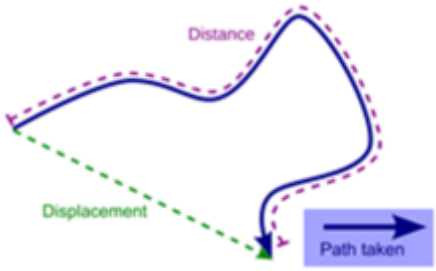
MOTION

Distance and Displacement

The magnitude of the length covered by a moving object is called distance. It has no direction.

Displacement is the shortest distance between two points or the distance between the starting and final positions with respect to time. It has magnitude as well direction.

Displacement can be zero, but distance cannot.



Distance VS Displacement

Magnitude

Magnitude is the size or extent of a physical quantity. In physics, we have scalar and vector quantities.

Scalar quantities are only expressed as magnitude. E.g: time, distance, mass, temperature, area, volume

Vector quantities are expressed in magnitude as well as the direction of the object. E.g: Velocity, displacement, weight, momentum, force, acceleration etc.

Time, Average Speed and Velocity

Time and speed

Time is the duration of an event that is expressed in Seconds. Most physical phenomena occur with respect to time. It is a scalar quantity.

Speed is the rate of change of distance. If a body covers a certain distance in a certain amount of time, its speed is given by

Speed = $\boldsymbol{distance/time}$
Average speed = Total distance travelled / Total timetaken

Uniform motion and non-uniform motion

When an object covers equal distances in equal intervals of time it is in uniform motion.

When an object covers unequal distances in equal intervals of time it is said to be in non-uniform motion.

Velocity

The Rate of change of displacement is velocity. It is a vector quantity. Here the direction of motion is specified.

Velocity = Displacement/Time.
Average velocity =(InitialVelocity+Finalvelocity)/2 = (u+v)/2.

Acceleration

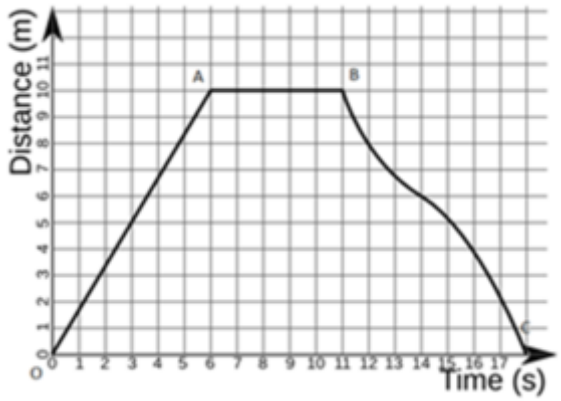
The rate of change of velocity is called acceleration it is a vector quantity. In non-uniform motion
velocity varies with time, i.e change in velocity is not 0. It is denoted by "a"

Acceleration = ChangeinVelocity/Time (OR) a = (v-u)/t

Graphical Representation of Motion

Distance-Time graph

- Distance-Time graphs show the change in position of an object with respect to time.
- Linear variation = uniform motion & non-linear variations imply non- uniform motion
- The slope gives us speed



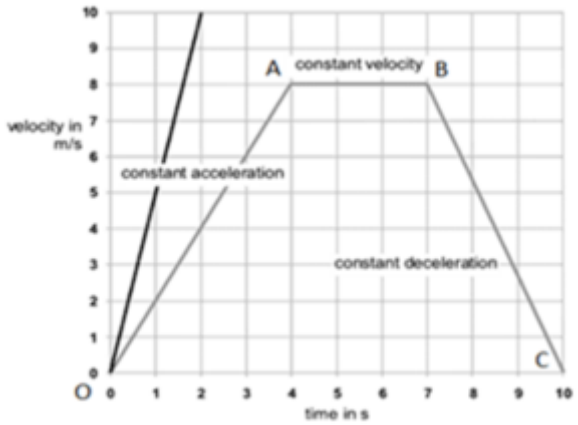
Distance – Time Graph

- OA implies uniform motion with constant speed as the slope is constant
- AB implies the body is at rest as the slope is zero
- B to C is non-uniform motion

Velocity-Time Graph

- Velocity-Time graphs show the change in velocity with respect to time.
- Slope gives acceleration
- The area under the curve gives the displacement

- Line parallel to x-axis implies constant velocity-



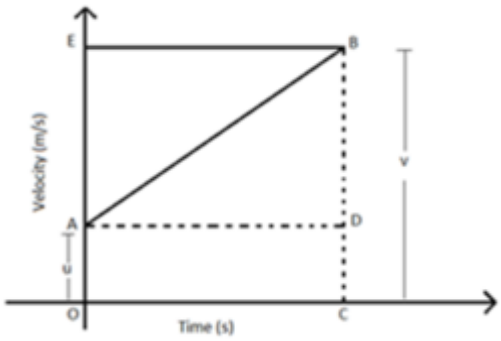
Velocity – Time Graph

OA = constant acceleration, AB = constant velocity , BC = constant retardation

Equations of Motion

The motion of an object moving at uniform acceleration can be described with the help of three equations, namely
(i) $v=u+at$
(ii) $v^2-u^2=2aS$
(iii) $S=ut+1/2at^2$

Derivation of velocity-time relation by graphical method



Velocity – Time Graph

A body starts with some initial non-zero velocity at A and goes to B with constant acceleration a.

From the graph BC = v (final velocity), DC = u (initial velocity)–(eq 1).

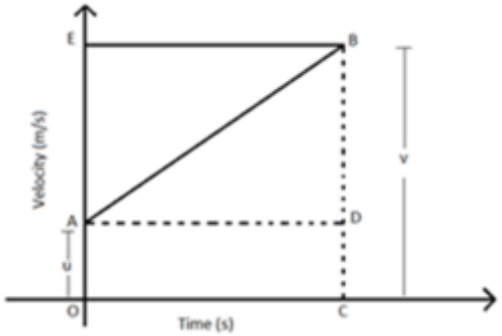
BD = BC – DC– (*eq 2*).

We know acceleration a = slope = BD/AD or AD = OC = t (time taken to reach point B).
Therefore BD = at — (eq 3).

Substitute everything we get : at = v – u.

Rearrange to get v = u + at.

Derivation of position-time relation by graphical method



Velocity – Time Graph

A body starts with some initial non-zero velocity at A and goes to B with constant acceleration a

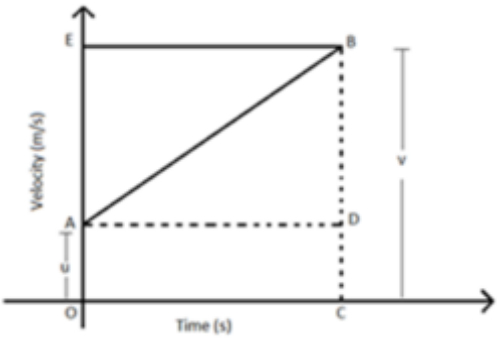
Area under the graph gives

Displacement =A(ΔABD)+A(□OADC)=($1/2$AD×BD)+OA×OC — (eq 1)

OA = u , OC = t and BD = at

Substituting in (eq 1) we get S= ut+$1/2$at^2

Derivation of position-velocity relation by graphical method



Velocity – Time Graph

A body starts with some initial non-zero velocity at A and goes to B with constant acceleration a

Displacement covered will be the area under the curve which is the trapezium OABC.

We know the area of trapezium is S=$\frac{(OA+BC)}{2}$∗OC

OA = u and BC = v and OC = t

Therefor, S= $\frac{(V+U)}{2}$ *t—(eq 1)

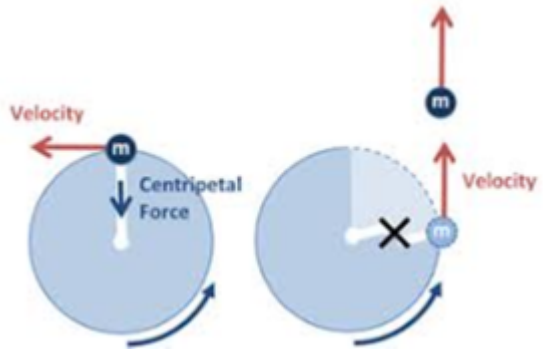
We also know that t =(v-u)/a —(eq 2)

Substitute (eq 2) in (eq 1) and arrange to get

V^2–u^2=2aS.

Uniform circular motion

- If an object moves in a circular path with uniform speed, its motion is called uniform circular motion.
- Velocity is changing as direction keeps changing.
- Acceleration is constant



ASSIGNMENT

CLASS - IX Science (Motion)

1. If a body starts from rest, what can be said about the acceleration of body?
(a) Positively accelerated (b) Negative accelerated
(c) Uniform accelerated (d) None of the above [1]

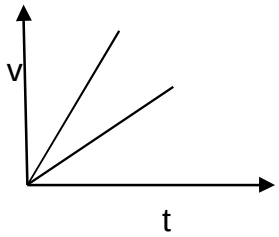
2. What does slope of position time graph give?
(a) speed (b) acceleration (c) uniform speed
(d) Both (a) and (c) depending upon the type of graph. [1]

3. When a body moves uniformly along the circle, then:-
(a) its velocity changes but speed remains the same
(b) its speed changes but velocity remains the same
(c) both speed and velocity changes
(d) both speed and velocity remains same [1]

4. Which of the following statements is correct?
(a) speed distance are scalar, velocity and displacement are vector
(b) speed distance are vector, velocity and displacement are vector
(c) speed and velocity are scalar, distance and velocity are vector
(d) speed and velocity are vector, distance and displacement are scalar [1]

5. A car travels at a speed of 40km/hr for two hour and then at 60km/hr for three hours. What is the average speed of the car during the entire journey? [2]

6. The velocity time graph of two bodies A and B traveling along the +x direction are given in the figure
(a) Are the bodies moving with uniform acceleration?
(b) Which body is moving with greater acceleration A or B?
[2]



7. Calculate the acceleration and distance of the body moving with $5m/s^2$ which comes to rest after traveling for 6sec? [2]

8. A body is dropped from a height of 320m. The acceleration due to the gravity is $10m/s^2$?
(a) How long does it take to reach the ground?
(b) What is the velocity with which it will strike the ground? [3]

9. Derive third equation of motion $v^2-u^2 = 2aS$ graphically? [3]

10. A boy throws a stone upward with a velocity of 60m/s.
(a) How long will it take to reach the maximum height ($g = -10m/s^2$)?
(b) What is the maximum height reached by the ball?
(c) How long will it take to reach the ground? [3]