

Chapter-1 Motion

Motion :-

A body said to be in motion when its position changes continuously with respect to a stationary object taken as reference point.

Ex:- When the position of a car changes continuously with respect to stationary object like houses, we can say that the car is in motion.

Rest :-

A body is said to be in motion rest when its position doesn't change continuously with respect to a stationary object taken as reference point.

Scalar Quantity :-

Those quantity has magnitude only it has no specified direction.

Ex:- Distance, speed, electric current, Compressor etc.

Vector Quantity :-

Those quantity has magnitude as well as a direction called Vector quantity.

(also follow vector triangular law).

Ex:- Displacement, velocity, acceleration etc.

Distance:-

The distance travelled by a body is the actual length of the path covered by a moving body irrespective of the direction in which the body travels. It is a scalar quantity. The distance travelled by a moving body cannot be zero & negative. The SI unit of distance is meter.

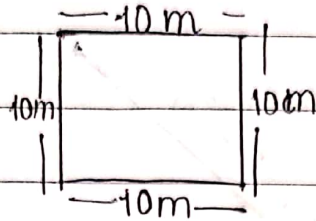
Displacement:-

When a body moves from one point to another the distance refers to the actual length of the indirect path whereas displacement refers to the straight line path between the initial & the final positions.

Or

When a body moves from one position to another the shortest distance between the initial position & the final position of the body along with direction is known as its displacement. Displacement is a vector quantity. It may be positive, negative or zero. The SI unit of displacement is m.

2 :- A farmer moves along the boundary of a square field of side 10m in 40 second. What will be the magnitude of the displacement of the farmer at the end of two minutes 20 seconds from his initial position.

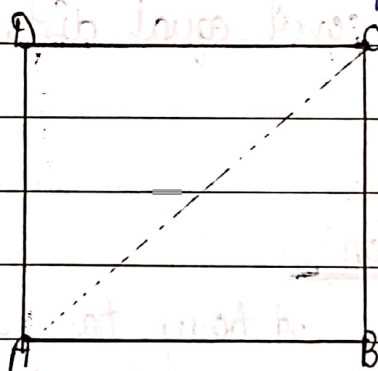


Total Time = 2 min = 120 seconds

120 + 20 = 140 seconds

In 40s, he made 1 round

In 140s, he made round = $\frac{1}{40} \times 140 = 3.5$ rounds



Distance = 3.5×40
140 m Ans.

If he starts moving from point A, then after 3.5 rounds he reach at point C.

Displacement :-

$$AC^2 = AB^2 + BC^2$$

$$AC^2 = 10^2 + 10^2$$

$$AC = \sqrt{200}$$

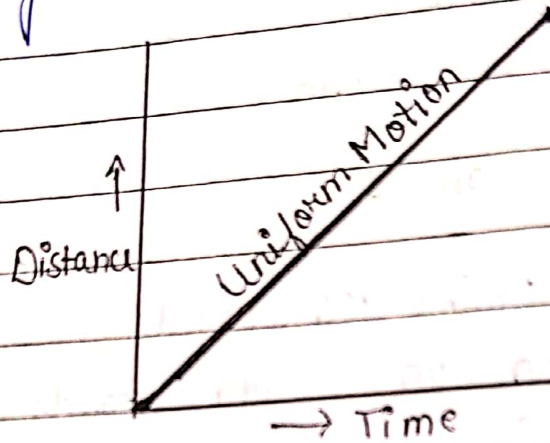
$$AC = 14.14 \text{ m Ans.}$$

$$14.143 \text{ m}$$

$$\begin{array}{r} 14.1 \\ 1 \overline{) 200} \\ \underline{+ 1} \\ 100 \\ \underline{+ 4} \\ 96 \\ \underline{+ 8} \\ 400 \\ \underline{+ 8} \\ 481 \end{array}$$

Uniform Motion:-

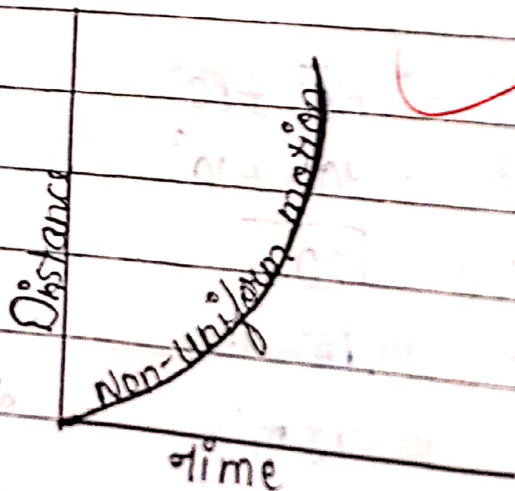
A body has a uniform motion if it travels equal distances in equal intervals of time. No matter how small these intervals may be.



Example:- A running car at a speed 10 m/s will cover equal distances of 10 m every second.

Non-Uniform Motion:-

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



Ex:- The motion of a freely falling body is an example of non-uniform motion.

Speed:- The rate of change in distance.

Speed of a body is the distance travelled by it per unit time.

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

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

Where V = speed, s = distance travelled and t = time taken.

Speed is a scalar quantity. speed is m/s. The speed of a running car at any distance of time is shown by an instrument called speedometer.

Ex:- Suppose a car travels a distance of 100 km in 4 hours. Then, the speed of this car is

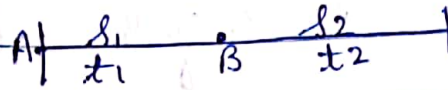
$$\frac{100}{4} = 25 \text{ km/h}$$

Average Speed:-

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

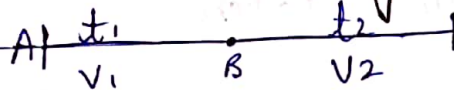
$$\text{Average Speed} = \frac{\text{Total distance}}{\text{Total time taken}}$$

[i] When distance & time is given :-



$$V_{av} = \frac{s_1 + s_2}{t_1 + t_2}$$

ii) When time & ^{speed} ~~velocity~~ is given :-



$$s_1 = v_1 t_1$$

$$s_2 = v_2 t_2$$

$$V_{av} = \frac{v_1 t_1 + v_2 t_2}{t_1 + t_2}$$

(i) (a) When time interval is same,

$$V_{av} = \frac{v_1 + v_2}{2}$$

iii) When distance & ^{speed} ~~velocity~~ given :-



$$t_1 = \frac{s_1}{v_1}, \quad t_2 = \frac{s_2}{v_2}$$

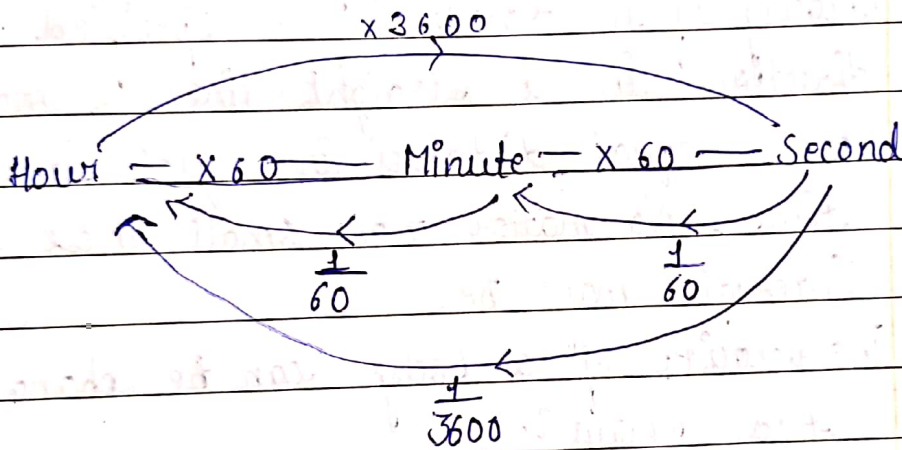
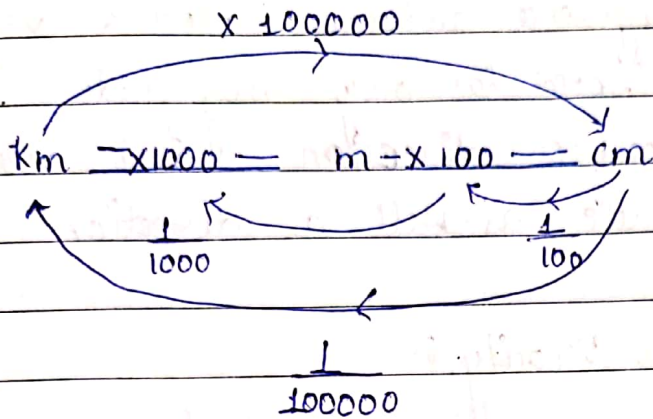
$$V_{av} = \frac{s_1 + s_2}{\frac{s_1}{v_1} + \frac{s_2}{v_2}}$$

V. Imp
(a)

when distance is same.

$$V_{av} = \frac{2V_1 V_2}{V_1 + V_2}$$

Note:-



Velocity:-

Velocity of a body is the distance travelled by it per unit time in a given direction.

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

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

The SI unit of velocity is m/s. It is a vector quantity. It may be positive, negative & zero.

The difference between speed & velocity is that speed has only magnitude it has no specific direction but velocity has magnitude as well as direction.

Uniform Velocity:-

A body has a uniform velocity if it travels in a specified direction in a straight line & moves over equal distances in equal intervals of time. No matter how small these time intervals may be.

The velocity of a body can be change in two ways:-

i) By changing the speed of the body &

ii) By keeping the speed constant but by changing the direction.

Note:-

The magnitude of speed & velocity of a moving body is equal only if the body moves in a single straight line. If however, a body doesn't move in a single straight line when the speed &

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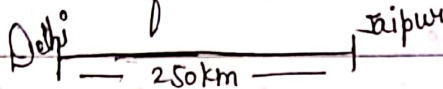
ii) By keeping the speed constant but by changing the direction.

:- The magnitude of speed & velocity of a moving body is equal only if the body moves in a single straight line. If however, a body doesn't move in a single straight line when the speed &

velocity of the body are not equal.

Q - A bus covers a distance of 250 km from Delhi to Jaipur toward west in 5 hours in the morning & returns to Delhi in the evening covering the same distance of 250 km in the same time. Find :-

a) average speed & b) average velocity of the bus for the whole journey.



$$\text{Average speed} = \frac{\text{total distance}}{\text{total time taken}}$$

$$\text{Avg speed} = \frac{250+250}{5+5} = \frac{500}{10} = 50 \text{ km/h} \underline{\text{Ans}}$$

$$\text{Average Velocity} = \frac{\text{Displacement}}{\text{total time taken}}$$

$$\text{Average Velocity} = \frac{0}{5+5} = \frac{0}{10} = 0 \text{ km/h} \underline{\text{Ans}}$$

Acceleration :-

Acceleration of a body is defined as the rate of change of its velocity with time.

Acceleration = $\frac{\text{Change in velocity}}{\text{Time taken for change}}$

$$= \frac{\text{Final velocity} - \text{Initial velocity}}{\text{Time taken}}$$

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

Acceleration is a vector quantity. The SI unit of acceleration is (m/s^2) (metre per second square).

When a body is moving with uniform velocity its acceleration will be zero.

If the velocity of a body increases the acceleration is positive & if the velocity of a body decreases the acceleration is negative. Negative value of acceleration is known as Retardation or Deceleration.

Uniform Acceleration :-

A body has a uniform acceleration if it travels in a straight line & its velocity

Increases by equal amount in equal intervals of time. The velocity ~~g~~ time graph of a body having uniformly accelerated motion is a straight line.

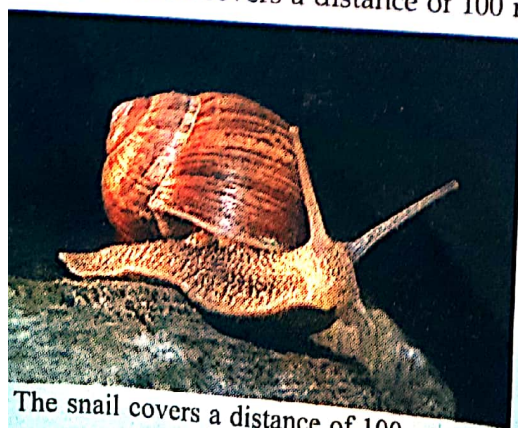
Very Short Answer Type Questions

1. Is displacement a scalar quantity ?
2. State whether distance is a scalar or a vector quantity.
3. Change the speed of 6 m/s into km/h.
4. What name is given to the speed in a specified direction ?
5. Give two examples of bodies having non-uniform motion.
6. Name the physical quantity obtained by dividing 'Distance travelled' by 'Time taken' to travel that distance
7. What do the following measure in a car ?
(a) Speedometer (b) Odometer

8. Name the physical quantity which gives us an idea of how slow or fast a body is moving.
9. Under what conditions can a body travel a certain distance and yet its resultant displacement be zero?
10. In addition to speed, what else should we know to predict the position of a moving body?
11. When is a body said to have uniform velocity?
12. Under which condition is the magnitude of average velocity equal to average speed?
13. Which of the two can be zero under certain conditions : average speed of a moving body or average velocity of a moving body?
14. Give one example of a situation in which a body has a certain average speed but its average velocity is zero.
15. What is the acceleration of a body moving with uniform velocity?
16. What is the other name of negative acceleration?
17. Name the physical quantity whose SI unit is :
(a) m/s (b) m/s²
18. What type of motion is exhibited by a freely falling body?
19. What is the SI unit of retardation?
20. Fill in the following blanks with suitable words :
(a) Displacement is a quantity whereas distance is a quantity.
(b) The physical quantity which gives both, the speed and direction of motion of a body is called its.....
(c) A motorcycle has a steady of 3 m/s². This means that every.....its.....increases by.....
(d) Velocity is the rate of change of It is measured in
(e) Acceleration is the rate of change of..... It is measured in

Short Answer Type Questions

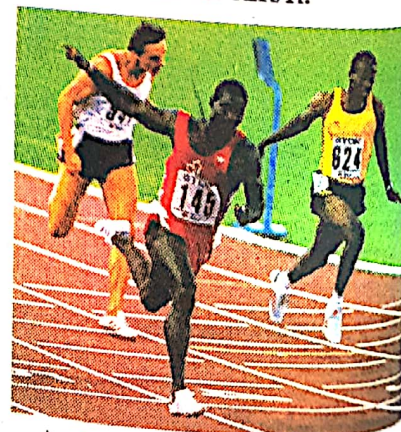
21. What type of motion, uniform or non-uniform, is exhibited by a freely falling body? Give reason for your answer.
22. State whether speed is a scalar or a vector quantity. Give reason for your choice.
23. Bus X travels a distance of 360 km in 5 hours whereas bus Y travels a distance of 476 km in 7 hours. Which bus travels faster?
24. Arrange the following speeds in increasing order (keeping the least speed first):
(i) An athlete running with a speed of 10 m/s.
(ii) A bicycle moving with a speed of 200 m/min.
(iii) A scooter moving with a speed of 30 km/h.
25. (a) Write the formula for acceleration. Give the meaning of each symbol which occurs in it.
(b) A train starting from Railway Station attains a speed of 21 m/s in one minute. Find its acceleration.
26. (a) What term is used to denote the change of velocity with time?
(b) Give one word which means the same as 'moving with a negative acceleration'.
(c) The displacement of a moving object in a given interval of time is zero. Would the distance travelled by the object also be zero? Give reason for your answer.
27. A snail covers a distance of 100 metres in 50 hours. Calculate the average speed of snail in km/h.



The snail covers a distance of 100 metres in 50 hours.



The tortoise covers the same distance of 100 metres in 15 minutes.



And this sprinter (in red vest) covers a distance of 100 metres in just 9.83 seconds.

28. A tortoise moves a distance of 100 metres in 15 minutes. What is the average speed of tortoise in km/h ?
29. If a sprinter runs a distance of 100 metres in 9.83 seconds, calculate his average speed in km/h.
30. A motorcyclist drives from place A to B with a uniform speed of 30 km h^{-1} and returns from place B to A with a uniform speed of 20 km h^{-1} . Find his average speed.
31. A motorcyclist starts from rest and reaches a speed of 6 m/s after travelling with uniform acceleration for 3 s. What is his acceleration ?
32. An aircraft travelling at 600 km/h accelerates steadily at $10 \text{ km/h per second}$. Taking the speed of sound as 1100 km/h at the aircraft's altitude, how long will it take to reach the 'sound barrier' ?
33. If a bus travelling at 20 m/s is subjected to a steady deceleration of 5 m/s^2 , how long will it take to come to rest ?

Long Answer Type Questions

34. (a) What is the difference between 'distance travelled' by a body and its 'displacement' ? Explain with the help of a diagram.
(b) An ant travels a distance of 8 cm from P to Q and then moves a distance of 6 cm at right angles to PQ. Find its resultant displacement.
35. Define motion. What do you understand by the terms 'uniform motion' and 'non-uniform motion' ? Explain with examples.
36. (a) Define speed. What is the SI unit of speed ?
(b) What is meant by (i) average speed, and (ii) uniform speed ?
37. (a) Define velocity. What is the SI unit of velocity ?
(b) What is the difference between speed and velocity ?
(c) Convert a speed of 54 km/h into m/s .
38. (a) What is meant by the term 'acceleration' ? State the SI unit of acceleration.
(b) Define the term 'uniform acceleration'. Give one example of a uniformly accelerated motion.
39. The distance between Delhi and Agra is 200 km. A train travels the first 100 km at a speed of 50 km/h . How fast must the train travel the next 100 km, so as to average 70 km/h for the whole journey ?
40. A train travels the first 15 km at a uniform speed of 30 km/h ; the next 75 km at a uniform speed of 50 km/h ; and the last 10 km at a uniform speed of 20 km/h . Calculate the average speed for the entire train journey.
41. A car is moving along a straight road at a steady speed. It travels 150 m in 5 seconds :
(a) What is its average speed ?
(b) How far does it travel in 1 second ?
(c) How far does it travel in 6 seconds ?
(d) How long does it take to travel 240 m ?

Multiple Choice Questions (MCQs)

42. A particle is moving in a circular path of radius r . The displacement after half a circle would be :
(a) 0 (b) πr (c) $2r$ (d) $2\pi r$
43. The numerical ratio of displacement to distance for a moving object is :
(a) always less than 1 (b) equal to 1 or more than 1
(c) always more than 1 (d) equal to 1 or less than 1
44. A boy is sitting on a merry-go-round which is moving with a constant speed of 10 m s^{-1} . This means that the boy is :
(a) at rest (b) moving with no acceleration
(c) in accelerated motion (d) moving with uniform velocity
45. In which of the following cases of motion, the distance moved and the magnitude of displacement are equal ?
(a) if the car is moving on straight road (b) if the car is moving on circular road
(c) if the pendulum is moving to and fro (d) if a planet is moving around the sun
46. The speed of a moving object is determined to be 0.06 m/s . This speed is equal to :
(a) 2.16 km/h (b) 1.08 km/h (c) 0.216 km/h (d) 0.0216 km/h

47. A freely falling object travels 4.9 m in 1st second, 14.7 m in 2nd second, 24.5 m in 3rd second, and so on. This data shows that the motion of a freely falling object is a case of :
 (a) uniform motion
 (b) uniform acceleration
 (c) no acceleration
 (d) uniform velocity
48. When a car runs on a circular track with a uniform speed, its velocity is said to be changing. This is because :
 (a) the car has a uniform acceleration
 (b) the direction of car varies continuously
 (c) the car travels unequal distances in equal time intervals
 (d) the car travels equal distances in unequal time intervals
49. Which of the following statement is correct regarding velocity and speed of a moving body ?
 (a) velocity of a moving body is always higher than its speed
 (b) speed of a moving body is always higher than its velocity
 (c) speed of a moving body is its velocity in a given direction
 (d) velocity of a moving body is its speed in a given direction
50. Which of the following can sometimes be 'zero' for a moving body ?
 (i) average velocity (ii) distance travelled (iii) average speed (iv) displacement
 (a) only (i) (b) (i) and (ii) (c) (i) and (iv) (d) only (iv)
51. When a car driver travelling at a speed of 10 m/s applies brakes and brings the car to rest in 20 s, the retardation will be :
 (a) $+ 2 \text{ m/s}^2$ (b) $- 2 \text{ m/s}^2$ (c) $- 0.5 \text{ m/s}^2$ (d) $+ 0.5 \text{ m/s}^2$
52. Which of the following could not be a unit of speed ?
 (a) km/h (b) s/m (c) m/s (d) mm s^{-1}
53. One of the following is not a vector quantity. This one is :
 (a) displacement (b) speed (c) acceleration (d) velocity
54. Which of the following could not be a unit of acceleration ?
 (a) km/s^2 (b) cm s^{-2} (c) km/s (d) m/s^2

Questions Based on High Order Thinking Skills (HOTS)

55. A body is moving along a circular path of radius R . What will be the distance travelled and displacement of the body when it completes half a revolution ?
56. If on a round trip you travel 6 km and then arrive back home :
 (a) What distance have you travelled ?
 (b) What is your final displacement ?
57. A body travels a distance of 3 km towards East, then 4 km towards North and finally 9 km towards East.
 (i) What is the total distance travelled ?
 (ii) What is the resultant displacement ?
58. A boy walks from his classroom to the bookshop along a straight corridor towards North. He covers a distance of 20 m in 25 seconds to reach the bookshop. After buying a book, he travels the same distance the same time to reach back in the classroom. Find (a) average speed, and (b) average velocity, of the boy.
59. A car travels 100 km at a speed of 60 km/h and returns with a speed of 40 km/h. Calculate the average speed for the whole journey.
60. A ball hits a wall horizontally at 6.0 m s^{-1} . It rebounds horizontally at 4.4 m s^{-1} . The ball is in contact with the wall for 0.040 s. What is the acceleration of the ball ?