Rest: When a body does not change its position with respect to time and its surroundings, the body is said to be at rest. For example, if a chair is placed in the middle of a room, then the walls of the room are its surroundings. If the position of the chair (i.e. its distances from the walls) does not change with respect to the walls as well as time, then the chair is at rest. Motion: When the position of a body continuously changes with respect to time and its surroundings, the body is said to be in motion. In other words, when the position of a body continuously changes with respect to the reference point and time (any stationary object around the body), the body is said to be in a state of motion.
Distance: It is the actual length of the path traveled by a moving body irrespective of the direction in which the body moves.
Units of distance: In S.I. system, unit of the distance is metre (m). However, for distance more than 1000 m , we use a bigger unit called kilometer (km).
Displacement: The shortest distance of a moving body from the point of reference (initial position ofbody), in a specified direction is called the displacement.
Units of displacement: It has the same units as the distance except that the direction is also specified

## DIFFERENCES BETWEEN DISTANCE \& DISPLACEMENT

| Distance |  | Displacement |
| :--- | :--- | :--- | :--- |
| 1.It is the actual length of the path traveled by a <br> moving object. | 1.It is the shortest distance between the initial <br> position (point of origin) and the final position <br> of the object. |  |
| 2. $\quad$ The direction need not be specified. | 2.The direction has to be specified with respect to <br> the reference line. |  |
| 3.The distance covered in different directions can <br> be added by simple arithmetic. | 3.The displacements in different directions can <br> not te added by simple arithmetic. |  |
| 4. $\quad$The distance covered by a moving object cannot <br> be zero. | 4.The displacement of a moving object can be <br> zero. |  |

## Scalar Quantities

The physical quantities which are completely described by the magnitude only are called scalar quantities.
Examples of scalar quantities: Physical quantities such as mass, length, area, volume, distance, speed, work, energy, power, temperature, pressure, electric charge, electric potential etc. scalar quantities.

## Characteristics of scalar quantities:

(i). They can be completely described by magnitude alone.
(ii). They can be added by simple arithmetic. For example, the total mass of 5 kg of sugar and 5 kg of salt is 10 kg

## Vector Quantities

The physical quantities which are completely described only if their magnitudes and directions are specified are called vector quantities.
Examples of vector quantities: Physical quantities such as displacement, velocity, acceleration, Retardation momentum, force, moment of a force weight, electric intensity, magnetic intensity etc., are vector quantities.

## Characteristics of vector quantities:

(i). They can be completely described only by specifying the magnitude as well as direction.
(ii). They cannot be added by simple arithmetic. For example, a displacement vector of 3 m towards east and 4 m towards north cannot be 7 m towards north of east. Instead it is 5 m at an angle of $53^{\circ}$, north of east.
(iii). They can be represented on graph as their direction is specified

## UNIFORM MOTION

When a body covers equal distances in equal intervals of time, however small may be time intervals, the body is said to describe uniform motion.

## Characteristics of uniform motion

(i) The moving body covers equal distances in equal intervals of
time, however small the time intervals may be.
(ii) The graph between the distance covered and the time, is a straight line.
(iii) The motion is non-accelerated in nature.


NON - UNIFORM MOTION
When a body covers unequal distances in equal intervals of time, it is said to be moving with a non-uniform motion.

## Characteristics of non-uniform motion

(i) The body does not cover equal distances in equal intervals of time.
(ii) The graph line between distance and the time is always a curve.
(iii) The motion is accelerated in nature.


## SPEED

Speed of an object is defined as the distance travelled by it per unit time

## Mathematical expression for speed:

If a body travels a distance $S$ in time $t$, then
Speed $=S / \mathrm{t}$
$V=S / t$

## Units of speed

In S.I system, the unit of speed is metre per second ( $\mathrm{m} / \mathrm{s}$ ). For measuring larger speeds, the unit is kilometer per hour ( $\mathrm{km} / \mathrm{hr}$ ). Speed is a scalar quantity. It is because it has the magnitude, but no direction
UNIFORM SPEED
When a body covers equal distances in equal intervals of time, however small the intervals may be, the body is said to be moving with uniform speed.
VARIABLE SPEED OR NON-UNIFORM SPEED
When a body covers unequal distances in equal intervals of time, the body is said to be moving with variable speed or non-uniform Speed.
AVERAGE SPEED
The quotient of the total distance traveled by a body divided by the total time taken by the body to cover the distance is called its average speed.

## Average speed $=\frac{\text { Total distance travelled }}{\text { Total time taken }}$

## VELOCITY

The distance covered by a body per unit time in a specified direction is called the velocity.
Or
The speed of a body in a specified direction is called the velocity. Thus, mathematically Velocity =Distance travelled in a specified direction/Time taken to travel the distance
Units of Velocity=m/s or Km/h
Differences between speed and velocity

| Speed |  | Velocity |
| :--- | :--- | :--- | :--- |
| 1. $\quad$The distance covered per unit time is called <br> speed. | 1.The distance covered per unit time in a <br> specified direction is called velocity. |  |
| 2. $\quad$ It is a scalar quantity. | 2. $\quad$ It is a vector quantity. |  |

## ACCELERATION

The rate of change of velocity of a moving body is called acceleration.
Acceleration = Change in velocity/ Time
Acceleration is a vector quantity.

## Expression for acceleration

Let the velocity of an object at time $(t=0)=u$ (known as initial velocity)
And the velocity of an object at time ( $=\mathrm{t}$ ) $=\mathrm{v}$ (known as final velocity)
Then change in velocity of the object $=v-u$
Time taken for this change in velocity $=\mathrm{t}-\mathrm{0}=\mathrm{t}$

## Now, acceleration of the object $=\frac{\text { Change in velocity }}{\text { Time }}$ $=\frac{\text { Final velocity }- \text { Initial velocity }}{\text { Time taken }}$

## Positive acceleration

The rate of change of velocity of a moving body, when the velocity is INCREASING is called positive acceleration only and is denoted by ' $a$ '.

## Negative acceleration (Retardation)

Negative acceleration is commonly referred to as retardation or de-acceleration or deceleration Units of acceleration
The unit of acceleration must have the unit of length and square of time. In S. I system, the unit of acceleration in $\mathbf{m} / \mathbf{s 2}$.
UNIFORM ACCELERATION
When a body undergoes equal changes in velocity in equal intervals of time (however small the time intervals may be), the body is said to be moving with uniform acceleration.
Example:- i) The motion of an object falling freely form the top of a building.
ii) The motion of a ball rolling down a smooth inclined plane.

## NON-UNIFORM ACCELERATION OR VARIABLE ACCELERATION

When a body describes unequal changes in velocity in equal intervals of time, the body is said to be moving with non-uniform acceleration.
A body moving with a variable velocity has non-uniform acceleration. For example, a car moving on a busy road has a non-uniform acceleration.
Example:- i) The motion of a bus leaving or entering the bus stop.
ii) The motion of a train leaving or entering the platform.

## DISTANCE-TIME GRAPHS

Distance-time graph shows how the distance of a body from a fixed point changes with time. To draw distancetime
graph, distance travelled by the body is plotted along Y-Oaxis and the time taken by the body to travel this
distance is plotted along X -axis.

## DISTANCE-TIME GRAPHS FOR A STATIONARY BODY



## DISTANCE-TIME GRAPHS FOR UNIFORM MOTION

Time

## DISTANCE-TIME GRAPHS FOR NON-UNIFORM MOTION





## VELOCITY-TIME GRAPHS

In these graphs, the velocity is plotted on Y -axis and time on X -axis. The slope of the velocitytime graph gives acceleration. It is because:
Acceleration $=$ Change in velocity/ time
The distance covered by the body in a specified direction, i.e., displacement can be calculated by calculating the area of rectangle PQRS.
Thus,
Displacement $=$ Area of rectangle $P Q R S=P S \times S R$

## Equation of motion:

(i) $v=u+a t$
(ii) $S=u t+1 / 2 a t^{2}$
(iii) $V^{2}-u^{2}=2 a s$

## CIRCULAR MOTION

The motion of a body around a circular path with a uniform speed is called circular motion. The direction of motion keeps changing in uniform circular motion.
If the radius of the circular path is $r$, then in one round the distance travellved by a body is equal to the circumference of the circle. It' is the time taken for completing one round and if ' $v$ ' is the constant speed with which the body is moving, then

## CHAPTER-MOTION

## CHAPTER-1: MOTION

1.What is meant by the statement 'Rest and motion are relative terms'? Give example to show it.
2.Explain whether the walls of a classroom are at rest or in motion.
3.Define scalar and vector quantities.
4.Identify the following as scalar or vector quantities:-mass, velocity, speed, length, distance, displacement, temperature, force, weight, power, work and energy.
5.The school of a boy from his home is 1 km to the east. When he reaches back home, he says that he had traveled 2 km distance but his displacement is zero. Justify your answer.
6. Under what condition, the average speed is equal to the magnitude of the average velocity.
7.Can the average speed of a moving body be zero?
8. Can the average velocity of a moving body be zero? State examples.
$9 . A$ car covers a distance of 5 km in 20 mins . Find the velocity of the car in (a) $\mathrm{km} / \mathrm{min}(\mathrm{b}) \mathrm{m} / \mathrm{s}(\mathrm{c}) \mathrm{m} / \mathrm{min}$
(d) $\mathrm{km} / \mathrm{hr}$.
10.a train is moving with a velocity of $45 \mathrm{~km} / \mathrm{hr}$. calculate the distance traveled by it in $1 \mathrm{hr}, 1 \mathrm{~min}$, 1second.
11.An object $P$ is moving with a constant velocity for 5 mins. Another object $Q$ is moving with changing velocity for 5 mins. Out of these two objects, which one has acceleration? Explain. 12. Can an object be accelerated if it is moving with constant speed? If yes, explain giving examples. 13.(i) When do you say that an object has positive acceleration? (ii) When do you say that an object has negative acceleration?
14.State which of the following situations are possible and give an example of each of these:-(a)a body moving with constant acceleration but with zero velocity.(b)A body moving horizontally with acceleration in vertical direction.(c)A body moving with a constant speed in an accelerated motion.
15.What is a reference point?
16.Name the 2 physical quantities which can be obtained from velocity-time graph.
17.An electric train is moving with a velocity of $120 \mathrm{~km} / \mathrm{hr}$. how much distance will it cover in 30 sec ?
18. Give differences between linear motion and circular motion.
19.Velocity time graph of a body is shown in the figure. What are initial and final velocities of the body?
20.A body moves around the sun with constant speed in circular path. Is the motion of the body uniform or accelerated?
21.Name the physical quantity which remains constant during uniform circular motion.
22.Name the physical quantity which changes during uniform circular motion
23. An object is moving up an inclined plan. Its velocity changes from $15 \mathrm{~m} / \mathrm{s}$ to $10 \mathrm{~m} / \mathrm{s}$ in two seconds. What is its acceleration? (ans. $-2.5 \mathrm{~m} / \mathrm{s} 2$ )
24. A particle moving with an initial velocity of $5 \mathrm{~m} / \mathrm{s}$ is subjected to a uniform acceleration of $2.5 \mathrm{~m} / \mathrm{s} 2$. Find the displacement in the next 4 sec . (ans. 0 )
25 . A car covers 30 km at a uniform speed of $30 \mathrm{~km} / \mathrm{hr}$. what should be its speed for the next 90 km if the average speed for the entire journey is $60 \mathrm{~km} / \mathrm{h}$ ? (ans. $90 \mathrm{~km} / \mathrm{hr}$ )
26. A boy runs for 10 min . at a uniform speed of $9 \mathrm{~km} / \mathrm{h}$. At what speed should he run for the next 20 min . so that the average speed comes $12 \mathrm{~km} / \mathrm{hr}$ ? (ans. $13.5 \mathrm{~km} / \mathrm{h}$ )

