

## DYNAMICS (FORCES)

### Balanced Forces

If the forces acting on the object are **balanced**, the resultant force is **zero**.

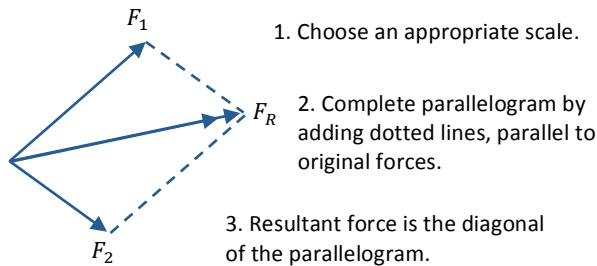
**Newton's First Law of Motion** states that every object will continue in its state of rest or *uniform* motion in a *straight* line unless a resultant force acts on it.

### Vector Addition

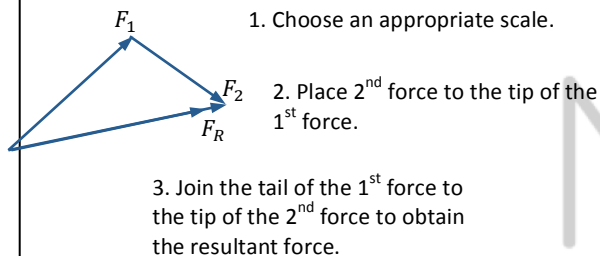
**For parallel vectors:** Same direction (add), opposite direction (Subtract)

#### Non-Parallel vectors

Method 1: Parallelogram method

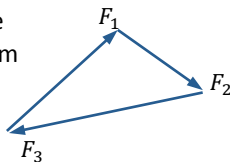


Method 2: Tip-to-tail method



When using the tip-to-tail method, if the resultant force is zero, the vector diagram would form a **closed triangle**.

The forces are said to be in equilibrium.



### Definition

A force is a **push** or **pull** that one exerts on another body. It can produce, slow down, speed up, stop or change direction of motion.

### Unbalanced Forces

**Newton's Second Law of Motion** states that the resultant force acting on an object is equal to the product of mass and the acceleration of the object; the force acts in the same direction as the acceleration of the object.

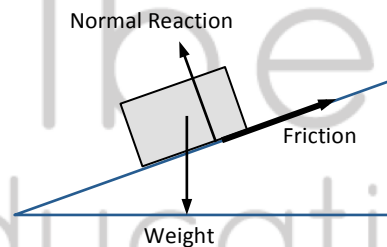
$$F = ma$$

F : resultant force (N)  
m : mass (kg)  
a : acceleration ( $\text{ms}^{-2}$ )

If the object is moving at constant speed, the acceleration is zero. The resultant force is also zero.

### Free-Body Diagrams (FBD)

- Identify and **isolate** the body.
- Draw all the physical forces acting on the body clearly. **Length of arrow** represents the magnitude of the force. Take note of the relative magnitude of forces.
- Ensure **correct point of application** of force.
- Label** all forces drawn.



### Types of Forces

Forces can be classified into two main types:

Contact Forces	Non-contact forces
Friction	Gravitational force (Weight)
Normal reaction	Electric force
Tension	Magnetic force

### Action-Reaction Forces

**Newton's Third Law of Motion** states that for every action force acting on a body, there is an *equal* and *opposite* reaction force acting on the opposite body.

#### Characteristics action-reaction forces:

- The forces are of the same nature.
- They are equal in magnitude and opposite in direction.
- Action and reaction act on different bodies.

### Friction

**Friction** is a contact force that opposes or tends to oppose motion between surfaces in contact.

#### Effects of Friction

Positive effects	Negative effects
Helps us to walk without slipping	Reduces efficiency of machines
Help us to grip things	Causes wear and tear
Moving vehicles can slow down when needed.	Causes unwanted heating

#### Friction can be reduced by using

- Wheels
- Ball bearings
- Lubricants and polished surfaces
- Air cushion (hovercrafts, maglev etc)