**1st June, 2020 JESUS AND MARY SCHOOL AND COLLEGE MODULE-3**

**CLASS 9**

**PHYSICS**

**MOTION IN ONE DIMENSION**

As we have already discussed earlier, motion is the state of change in position of an object over time. It is described in terms of [displacement](https://www.toppr.com/guides/physics/motion-in-a-straight-line/position-path-length-and-displacement/), [distance](https://www.toppr.com/guides/maths/coordinate-geometry/distance-formula/), [velocity](https://www.toppr.com/guides/physics/motion-in-a-straight-line/relative-velocity/), [acceleration](https://www.toppr.com/guides/physics/motion-in-a-straight-line/acceleration/), [time and speed](https://www.toppr.com/guides/quantitative-aptitude/time-and-speed/). Jogging, driving a car, and even simply taking a walk are all everyday examples of [motion](https://www.toppr.com/guides/physics/motion/). The relations between these quantities are known as the equations of motion.

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# Equations of Motion

Cricket fan? Hockey fan? Soccer fan? What is the first thing that is taught when you first start training for these or any other sports? It is understanding the correct motion, speed acceleration or the Equations of Motion. Once you master the Equations of Motion you will be able to predict and understand every motion in the world.

## **Equations of Motion For Uniform Acceleration**

As we have already discussed earlier, motion is the state of change in position of an object over time. It is described in terms of [displacement](https://www.toppr.com/guides/physics/motion-in-a-straight-line/position-path-length-and-displacement/), [distance](https://www.toppr.com/guides/maths/coordinate-geometry/distance-formula/), [velocity](https://www.toppr.com/guides/physics/motion-in-a-straight-line/relative-velocity/), [acceleration](https://www.toppr.com/guides/physics/motion-in-a-straight-line/acceleration/), [time and speed](https://www.toppr.com/guides/quantitative-aptitude/time-and-speed/). Jogging, driving a car, and even simply taking a walk are all everyday examples of [motion](https://www.toppr.com/guides/physics/motion/). The relations between these quantities are known as the equations of motion.

In case of [uniform acceleration](https://www.toppr.com/guides/physics/motion-in-a-straight-line/acceleration/), there are three equations of motion which are also known as the laws of constant acceleration. Hence, these equations are used to derive the components like displacement(s), velocity (initial and final), time(t) and acceleration(a). Therefore they can only be applied when acceleration is constant and motion is a straight line. The three equations are,

* v = u + at
* v² = u² + 2as
* s = ut + ½at²

where, s = displacement; u = initial velocity; v = final velocity; a = acceleration; t = time of motion. These equations are referred as SUVAT equations where SUVAT stands for displacement (s), initial velocity (u), final velocity (v), acceleration (a) and time (T)

## Derivation of the Equations of Motion

## v = u + at

Let us begin with the first equation, v=u+at. This equation only talks about the acceleration, time,[**the initial and the final velocity**](https://www.toppr.com/bytes/kinematics-2/3-vf-final-velocity-4-vi-initial-velocity-5-t-time-sec/)**.** Let us assume a body that has a mass “m” and initial velocity “u”. Let after time “t” its final velocity becomes “v” due to uniform acceleration “a”. Now we know that:

Acceleration = Change in velocity/Time Taken

Therefore,  Acceleration = (Final Velocity-Initial Velocity) / Time Taken

Hence, a = v-u /t or at = v-u

Therefore, we have: v = u + at

## v² = u² + 2as

We have, v = u + at. Hence, we can write t = (v-u)/a

Also, we know that, Distance = average velocity × Time

Therefore, for constant acceleration we can write: [Average velocity](http://toppr.com/guides/physics/motion-in-a-straight-line/average-velocity-and-average-speed/) = (final velocity + initial velocty)/2 = (v+u)/2

Hence, Distance (s) = [(v+u)/2]  × [(v-u)/a]

or  s = (v² – u²)/2a

or 2as = v² – u²

or v² = u² + 2as

## s = ut + ½at²

Let the distance be “s”. We know that

Distance = Average velocity × Time. Also, Average velocity = (u+v)/2

Therefore, Distance (s) = (u+v)/2 × t

Also, from v = u + at, we have:

s = (u+u+at)/2 × t = (2u+at)/2 × t

s = (2ut+at²)/2 = 2ut/2 + at²/2

or s = ut +½ at²

**WORKSHEET 3**

**Q. 1.** What is the second equation of motion?

**Q. 2.** Derive first equation of motion by analytical method.

**Q. 3.** What does the slope of velocity-time graph represent?

**Q. 4.** How would you calculate area enclosed by a velocity-time graph?

**Q. 5.** What can you say about the nature of the motion of a body if its displacement time graph is:

a) a straight line parallel to time axis?

b) a straight line inclined to the time axis with an acute angle?

c) a straight line inclined to the time axis with an obtuse angle?

**Note:- Please do this work in yourcopies which will be checked when the school reopens . Please consider this important.**

Solutions to worksheet 2 uploaded on 18 may, 2020

**A. 1.** The rate of change of distance with respect to time is known as speed. It is a scalar quantity having SI unit metre/second.

**A. 2.**  The rate of change of displacement with respect to time is known as velocity. It is a vector quantity having SI unit metre/second.

**A. 3.**  The differences between speed and velocity are as follows:

1. Speed is rate of change of distance while velocity is rate of change of displacement .

2. Speed is a scalar quantity whereas velocity is a vector quantity.

3. Speed cannot be zero or negative while velocity can be positive, negative or zero.

**A. 4.** Rate of change of velocity is known as acceleration. It is a vector quantity having SI unit metre/second2.

**A. 5.** The differences between distance and displacement are as follows:

1. Distance is the length of path covered by a body while displacement is the difference between the initial and final positions of the body.

2. Distance is a scalar quantity whereas displacement is a vector quantity.

3. Distance cannot be zero or negative while displacement can be positive, negative or zero.

**A. 6.** The first three fundamental quantities are:

1. Length

2. Mass

3. Time

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