

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:

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

"Force equals mass times acceleration"

- to be continued...

Unit of force is called Newton (N)

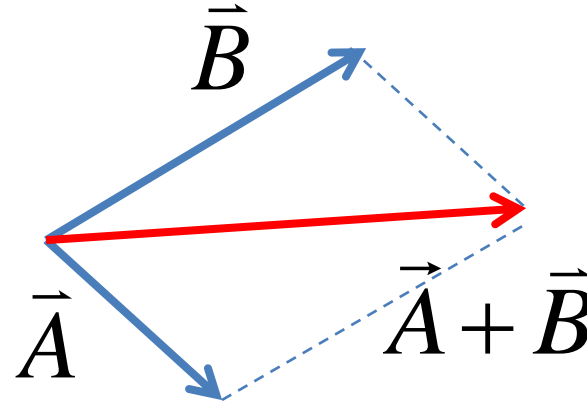
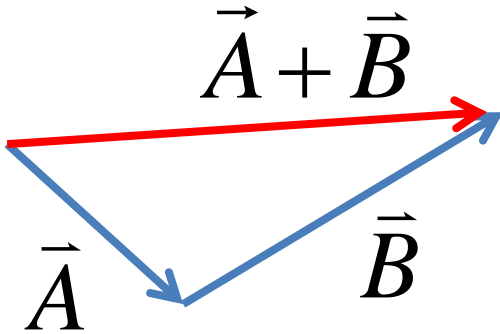
$$1N = 1 \frac{\text{kg} \cdot \text{m}}{\text{s}^2}$$

Adding vectors

Forces are vectors! There are two ways of thinking about **vectors**:

- **Geometrically**, vector is a directed line segment. It has direction and magnitude.
- **Algebraically**, vectors can be written as a list of numbers: their X, Y and Z components. For instance (3,4,-5).

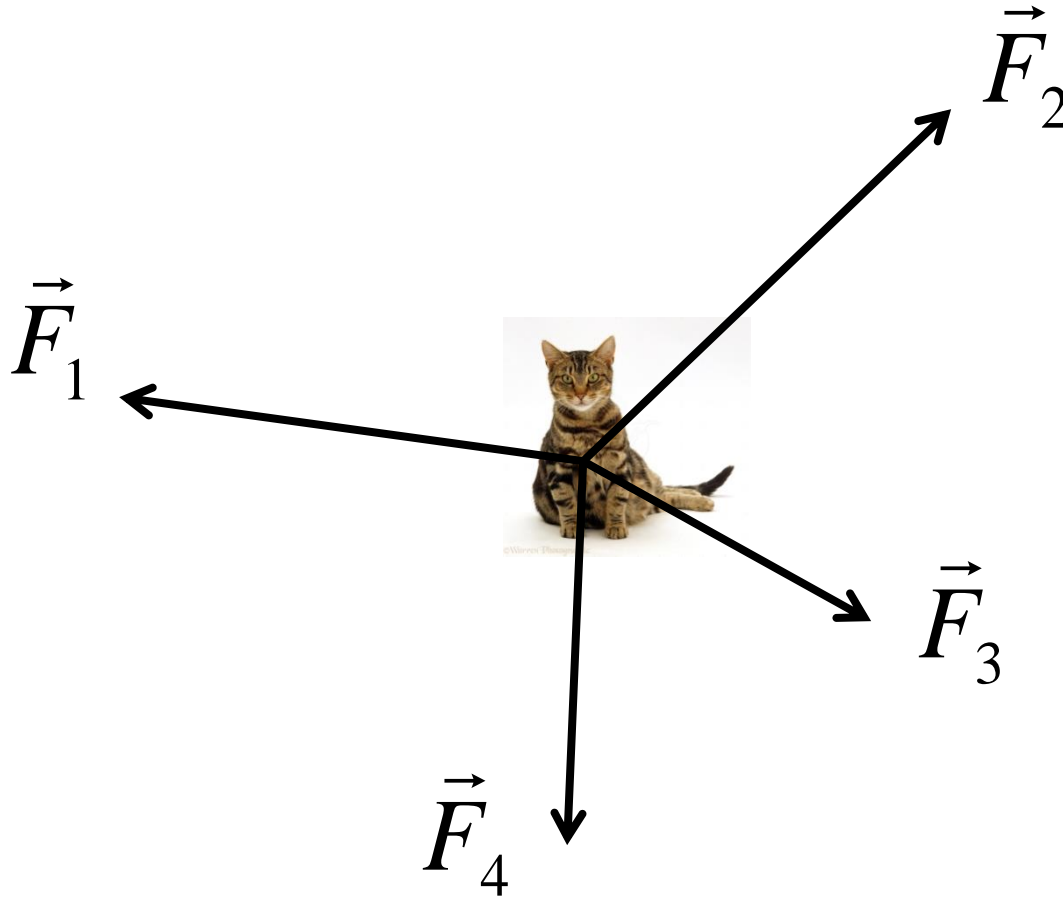
To add vectors A and B geometrically, you can use “triangle” or “parallelogram” rules:

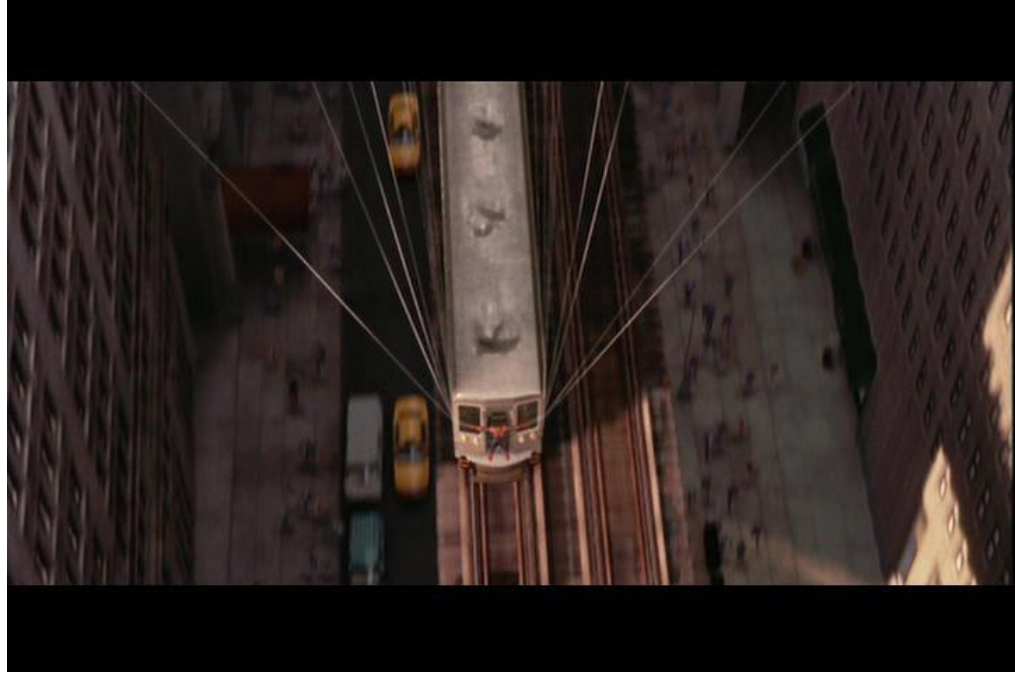


Homework 9

Problem 1.

Find the total force acting on a cat (graphically)





Problem 2

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 $300,000\text{kg}$.