## Second Newton's law

We have already discussed the law of inertia that says the following: velocity of an object does not change unless the object interacts with other objects.
Force can be determined as interaction which makes the object accelerate. Force and acceleration are connected by a simple formula known as second Newton's law.

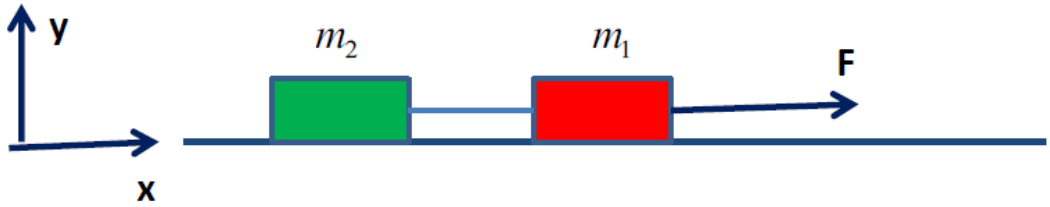
### Newton's Laws (1st and 2nd )

1st Law (Same as Galileo's Law of Inertia): $\vec{F} = 0 \quad \Rightarrow \quad \vec{v} = const$

Modern interpretation : definition of Inertial Reference Frame.

2nd Law : $\vec{F} = m\vec{a}$

### Free Body Diagram

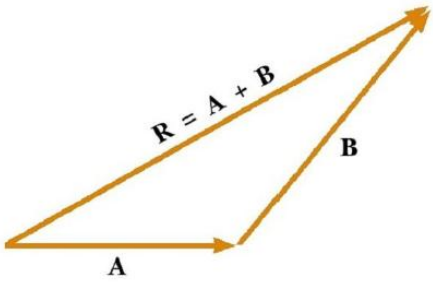



1. Choose the coordinate system (for each object).
2. Show all forces applied to each object.
3. Write 2nd Newton's Law for each object, and each axis.
4. Solve equations to find acceleration.

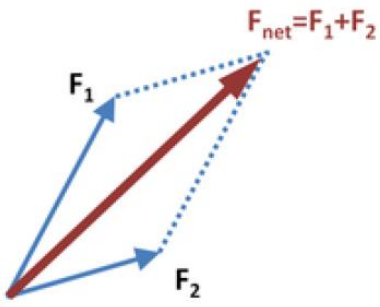
### Adding Forces

The **force *F* in the laws above is the sum of all the forces applied to the object**. We will call this sum as ***total net force***. How can we sum up forces?
Force is a measure of interaction. It is a vector (has direction). When several forces are acting on an object, they **are added as vectors.** Pythagorean Theorem comes in handy here if the forces are perpendicular.

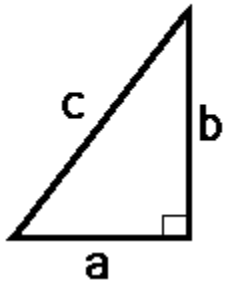
**Triangle rule**
**(best for displacements)**




**Parallelogram rule**
**(best for forces)**



## Pythagorean Theorem




$$a^2 + b^2 = c^2$$

**Homework:**

**1)** A single force of 10N acts on a mass *m*. The mass starts from rest and travels in a straight line a distance of 18m in 6 seconds. Find mass *m*.

**2)** A group of workers uses a bucket with a rope tied to it to lift bricks to higher floors of a building they construct. The bucket has mass 2 kilograms; each brick is rectangular with length 20 cm, width 10 cm and height 5 cm. Density of a brick is 1.8 g/cm3. How many bricks can be transported in the bucket at once if the rope withstands force up to 100 N?

**3)** A model rocket shown in the figure has mass m=10 kg. In addition to gravity, there is a thrust force F= 200N applied to it, directed forward.
a) Sketch both forces (gravity and thrust) as vectors, up to scale to each other.
b) By adding forces graphically, find the total force acting on the rocket, and its acceleration.