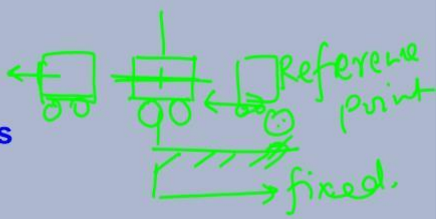
MOTION lecture 1

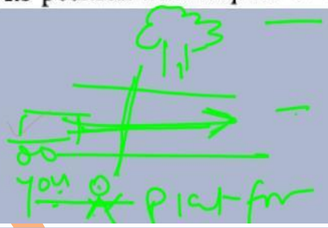


- Motion is common to everything in the universe. We walk, run and ride a bicycle. Even when we are sleeping, air moves into and out of our lungs and blood flows in arteries and veins.
- Motion is change in position of an object with time. How does the position change with time ?

Suppose we are sitting on a railway platform and looking at a tree nearby, we say that the tree is at rest because the tree does not change its position *with respect to us*. But when we see a train passing out of the station, we say that the train is in motion because it is continuously changing its position *with respect to us*.

>Rest-

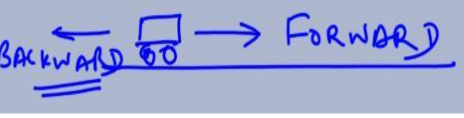
Thus, *a body is said to be at rest if it does not change its position with respect to its immediate surroundings, while a body is said to be in motion if it changes its position with respect to its immediate surroundings.*

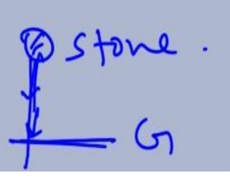


POINT PARTICLE – If distance travelled by Body is large as compare to Body size then Body can be considered as point particle.

One dimentional motion - : *When a body moves along a straight line path, its motion is said to be the one dimensional motion.* It is also called the motion in a straight line or rectilinear motion. For example, the motion of a train on a straight track, a stone falling down vertically, a car moving on a long and straight road etc.,

↳ x axis
or
y-axis
or
z axis

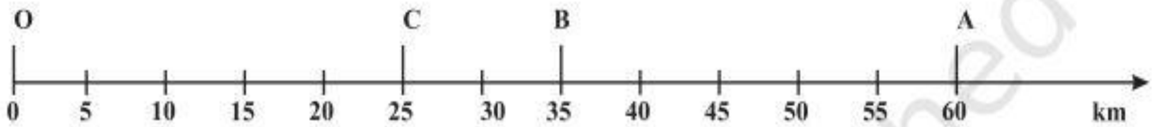




8.1.1 Motion along a straight line

The simplest type of motion is the motion along a straight line. We shall first learn to describe this by an example. Consider the motion of an object moving along a straight path. The object starts its journey from O which is treated as its reference point (Fig. 8.1). Let A, B and C represent the position of the object at different instants. At first, the object moves through C and B and reaches A. Then it moves back along the same path and reaches C through B.

while the magnitude of displacement = 35 km. Thus, the magnitude of displacement (35 km) is not equal to the path length (85 km). Further, we will notice that the magnitude of the displacement for a course of motion may be zero but the corresponding distance covered is not zero. If we consider the object to travel back to O, the final position concides with the initial position, and therefore, the displacement is zero. However, the distance covered in this journey is OA + AO = 60 km + 60 km = 120 km. Thus, two different physical quantities — the distance and the



Questions

1. *An object has moved through a distance. Can it have zero displacement? If yes, support your answer with an example.*
2. *A farmer moves along the boundary of a square field of side 10 m in 40 s. What will be the magnitude of displacement of the farmer at the end of 2 minutes 20 seconds from his initial position?*
3. *Which of the following is true for displacement?*
   (a) *It cannot be zero.*
   (b) *Its magnitude is greater than the distance travelled by the object.*

- When a body moves from one position to another, the shortest (straight line) distance between the initial position and final position of the body, alongwith direction, is known as its displacement. The S.I. unit of displacement is metre (m). Displacement is a vector quantity.
- **Uniform motion :** A body has a **uniform motion** if it travels equal distances in equal intervals of time.
- **Non-uniform motion :** A body has a non-uniform motion if it travels unequal distances in equal intervals of time.

  Speed : Distance travelled by a moving body in (one second) unit time is called speed. The S.I. units of speed is ms^{-1}.

$$\text{Speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

- The average distance covered by a body per unit time when the body is moving with non-uniform speed is known as **average speed**.

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

- Velocity of a body is defined as the displacement produced per unit time. It is the distance travelled by a body per unit time in a given direction. The S.I. unit of velocity is m/s.

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

- **Average Velocity :** It is defined as the total displacement covered divided by the total time taken.

$$\text{Average velocity} = \frac{\text{Total displacement}}{\text{Total time taken}}$$

- **Acceleration :** It is defined as the rate of change of velocity with time.

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time taken}} \text{ or } a = \frac{v-u}{t}$$

The S.I. unit of acceleration is m/s^2.

Retardation: Negative acceleration is called 'retardation' or 'deceleration'.

- A body has uniform acceleration if it travels in a straight line and its velocity increases by equal amounts in equal intervals of time. For example, the motion of a freely falling body.
- A body has a non-uniform acceleration if the velocity increases by unequal amounts in equal intervals of time. In other words, a body has a non-uniform acceleration if its velocity changes at a non-uniform rate.
- **Equations of motion :** These are the equations which give relation between velocity, acceleration, distance covered, time taken for a body in uniform acceleration.

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 - u^2 = 2as$$

- In case the velocity of the object is changing at a uniform rate, then average velocity is given by the arithmetic mean of initial velocity and final velocity for a given period of time, i.e.,

$$\text{average velocity} = \frac{\text{initial velocity} + \text{final velocity}}{2}$$

- **Graphical Representation of Motion :**

  (i) **Distance-time graph :** For uniform speed, a graph of distance travelled against time will be a straight line as shown by the line OA in figure given below.

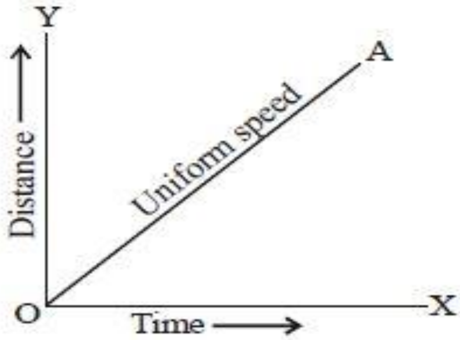


Fig. Distance-time graph for uniform speed

If the speed of a body is non-uniform, then the graph between distance travelled and time is a curved line.

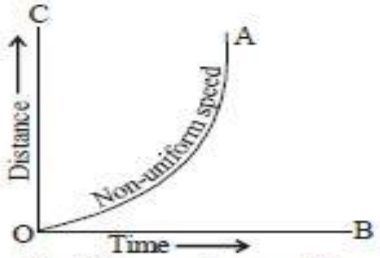


Fig. Distance-time graph for non-uniform speed

(ii) **Velocity-time graphs :**

(a) **Velocity-time graph parallel to time axis (uniform motion)**

(i) The area of the graph under velocity-time curve gives the displacement of the body.

Displacement = Velocity × Time

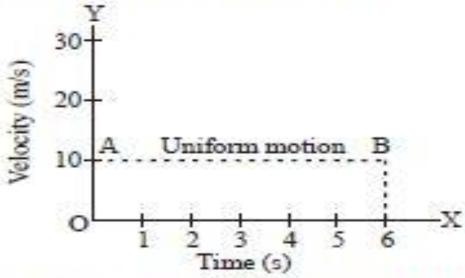


Fig. Velocity-time graph for uniform motion

(ii) The slope of velocity-time graph gives acceleration.

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

If the slope of graph is zero, the acceleration is zero.

(iii) If the slope of velocity-time graph is positive, then acceleration is a positive. If the slope is negative, then acceleration is negative i.e. retardation.