

# CLASS 9th NOTES PHYSICS

# MOTION

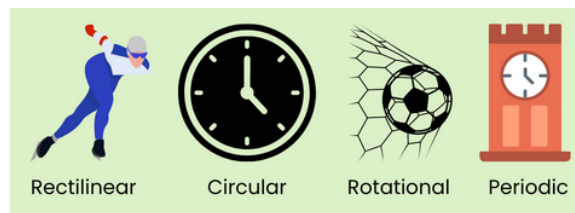
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# MOTION

**Motion** - An object is said to be in motion when its position changes with time.

Motion can be of different types depending upon the type of path by which the object is going through :

- Circulatory motion/Circular motion - In a circular path.
- Linear motion - In a straight line path.
- Oscillatory/Vibratory motion - To and fro path with respect to origin.

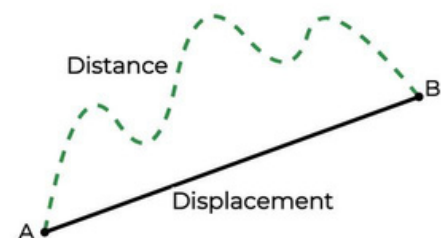


## Distance :

- The actual path or length travelled by a object during its journey from its initial position to its final position is called the distance.
- Distance is a scalar quantity which requires only magnitude but no direction to explain it.

## Displacement :

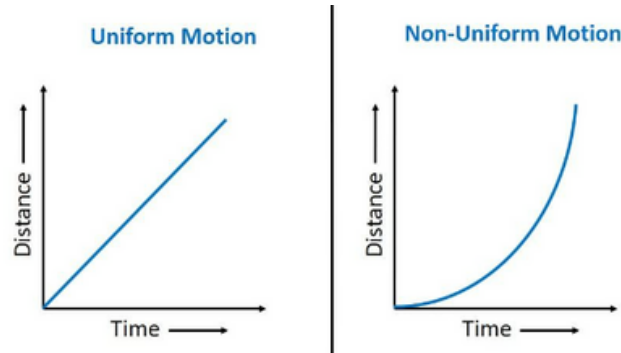
- The shortest path travelled by a object during its journey from its initial position to its final position is called the displacement.
- Displacement is a vector quantity requiring both magnitude and direction for its explanation.
- Displacement can be zero.



Distance	Displacement
<ol style="list-style-type: none"> <li>1. It is the length of the actual path covered by an object, irrespective of its direction of motion.</li> <li>2. Distance is a scalar quantity.</li> <li>3. Distance covered can never be negative. It is always positive or zero.</li> <li>4. Distance between two given points may be same or different for different path chosen.</li> </ol>	<ol style="list-style-type: none"> <li>1. Displacement is the shortest distance between the initial and final positions of an object in a given direction.</li> <li>2. Displacement is a vector quantity.</li> <li>3. Displacement may be positive, negative or zero.</li> <li>4. Displacement between two given points is always the same.</li> </ol>

**Uniform motion :** When a body travels equal distance in equal interval of time, then the motion is said to be uniform motion.

**Non-uniform motion :** In this type of motion, the body will travel unequal distances in equal intervals of time.



(i) **Scalar Quantity :** It is the physical quantity having own magnitude but no direction. **Example :** distance, speed.

(ii) **Vector Quantity :** It is the physical quantity that requires both magnitude but direction. **Example :** displacement, velocity.

**Speed :** The measurement of distance travelled by a body per unit time is called speed. Its SI unit is metre (m).

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

**Average Speed :** Average speed is stated as the distance covered by the object within a period of time.

$$\text{Average Speed} = \frac{\text{Total Distance Covered}}{\text{Total Time Taken}}$$

**Velocity :** The rate of change of displacement is velocity. It is a vector quantity. Here the direction of motion is specified.

Velocity of an object is measured in meter per second in SI unit.

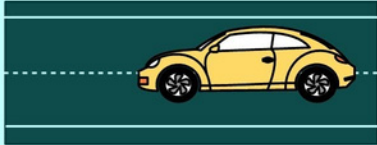
$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}}$$

or

$$v = \frac{s}{t}$$

## Acceleration

- The rate of change of velocity is called acceleration.
- It is a vector quantity.
- In non-uniform motion, velocity varies with time, i.e., the change in velocity is not zero.
- It is denoted by "a".

$$a = \frac{v_f - v_i}{t}$$


If the velocity of an object changes from an initial value  $u$  to the final value  $v$  in time  $t$  the acceleration  $a$  is :

$$a = \frac{v - u}{t}$$

- This kind of motion is known as accelerated motion.
- The acceleration is taken to be positive if it is in the direction of velocity and negative when it is opposite to the direction of velocity.
- Negative acceleration is also called De-acceleration or Retardation.
- The SI unit of acceleration is  $\text{ms}^{-2}$ .

**Uniform acceleration :** An object is said to have a uniform acceleration if it travels along a straight path and its velocity changes (increases or decreases) by equal amounts in equal time intervals.

e.g. the motion of a freely falling body.

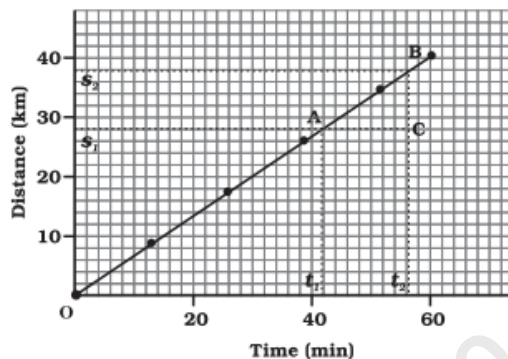
**Non-uniform acceleration :** An object is said to have a non-uniform acceleration if its velocity changes (increases or decreases) by unequal amounts in unequal time intervals.

e.g. if a car travelling along a straight road increases its speed by unequal amounts in equal intervals of time, then the car is said to be moving with non-uniform acceleration.

## Graphical Representation of Motion :

**Distance-Time Graph :** It represents a change in position of the object with respect to time.

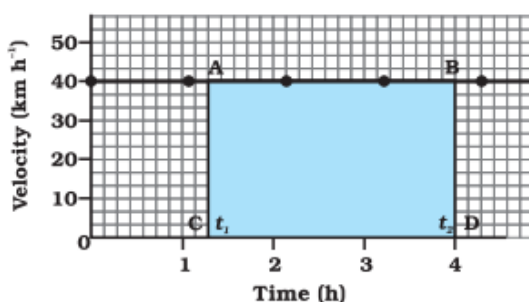
- Linear variation = uniform motion and non-linear variations imply non-uniform motion
- The slope gives us speed.



Distance-time graph of an object moving with uniform speed

**Velocity-Time Graph :** Velocity-Time graphs show the change in velocity with respect to time.

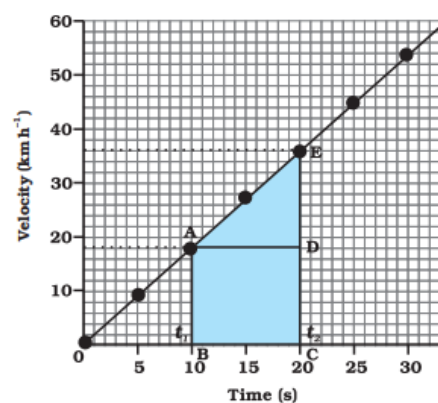
- Slope gives acceleration
- The area under the curve gives displacement
- Line parallel to x-axis implies constant velocity-



Velocity-time graph for uniform motion of a car

So, the distance  $s$  moved by the car in time  $(t_2 - t_1)$  can be expressed as

$$\begin{aligned} s &= AC \times CD \\ &= [(40 \text{ km h}^{-1}) \times (t_2 - t_1) \text{ h}] \\ &= 40 (t_2 - t_1) \text{ km} \\ &= \text{area of the rectangle ABDC} \end{aligned}$$



Velocity-time graph for a car moving with uniform accelerations.

$$\begin{aligned} s &= \text{area ABCDE} \\ &= \text{area of the rectangle ABCD} + \text{area of the triangle ADE} \\ &= AB \times BC + \frac{1}{2} (AD \times DE) \end{aligned}$$

## Equations of Motion by Graphical Method :

$$v = u + at$$

$$v^2 = u^2 + 2as$$

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

Here,  $u$  = initial velocity  
 $v$  = final velocity  
 $a$  = uniform acceleration  
 $s$  = distance travelled  
 $t$  = time taken

EXPHUB 9 & 10