CHAPTER–8

Motion

CBSE CLASS IX

Dr. SIMIL RAHMAN

MOTION

[NOTES]

State of rest :- A body is said to be at rest if it does not change its position with respect to time

Motion :- A body is said to be in motion if it changes its position with respect to time

. eg; Types

1; rectilinear motion
2; Oscillatory motion
3; vibratory motion

Scalar Quantity :- A physical quantity which is described completely by its magnitude

eg; distance, speed

Vector Quantity :- A physical quantity which is described completely by its magnitude and direction is called a vector quantity

eg; displacement, velocity

Distance

The actual length of the path travelled by a moving body.

* S.I unit is meter

m

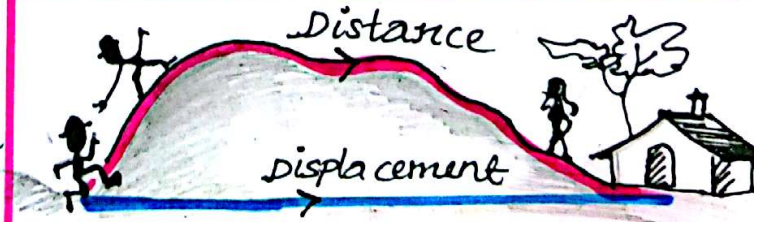
Displacement

The shortest distance (straight distance) measured between the initial and final position of the moving body

* S.I unit is 'm'

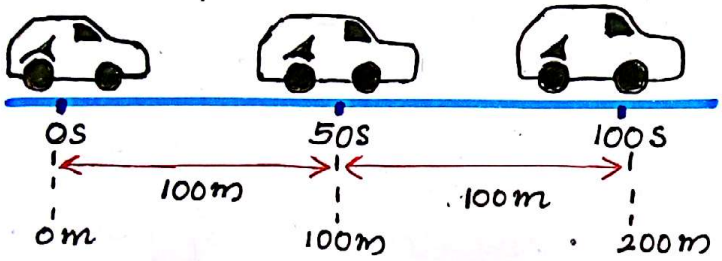
Difference between distance and displacement. [CBSE]

Distance	Displacement
1; the length of path travelled by an object	1; The shortest distance between the initial and final positions of a moving object.
2; is always positive	2; positive, negative or zero.
3; scalar quantity	3; vector Quantity
4; depends on path followed by the moving object	4; does not depend on the path



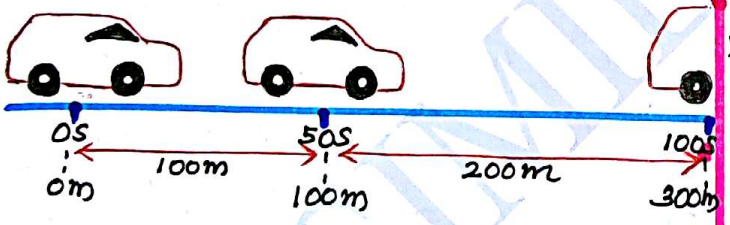
Uniform motion

A body has a uniform motion if it travels equal distances in equal Intervals of time.



Non uniform motion

A body has a non-uniform motion if it travels unequal distances in equal Intervals of time.



* A body (car) having non-uniform motion

Speed

The speed of a body is the distance travelled by it per unit time

$$\text{speed} = \frac{\text{Distance}}{\text{time}}$$

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

$v \rightarrow$ speed
$s \rightarrow$ distance
$t \rightarrow$ time

* speed is a scalar Quantity
* SI unit is m/s
* $\frac{km}{hr} \rightarrow m/s$ multiply with $\frac{5}{18}$
* $m/s \rightarrow \frac{km}{hr}$ multiply with $\frac{18}{5}$
* Odometer - measures distance travelled by object (vehicles)
* Speedometer - measures speed of the moving object (vehicles)
* Average speed.

The average speed of a moving body is the total distance travelled by the body divided by the total time taken to cover this distance

$$\text{avg speed} = \frac{\text{Total distance travelled}}{\text{Total time taken.}}$$

* Instantaneous speed

The speed at any instant of time is called the Instantaneous speed.

Velocity

Velocity is the speed of an object moving in a definite direction

$$\text{velocity} = \frac{\text{displacement}}{\text{time}}$$

* Vector Quantity

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

* unit (SI) m/s

$v \rightarrow$ velocity
$x \rightarrow$ displacement
$t \rightarrow$ time

* **When is a body said to have uniform velocity?** (CBSE)

velocity of an object is uniform if it has equal displacements in equal intervals of time.

* **When is a body said to have non-uniform velocity?**

velocity of an object is non-uniform if it has unequal displacements in equal intervals of time.

Define Average Velocity?

Average velocity of an object is the ratio of total displacement to the total time taken by it.

Define acceleration of a body?

Acceleration is defined as the change in velocity per unit time

i.e; $$a = \frac{v - u}{t}$$

$u \rightarrow$ Initial velocity
$v \rightarrow$ final velocity
$t \rightarrow$ time

* SI unit is m/s^2

* **What do you mean by positive acceleration? Give one example**

when the velocity of a body increases with time its acceleration is positive.
eg; when a body falls from certain height.

* **What do you mean by negative acceleration or retardation?**

when the velocity of the body decreases with time its acceleration is negative (deceleration)
eg. when a ball is thrown vertically upwards.

* **Define uniform acceleration?** (CBSE)

when the velocity of a body

changes by an equal amount in equal intervals of time, then the body is in uniform acceleration

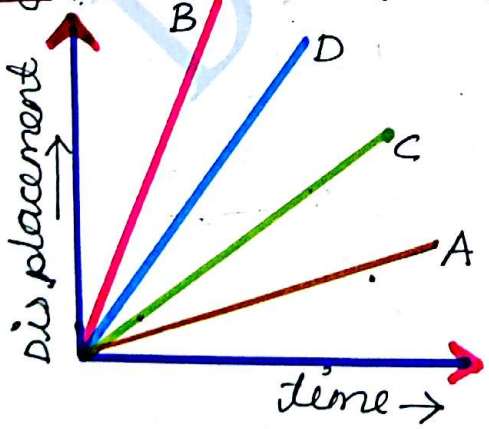
* **when do you say that a body has non-uniform acceleration?**

When the velocity of a body changes by unequal amount in equal intervals of time, then the body is in non uniform acceleration

* **what does the slope of a velocity-time graph represent?** [CBSE]

It represent acceleration of the body.

* **Figure shows the displacement-time graph of four children A, B, C and D. which child has the highest velocity?** (CBSE)



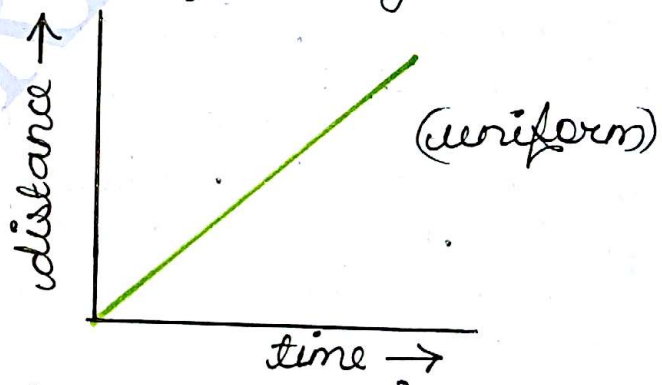
velocity = slope of displacement-time graph

since the slope of child B is greater than all other children. child B has the highest velocity

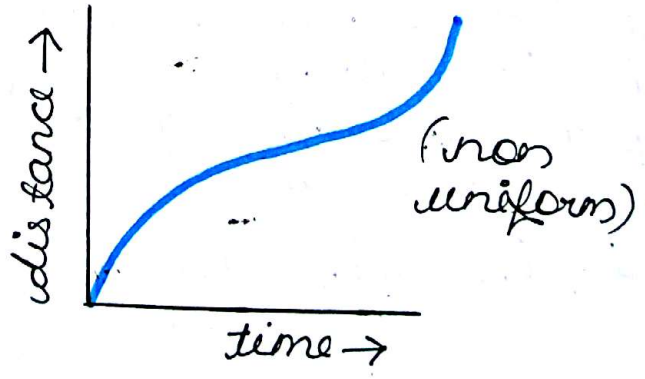
Distance-time graph.

A graph showing the change in position of an object with the change in time is called distance-time graph.

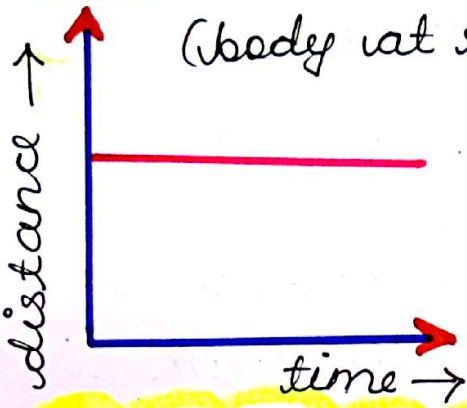
* for a moving body with uniform speed is a straight line



* for a moving body with non-uniform speed is a curved line



* For a body at rest is a straight line parallel to the time axis.



* **Velocity-time graph**

A graph showing the variation of velocity with the change in time is called the velocity time graph

* Shape of velocity-time graph depends upon the nature of motion of the body
* The slope of the velocity-time graph gives the acceleration of the body.
* The area under the velocity-time graph gives the distance travelled by the body.

Derive the equation of Motion $V = u + at$ using graphical Method? (CBSE)

from figure →

$$\text{acceleration} = \frac{CB}{AC}$$

$$a = \frac{DB - DC}{OD}$$

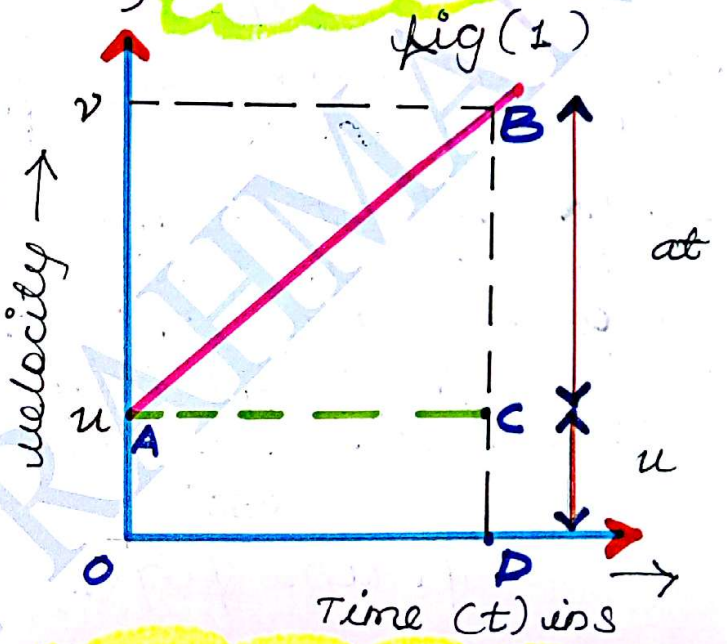
$[\because AC = OD]$

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

$$at = v - u$$

$$at + u = v$$

i.e., $v = u + at$



using velocity time graph derive $S = ut + \frac{1}{2}at^2$ [CBSE]

from fig (1)

Distance travelled

S = area OABD (area of trapezium)

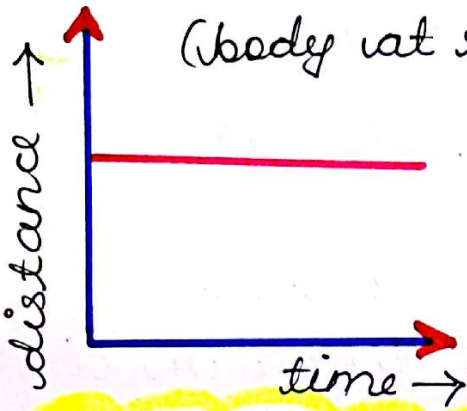
S = area of $\triangle ABC$ + area of □gle OACD

$$S = \frac{1}{2} \times (bh) + (l \times b)$$

$$S = \frac{1}{2} \times (AC \times CB) + (OD \times OA)$$

Here $AC = OD = t$

$CB = at$



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[$\because AC = OD$]

$$\Rightarrow a = \frac{V - u}{t} \quad (\because t)$$

$$at = V - u$$

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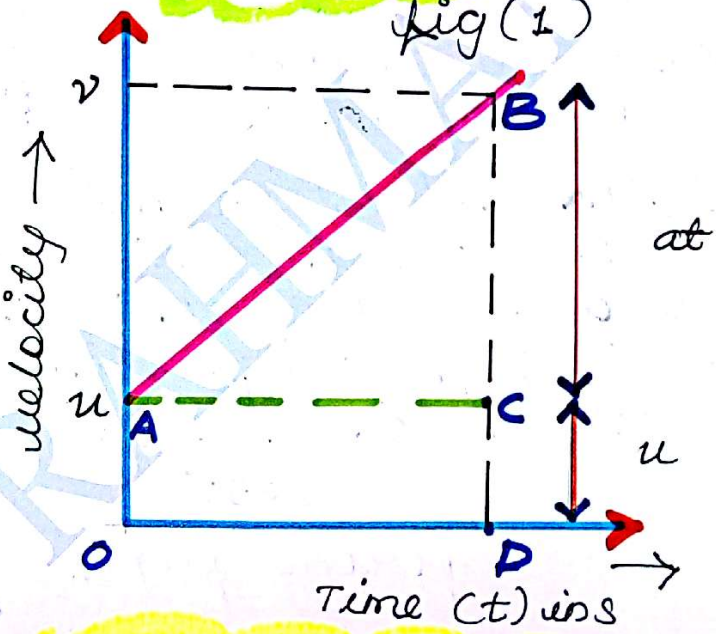
i.e., $V = u + at$

fig (1)



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$$S = \frac{1}{2} \times (bh) + (l \times b)$$

$$S = \frac{1}{2} \times (AC \times CB) + (OD \times OA)$$

Here $AC = OD = t$

$CB = at$

$OA = u$

$\therefore S = \frac{1}{2} \times t \times at + u \times t$

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

* also known as position time relation (CBSE)
* IInd equation of motion

Draw velocity-time graph for an uniformly accelerated object. using velocity-time graph, Derive $v^2 - u^2 = 2as$ (CBSE)

from fig (1)

S = area of trapezium $OABD$

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

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

$OD = t$
$OA = u$
$BD = v$

we know

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

$$\therefore t = \frac{v-u}{a} \quad \ldots (2)$$

(2) in (1)

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

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

$$2aS = v^2 - u^2$$

$$\therefore v^2 - u^2 = 2aS$$

or

$$v^2 = u^2 + 2aS$$

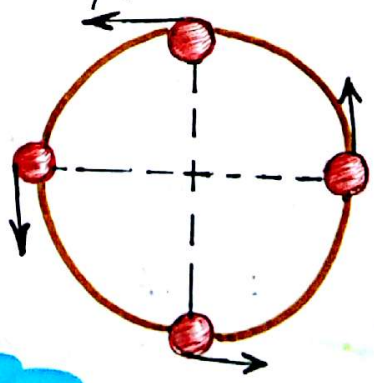
what is uniform circular motion? How is uniform circular motion regarded as accelerated motion? Explain.

Circular motion of a body having constant speed is known as uniform circular motion.

when a body has uniform circular motion, its velocity changes due to continues change in direction of its motion. Hence the motion of the body is accelerated motion

Note:

when an object moves in a circular path of radius r



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

($2\pi r$ - circumference)

*what is the difference between uniform motion in a straight line and uniform circular motion? (CBSE)

(I) uniform motion:

*1. The direction of motion of an object does not change.
2. If an object moves with constant speed, acceleration of object is zero.

II uniform circular motion

*1. direction of motion of an object changes continuously.
2. object moves with constant speed but the motion of the object is accelerated motion.

FORMULAE

1. speed $v = \frac{s}{t}$
2. velocity = $\frac{\text{displacement}}{\text{time}}$

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

3. acceleration

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

4. Equations of motion

I $\Rightarrow$ $v = u + at$

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

III $\Rightarrow$ $v^2 - u^2 = 2as$

SI units

Distance s = metre (m)
speed (v) = m/s
velocity(v) = m/s
acceleration a = m/s2