



# Motion

Rest: An object is said to be at rest if it does not change its position with point of reference in due course of time.

Motion: An object is said to be in motion if it changes its position with point of reference in due course of time.

Scalar quantity: A physical quantity having only magnitude is called scalar quantity. eg: distance, speed etc.

Vector quantity: A physical quantity having both magnitude and direction is called vector quantity. eg: displacement, velocity etc.

Distance: The actual path covered by an object is called distance. It is a scalar quantity. Its S.I Unit is 'm'.

Displacement: The gap between initial and final positions of an object is called displacement. It is the shortest path covered by an object. It is a vector quantity. Its S.I Unit is 'm'.

Uniform motion: An object is said to be in uniform motion when it covers equal distance in equal intervals of time.

Non Uniform motion: An object is said to be in non uniform motion when it covers equal distance in unequal intervals of time or unequal distance in equal intervals of time.

Speed:

- The distance covered per unit time is called speed.
- It is a scalar quantity.
- Its S.I Unit is m/s.

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

Velocity:

- The displacement covered per unit time is called velocity.
- It is a vector quantity.
- Its S.I Unit is m/s.

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



Acceleration : The change in velocity per unit time is called acceleration.

- It is a vector quantity
- It's S.I Unit is  $\text{m/s}^2$ .

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

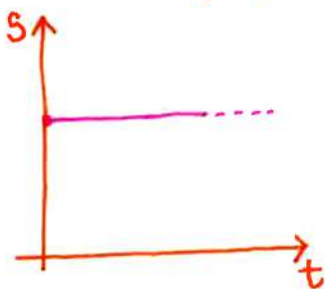
$u \rightarrow$  initial velocity  
 $v \rightarrow$  final velocity

### Types of acceleration

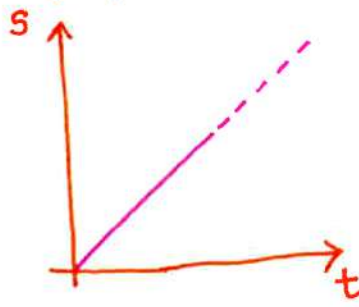
- ① Positive acceleration : When velocity of an object increases with time.  
i.e.  $v > u$
- ② Negative acceleration : When velocity of an object decreases with time.  
i.e.  $v < u$
- ③ Zero acceleration : When velocity of an object do not change with time.  
i.e.  $v = u$

### Graphical Representation of Motion

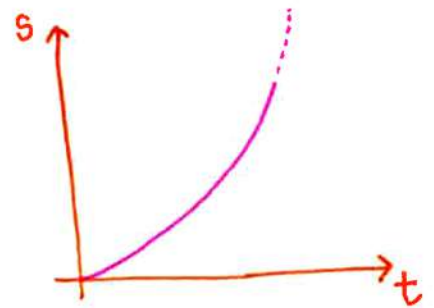
- Distance-time graph (s-t graph)



(Rest)



(Uniform motion)



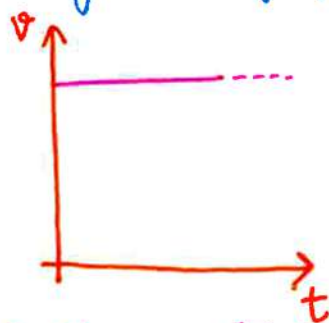
(Non uniform motion)

- Slope of distance time graph gives speed.
- Slope of displacement time graph gives velocity.

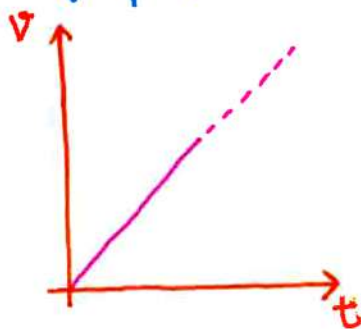




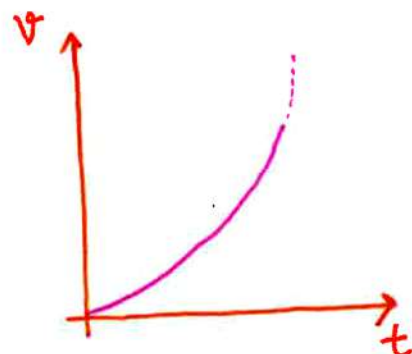
## • Velocity - time graph (v-t graph)



(uniform motion)



(uniform acceleration)



(non uniform acceleration)

- Slope of velocity-time graph gives acceleration
- Area under velocity-time graph gives displacement

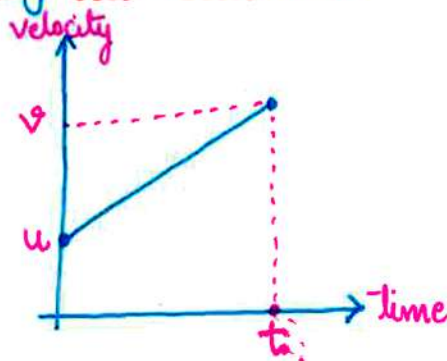
## Equations of Motion

### ① First equations of motion (velocity time relation)

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

$$v-u = at$$

$$\boxed{v = u + at}$$



### ② Second equation of motion (position velocity relation)

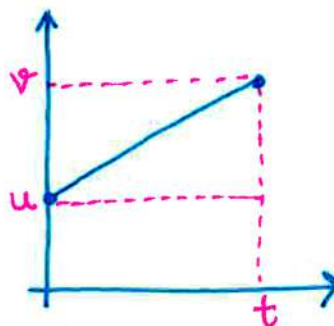
Displacement = Area under v-t graph

$S = \text{Area of rectangle} + \text{Area of triangle}$

$$S = ut + \frac{1}{2} \times (v-u) \times t$$

$$v-u = at$$

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





### ③ Third equation of Motion (position velocity relation)

Displacement = Area under v-t graph

$S = \text{Area of Trapezium}$

$$S = \frac{1}{2} \times (\text{Sum of 11 sides}) \times \text{height}$$

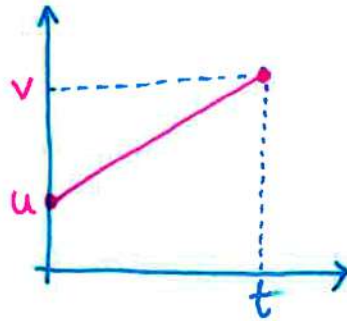
$$S = \frac{1}{2} \times (u + v) \times t$$

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

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

$$S = \frac{1}{2} \times (v + u) \times \frac{v - u}{a}$$

$$\boxed{2as = v^2 - u^2}$$



### Uniform Circular Motion

- An object moving in a circular path with constant speed is said to be in uniform circular motion.
- The velocity changes at every point and its direction is along the tangent drawn at that point.
- It is uniformly accelerated motion.