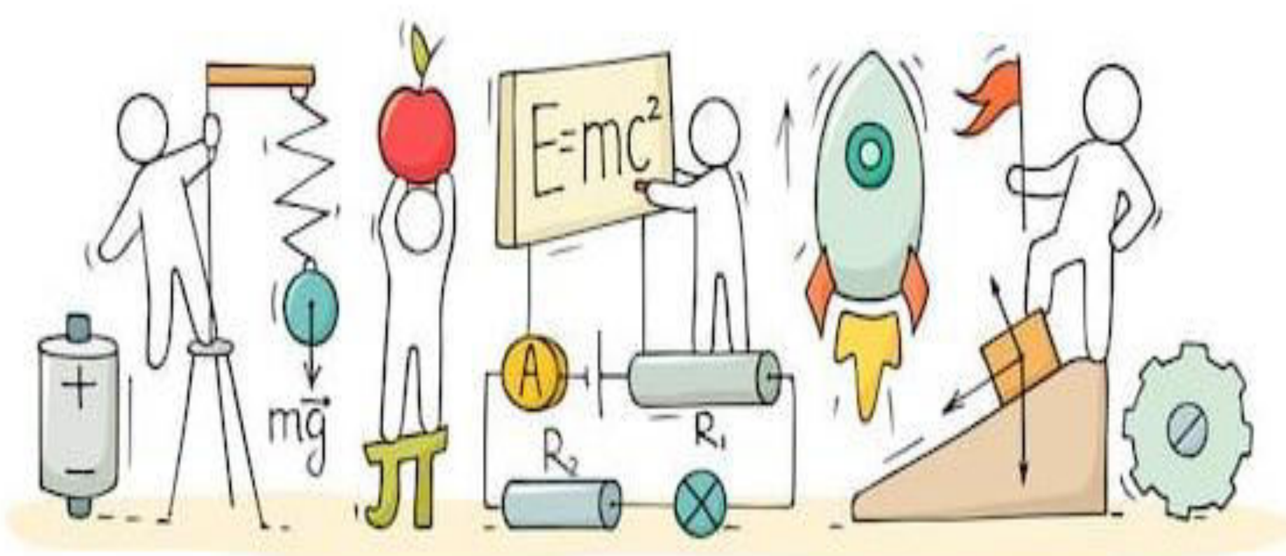
PHYSICS

Chapter 7: Motion



Motion

- To describe the position of an object we need a reference point or origin. An object may seem to be moving to one observer and stationary to another.
- Example: A passenger inside a bus sees the other passengers to be at rest, whereas an observer outside the bus sees the passengers to be in motion.
- In order to make observations easy, a convention or a common reference point or frame is needed. All objects must be in the same reference frame.

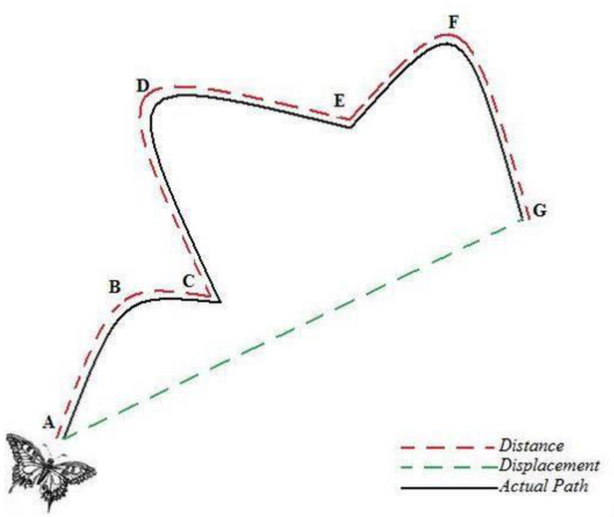
Rest and Motion

- If the position of an object does not change as time passes, then it is said to be at **rest**. If the position of an object changes as time passes, then it is said to be in **motion**.
- An object can be at rest with respect to one thing and in motion with respect to some other thing at the same time. So, the states of **rest and motion are relative** only.
- To locate the position of an object, we have to choose some suitable **reference point** called the

  origin.

Distance and Displacement

- The **distance** travelled by an object is the length of the actual path traversed by the object during motion. It is a **scalar** quantity.
- The **displacement** of an object in motion is the shortest distance between the initial position and the final position of the object. It is a **vector** quantity.



- The distance travelled by an object in motion can never be zero or negative.
- The displacement of an object can be positive, zero or negative. Never can the distance travelled be less than the displacement.
- Both distance and displacement have the same units.

Magnitude

- Magnitude is the size or extent of a physical quantity. In physics, we have scalar and vector quantities.
- Scalar quantities are only expressed as magnitude. E.g.: time, distance, mass, temperature, area, volume
- Vector quantities are expressed in magnitude as well as the direction of the object. E.g: Velocity, displacement, weight, momentum, force, acceleration, etc.

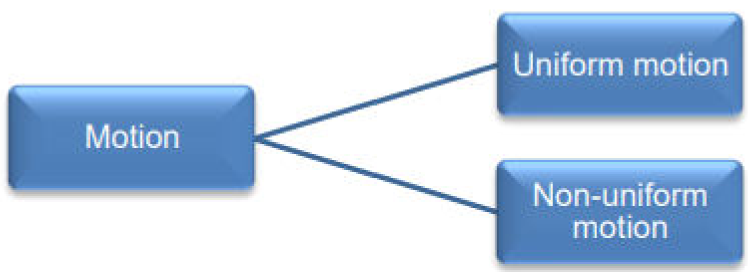
Time and speed

Time is the duration of an event that is expressed in seconds. Most physical phenomena occur with respect to time. It is a scalar quantity.

Speed is the rate of change of distance. If a body covers a certain distance in a certain amount of time, its speed is given by

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

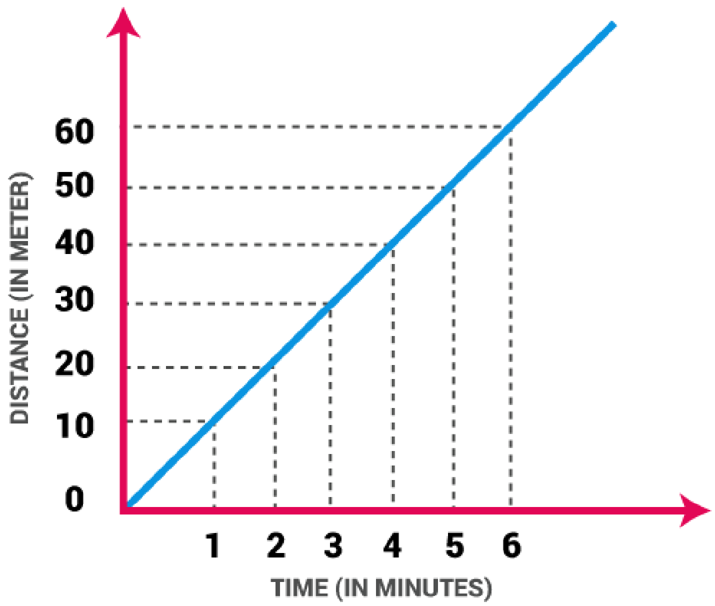
Uniform and Non-uniform Motion



- An object is said to be in **uniform motion** if it travels equal distances in equal intervals of time, howsoever small the intervals may be.
- An object is said to have **non-uniform motion** if it travels unequal distances in equal intervals of time.

Uniform Motion:

Definition: This type of motion is defined as the motion of an object in which the object travels in a straight line and its velocity remains constant along that line as it covers equal distances in equal intervals of time, irrespective of the duration of the time.



If a body is involved in rectilinear motion and the motion is consistent, then the acceleration of the body must be zero.

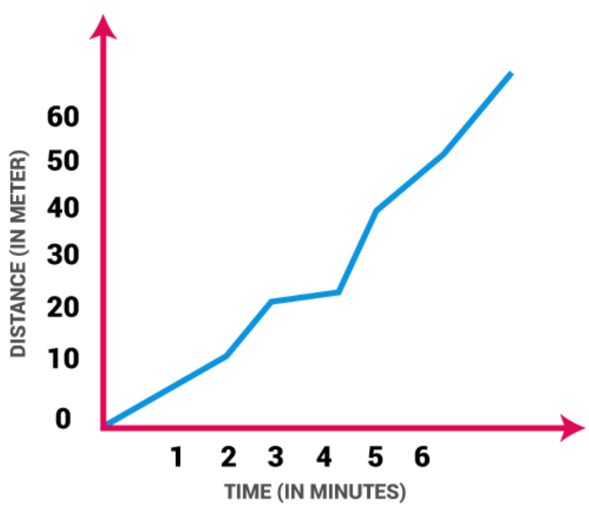
Example of Uniform Motion:

If the speed of a car is 10 m/s, it means that the car covers 10 meters in one second. The speed is constant in every second.

Movement of blades of a ceiling fan.

Non Uniform Motion:

Definition: This type of motion is defined as the motion of an object in which the object travels with varied speed and it does not cover same distance in equal time intervals, irrespective of the time interval duration.



Speed

Speed of a body is defined as the distance travelled by the body in unit time. The SI unit of speed is

metre/second (m/s

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

- If ‘s’ is the distance travelled by a body in time ‘t’, then its speed ‘v’ ’ is given as v = s\t
- Speed of a body is a scalar quantity. It can be zero or positive but can never be negative.
- If a body covers equal distances in equal time intervals, howsoever small the intervals may be, then it is said to have uniform speed (or constant speed).
- If a body covers unequal distances in equal time intervals, however small the intervals may be, then it is said to have non-uniform speed (or variable speed).
- For bodies moving with non-uniform speed, we describe the rate of motion in terms of their average speed.

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

Velocity

- **Velocity** of a body is defined as the distance travelled by the body in unit time in a given direction.
- The SI unit of velocity is the same as that of speed, i.e. metre/second (m/s).

$$\text{Velocity} = \frac{\text{Distance travelled in a given direction}}{\text{Time taken}}$$

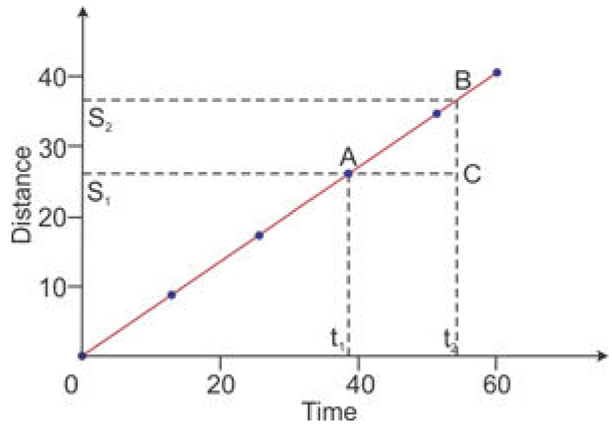
$$\text{or, Velocity} = \frac{\text{Displacement}}{\text{Time taken}}$$

$$\text{i.e. } \vec{v} = \frac{\vec{s}}{t}$$

where $\vec{v}$ is velocity and $\vec{s}$ is displacement of the body in time t.

- Velocity of a body is a **vector** quantity. It can be positive, negative or zero.
- A body is said to be moving with **uniform velocity** (or **constant velocity**) if it travels along a straight line, covering equal distances in equal intervals of time, howsoever small these intervals maybe.
- A body is said to be moving with **non-uniform velocity** (or **variable velocity**) if it covers unequal distances in a particular direction in equal intervals of time or if the direction of motion of the body changes.
- When the velocity of a body is changing at a uniform rate over a period of time, the **average velocity**

  for that time period is given by the arithmetic mean of the initial and final velocity of the body.



$$\text{Average velocity} = \frac{\text{Initial velocity + Final velocity}}{2}$$

or $$\vec{v}_{av} = \frac{u + v}{2}$$

where 'u' is initial velocity, 'v' is final velocity and $\vec{v}_{av}$ is average velocity.

Acceleration

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

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

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

where 'u' is initial velocity, 'v' is final velocity, 'a' is acceleration of the body and 't' is time taken for change in velocity.

- Acceleration is a **vector** quantity. It can be positive, negative or zero. The SI unit of acceleration is metre per second square (m/s^2).
- If the velocity of a body increases, then the acceleration is positive. If the velocity of a body decreases, then the acceleration is negative. **Negative acceleration** is called **retardation**.
- If acceleration occurs in the direction of velocity, then it is taken as positive and negative when it is opposite to the direction of velocity.
- A body is said to possess **uniform acceleration** if it travels in a straight line and its velocity increases or decreases by equal amounts in equal intervals of time.
- A body is said to possess **non-uniform acceleration** if its velocity changes by unequal amounts in equal intervals of time.

Distance–Time Graph

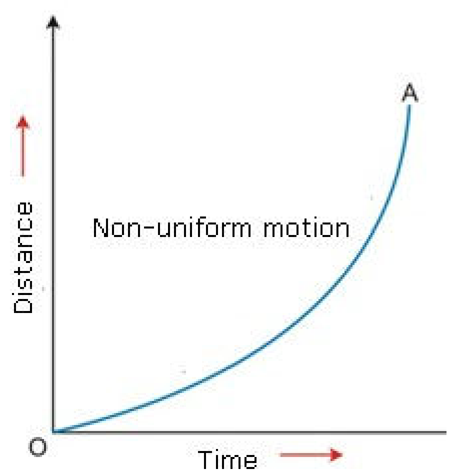
- Distance-Time graphs show the change in position of an object with respect to time.

- Linear variation = uniform motion and non-linear variations imply non- uniform motion
- The slope gives us speed
- The distance–time graph of a body moving with uniform speed is a straight line.
- Speed of a body can be obtained from the slope of the distance–time graph.
- Let s_1 and s_2 be the distance travelled by the object in time t_1 and t_2, respectively. Here $(s_2 - s_1)$ gives the distance travelled by the body in time interval $(t_2 - t_1)$.

  Speed

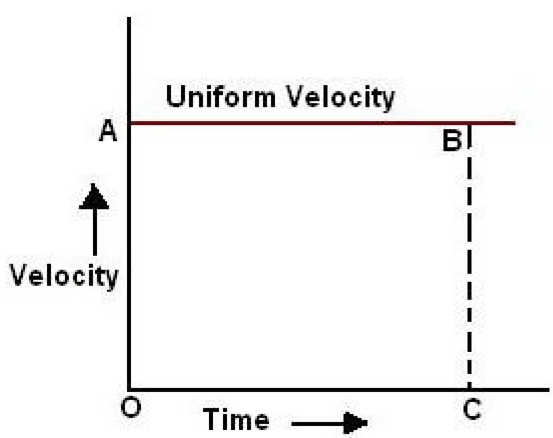
  $$v = \frac{s_2 - s_1}{t_2 - t_1}$$

- The distance–time graph of a body moving with non-uniform speed is a curved line with a variable slope indicating variable speed.



Velocity–Time Graph

- The velocity–time graph of a body moving with uniform velocity is a straight line parallel to the time axis.



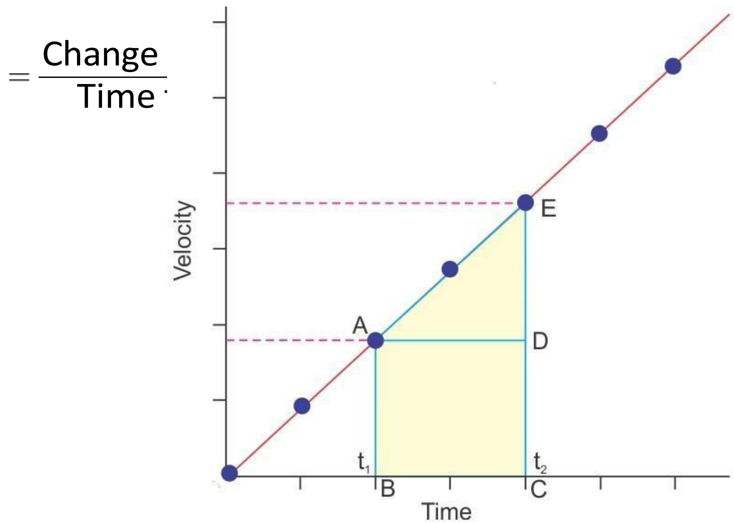
- The magnitude of displacement or distance travelled by the body is equal to the area enclosed by the velocity–time graph and time axis.

  Distance travelled = Speed × Time taken

= OA × OC

= Area of rectangle OABC

- The velocity–time graph of a body moving with uniform acceleration is a straight line inclined to the time axis.



- The slope of the velocity–time graph represents the acceleration of the body.

$$\text{Acceleration} = \frac{\text{Change in speed}}{\text{Time taken}} = \frac{ED}{AD}$$

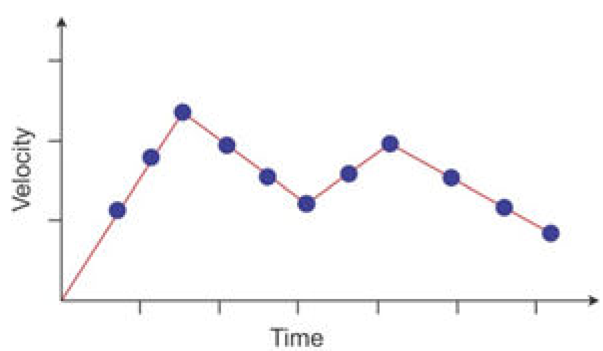
The area enclosed by the velocity–time graph and time axis gives the distance travelled by the body.

Distance travelled = Area of ABCDE

= Area of triangle ADE+ Area of rectangle ABCD

$$= \frac{1}{2} \times AD \times DE + AB \times BC$$

- The velocity–time graph of a body moving with non-uniform acceleration can have any shape, indicating variable speed.



Application Of Distance - Time Graph

What is a Distance-Time Graph

A distance-time graph shows how far an object has travelled in a given time. It is a simple line graph that denotes distance versus time findings on the graph.

Distance is plotted on the Y-axis.

Time is plotted on the X-axis.

Note: Curved lines on a distance-time graph indicate that the speed is changing.

Importance of Distance-Time Graph

We deal with the distance-time graph while studying the motion of bodies. If we record distance and time for the motion of a body and plot the same data on a rectangular graph, we will obtain a distance-time graph corresponding to the motion of that body.

Example:

For better understanding, let us consider an example of uniform motion. A bus driver drives at a constant speed which is indicated by the speedometer and the driver measures the time taken by the bus for every kilometre. The driver notices that the bus travels 1 kilometre in every 2 minutes.

DISTANCE (IN KM)	1	2	3	4	5	6	7
TIME (IN MIN)	2	4	6	8	10	12	14

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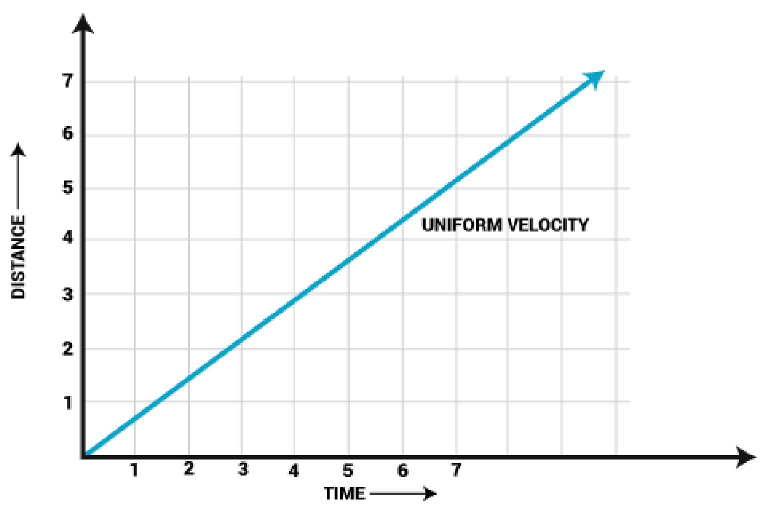
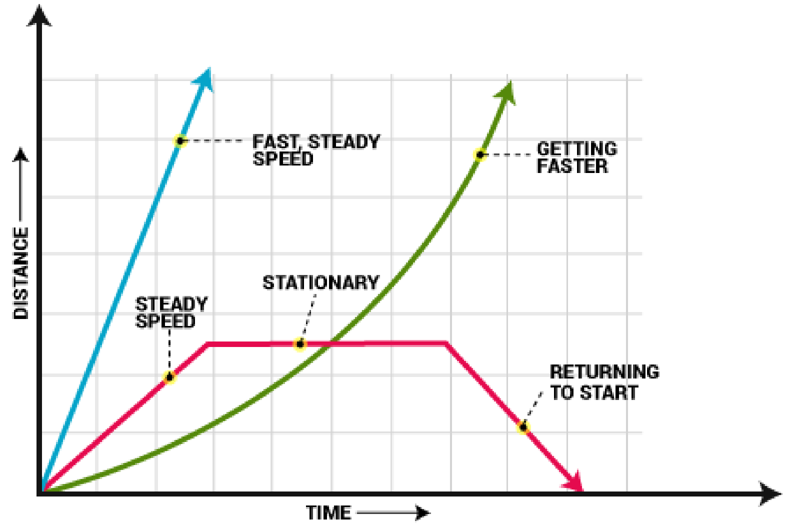


By this table, he had a clear idea about the speed which is: ½ × 60 = 30 km/hr.

The graph is a straight line and the motion of the bus is also uniform. Also, from the graph, we can find the speed of the bus at any instant of time. The initial and final position of the car can be found as the following:

Speed = (Final Position-Initial position)/Time

The slope of the line can be found by drawing a rectangle anywhere near the straight line which determines the speed of the bus. If an object is not moving, the distance-time graph results in a horizontal line which shows that the object is at rest.



The following things can be concluded now:

If the distance-time graph is a straight line then the motion is uniform.

If the distance-time graph of anybody is given, its speed can be calculated using the slope of the graph.

The slope of the straight-line graph is the same irrespective of the interval which is chosen. This implies that the speed of an object under uniform motion remains constant.

Equations of Motion

- The three equations of motion of a body moving along a straight line with uniform acceleration are

$$v = u + at$$

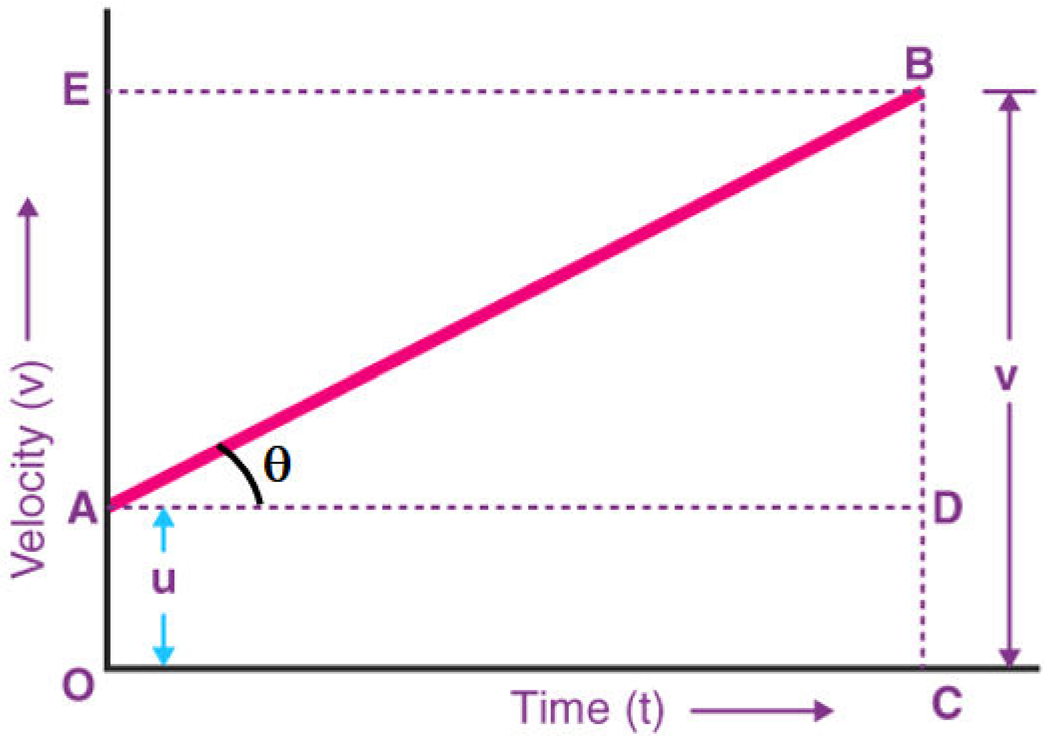
$$s = ut + (1/2)\,at^2$$

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

where 'u' is initial velocity of the body which moves with uniform acceleration 'a' for time t, 'v' is final velocity and 's' is distance travelled by the body in time t.

Equation of motion

In this article, we will learn how we can relate quantities like velocity, time, acceleration and displacement provided the acceleration remains constant. These relations are collectively known as the equation of motion. There are three equations of motion. There are three ways to derive the equation of motion and here we are going to derive with the help of graph.



First Equation of Motion

First equation of motion relates velocity, time and acceleration. Now in Δuxy,

tanθ = $\frac{xy}{uy}$

tanθ = $\frac{v-u}{t}$

We also know that tanθ is nothing but the slope and slope of v – t graph represents acceleration.

⇒ v = u + at ———– (1)

This is the first equation of motion where,

v = final velocity

u = initial velocity

a = acceleration

t = time taken

Second Equation of Motion

Now coming to the second equation of motion, it relates displacement, velocity, acceleration and time. The area under v – t graph represents the displacement of the body.

In this case,

Displacement = Area of the trapezium (ouxt)

S = $\frac{1}{2}$

x sum of parallel sides x height

S = $\frac{1}{2}$

x (v + u) x t ———- (2)

We can substitute v in terms of others and get the final equation as:

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

Where symbols have their usual meaning.

Third Equation of Motion

The third equation of motion relates to velocity, displacement, and acceleration. Using the same equation (2),

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

Using equation (1) if we replace t we get,

S = $\frac{1}{2} \times (v + u) \times \frac{(v-u)}{a}$ S = $\frac{v^2-u^2}{2a}$ $u^2 = u^2 + 2as$

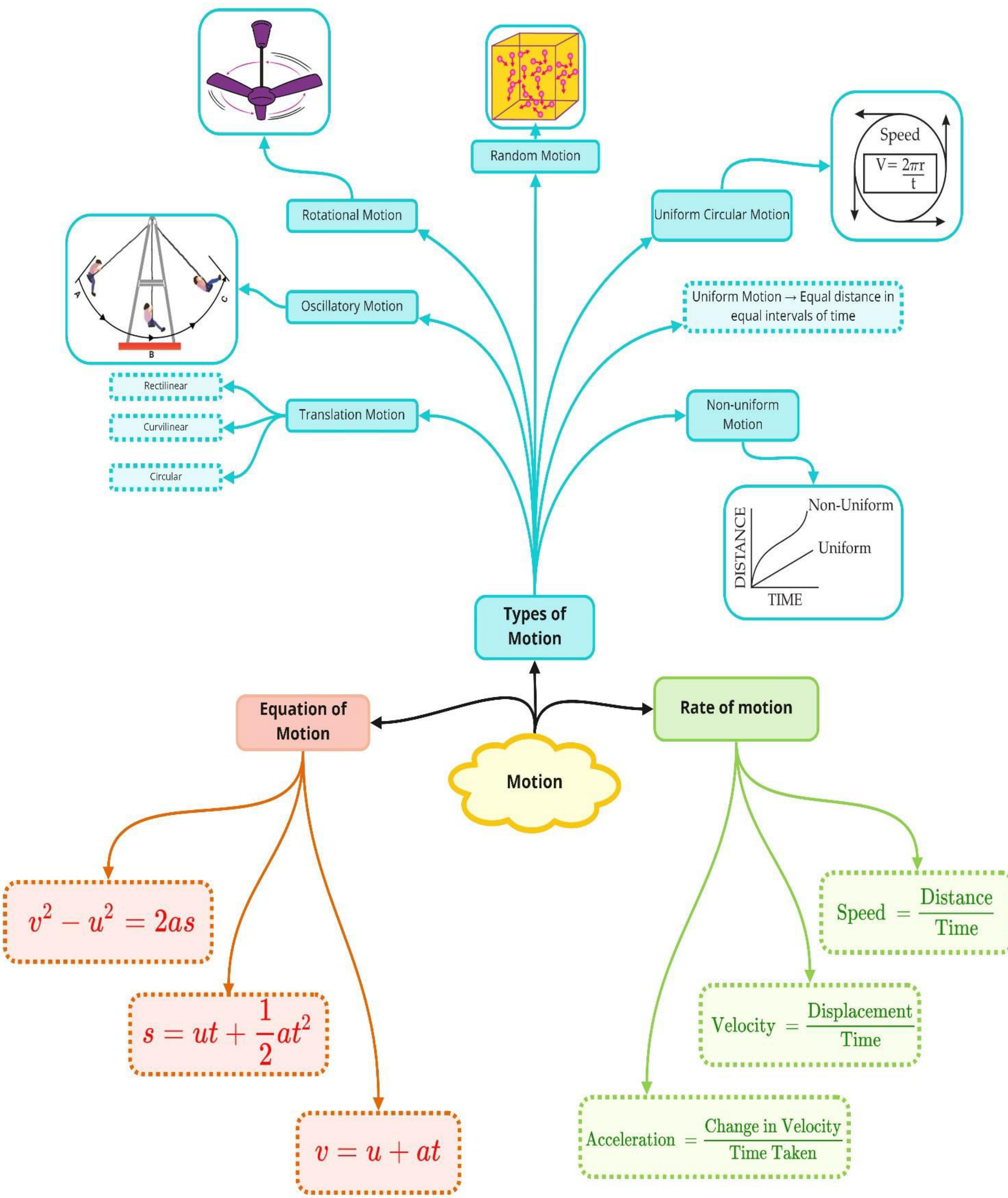
Uniform Circular Motion

- When a body moves along a circular path with a uniform speed, its motion is called uniform circular motion.
- Examples: Motion of the Moon around the Earth, a cyclist moving in a circular track at constant speed
- In uniform circular motion, although the speed remains constant, the direction of motion and velocity change continuously. Thus, uniform circular motion is an accelerated motion.
- The external force needed to make a body travel in a circular path is known as centripetal force.
- The circumference of a circle of radius ‘r’ is given by 2πr. If a body takes ‘t’ seconds to go once

round the circular path of radius ‘r’, then its velocity ‘v’ is given by $\frac{2\pi r}{t}$

Shiksha CLASSES

Class : 9th Science
Chapter- 8 : Motion



Important Questions

➢ Multiple Choice Questions:

1. A particle is moving in a circular path of radius r. The displacement after half a circle would be:

(a) Zero

(b) πr

(c) 2r

(d) 2πr

2. A body is thrown vertically upward with velocity u, the greatest height h to which it will rise is,

(a) ulg

(b) u^2l2g

(c) u^2lg

(d) ul2g

3. The numerical ratio of displacement to distance for a moving object is

(a) always less than 1

(b) always equal to 1

(c) always more than 1

(d) equal or less than 1

4. If the displacement of an object is proportional to square of time, then the object moves with

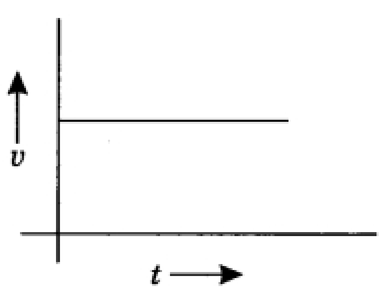
(a) uniform velocity

(b) uniform acceleration

(c) increasing acceleration

(d) decreasing acceleration

5. From the given υ – t graph, it can be inferred that the object is



(a) in uniform motion

(b) at rest

(c) in non-uniform motion

(d) moving with uniform acceleration

6. Suppose a boy is enjoying a ride on a merry-go-round which is moving with a constant speed of 10 ms^{-1} It implies that the boy is

(a) at rest

(b) moving with no acceleration

(c) in accelerated motion

(d) moving with uniform velocity

7. Area under a υ -1 graph represents a physical quantity which has the unit

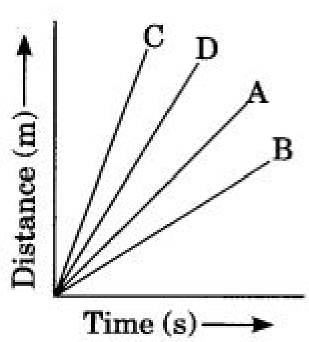
(a) m^2

(b) m

(c) m3

(d) ms^{-1}

8. Four cars A, B, C and D are moving on a levelled road. Their distance versus time graphs are shown in the adjacent figure. Choose the correct statement.



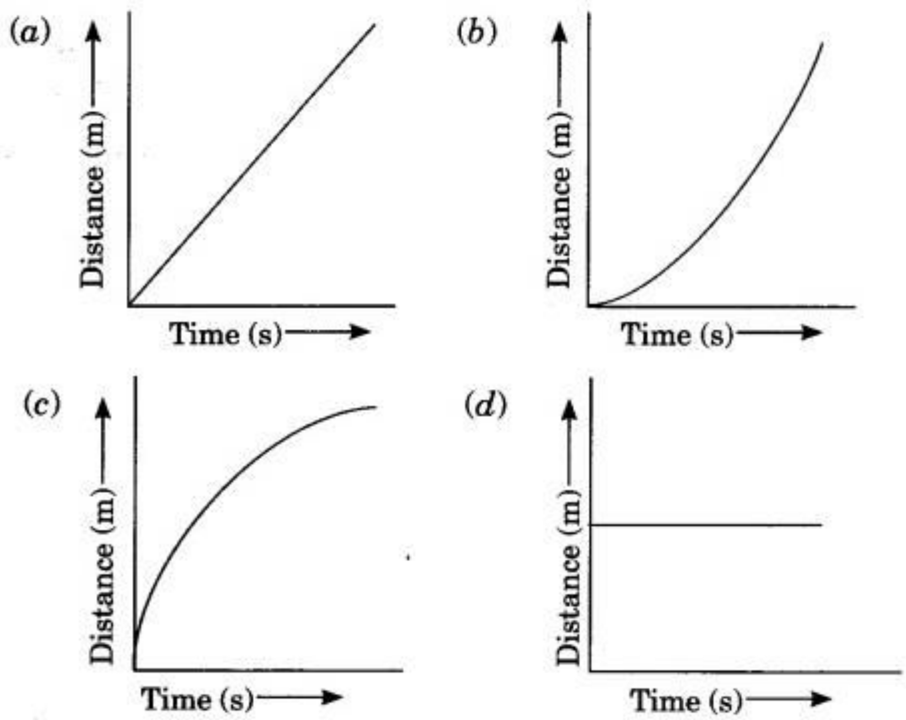
(a) Car A is faster than car D.

(b) Car B is the slowest.

(c) Car D is faster than car C.

(d) Car C is the slowest.

9. Which of the following figures correctly represents uniform motion of a moving object?



10. Slope of a velocity-time graph gives

(a) the distance

(b) the displacement

(c) the acceleration

(d) the speed

11. In which of the following cases of motions, the distance moved and the magnitude of displacement are equal?

(a) If the car is moving on a straight road

(b) If the car is moving in Circular path

(c) The pendulum is moving to and from

(d) The earth is revolving around the sun.

12. A boy goes from A to B with a velocity of 20 m/min and comes back from B to A with a velocity of 30 m/min. The average velocity of the boy during the whole journey is

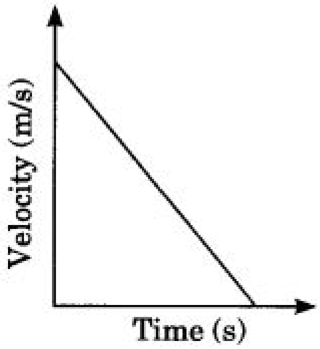
(a) 24 m/min

(b) 25 m/s

(c) Zero

(d) 20 m/min

13. Velocity-time graph of an object is given below. The object has



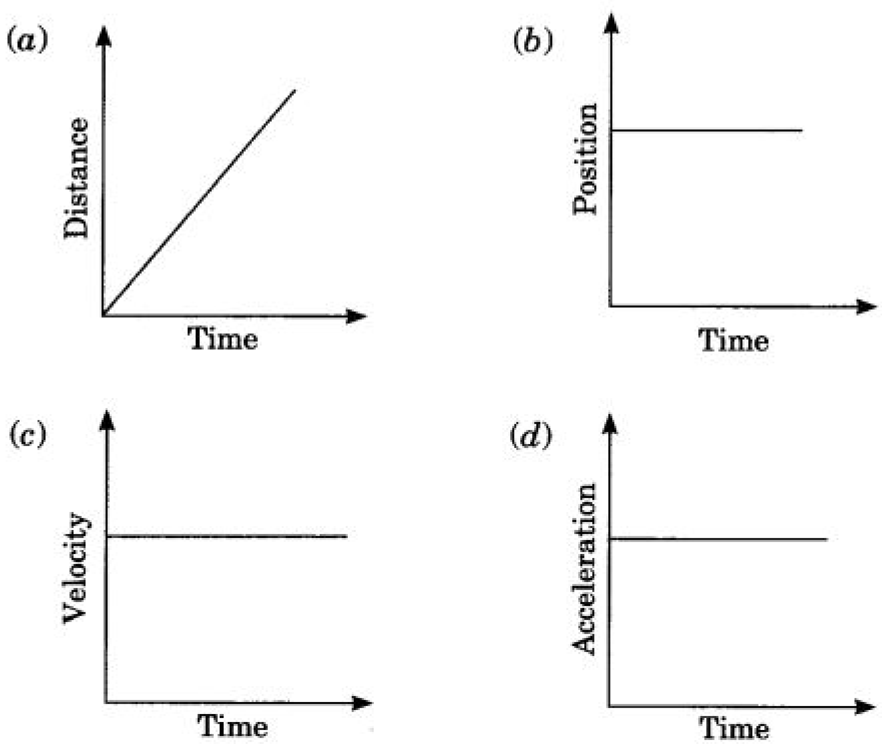
(a) Uniform velocity

(b) Uniform speed

(c) Uniform retardation

(d) Variable acceleration

14. Which one of the following graphs shows the object to be stationary?



15. A body is projected vertically upward from the ground. Taking vertical upward direction as positive and point of projection as origin, the sign of displacement of the body from the origin when it is at height h during upward and downward journey will be

(a) Positive, positive

(b) Positive, negative

(c) Negative, negative

(d) Negative, positive

➢ Very Short Question:

1. An object has moved through a distance. Can it have zero displacement? If yes, support your answer with an example.

2. What do you mean by a body in rest?

3. Are motion and rest absolute or relative? Explain with an example.

4. What is meant by scalars and vectors?

5. A farmer moves along the boundary of a square field of side 10 m in 40 s. What will be the magnitude of displacement of the farmer at the end of 2 minutes 20 seconds?

6.Which of the following is true for displacement?

(a) It cannot be zero.

(b) Its magnitude is greater than the distance travelled by the object.

7. What does the odometer of an automobile measure?

8. Distinguish between speed and velocity.

9. Under what condition(s) is the magnitude of average velocity of an object equal to its average speed?

10. What does the path of an object look like when it is in uniform motion?

➢ Short Questions:

1. Distinguish between distance and displacement.

2. Write down the SI unit of the following quantities:

(a) Displacement

(b) Speed

(c) Velocity

(d) Acceleration

3. Distinguish between uniform motion and non-uniform motion.

4. Distinguish speed at any instant and average speed.

5. Draw a velocity versus time graph of a stone thrown vertically upwards and then coming downwards after attaining the maximum height.

6. What is uniform circular motion? How is uniform circular motion regarded as an acceleration motion? Explain.

7. A person travels a distance of 4.0 m towards the east, then turns left and travels 3.0 m towards the north.

8. A person travels on a semi-circular track of radius 50 m during a morning walk. If he

starts from one end of the track and reaches the other end, calculates the distance traveled and displacement of the person.

➢ Long Questions:

1. Derive an expression for three equations of motion for uniform accelerated motion graphically.

➢ Assertion Reason Questions:

1. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: An object may acquire acceleration even if it is moving at a constant speed.

   Reason: With change in the direction of motion, an object can acquire acceleration.
2. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both Assertion and Reason are correct, and reason is the correct explanation for assertion.
   b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.
   c. Assertion is true but Reason is false.
   d. Both Assertion and Reason are false.

   Assertion: Displacement of an object may be zero even if the distance covered by it is not zero.

   Reason: Displacement is the shortest distance between the initial and final position.

➢ Case Study Based Question:

1. Read the following and answer any four questions from (i) to (v)

   One day Rahul decided to go his office by his car. He is enjoying the driving along with listening the old songs. His car is moving along a straight road at a steady speed. On a particular moment, he notices that the car travels 150 m in 5 seconds.

(i) What is its average speed?

(a) 20 m/s

(b) 30 m/s

(c) 10 m/s

(d) 40 m/s

(ii) How far does it travel in 1 second?

(a) 20 m

(b) 30 m

(c) 10 m

(d) 40 m

(iii) How far does it travel in 6 seconds?

(a) 120 m

(b) 130 m

(c) 180 m

(d) 140 m

(iv) How long does it take to travel 240 m?

(a) 2s

(b) 4s

(c) 6s

(d) 8s

(v) 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

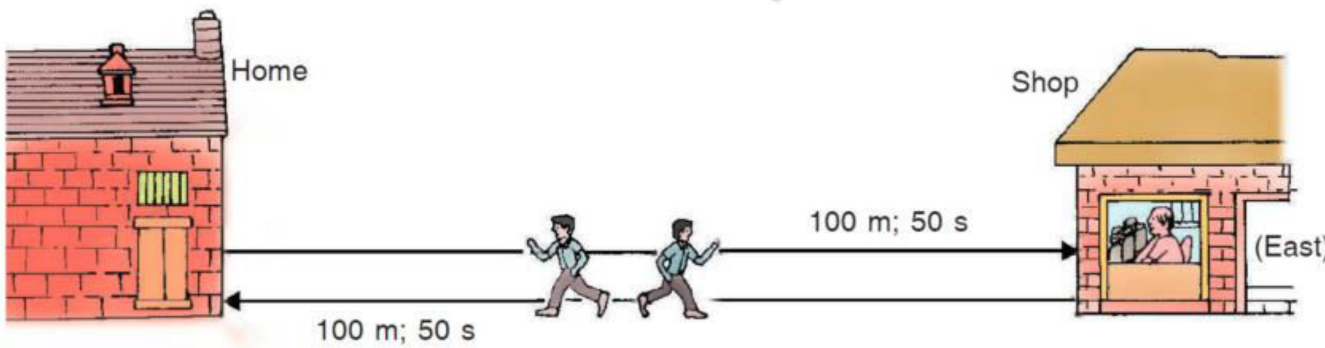
(b) speed of a moving body is always higher than its velocity

(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

2. Read the following and answer any four questions from (i) to (v)

Suppose the boy first runs a distance of 100 metres in 50 seconds in going from his home to the shop in the East direction, and then runs a distance of 100 metres again in 50 seconds in the reverse direction from the shop to reach back home from where he started (see Figure 21).



(i) Find the speed of the boy.

(a) 1 m/s

(b) 2 m/s

(c) 3 m/s

(d) none of these

(ii) Find the Velocity of the boy.

(a) 1 m/s

(b) 2 m/s

(c) 3 m/s

(d) 0 m/s

(iii) A boy is sitting on a merry-go-round which is moving with a constant speed of 10m/s. This means that the boy is:

(a) at rest

(b) moving with no acceleration

(c) in accelerated motion

(d) moving with uniform velocity

(iv) 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 from

(d) if a planet is moving around the sun

(v) 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) 2πr

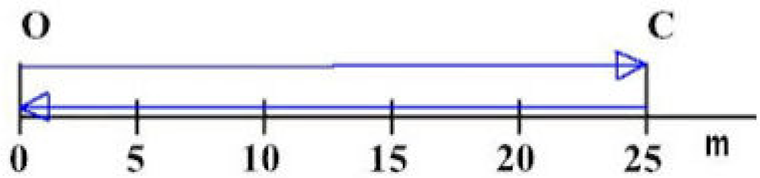
✓ Answer Key-

➢ Multiple Choice Answers:

1. (c) 2r
2. (b) u^2l2g
3. (d) equal or less than 1
4. (b) uniform acceleration
5. (a) in uniform motion
6. (c) in accelerated motion
7. (b) m
8. (b) Car B is the slowest.
9. (a)
10. (c) the acceleration
11. (a) If the car is moving on a straight road
12. (a) 24 m/min
13. (c) Uniform retardation
14. (b)
15. (a) Positive, positive

➢ Very Short Answers:

1. Answer: Yes an object can have zero displacement even though it has moved through a distance. It happens when the object moves back to its original position i.e. final position coincides with the starting position.



Example: Suppose an object travels from O to C and then comes back to original position O.

Total distance traveled = actual path covered = OC + CO = 25 + 25 = 50m

Total displacement = shortest distance between final position and initial position = 0m

2. Answer: A body is said to be at rest, if it does not change its position with respect to a fixed point in its surroundings.
3. Answer: No these terms rest and motion are relative. For example, a person inside a car, carrying a ball in his hand will see the ball is at rest. While for another person, outside the car will see the ball is also moving.
4. Answer:

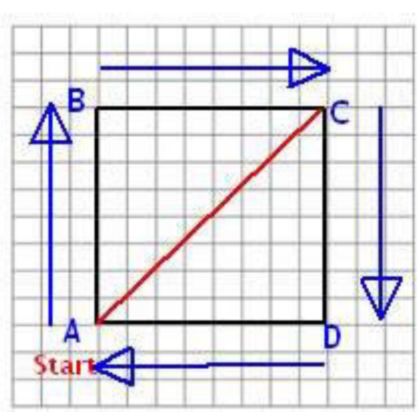
   Scalar Quantities: Quantities that require magnitudes only to specify them are called scalar quantities or scalars. Mass, length, time, temperature, angle, area, speed, distance, volume and density are examples of scalar quantities.

   Vector Quantities: Quantities that require both magnitudes and direction to specify them are called vector quantities or vectors. Displacement, velocity, force, momentum, weight etc. are the examples of vectors.

5. Answer: As shown in figure, let us assume, the farmer starts from A.

   Given, length of each side = 10m

   Distance covered in 1 lap = Perimeter of ABCD = 4 x 10 = 40m



   Time taken by farmer to cover 1 lap = 40s

   Speed of farmer = Distance ÷ Time Taken for one lap = 40/40s = 1m/s

   Distance covered by farmer in 2min 20 secs = Speed x Time = 1 x 140s = 140m

   Number of laps covered = 140 ÷ 40 = 3.5 laps.

⇒ After 140s, the farmer will be at position C (i.e. 3 and ½ laps).

Displacement = AC = (AB2 + BC2)½

(applying Pythagoras theorem)

= (100+100)½ = 10√2 = 10 x 1.414 = 14.14m

Note: Displacement is a vector quantity that measures the shortest distance (straight line) between the starting point and ending point, not taking the actual path traveled into account.

6. Answer:

(a) False. Displacement can be zero. (See Q1).

(b) False. Displacement is less than or equal to the distance travelled by the object.

7. Answer: Odometer is used to measure the distance covered by the automobile. It also tells the instant speed of the vehicle. It can be mechanical or electronic or electro-mechanical.

8. Answer:

Speed	Velocity
It is distance traveled by an object per unit time.	It is the displacement covered by an object per unit of time.
Speed = distance ÷ time	Velocity = displacement ÷ time
It is scalar quantity i.e. it has magnitude only.	It is vector quantity i.e. has both magnitude and direction.

9. Answer: When a body is in rectilinear motion i.e. moves in straight line, the magnitude of average velocity of an object is equal to its average speed.

10. Answer: When an object is in uniform motion, it means its speed is constant. Or it travels equal distance in equal intervals of time. The path may be a straight line or curved or zig-zag. Its direction may also vary but the magnitude is fixed.

➢ Short Answers:

1. Answer:

Distance:

- It is the actual length of the path covered by a moving body.
- It is always positive or zero.
- It is a scalar quantity.

Displacement:

- It is the shortest distance measured between the initial and final positions.

- It may be positive, negative, or zero.
- it is a vector quantity.

2. Answer:

   (a) m

   (b) m/s

   (c) m/s

   (d) m/s^2

3. Answer:

   Uniform motion: A body moving in a straight line has a uniform motion if it travels the equal distance in equal intervals of time

   Non-uniform motion: A body has a non-uniform motion if it travels the unequal distance in equal intervals of time

4. Answer:

   1. Instantaneous speed:

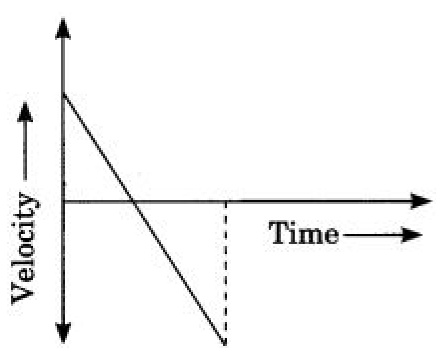
   The speed at any particular instant is known as instantaneous speed.

   2. Average speed:

   Average speed is the ratio of total distance traveled by a body and time taken to travel that distance.

5. Answer:

   velocity-time graph



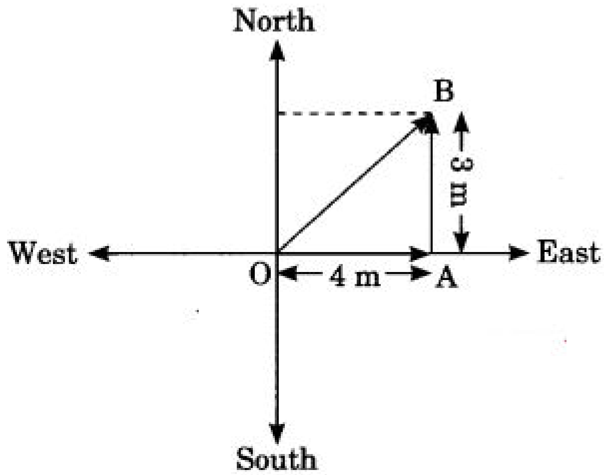
6. Answer: When an object is moving in a circular path with a constant speed, the motion of an object is said to be uniform circular motion. When a body has a uniform circular motion, its velocity changes due to the continuous change in the direction of its motion. Hence, the motion of the body is accelerated motion.

7. Answer:

   1. Total distance = OA + AB

   = 4m + 3m

Total distance = 7m



2. Total displacement = OB = $\sqrt{(OA)^2 + (AB)^2}$

= $\sqrt{(4)^2 + (3)^2}$ = $\sqrt{25}$ = 5

Displacement = 5 m

8. Answer:

Let the person start moving from A and reach B via O.

The distance travelled by the person

= Length of track = πr

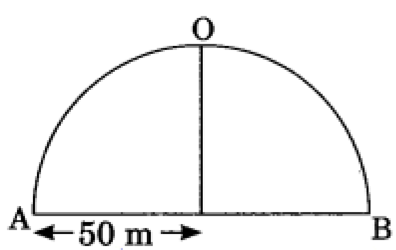
= 227 x 50 m = 157.14m

Distance = 157.14 m

The displacement is equal to the diameter of the semi-circular track joining A to B via O.

= 2r = 2 x 50 m = 100m

∴ Displacement = 100 m

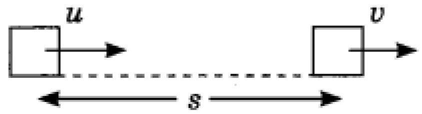


➢ Long Answers:

1. Answer:

Equation of motion by graphical method

Let us consider a body is moving with acceleration where u is initial velocity and u is final velocity, s is the displacement of object and t is a time interval.



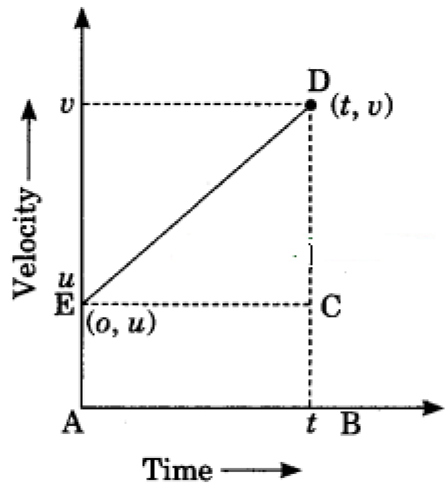
1. $\upsilon = u + at$

We know that slope of $\upsilon - t$ graph gives acceleration so slope

$= a = \frac{v-u}{t-0}$

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

$\therefore \upsilon = u + at$



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

We know that area under $u - t$ graph gives the displacement.

Area = s = area of triangle CDE + area of rectangle ABCE

$s = ut + \frac{1}{2} \times t \times (\upsilon - u)$ from $(\upsilon - u = at)$

Putting the value of $\upsilon - u$

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

3. $\upsilon^2 - u^2 = 2as$

We know that area under $\upsilon - t$ graph gives displacement

Area = s = area of trapezium ABDE

$s = \frac{1}{2} \times (\upsilon + u) \times t$ From I $(t = \frac{v-u}{a})$

Putting the value of t.

$\upsilon^2 - u^2 = 2as$

➢ Assertion Reason Answer:

1. (a) Both Assertion and Reason are correct, and reason is the correct explanation for assertion.
2. (a) Both Assertion and Reason are correct, and reason is the correct explanation for

assertion.

➢ Case Study Answer:

1. Answer:

(i) (b) 30 m/s

Solution:

Average speed = total distance travelled/total time taken

= 150/5

= 30 m/s

(ii) (b) 30 m

Solution:

Time = 1 s

Distance = (average speed)(time)

= 30 m/s x 1s

= 30 m

(iii) (c) 180 m

Solution:

Time = 6 s

Distance = (average speed)(time)

= 30 m/s x 6s

= 180m

(iv) (d) 8s

Solution:

Distance = 240m

Time = Distance/average speed

= 240/30

= 8s

(v) (d) velocity of a moving body is its speed in a given direction.

2. Answer:

(i) (b) 2 m/s

Solution:

Total distance travelled is 100 m + 100 m = 200 m and the total time taken is 50 s + 50 s = 100 s.

$$\text{Speed of boy} = \frac{\text{Distance travelled}}{\text{Time taken}} = \frac{200 \text{ m}}{100 \text{ s}} = 2 \text{ m/s}$$

(ii) (d) 0 m/s

Solution:

The boy runs 100 m towards East and then 100 m towards West and reaches at the starting point, his home. So, the displacement will be 100 m – 100 m = 0 m.

The total time taken is 50 s + 50 s = 100 s.

$$\text{Velocity of boy} = \frac{\text{Displacement}}{\text{Time taken}} = \frac{0 \text{ m}}{100 \text{ s}} = 0 \text{ m/s}$$

(iii) (c) in accelerated motion

(iv) (a) if the car is moving on straight road

(v) (c) 2r