09/01/19

# Chapter- 1

## Motion

Notes :-

☆ Motion :-

If a body changes its position continuously with respect to fixed point and time is said to be in motion.

☆ Rest :-

If a body does not changes its position with respect to any fixed point in its surrounding is said to be in rest.

☆ Scaler Quantity :-

A physical quantity which is described only by its magnitude is called scaler quantity. Example :-

Distance, Speed, Area, Temperature, Mass, etc.

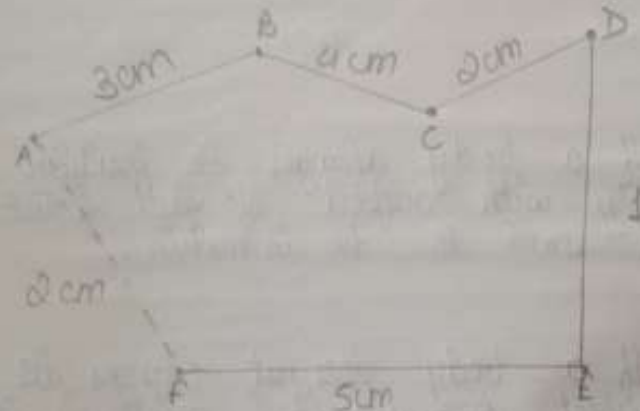
☆ Vector Quantity :-

A physical quantity which is described by both magnitude and direction is called Vector quantity. Example :-

Displacement, Velocity, Weight, etc.

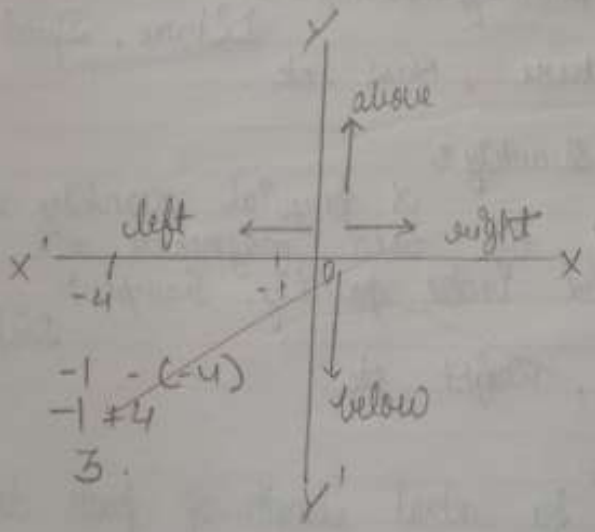
☆ Distance :-

The actual length of path travelled by




Distance = AB + BC + CD + DE + EF
(A to F) = 3 + 4 + 2 + 1 + 5
= 15cm.

Displacement = 2cm.




-1 - (-4)
-1 + 4
3.

a moving body is called distance travelled by the body. Unit = metre (m).

☆ Displacement :-

The change in position of moving body in a particular direction is called Displacement.

In other words we can say that shortest distance between initial and final position of a moving body is called Displacement. It is vector quantity. Unit = Metre (m).

Displacement = Final Position - Initial Position

$= x_2 - x_1$,

Displacement can be positive, negative and zero.

(i) Positive displacement :-

If $x_2 > x_1$, then displacement will be positive. The final position must be lie on the right side or above its initial position.

(ii) Negative displacement :- If negative $x_2 < x_1$, then displacement will be negative. The final position must be lie on the left side or below its initial position.

(iii) Zero displacement :-

If $x_1 = x_2$ then displacement will be zero. If $x_1$ = The final and initial position will be same.

★ Speed :-

Distance travelled by any body per unit time is known as its speed.

Speed (v) = $\frac{\text{Distance}}{t}$ | SI unit m/sec or $ms^{-1}$.

It is scaler quantity.

★ Average Velocity :- Speed :-

Average Speed of any body is the ratio of total distance travelled by the body to the total time taken by it to cover the distance.

Average Speed = $\frac{\text{Total distance}}{\text{Total time}}$

Numerical :-

① A train travelled 60km/hr for half hr, 30 km/hr for next two hours, 70 km/hr for next 3 hours. Find the average speed.

Distance = Speed × Time

$D_1 = 60 \times \frac{1}{2} = 30$ km

$D_2 = 30 \times 2 = 60$ km

$D_3 = 70 \times 3 = 210$ km

Total Time = $\frac{1}{2} + 2 + 3$

$= 0.5 + 5$

$= 5.5$ hours

Average Speed = $\frac{30 + 60 + 210}{5.5}$

Speed = $\frac{300}{5.5}$

Speed = $\frac{3000}{55} \times 600$

$= 54.545$ km/hr.

Rule = 1 km/hr = $\frac{5}{18}$ m/sec

1 m/sec = $\frac{18}{5}$ km/hr

(2) An object travels 16m in 4 sec and then another 16m in 2 seconds. What is average speed of the object?

(Distance = Speed x Time) ✗

$D_1 = 16 \times 4$

$= 64$ m

$D_2 = 16 \times 2$

$= 32$ m

Total time = 4+2

= 6 seconds

(Average speed = $\frac{64+32}{6}$

= $\frac{96}{}$) ✗

$D_1 = 16m, \quad t_1 = 4$ sec

$D_2 = 16m, \quad t_2 = 2$ sec

A. Speed = $\frac{D_1 + D_2}{t_1 + t_2}$

$= \frac{16+16}{4+12} = \frac{32}{6} = 5.33$ m/sec.

③ In driving the usual route Abdul completes with average speed 20km/hr. On returning on the same route there is less traffic and the average speed is 40km/hr. What is the average speed of Abdul in total trip.

Let distance is 'd' of route

$D_1 = 20 \times t_1$

$d = 20t_1$

$t = \frac{d}{20}$

$D_2 = 40 \times t_2$

$d = 40 \times t_2$

$t_2 = \frac{d}{40}$

$= \frac{D_1 + D_2}{t_1 + t_2}$

$= \frac{d + d}{\frac{d}{20} + \frac{d}{40}}$

$= \frac{2d}{\frac{2d + d}{40}}$

$= 2d \times \frac{40}{3d}$

$= \frac{80}{3}$

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Uniform Speed :-

When a moving body travels equal distance in equal interval of time then it is said to have uniform speed. (Constant speed)

Example :-

If a body covers 10m distance in every 2 seconds.

Non-Uniform Speed :-

When a moving body travels unequal distance in equal interval of time then it is said to have non-uniform speed.

Example :-

When we ride our cycle we cover unequal distance in equal time.

Velocity :-

Distance (Displacement) travelled by a body per unit time in a given direction is called velocity. It is vector quantity.

SI unit = m/sec or $ms^{-1}$

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

$$V = \frac{\text{Distance travelled by any object in any direction}}{\text{time}}$$

Uniform Velocity :-

When a moving body travels equal distance in equal interval of time in a particular direction (straight line) is called Uniform Velocity.

Non-Uniform Velocity :-

When a moving body travels unequal distance in a equal interval of time in a particulare direction (straight line) is called Non-Uniform Velocity. When a body covers equal distance in equal time and travel but changes its direction during the motion, is called Non-Uniform velocity.

Accelaration :-

The change in velocity of a body per unit time is called accelaration.

$$\text{accelaration} = \frac{\text{Change in Velocity}}{\text{time interval}}$$

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

Here, $u$ = initial
$v$ = final
$t$ = time interval.

Unit = $m/s^2$ or $ms^{-2}$

Positive acceleration :-

If the final velocity is greater than initial velocity ie $v > u$ then the acceleration is said to be positive acceleration. Simply, we say acceleration.

Example :-

A body falling towards earth as positive acceleration.

Negative acceleration :-

If the final velocity is lesser than initial velocity $v < u$ then the acceleration is said to be negative acceleration.

Example :-

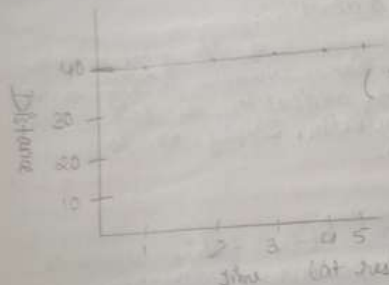
We apply brick to a moving car, speed continously decreasing. It is also called retardation or Deceleration.

Uniform acceleration :-

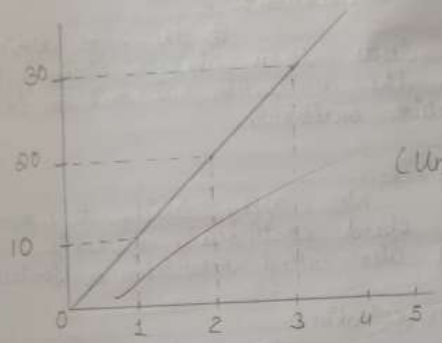
When a body travels in a straight line and its velocity changes by equal amount in equal interval of time, it is said to have uniform acceleration.

Example :-

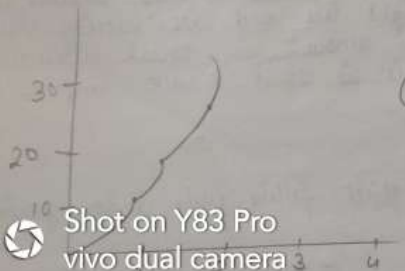
Object falling fully under gravity.




(Distance time graph)




(Uniform Speed)




(Non Uniform Speed)

Non-Uniform acceleration :-

When a velocity of body changes by unequal amount in equal interval of time, it is said to have Non-Uniform acceleration.

- Example :-

An auto driver on a crowded city road.

Graphical representation :-

(i) Distance time graph.
(ii) Uniform Speed.
Non-Uniform.

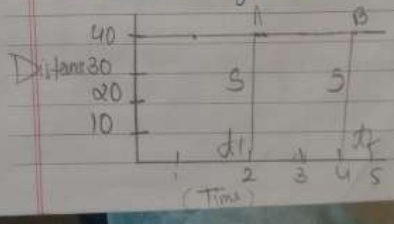
Distance Time Graph :-

In drawing these graphs, time is always taken along the x-axis where as distance is taken along the y-axis.

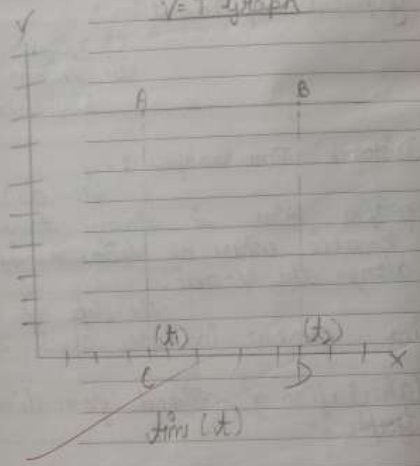
The slope of distance time graphs indicates speed of the body.

Calculation of Speed from distance time graph :-

When body is at rest.



V-T graph




(1) for Uniform motion

From the graph

at time $t_1$, distance = $S_1$
$t_2$, distance = $S_2$
time interval = $t_2 - t_1$

change in distance = $S - S$
$= 0$

Speed = $\frac{0}{t_2 - t_1}$

Speed = 0.

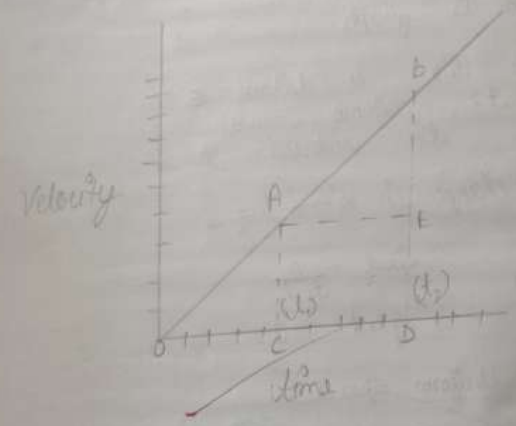
At Uniform Speed :-

From the graph,
at time $t_1$, distance = $S_1$
$t_2$, distance = $S_2$
time interval = $t_2 - t_1$
change in distance = $S_2 - S_1$
Speed = $\frac{S_2 - S_1}{t_2 - t_1}$

Velocity time graph :-

To draw VT graph, Velocity is plotted along Y-axis and time is plotted along X-axis. The area under the graph gives distance.

(1) Calculation of distance or magnitude of displacement :-




Here Velocity = AC (AC=BD)
Time = CD (CD = AB)

distance = Area of quadrilateral ABCD
= AC × CD = AC × (OD − OC) = AC(t₂ − t₁)
= Velocity × Time.

(ii) Vt graph for an object with Uniform acceleration:

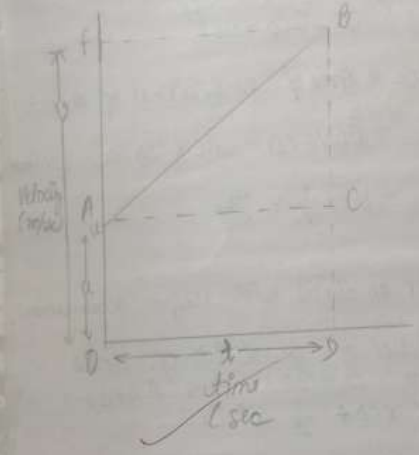
Distance = area of quadrilateral ACDB
= area (□ACDE) + area (△AEB)
= AC × CD + ½ AE × BE.

Or = ½ (AC+BD) × CD

Equation of Motion:-
There are three equation of motion.

(i) $v = u + at$
(ii) $s = ut + \frac{1}{2}at^2$
(iii) $v^2 = u^2 + 2as$

where
u = initial velocity
v = final velocity
t = time
a = acceleration
s = distance.




(i) First equation of motion (velocity time relation).

Time interval = OD
= t

Velocity at point A = OA
= u

Velocity at point B = OF
= v

Change of velocity = AE AF
= OF - OA
= v - u

Acceleration = change in velocity / time interval

$\frac{a}{1} = \frac{v-u}{t}$

$v - u = at$

$\boxed{v = u + at}$

(ii) Second equation of motion (Position time relation).

Distance = area of quadrilateral AODB
= ar (quadrilateral AODC) + ar (ΔACB)
= OA × OD + $\frac{1}{2}$ AC × BC

= ut + $\frac{1}{2}$ t (AF) (∵) AC = OD = t)

ut + $\frac{1}{2}$ t (OF - OA)

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

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

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

(iii) Third equation of motion (Position velocity Relation).

Distance = area of trapezium AODB

$= \frac{1}{2}(OA + BD) OD$

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

$= \frac{1}{2}(v+v)\frac{(v-u)}{a}$ ($\because BD - AF = v$)

($\because v = u + at = t$)

$v - u = at$

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

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

$S = \frac{v^2 - u^2}{2a}$

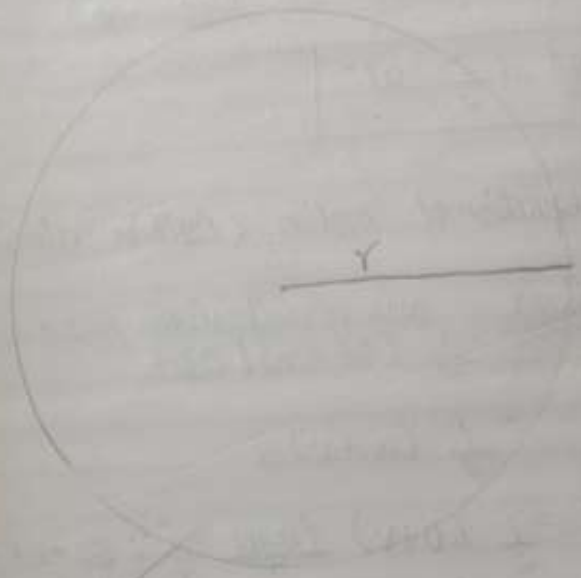
$v^2 - u^2 = 2as$

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

Uniform Circular motion :-

When a body moves in a circle, it is called circular motion.

When a body moves in a circular path with uniform speed, its motion is called uniform circular motion.




r = radius of circular path

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

$= \frac{2\pi r}{t}$

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