BHAGIRATHI BAL SHIKSHA SADAN SEC SCHOOL

Class - IX
Sub - Science (Physics)
Topic - motion
Chapter - 8

Concept mapping

Physical State

Rest (No Change in Position)

Motion (change in Position)

- **Uniform motion**: Equal distance Travelled in equal time intervals.
- **Non Uniform motion**: Unequal distance travelled in equal time intervals.
  - **Accelerated motion**: Increase in motion with time.
    - → Uniformly accelerated motion
    - → Non uniformly motion.
  - **Deaccelerated motion**: Decrease in motion with time.
    - → Uniformly Deaccelerated motion
    - → Non uniformly Deaccelerated motion.
- **Linear motion**: straight line Path
  - **Distance**: Actual Path travelled by a body.
  - **Speed**: Distance travelled in a unit time. unit m/s. It is scalar quantity.
- **circulatory motion**: Circulatory Path.
  - **Displacement**: Shortest distance between initial and final Position.
  - **Velocity**: Displacement traveled in a unit time. unit m/s. It is vector.

Equations of motion

$v = u + at$ — First Equation.

$s = ut + \frac{1}{2}at^2$ — Second Equation.

$v^2 = u^2 + 2as$ — Third Equation.

Where :—

v = Final velocity
u = Initial velocity
a = Acceleration.
t = Time Taken.
s = Distance Covered.

Rest:- A body is said to be in a state of rest when its position does not change with respect to a reference point.

Motion:- A body is said to be in a state of motion when its position changes continuously with reference to a point. It can be of different types:-

(i) Circulatory motion:- In a circular path.

(ii) Linear motion:- In a straight line path.

(iii) Oscillatory / Vibratory motion:- To and fro path with respect to origin.

Scalar Quantity:- It is the physical quantity having own magnitude but no direction.

e.g - Distance, Height, Speed.

Vector Quantity:- It is the physical quantity having own magnitude along with direction.

e.g.. Displacement, Velocity.

Distance	Displacement
1. Length of actual path travelled by an object.	1. Shortest path / length between initial point and final point of object.
2. It is scalar quantity.	2. It is vector quantity.
3. It remains positive, can't be zero or negative.	3. It can be positive, negative or zero.
4. Distance can be equal to displacement (in linear path).	4. Displacement can be equal to distance or its lesser than distance.

Example:- A body travels in a semicircular path of radius 10m starting its motion from point "A to Point B". Calculate the displacement and distance.

Solution:— Total distance travelled by body, $s = ?$

$\pi = 3.14$

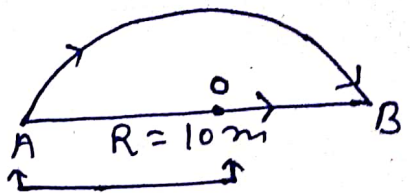
$R = 10\,m$

$S = \pi R$

$S = 3.14 \times 10$

$= 31.4\,m$

$\pi = 3.14$



Total displacement, $D = ?$

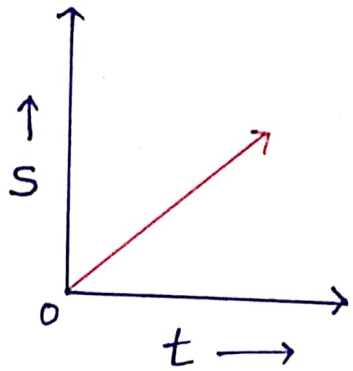
$R = 10m$

$D = 2 \times R$

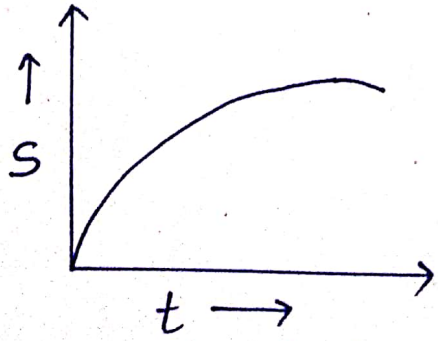
$= 2 \times 10$

$= 20\,m$

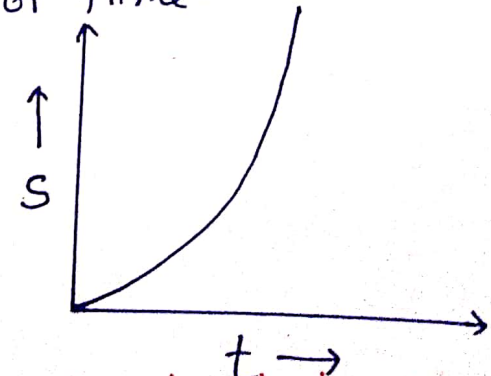
Uniform motion:— When a body travels equal distance in equal interval of time, then the motion is said to be uniform motion.



Non uniform motion:— In this type of motion, the body will travel unequal distance in equal time intervals of time.



Deaccelerated non uniform motion.



accelerated non uniform motion.

Speed :- The measurement of distance travelled by a body per unit time is called speed.

$$\text{Speed} = \frac{\text{Distance Travelled}}{\text{Time Taken}}.$$

$$V = \frac{s}{t} \quad m/s$$

Also - $$\text{Average Speed} = \frac{\text{Total Distance travelled}}{\text{Total Time Taken}}$$

Example :- What will be the speed in m/s and km/hrs if it travels 40 kms in 5 Hours ?

Solution :- Distance = 40 km

Time = 5 Hrs

$$\text{Speed in km/hr} = \frac{\text{Total distance}}{\text{Total Time}}$$

$$= \frac{40 \text{ km}}{5 \text{ Hrs}} = 8 \text{ km/hr}$$

Speed in m/s = ?

$$40 \text{ km} = 40 \times 1000 \text{ m} = 40,000 \text{ m}$$

$$5 \text{ hrs} = 5 \times 60 \times 60 = 18,000 \text{ Sec}$$

$$\text{speed} = \frac{40,000}{18000} = \frac{40}{18} \frac{20}{9} = \frac{20}{9}$$

$$\text{Average Velocity} = \frac{\text{Total displacement}}{\text{Total Time}} = 2.22 \text{ m/s}$$

$$= \frac{\text{Initial velocity} + \text{final velocity}}{2}$$

Velocity :- It is the speed of a body in given direction.

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

It is a Vector quantity.

Example :- During first half of a journey by a body it travels with a speed of 40 km/hr and in the next half it travels with a speed of 20 km/hr. Calculate the average speed of the whole journey.

Solution:- Speed during first half (u) = 40 km/hr
" " second " (v) = 20 km/hr

we know that —

$$\text{Average speed} = \frac{v+u}{2} = \frac{20+40}{2}$$

$$= \frac{60}{2} = 30 \text{ km/hr}$$

Retardation :- It is seen in non-uniform motion during decrease in velocity with time.

It has same definition as acceleration.

$$a' = \frac{\text{Change in velocity}}{\text{Change in time}}$$

$$a' = \frac{v-u}{t}$$

Here $v < u$ so a' is always negative. Its unit is m/s^2 as acceleration.

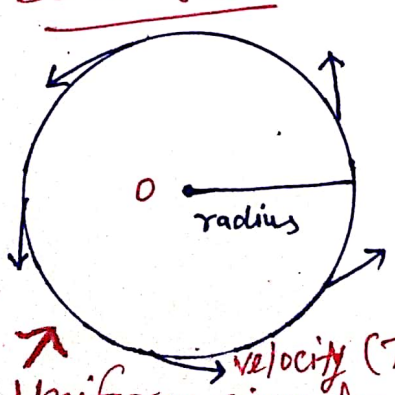
Example :- A car travelling with a speed of 20 km/hr comes into rest in 0.5 hrs. what will be the value of its retardation?

Solution:-

$v = 0$ km/hr
$u = 20$ km/hr
$t = 0.5$ hrs
Retardation, $a' = ?$

$$a' = \frac{v-u}{t} = \frac{0-20}{0.5} = \frac{-200}{0.5}$$

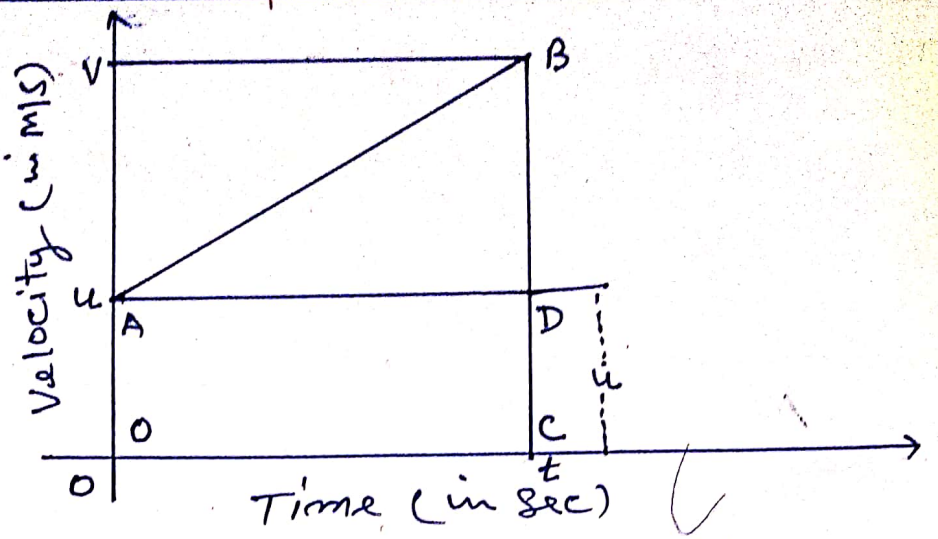
$$= \frac{-200}{5} = -40 \text{ km/hr}^2$$



Uniform circular motion:- In this motion a body moves in a circular path with uniform speed. In such a motion speed may be same throughout the motion but its velocity is different at each and every point of its motion due to continuous change in direction. Thus it is accelerated motion.

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

Derivation of first equation of motion:—



for such a body there will be an acceleration:—

$$a = \frac{\text{Change in Velocity}}{\text{Change in time}}$$

$$a = \frac{OB - OA}{OC - O} = \frac{v - u}{t - 0} = \frac{v - u}{t}$$

or $at = v - u$

or

$$v = u + at$$

(ii) Second Equation:— $s = ut + \frac{1}{2}at^2$

Distance travelled by object = Area of OABC (Trapezium)

or = Area of OADC + area of Δ ABD

or = $OA \times AD + \frac{1}{2} \times AD \times BD$

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

= $ut + \frac{1}{2} \times t \times at$

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

$\left[\because \frac{v-u}{t} = a\right]$ so $[v - u = at]$

Third Equation:—

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

s = Area of Trapezium $OABC$

$$s = \frac{(OA + BC) \times OC}{2}$$

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

or ($\because \frac{v-u}{t} = a$)

$$s = \left(\frac{u+v}{2}\right) \times \left(\frac{v-u}{a}\right)$$

$$2as = (u+v) \times (v-u)$$

$\{(a+b)(a-b) = a^2 - b^2\}$

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

or

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

Example:— A car starting from the rest moves with uniform acceleration of $0.1\ m/s^2$ for 4 mins. find the speed and distance travelled.

Solution:—

$u = 0\ m/s$ ∵ Car is at rest.

$a = 0.1\ m/s^2$

$t = 4\ min = 4 \times 60 = 240\ sec$

$v = ?$

We know that, $v = u + at$

$v = 0 + 0.1 \times 240$

$v = 0 + 24.0$

$v = 24\ m/s$

Also, Distance, $s = ut + \frac{1}{2}at^2$

$s = 0 \times 240 + \frac{1}{2} \times 0.1 \times 240 \times 240$

$s = 0 + \frac{1}{2} \times 24 \times 240^{120}$

$s = 2880\ mts$

—:: Assignment To do ::—

Q1 No1:— Change the speed 6 m/s into Km/hr.

Q2 No2:- what do speedometer and odometer used for?

Q3 No3:— What is the other name of negative acceleration?

Q4 No4:— Define motion.

Q5 No5:— what is difference between speed and velocity?

Q6 No6:- write difference between distance and displacement?.

Q7 No7:— A tortoise moves a distance of 100 m in 15 minutes. what is its speed in Km/hr?.

Q8 No8:— A Car speed increases from 40 Km/hr to 60 Km/hr in 5 sec. Calculate the acceleration of Car-

Q9 No9:— A body travels 4 Km towards North the it turns to its right and travels another 4 Km before Coming to rest. Calculate (i) Total distance travelled. (ii) Total displacement.

Q No 10:— Derive the equations - $v = u + at$, $s = ut + \frac{1}{2}at^2$ and $v^2 = u^2 + 2as$. graphically.

Q No11:- what is uniform circular motion? Give two examples which force is responsible for that.

Q No 12:— Convert a speed of 54 Km/hr into m/s.