CLASS 9

MoTioN

# TOPICS TO BE COVERED :-

➢ **Introduction**
➢ **Reference point or frame of reference**
➢ **Scalar and vector quantities**
➢ **Motion in a straight line**
➢ **Graphical representation of motion**
➢ **Equation of motion by graphical method**
➢ **Derivation of equation of motion**
➢ **Uniform circular motion**

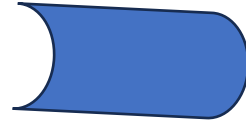# Introduction

## Rest : -

A body is said to be in rest if it is not changing its position w.r.t (with respect to) passage of time .

## MOTION : -

A body is said to be in motion if it is changing its position w.r.t passage of time

# Reference point or Frame of reference

# Reference point or Frame of reference

❖ A fixed point or a fixed object w.r.t which the given body changes its position is known as reference point or origin.

❖ An object is in motion w.r.t one reference point but the same object may be at rest w.r.t another reference point.

❖ Thus, rest and motion are relative terms

# Physical Quantities

❖ **Physical quantities are those which can be measure.**

Physical Quantities

| SCALAR QUANTITIES | VECTOR QUANTITIES |
|---|---|
| Those physical quantities which have only magnitude or size (numerical value). | Those physical quantities which have both magnitude as well as direction. |
| E.g :- Distance, mass, volume, speed, density, time, work, etc. | E.g :- Displacement, velocity, acceleration, force, pressure, momentum, etc. |

NOTE :- Vector quantities is represented by an arrow on the head as $\vec{F}$, $\vec{a}$, etc.
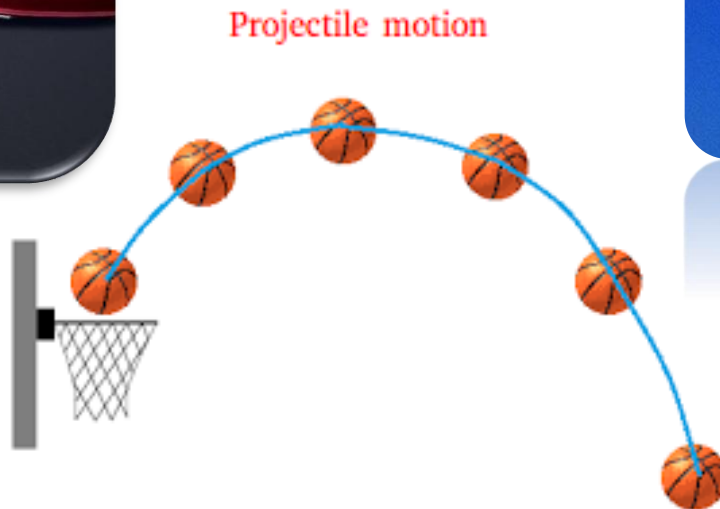
# Motion in a straight line
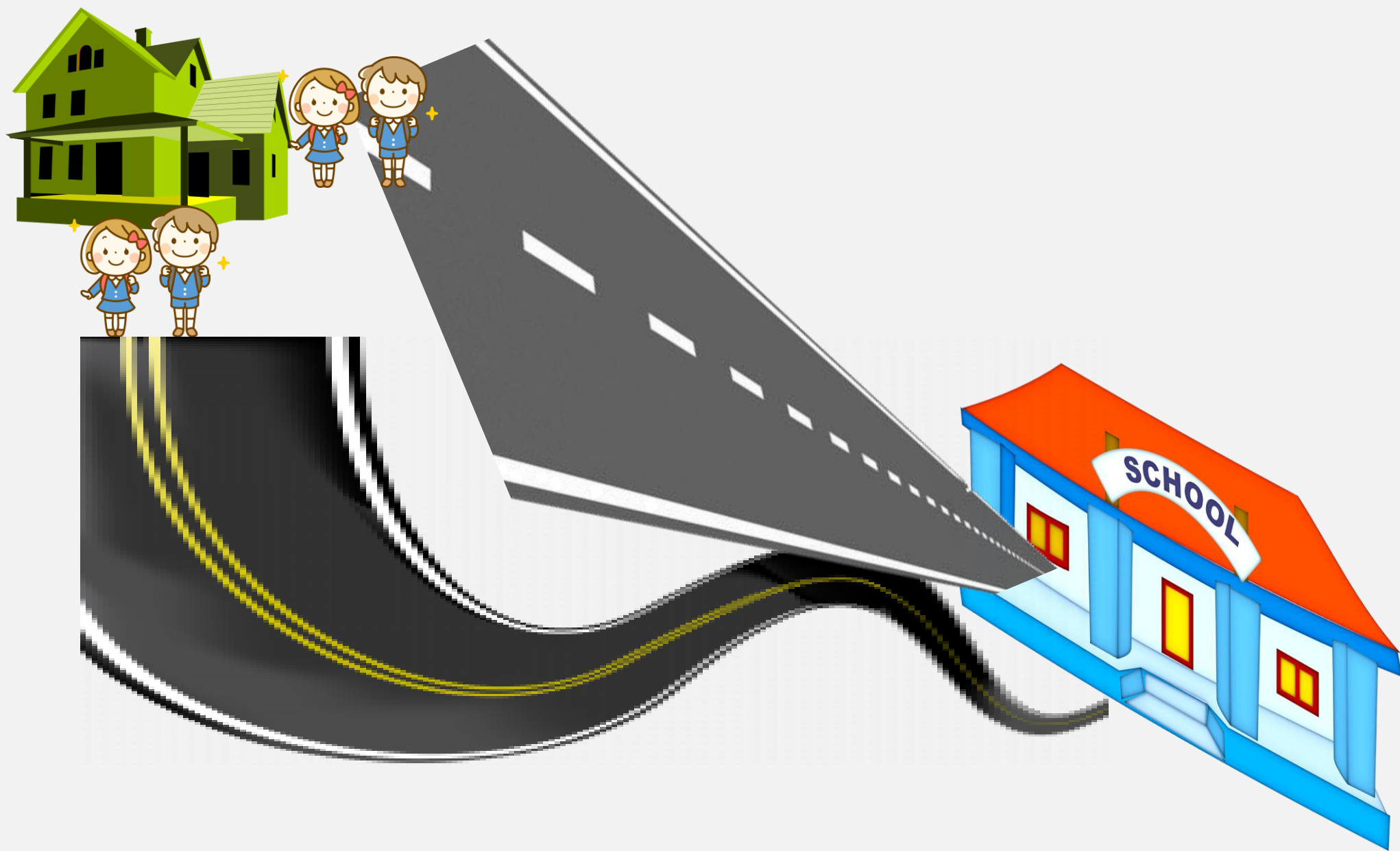
A body travel in a straight line .

Also known as linear or rectilinear motion.

eg:- motion of a car , stone dropped from roof ,etc

There are many types of motion as linear , circular ,projectile motion, etc



Projectile motion

SCHOOL

# TERMS RELATED TO MOTION

## DISTANCE

❑ The length of the actual path between initial and final position.
❑ It is a scalar quantity
❑ Measured by a device known as a odometer ( used in a vehicle )
❑ It cannot be zero and negative

## DISPLACEMENT

❑ The shortest distance between initial and final position
❑ Displacement = final position – initial position
❑ It can be zero and negative

Note :- The unit of distance and displacement are same known as meters (m)

Magnitude of displacement is always less than or equal to distance
i.e | Displacement | $\leq$ | Distance |

## Ques :- Difference between distance and displacement ?

SOL:-

| DISTANCE | DISPLACEMENT |
|---|---|
| It is an actual length of path covered by a body | It is the shortest distance between initial and final position |
| It is a scalar quantity | It is a vector quantity |
| It cannot be zero and negative | It can be zero as well as well as negative |
| It depends on the path followed by the object | It does not depend on the path followed by body |

Ques :- The minute hand of a clock is 7 cm long. Calculate the distance covered and the displacement of minute hand from 9:00 AM to 9: 30 AM

Ques :- Calculate the displacement and distance in the following in which A is initial and C is final position

A

5Km

B

12Km

C
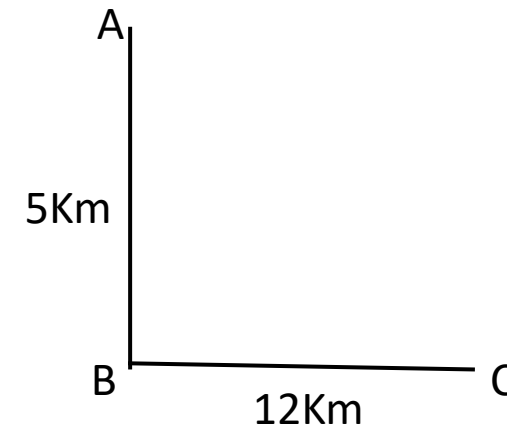
# UNIFORM AND NON-UNIFORM MOTION

## Uniform or constant motion

An object is said to be in uniform motion, if it covers equal distance in equal interval of time.
Eg :-motion of planets

## Non uniform or variable motion

An object is said to be in non uniform motion if it is covers unequal distance in equal interval of time
Eg :- running of athlete ,

## Speed

Distance travelled by an object for unit time
                    OR
Rate of change of distance

Unit :- m/s
It is a scalar quantity
Measured by a device known as speedometer (used in a vehicle measure instantaneous speed )

$$Speed = \frac{distance}{time}$$ OR $$S = \frac{D}{T}$$

TYPES OF SPEED

a) Uniform speed                    c ) average speed
b) Non – uniform speed              d ) Instantaneous speed

# Average speed :-

Ratio of total distance covered by body to total time taken by it.

$$\text{Average speed} = \frac{\text{total distance}}{\text{total time}}$$

# Instantaneous speed :-

speed of an object at any instant time during its motion

# Questions

01. Change the speed of 6 m/s into km/h.

02. What do the following measure in a car ?
(a) Speedometer (b) Odometer

03. When is a body said to have uniform velocity ?

04. Bus X travels a distance of 360 km in 5 hours whereas bus Y travels a distance of 476 km in 7 hours.
Which bus travels faster ?

05. A snail covers a distance of 100 metres in 50 hours.
Calculate the average speed of snail in km/h.

06. A sound is heard after 5 second of the lighting is seen in the sky during a cloudy day. Find the distance of the location of lighting, if the speed of sound is 346m/s.

07. A motorcyclist drives from place A to B with a uniform speed of 30 km h$^{-1}$ and returns from place B to A with a uniform speed of 20 km h$^{-1}$. Find his average speed.

# Velocity :-

## Displacement per unit time

velocity =  Displacement
Time

$\vec{V} = \dfrac{\vec{S}}{T}$

S.I Unit :-   meter   ( m/s )
second

Vector quantity

### Types of velocity :-

 a ) uniform or constant velocity                                    c ) Average velocity
 b ) Non – uniform motion or variable motion                        d ) Instantaneous velocity


## Average velocity :-
The ratio of total displacement by a body to total time taken by it


## Instantaneous velocity :-
velocity of an object at any instant time during its motion

**Average velocity = Total displacement**
**Total time**

$$\vec{V} = \frac{U + V}{T}$$

U = initial velocity
V = final velocity

**Ques :- Difference between speed and velocity**

Sol :-

| Speed | Velocity |
|---|---|
| Distance covered per unit time | Displacement per unit time |
| Scalar quantity | Vector quantity |
| It is always positive | It may be positive or negative |

**Ques :- A car ravels 10 km distance at a speed of 600 km/h and returns with a speed of 40 km/h. Calculate its average speed for whole journey ?**

**Ques :- A sound is heard after 5 second of the lighting is seen in the sky during a cloudy day. Find the distance of the location of lighting if the speed of the sound is 346 m/s ?**

# Acceleration

Rate of change of velocity of an object
                    OR
The rate of change of the velocity of per unit time is known as acceleration

Mathematically , $\vec{a} = \dfrac{\vec{v} - \vec{u}}{\vec{t}}$

Where

a = acceleration
u = initial velocity
v = final velocity
t = time

Acceleration = $\dfrac{\text{change in velocity}}{\text{Time taken}}$

S.I unit :- meter/second$^2$  or  m/s$^2$
It is a vector quantity
Tells about how much velocity changed per unit time by an object

Types of acceleration :-

a ) positive acceleration ( or simply acceleration )          b) negative acceleration ( retardation)
c ) uniform acceleration                                              d ) Non- uniform acceleration

NOTE :- An object can have zero acceleration even when its velocity is not zero ( during the movement of body with same velocity  i.e initial velocity = final velocity        $a = \dfrac{v - u}{t} \longrightarrow \dfrac{0}{t} \longrightarrow a = 0$

## Positive acceleration :-

If the velocity of object increase with time in the direction of motion

i.e  v > u                so    a = $\dfrac{v - u}{t}$     ( + ve value )


## Negative acceleration -

If the velocity of an object decrease with time ( i.e   u > v )

so ,  a = $\dfrac{v - u}{t}$     ( - ve value )

Also known as" retardation "

eg:- when body wants to stop .


## Uniform motion :-

Body changes equal amount of velocity in equal interval of time

eg :- stone dropped from some height .

## Non – uniform motion :-

Body changes unequal amount of velocity in equal interval of time

eg :- bus moves in a crowded road .


Ques :- A Bus starts from rest and attains 40 km/h velocity after 10 seconds Calculate the acceleration of the bus in

1) $km/h^2$          2) $m/s^2$


Ques :- A car is retarded by applying brakes the rate of $2 m/s^2$ it is finally stop in 10 s . Find its initial velocity.
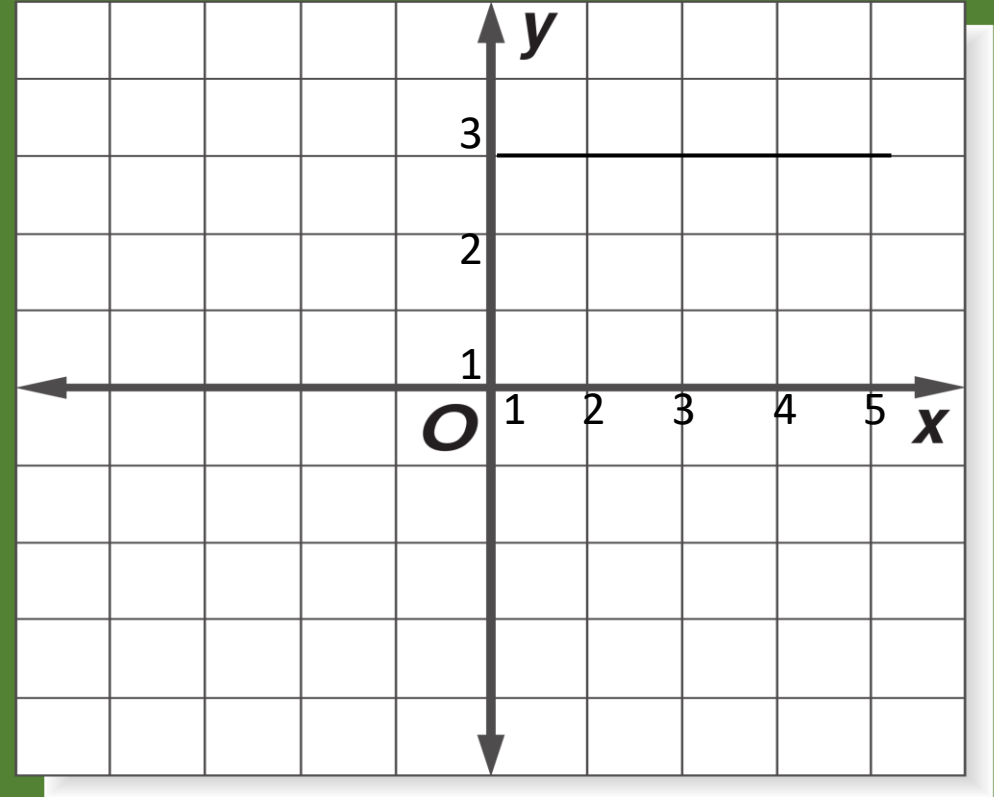
# GRAPHICAL REPRESENTATION OF MOTION

## Distance - Time graph
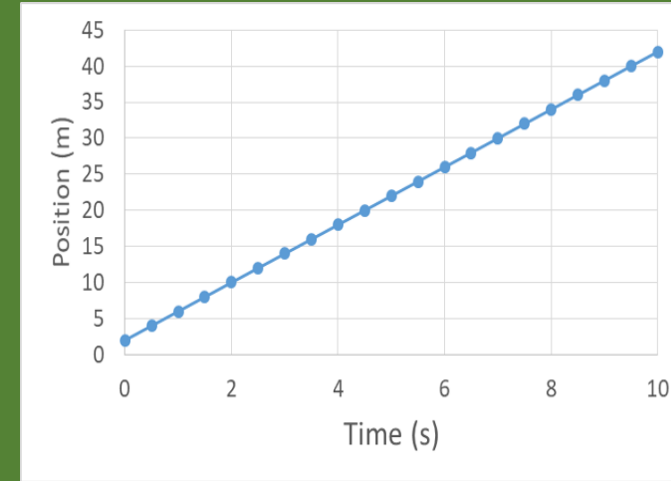
**Distance in y – axis and time in x axis**

**Graph for a stationary ( Rest ) body**

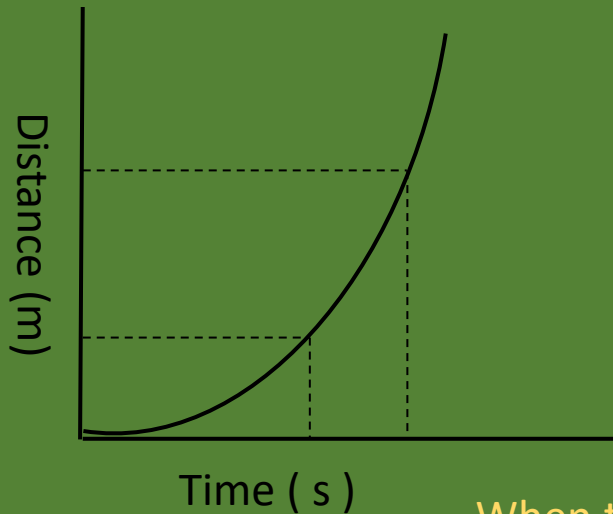**Distance time graph for stationary or rest object is parallel to x - axis**
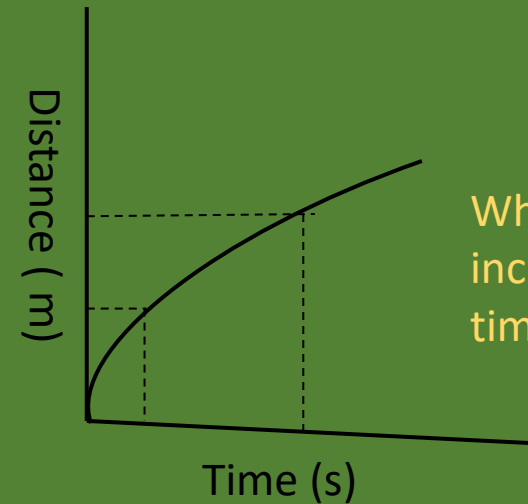
# Distance – time graph for uniform motion :-

Distance time graph for the uniform motion of a body is a straight line



# Graph for non - uniform motion :-



When the speed of the body increase with passage of the time



When the speed of the body increase with passage of the time