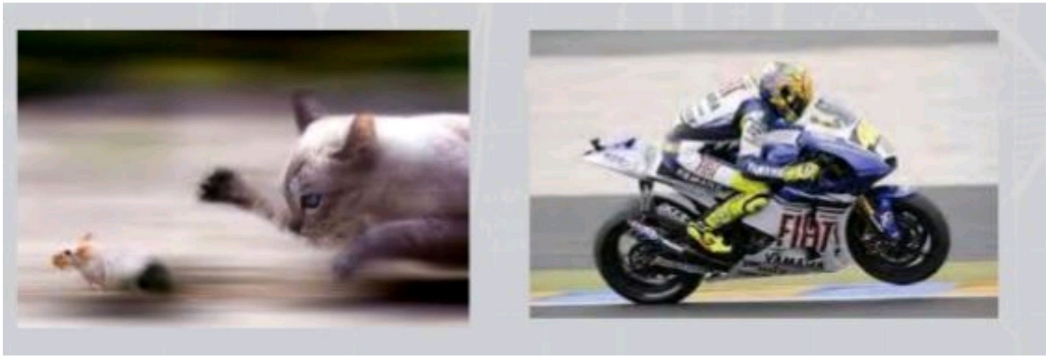
SPEED, VELOCITY & ACCELERATION



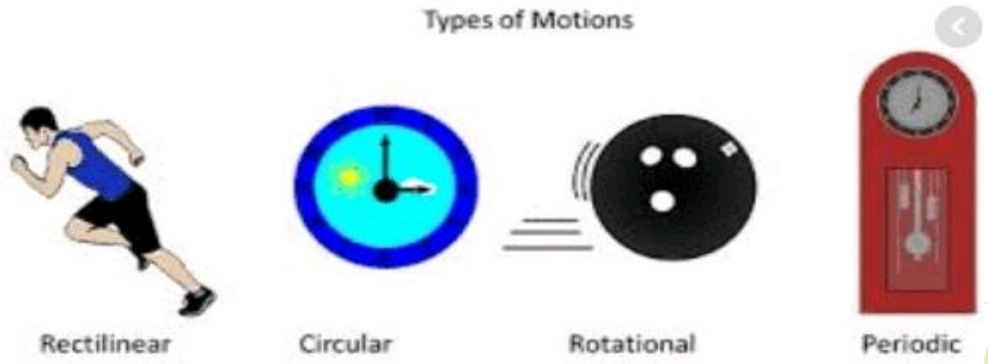
By, Mr. Rahul Chandra.

◆Rest:

- When a body does not change its position with respect to its surrounding, the body is said to be at rest.
- E.g. A book placed on a table is said to be at rest in relation to the table.

◆MOTION:

- When a body changes it's position with respect to its surrounding , the body is said to be in motion.
- E.g. A man walking on the road is said to be in motion in relation to the electric pole.



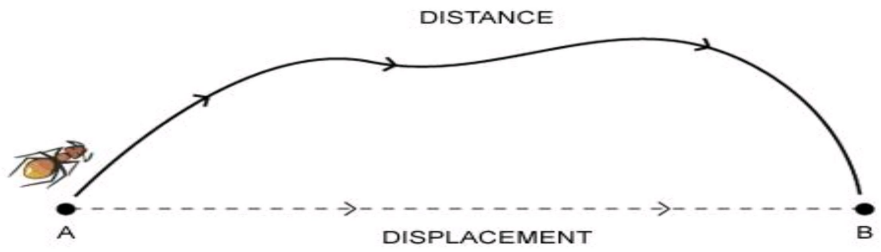
•SCALARS AND VECTOR QUANTITIES

- Scalar Quantities: The physical quantities which are specified with the magnitude or size alone are **Scalar Quantities**. For example, length, speed, work, mass, density, etc
- Vector Quantities: Vector quantities refer to the physical quantities characterized by the presence of both magnitude as well as direction. For example, displacement, force, torque, momentum, acceleration, velocity, etc.

Scalar Quantity	Vector Quantity
Lenght	Displacement
Mass	Velocity
Time	Acceleration
Area	Force
Speed	Momentum
Energy	Electrical Field

◆What is Displacement ?

- The change of position of a body in a specific direction is called displacement.
- Displacement is a vector quantity because, it has magnatiude as well as direction.



What is Speed?

- The distance travelled by a body per unit time is known as it's speed.

$$s = \frac{d}{t}$$

s = speed

d = distance traveled

t = time elapsed

◆What is Velocity ?

- The distance travelled by a body per unit time in a given direction is known as it's velocity.
- Or, The rate of change of displacement by a body per unit time is known as velocity.

$$\text{Velocity} = \frac{\text{Distance travelled in a given direction}}{\text{Time taken}}$$

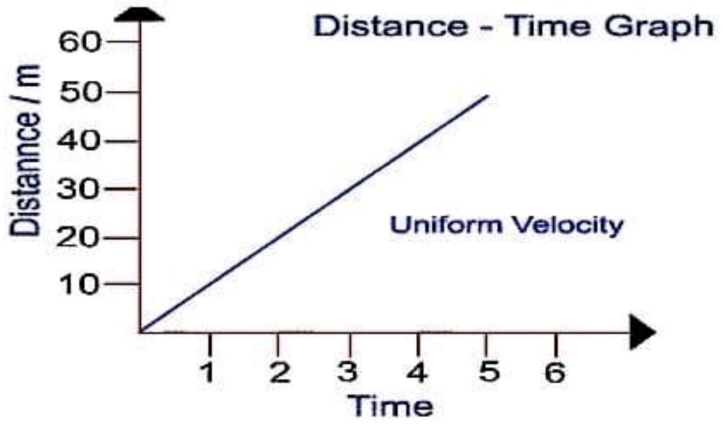
or

$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}}$$

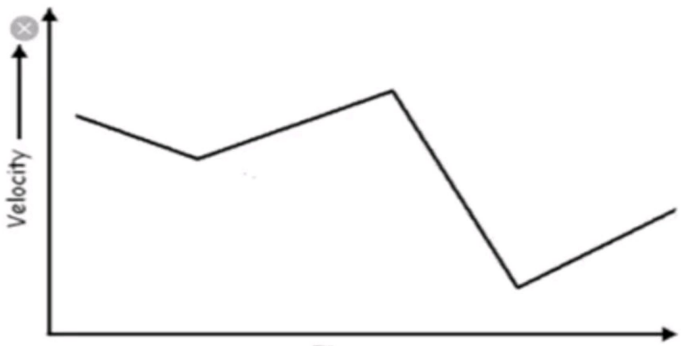
$$v = \frac{s}{t} \text{ or } s = vt$$

●TYPES OF VELOCITY :

- 1) Uniform Velocity : If a body travels equal distances in a given direction in equal intervals of time, no matter how small these time intervals may be, then the body has uniform velocity.



- 2) Variable Velocity : When a body does not travels equal distances in equal intervals of time, then the velocity of a body is said to be variable or non-uniform velocity.



Velocity - Time Graph of an object moving with Non-uniform velocity

- 3) Average Velocity : When a body travel certain distance at a variable speed in a perpendicular direction then average velocity can be find out by dividing total variable distance by time taken to travel that distance.

$$\text{Average Velocity} = \frac{\text{Total distance travelled}}{\text{Time taken}}$$

- # DIFFERENCE BETWEEN SPEED & VELOCITY:

Speed	Velocity
1) Speed of a body is the distance travelled by per unit time.	1) It is the distance travelled by a body per unit time in a particular direction.
2) It is a scalar quantity.	2) It is a vector quantity.
3) It can not be zero.	3) It can be zero.

◆ANGUALR VELOCITY :

- The angualr displacement of a body per unit of time is known as angular velocity.
- The vertical unit of angular velocity used in engineering field is Revolution Per Minute (RPM) but in certain applications , the unit radians per second also used.
- We know circumference of a circle = 2πr
- So , in one complete revolution there are 2π radians.
- 2π radians = 360°.
- 1 radiant = (360°/2π) = 57.3°.

◆ACCELERATION :

- The rate of change of velocity is known as acceleration.
- The S.I. Unit of acceleration is meters per second square (m/s^2).
- Acceleration is a Vector Quantity.

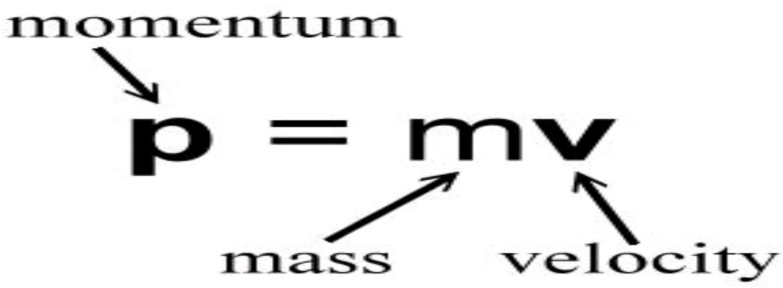
$$\text{Acceleration} = \frac{change\ in\ velocity}{time\ taken}$$

$$\text{Acceleration} = \frac{final\ velocity - initial\ velocity}{time\ taken}$$

$$a = \frac{Vf - Vi}{t}$$

●MOMENTUM :

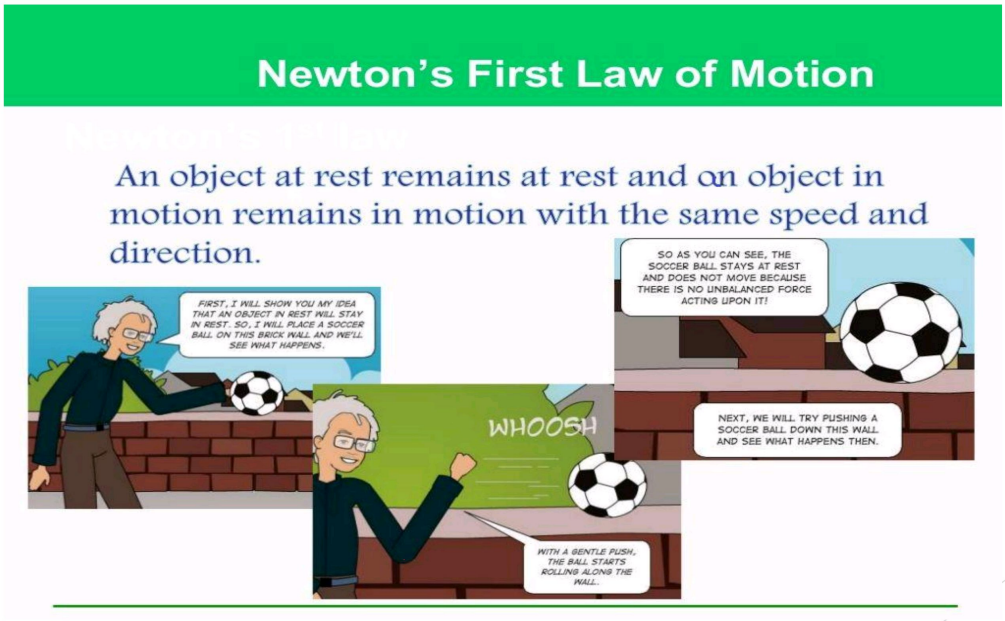
- Momentum of a body is defined as the product of mass of the body and it's velocity. Momentum is denoted by **P.**
- Momentum = Mass × Acceleration.
- P = m × v.



◆Force:

- Force is that push or pull which produce a change in the state of rest of a body or changes unifrom motion or direction of motion of the body.
- Force = Mass × Acceleration.
- $F = m \times a.$

●NEWTON'S LAWS OF MOTION :



◆Applications of Newton's First Law of Motion:

- A coin is placed on a playing card covering a glass. On giving a sudden jerk to the card, the playing card flies off and the coin drops into the glass. This happens because the coin is still at rest due to the inertia of rest.
- The passengers sitting in the bus experience a sudden jerk when the bus starts moving. This happens because the inertia of rest, which acts on the passengers' upper body; making them fall back when the bus is accelerated.

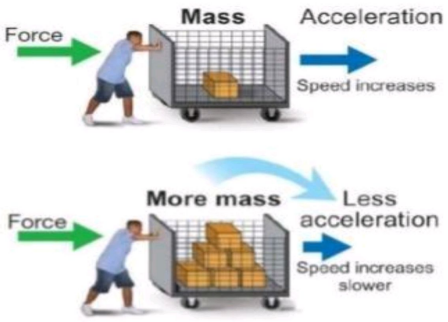
NEWTON 2ND LAW OF MOTION :

The rate of change of momentum of an object is directly proportional to the unbalanced force acting on it. The direction of the unbalanced force is the same as the direction of the change of momentum.

F = ma.

Applications of Newton's Second Law of Motion:

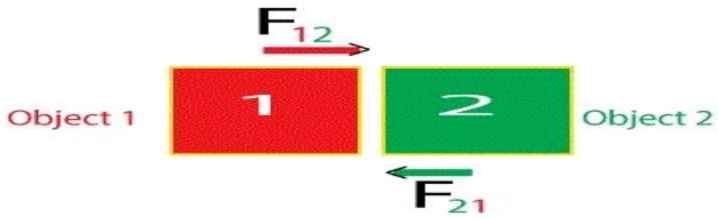
- It is extremely difficult for one person to lift a box weighing 6 pounds, whereas the same box can be lifted easily by multiple people. Since, more the number of people, more will be the amount of force, and hence, the box can be lifted with less difficulty.
- You require a much greater force in pushing a car, compared to the force required to push a soccer ball.



◆Newton's Third Law Of Motion :

- The third law of motion states that for every action, there is an equal and opposite reaction.
- Force always exists in pairs. A single and isolated force cannot exist.
- If two objects interact, the force, F_{12}, exerted on the object 1 by the object 2 (called action) is equal in magnitude but opposite in direction to the force, F_{21}, exerted on the object 2 by the object 1 (called reaction).
- Though action-reaction are equal and opposite, they never cancel each other.

F = Net force applied on the object



Therefore, $F_{12} = -F_{21}$

●Applications of Newton's Third Law of Motion:

- It is the horizontal component of the reaction, rendered by the ground, which enables us to walk, move forward, and run.
- When a man jumps down on the shore from a boat, the boat moves backwards.
- The gases ejected downward because of the burning of the fuel in a rocket exerts an upward reaction which is responsible for propelling the rocket upwards.