Distance and Displacement

For a moving object two points are significant. One is the point of start or origin where from the object starts its motion and the other is the point where it reaches after certain interval of time. Points of start and destination are connected by a path taken by the object during its motion.

Distance

The length of the path followed by object is called distance. There may be a number of paths between the point of start and the point of destination. Hence the object may cover different distances between same point of start and destination. Distance is a scalar quantity.

Displacement

In any motion, the object gets displaced while it changes its position continuously. The change in position of the object is called displacement. It is the shortest distance between initial and final position of the object. Displacement is a vector quantity. Its unit and dimensional formula are same as those of distance.

Uniform and Non-Uniform Motion

The motion in which an object covers equal distance in equal interval of time is called uniform motion whereas the motion in which distance covered by object is not equal in equal interval of time is called non-uniform motion.

For the uniform motion, the graph is a straight line graph and for non-uniform motion, the graph is not a straight line.

Speed and Velocity

Speed

The distance moved by an object in a unit time is called its speed.„ The speed of an object is the distance traveled divided by the time taken to cover that distance. Its SI unit is metre per second (m/s). Other common unit is km/hr.

If the speed of an object moving along a straight line keeps changing, its motion is said to be non-uniform. On the other hand, an object moving along a straight line with a constant speed is said to be in uniform motion.

Velocity

When motion is along the shortest path, it is directed from the point of start to the point of finish. How fast this motion is determines the velocity. The velocity is the ratio of length of the shortest path (displacement) to the time taken.

Average Speed & Average Velocity

Speed during a certain interval of time can not be used to determine total distance covered in given time of the journey and also the time taken to cover the total distance of journey. It is because a body does not always travel equal distance in equal interval of time. In most of the cases the body travels non-uniformly. Thus, in case of non-uniform motion to determine average speed is quite useful. The average speed can be determined by the ratio of total distance covered to the total time taken.

Similarly, in case of average velocity in place of total distance covered you can take total displacement.

Relative Velocity

The relative velocity of an object B relative to a stationary or moving object A is equal to the time rate of change of position of object B with respect to object A.

If two objects A and B are moving with velocities u and v respectively in the same direction then the velocity of A relative to B will be (u - v) and the velocity of B relative to A will be (v - u).

If A and B are moving in opposite directions then the velocity of A relative to B will be (u + v).

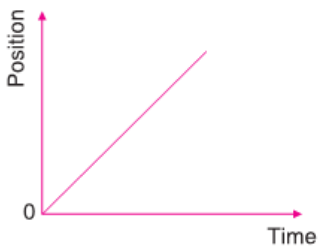
Graphical Representation

It shows the change in one quantity corresponding to another quantity in the graphical representation.

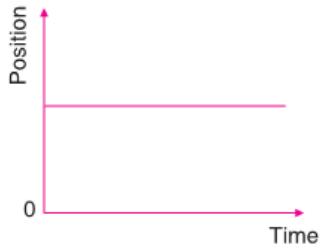
Position-Time Graph

To draw graph of the motion of an object, its position at different times are shown on y-axis and time on x-axis.

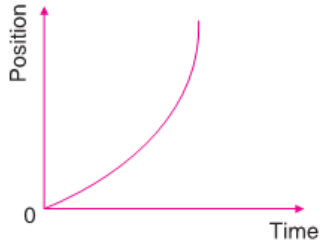
For uniform motion position-time graph is a straight line.



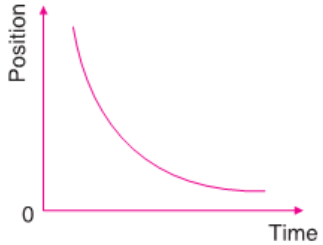
(A) Uniform motion



(B) Object is at rest



(C) Non-uniform motion, rate of change in position is increasing



(D) Non-uniform motion, rate of change in position is decreasing

Velocity-Time Graph

Take time is on the horizontal axis and velocity is on the vertical axis.

Area under velocity-time graph = Displacement of the object during that time interval

Acceleration

The change in velocity with time is called acceleration. Thus, the acceleration of an object is defined as the change in velocity divided by the time interval during which this occurs.

The unit of acceleration is ms^{-2}.

Uniform Acceleration

If the acceleration of an object during its motion is constant, the object is moving with uniform acceleration. The velocity-time graph of such a motion is straight line inclined to the time axis.

For a given time interval, if the final velocity is more than the initial velocity, then the acceleration will be positive. However, if the final velocity is less than the initial velocity, the acceleration will be negative.