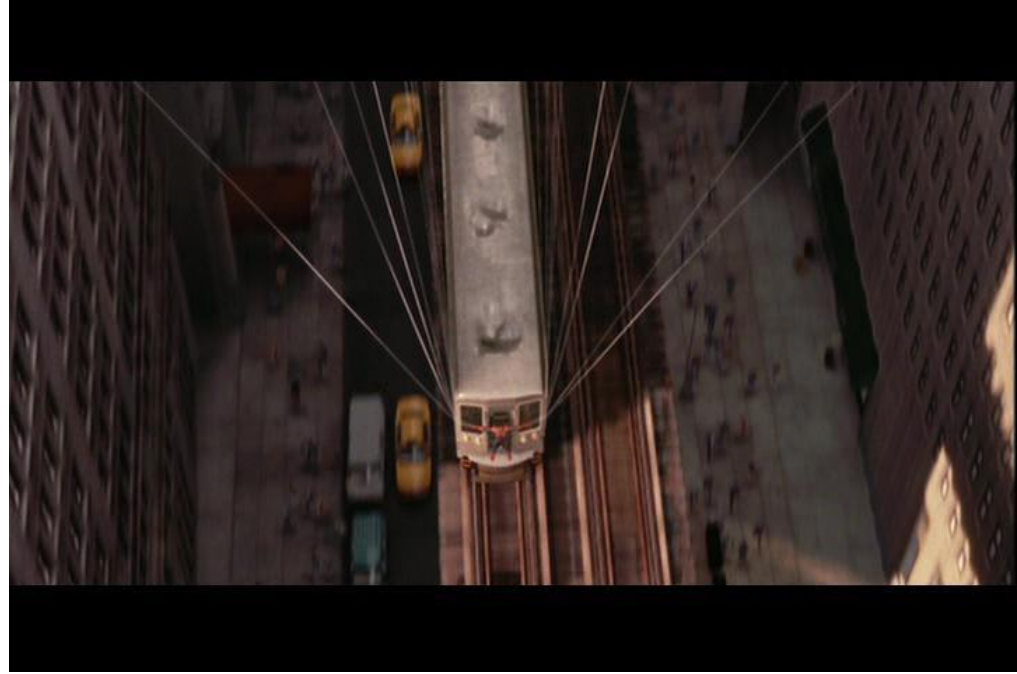
Examples of Forces



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

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

Homework



In the movie Spiderman 2, Peter Parker aka Spiderman manages to stop the train by using his web. (search youtube for “**Peter Stops The Train!**” clip). It takes $t=45\text{s}$ of screen time. The initial speed of the train is approximately $v=80\text{ km/hr}$ (you’ll need to convert to m/s !).

Find the average acceleration of the train, and the force that Spiderman can hold. This force is of strategic importance for any villain: you can see from the video that the superhero is close to his limit. Mass of the NYC subway train (full of people) is $300,000\text{kg}$.