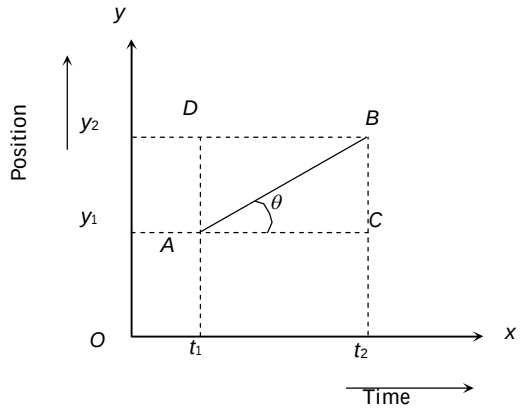
Graphical Representation of Motion

Position time Graph

During motion of the particle its parameters of kinematical analysis (*v*, *a*, *s*) changes with time. This can be represented on the graph.

Position time graph is plotted by taking time *t* along *x*-axis and position of the particle on *y*-axis.



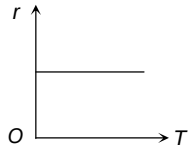
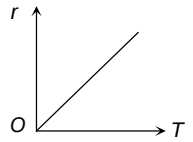
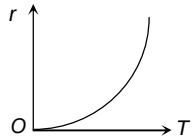
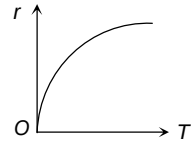
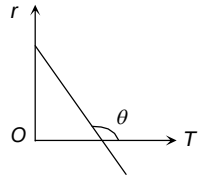
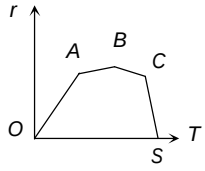
Let *AB* is a position-time graph for any moving particle

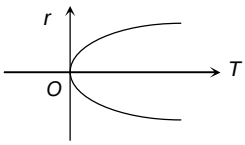
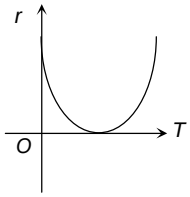
As Velocity = $\frac{\text{Change in position}}{\text{Time taken}} = \frac{y_2 - y_1}{t_2 - t_1}$ ...(i)

From triangle *ABC*, $\tan\theta = \frac{BC}{AC} = \frac{AD}{AC} = \frac{y_2 - y_1}{t_2 - t_1}$ ....(ii)

By comparing (i) and (ii) Velocity = $\tan\theta$

$$v = \tan\theta$$

	$\theta = 0°$ so $v = 0$ *i.e.*, line parallel to time axis represents that the particle is at rest.
	θ = constant so v = constant, $a = 0$ i.e., line with constant slope represents uniform velocity of the particle.
	θ is increasing so v is increasing, a is positive. *i.e.*, line bending towards position axis represents increasing velocity of particle. It means the particle possesses acceleration.
	θ is decreasing so v is decreasing, a is negative *i.e.*, line bending towards time axis represents decreasing velocity of the particle. It means the particle possesses retardation.
	θ constant but > 90^o so v will be constant but negative *i.e.*, line with negative slope represent that particle returns towards the point of reference. (negative displacement).
	Straight line segments of different slopes represent that velocity of the body changes after certain interval of time.

	This graph shows that at one instant the particle has two positions, which is not possible.
	The graph shows that particle coming towards origin initially and after that it is moving away from origin.

Velocity-time Graph

The graph is plotted by taking time *t* along *x*-axis and velocity of the particle on *y*-axis.

Distance and displacement : The area covered between the velocity time graph and time axis gives the displacement and distance travelled by the body for a given time interval.

Total distance $=|A_1|+|A_2|+|A_3|$

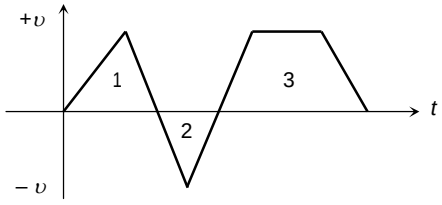
= Addition of modulus of different area. *i.e.* $s=\int|v|\,dt$

Total displacement $=A_1+A_2+A_3$

= Addition of different area considering their sign.

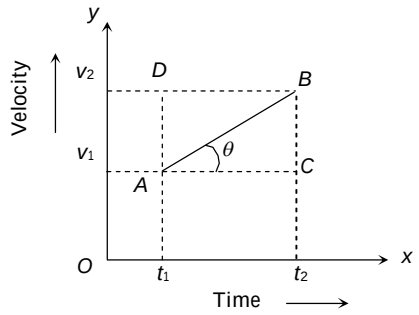
i.e. $r=\int v\,dt$

Area above time axis is taken as positive, while area below time axis is taken as negative



here A_1 and A_2 are area of triangle 1 and 2 respectively and A_3 is the area of trapezium .

Acceleration : Let *AB* is a velocity-time graph for any moving particle



As Acceleration = $\frac{\text{Change in velocity}}{\text{Time taken}}$

$= \frac{v_2 - v_1}{t_2 - t_1}$ ...(i)

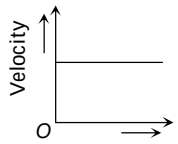
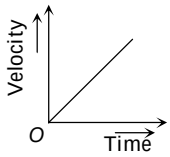
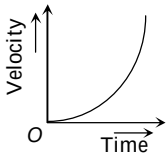
From triangle *ABC*, $\tan\theta = \frac{BC}{AC} = \frac{AD}{AC}$

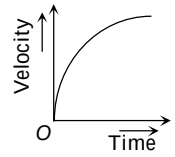
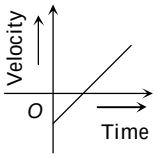
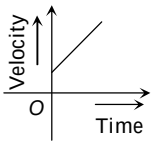
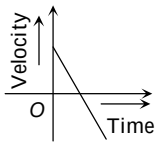
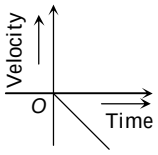
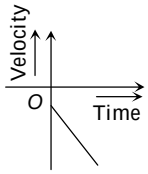
$= \frac{v_2 - v_1}{t_2 - t_1}$ ....(ii)

By comparing (i) and (ii)

Acceleration (a) = $\tan\theta$

It is clear that slope of tangent on velocity-time graph represents the acceleration of the particle.

	$\theta = 0°$, $a = 0$, v = constant *i.e.*, line parallel to time axis represents that the particle is moving with constant velocity.
	θ = constant, so a = constant and v is increasing uniformly with time*i.e.*, line with constant slope represents uniform acceleration of the particle.
	θ *is* increasing so acceleration increasing *i.e.*, line bending towards velocity axis represent the increasing acceleration in the body.

	θ decreasing so acceleration decreasing i.e. line bending towards time axis represents the decreasing acceleration in the body
	Positive constant acceleration because θ is constant and < 90 but initial velocity of the particle is negative.
	Positive constant acceleration because θ is constant and < 90 but initial velocity of particle is positive.
	Negative constant acceleration because θ is constant and > 90 but initial velocity of the particle is positive.
	Negative constant acceleration because θ is constant and > 90 but initial velocity of the particle is zero.
	Negative constant acceleration because θ is constant and > 90 but initial velocity of the particle is negative.