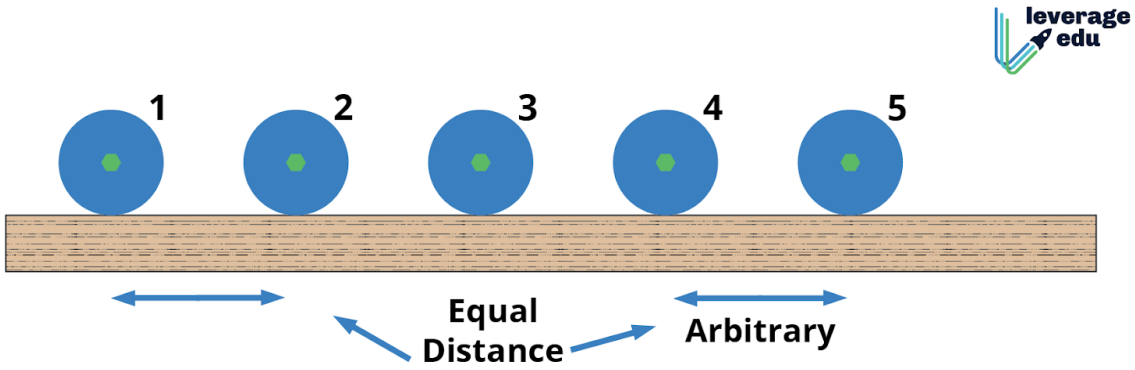
# Motion in a Straight Line

## Introduction to Motion in a Straight Line

When an object changes its position with respect to time, it is said to be in motion. If the object is moving in a straight line, it is said to be in motion in a straight line or Linear Motion. Let's understand this with an example. Rahul's school gets over at 2:00 PM, and then he runs from his school to his home and reaches his home at 2:10 PM. This is an example of motion. Now, in motion, two conditions must be satisfied: 1) Change in Position of an object (School to Home) 2) Change must be with me (2:00 PM TO 2:10 PM)

Note that motion in a straight line is also known as rectilinear motion. Also, if Rahul moves along a straight path and covers equal distances in equal intervals of me, then it is said to be uniform motion along a straight line.




*Curious to know about how many types of motion are there?*

*End your curiosity with our blog on types of motion!*

## The Frame of Reference

We use references, and a set of axes points to specify the object's position. In the rectangular coordinate system, we have X-axis: If the object moves only with respect to the X-axis then it is known as motion in one dimension. Y-axis: If the object moves with respect to both the X-axis and Y-axis, then it is motion in two dimensions. Z-axis: If the object moves with respect to all three axes, then it is motion in three dimensions. Their

intersection: Reference point, i.e. also represented as (0,0,0). (x,y,z) coordinates describe the position of the object with respect to this coordinate system.

*To know more about coordinate systems in the motion of a straight line,*

*refer to our blog on coordinate geometry formulas!*

## What is the difference between Distance and Displacement?

| Distance | Displacement |
|---|---|
| Distance is called the path length traversed by an object | The shortest distance is known as displacement |
| Distance has magnitude only | It has both magnitude and direction |
| Example: Rahul runs for 10 Kilometers | Example: Raul runs for 10 Kilometers north |
| Distance divided by the intervals is known as average speed. | Displacement divided by the intervals (in which displacement occurs) is known as average velocity. |

Important Note:

1. The magnitude of displacement may or may not be equal to the path length traversed by an object.
2. Both Displacement and Velocity are vector quantities. And similarly, distance and speed are scalar.

## What is the Difference between Instantaneous Speed and Instantaneous Velocity

Instantaneous velocity is the velocity at an instant. And to calculate instantaneous velocity, we assume that change in theme interval tends to zero. But on the other hand, instantaneous speed or simply speed is the magnitude of velocity. For example, if the

instantaneous speed at a time interval is -100 m/s^2, then instantaneous velocity will be equal to 100 m/s^2 only.

## Acceleration

If two athletes are running from point A to point B and athlete A reaches first then it is clear that athlete A is fast, which means that his acceleration is more. What is the acceleration? The acceleration is the change of velocity with me and the average acceleration over a time interval is defined as the change of velocity divided by the time interval. And similar to instantaneous velocity, instantaneous acceleration is when the time interval tends to zero.

Kinematic Equations for the Uniformly Accelerated Motion

The equations that relate displacement (x), me taken (t), initial velocity (v0), final velocity (v), and acceleration (a) are known as kinema c equations for uniformly accelerated motion.

EQUATION ONE: Initial velocity = Final velocity + Acceleration*Time

EQUATION TWO: Displacement = 1/2*Acceleration* me* me + Initial velocity * me

EQUATION THREE: final velocity*final velocity = Initial velocity initial velocity + 2*Acceleration*displacement

*You will come across a wide range of topics in Physics class 11 and 12 just like motion in a straight line. Do you know these chapters are actually*

*introducing you to different career possibilities in Physics!*

## Practical Examples of Motion in a Straigt Line

**Free Fall:**
A ball released near the surface of the Earth is accelerated downward under the force of gravity. Accelera on due to gravity = 9.8 m/s^2 If air friction is ignored, the object is said to be in free fall.

**Stopping distance of vehicles:**
When brakes are applied to a moving vehicle, the distance it travels before stopping is called stopping distance. It depends on Initial velocity and Deceleration Application: Road Safety.

**Relative velocity:**

Suppose you are on your school bus running at a speed of 40m/s and suddenly some other bus starts running along at the same speed as your bus, i.e. 40m/s. You may feel that the other bus is not moving, but someone from the road will easily be able to see that both the buses are running at a speed of 40m/s. Hence, the second bus is running at 0 m/s with respect to your bus but running at a speed of 40m/s with respect to the ground.

Now for the application of your learning through the above notes on motion in a straight line. It is necessary to go through some of the most important questions. Also making class 11 physics notes will help you in your entrance exams like NEET, JEE and defence exams.

*Now that you are through with the topic motion in a straight line,*

*have a look at the Electrostatics notes for class 12th!*

## Important questions: Motion in a Straight Line

1. When is average velocity equal to average speed?
2. When velocity is the same as the average velocity at all instants?
3. Obtain equations of motion for constant acceleration using the method of calculus.
4. Obtain equations of motion for constant acceleration using a graphical approach.
5. A ball is thrown vertically upwards with a velocity of 20 m s−1 from the top of a multi-storey building. The height of the point from where the ball is thrown is 25.0 m from the ground. (a) How high will the ball rise? And (b) how long will it be before the ball hits the ground? (Take g = 10 m s−2)
6. Discuss the motion of an object under free fall. 7) Derive an expression for stopping distance of a vehicle in terms of initial velocity and acceleration.