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Physics

Motion In One Dimension

Lecture - 01

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Topics *to be covered*

1. Scalar and Vector
2. Rest and Motion
3. Displacement
4. Questions

Scalar and Vector Quantities

PQ

Scalar → N U — Speed, Distance

Vector → N U D — Force, Velocity

Scalar Quantities or Scalars

These are the physical quantities which are expressed only by their magnitude.

For example, if we say that the mass of a body is 5.0 kg, it has a complete meaning and we are completely expressing the mass of the body. Thus, we need the following two parameters to express a scalar quantity completely:

(i) Unit in which the quantity is being measured, and

(ii) The numerical value of the quantity.

Vector Quantities or Vectors

These physical quantities require the magnitude as well as the direction to express them, then only their meaning is complete. For example, If we say that "displace a particle from a point by 5 m", the first question that will arise, will be "in which direction"? Obviously, by saying that the displacement is 5m, its meaning is incomplete. But if we say that displace the particle from that point by 5 metre towards east (or in any other direction), it has a comolete meaning. Thus, we require the following three meters to express a vector quantity completely:

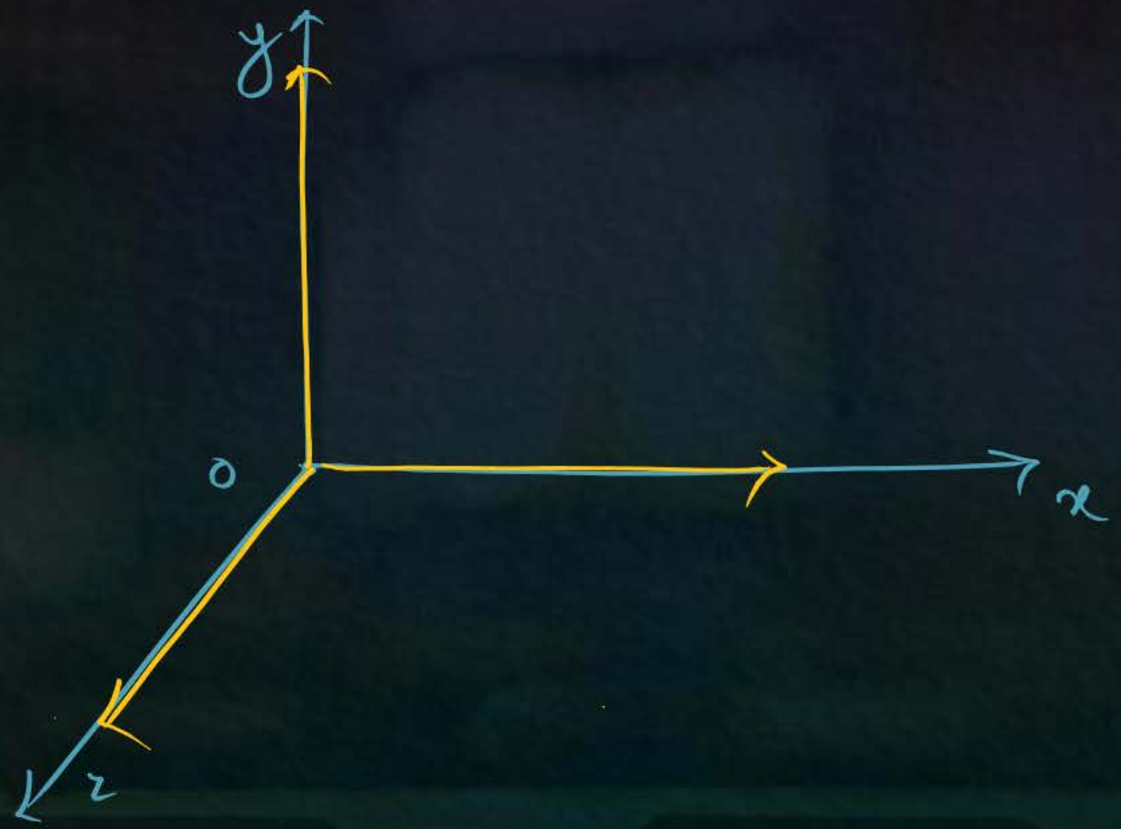
(i) unit,

(ii) numerical value of the quantity and

(iii) direction .

Rest and Motion

A body is said to be at rest if it does not change its position with respect to its immediate surroundings, while a body is said to be in motion if it changes its position with respect to its immediate surrounding.



any ①

2-D motion

One Dimensional Motion

When a body moves along a straight line path, its motion is said to be one dimensional motion. It is also called motion in a straight line or rectilinear motion. For example, the motion of a train on a straight track, a stone falling down vertically, a car moving on a long and straight road etc., a car one dimensional (or rectilinear) motion. In such a motion, there is no movment of the body in lateral direction (i.e., no sideways motion).

if a body moves on a plane along a curved path, its motion is two dimensional and if it moves in space, its motion is three dimensional. In this chapter, we shall consider only the one dimensional motion.

Distance

रास्ते की लंबाई

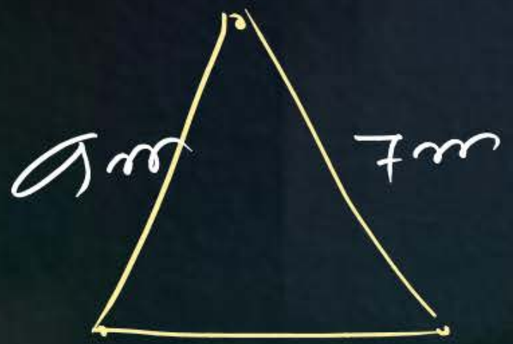
The total length of path through which a body moves, is called the distance travelled by it. The distance travelled by a body depends on the path followed by the body.

It is a scalar quantity. It is generally represented by the letter S.

Scalar

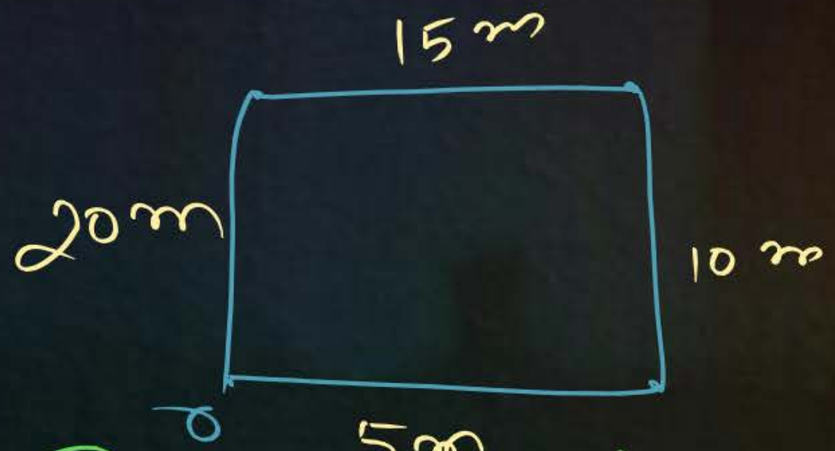
Unit:

The S.I. unit of distance is metre (m) and C.G.S., unit is centimeter (cm).



Distance = 5 + 7 + 9

= 21m



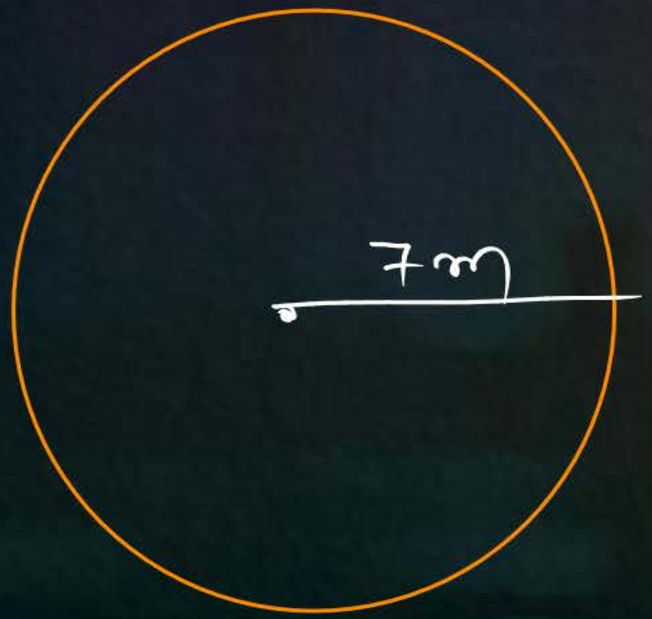
Distance = 50m

Distance = रास्ते की लंबाई

$= 2\pi r$

$= 2 \times \frac{22}{7} \times 7$

$= 44\,m$



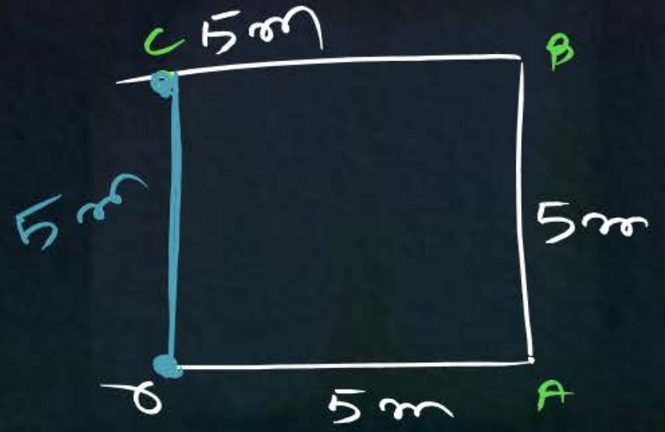
Displacement

The shortest distance from the initial to the final position of the body, is the magnitude of displacement and its direction is from the initial position to the final position.

It is a vector quantity. It is represented by the symbol $\vec{S}$.

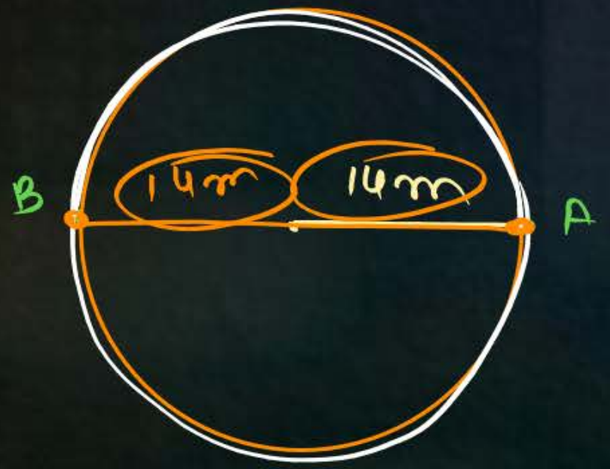
Unit:

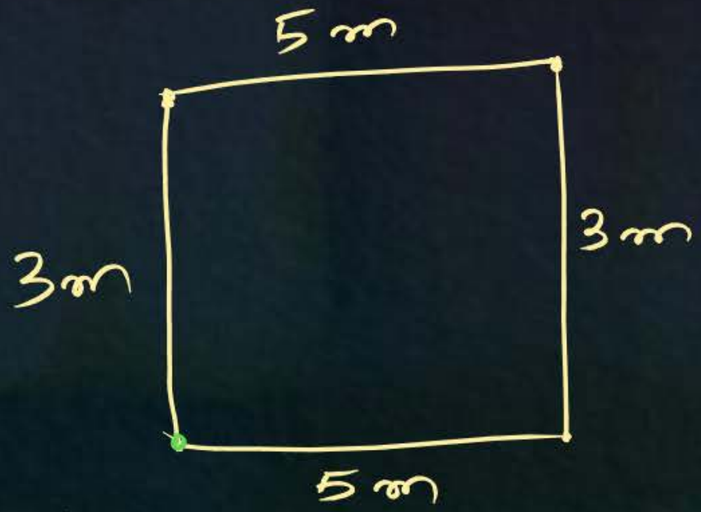
The S.I. unit of displacement is metre (m) and C.G.S. unit is centimetre (cm).



Distance = 15m

Displacement = 5m ($\vec{OC}$)



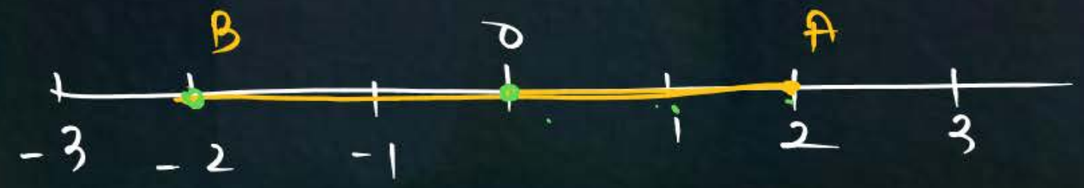


Distance = 16 m

Displacement = 0

Distance = $2\pi r + \pi r$

Displacement = 28 m (AB)



Distance = 6 Unit

Displacement = $\underline{-2}$

Representation of Displacement

The displacement being a vector, is represented by a straight line with an arrow, using a convenient scale. The tip of arrow on the straight line represents the direction of displacement, while the length of the straight line on proper scale represents its magnitude.

Distinction Between Distance and Displacement

(1) The magnitude of displacement is either equal to or less than the distance. If motion is along a fixed direction, the magnitude of displacement is equal to that of distance, but if motion is along a curve or any zig-zag path, the magnitude of displacement is always less than that of distance. The magnitude of displacement can never be greater than the distance travelled by the body.

Distinction Between Distance and Displacement

(2) The distance is the length of path travelled by the body so it is always positive, but displacement is the shortest length in direction from initial position to the final position so it can be positive or negative depending on its direction.

Distinction Between Distance and Displacement

(3) **The displacement can be zero even if the distance is not zero**. If a body, after travelling, comes back to its starting point, the displacement is zero but the distance travelled is not zero.

Distinction Between Distance and Displacement

Distance	Displacement
1. It is the length of the path traversed by the object in a certain time.	1. It is the distance travelled by the object in a specified direction in a certain time (i.e., it is the shortest distance between the final and initial positions).
2. It is a scalar quantity i.e., it has only the magnitude.	2. It is a vector quantity i.e., it has both the magnitude and direction.
3. It depends on the path followed by the object.	3. It does not depend on the path followed by the object.
4. It is always positive.	4. It can be positive or negative depending on its direction.
5. It can be more than or equal to the magnitude of displacement.	5. Its magnitude can be less than or equal to the distance, but can never be greater than the distance.
6. It may not be zero even if displacement is zero, but it can not be zero if displacement is not zero.	6. It is zero if distance is zero, but it can be zero even if distance is not zero.

Question

Express the speed 36 km h^{-1} in m s^{-1}.

$$\frac{km}{hr} \longrightarrow \frac{1000\,m}{3600\,s} \quad (\times \tfrac{5}{18})$$

$$36\,\frac{km}{hr} = 36 \times \frac{m}{s} \times \frac{5}{18}$$

$$= 10\,m/s$$

$$\frac{km}{hr} \xrightarrow{\times 5/18} m/s \qquad m/s \xrightarrow{\times 18/5} \frac{km}{hr}$$

Question

Express the speed 36 km h^{-1} in m s^{-1}.

Solution.

$$36 \text{ km } h^{-1} = \frac{36\text{km}}{1\text{h}} = \frac{36\times1000\text{m}}{60\times60\text{s}} = 10 \text{ m } s^{-1}$$

Question

Find the distance travelled by a body in 5 minutes if it travels with a uniform speed of $20\ m\ s^{-1}$.

Speed = 20 m/s

$t = 5\ min = 5 \times 60\ sec$

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

$20 = \frac{d}{5 \times 60}$

$20 \times 5 \times 60 = d$

100×60

$6000\ m = d$

$d = 6\ km$

Question

Find the distance travelled by a body in 5 minutes if it travels with a uniform speed of 20 m s^{-1}.

Solution.

Given, $u = 20\ \text{m s}^{-1}$, $t = 5\ \text{min} = 5 \times 60\ \text{s} = 300\ \text{s}$

Distance travelled S = speed u × time t

$= 20\ \text{m s}^{-1} \times 300\ \text{s}$

$= 6000\ \text{m} = 6\ \text{km}.$

Question

The vector quantity is:

A work

B pressure

C distance

D velocity

Question

The vector quantity is:

(A) work

(B) pressure

(C) distance

(D) velocity

ANSWER

(D) velocity

Question

What would be the displacement of a particle moving in a circular path of radius r after a displacement of half a circle?

A $2\pi r$

B πr

C $2r$

D Zero

Question

What would be the displacement of a particle moving in a circular path of radius r after a displacement of half a circle?

A $2\pi r$

B πr

C $2r$

D Zero

ANSWER

(C) $2r$

Question

The path length travelled by a body in a given time interval is known as_____.

A distance

B velocity

C acceleration

D moment

Question

The path length travelled by a body in a given time interval is known as_____.

(A) distance

(B) velocity

(C) acceleration

(D) moment

ANSWER

(A) distance

Speed

The speed of a body is the rate of change of distance with time. Numerically it is the distance travelled by the body in 1 s.

It is a scalar quantity- It is generally represented by the letter *u* or *v*.

$d = 100\ m$

$t = 1\ sec$

$S = \frac{d}{t} = \frac{100}{1} = 100\ m/s$

Scalar

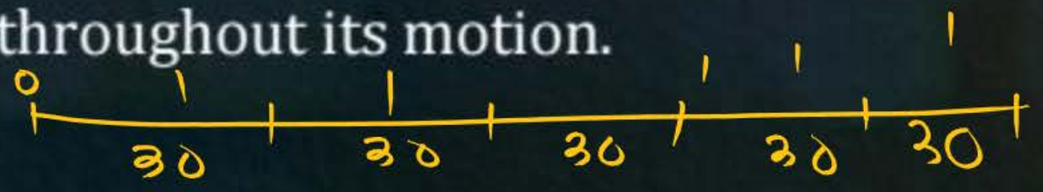
$t = 1\ H$

$d = 70\ km$

$S = \frac{d}{t} = \frac{70}{1} = 70\ km/hr$

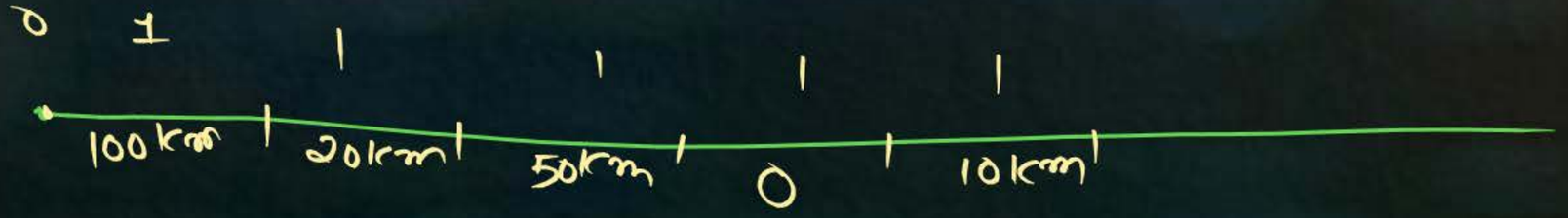
Uniform Speed

A body is said to be moving with uniform speed if it covers equal distances in equal intervals of time throughout its motion.



Non-uniform or Variable Speed

A body is said to be moving with non-uniform (or variable) speed if it covers unequal distance in equal intervals of time.



Instantaneous Speed

When the speed of a body keeps on changing, its speed at any instant is measured by finding the ratio of the distance travelled in a very short time interval to the time interval. This speed is called the instantaneous speed. Thus,

$$\textbf{Instantaneous speed} = \frac{\textbf{Distance travelled in a short time interval}}{\textbf{Time interval}}$$

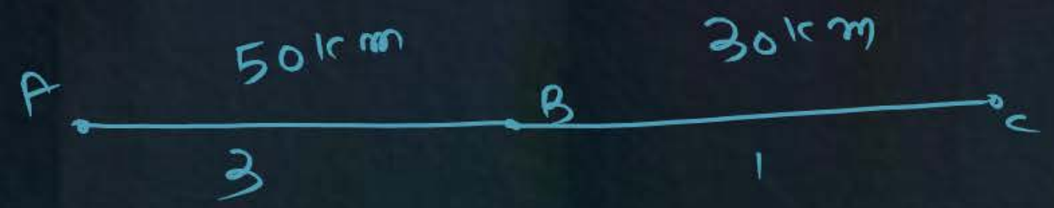
The speedometer of a vehicle measures the instantaneous speed.

Average Speed

The ratio of the total distance travelled by the body to the total time of journey is called its average speed. Thus,

$$\textbf{Average speed} = \frac{\textbf{Total distance travelled}}{\textbf{Total time taken}}$$

In case of a body moving with uniform speed, the instantaneous speed and the average speed are equal (same as the uniform speed).



$$S_{av} = \frac{50+30}{3+1} = \frac{80}{4} = 20 \text{ km/hr}$$


Thank You