Motion

Rest and Motion

We describe the position of an object with respect to a reference point with the help of directions,which in general is called a reference frame.

For example the google maps software can guide you to your destination with the help of directions such as North,South,East and West from the starting Point(The point of reference).

If a body does not change its position as time passes with respect to frame of reference, it is said to be at rest.

And if a body changes its position as time passes with respect to frame of reference, it is said to be in motion.

Frame of Reference : It is a system of coordinates are with reference to which observer describes any event.

A passenger standing on road observes that an electric pole roadside is at rest. But the same passenger moving away in a car, observes that electric pole is in motion. In both conditions observer is right. But observations are different because in first situation observer stands on ground, which is reference frame at rest and in second situation observer moving in car, which is reference frame in motion.

So rest and motion are relative terms. It depends upon the frame of references.

For all observations we do the ground is considered to be the standard reference frame.

Particle or Point Mass or Point object

The smallest part of matter with negligibly small dimension which can be described by its mass and position is defined as a particle or point mass.

If the size of a body is negligible in comparison to its range of motion then that body is known as particle if it does not rotate about its axis.

In above consideration when we treat body as particle, all parts of the body undergo same displacement and have same velocity and acceleration.

Rectilinear and Translatory Motion

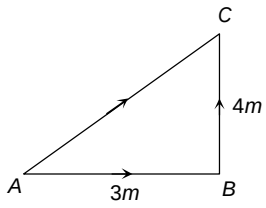
If a particle is moving along a straight line, the motion is called rectilinear. However if the body cannot be treated as a point but moves in such a way that all the particles move simultaneously along straight lines by shifting through equal distance in a given time, the motion of the body is called translator

Note: Translatory or rectilinear motion can be uniform or non-uniform.

Distance and Displacement

Distance : It is the actual length of the path covered by a moving particle in a given interval of time.

If a particle starts from A and reach to C through point B as shown in the figure.



Then distance travelled by particle

$= AB + BC = 7\ m$

Distance is a scalar quantity.

Unit : metre (S.I.)

Displacement : Displacement is the change in position vector i.e., A vector joining initial to final position.

Displacement is a vector quantity

Dimension : $[M^0L^1T^0]$

Unit : metre (S.I.)

In the above figure the displacement of the particle $\overrightarrow{AC} = \overrightarrow{AB} + \overrightarrow{BC} \Rightarrow |AC|$

$= \sqrt{(AB)^2 + (BC)^2 + 2(AB)(BC)\cos 90^o} = 5\ m$

If $\vec{S}_1, \vec{S}_2, \vec{S}_3 \ldots\ldots \vec{S}_n$ are the displacements of a body then the total (net) displacement is the vector sum of the individuals. $\vec{S} = \vec{S}_1 + \vec{S}_2 + \vec{S}_3 + \ldots\ldots + \vec{S}_n$

Distance and displacement :Coparision

The magnitude of displacement is equal to minimum possible distance between two positions.

So distance $\geq$ |Displacement|.

For a moving particle distance can never be negative or zero while displacement can be.

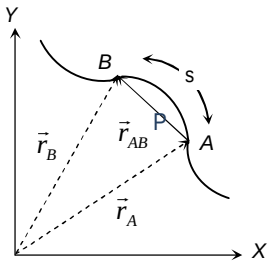
(zero displacement means that body after motion has came back to initial position)

i.e., Distance > 0 but Displacement > = or < 0

For motion between two points, displacement is single valued while distance depends on actual path and so can have many values.

For a moving particle distance can never decrease with time while displacement can. Decrease in displacement with time means body is moving towards the initial position.

In general, magnitude of displacement is not equal to distance. However, it can be so if the motion is along a straight line without change in direction.



If $\vec{r}_A$ and $\vec{r}_B$ are the position vectors of particle initially and finally.

Then displacement of the particle $\vec{r}_{AB} = \vec{r}_B - \vec{r}_A$ and *s* is the distance travelled if the particle has gone through the path *APB*.