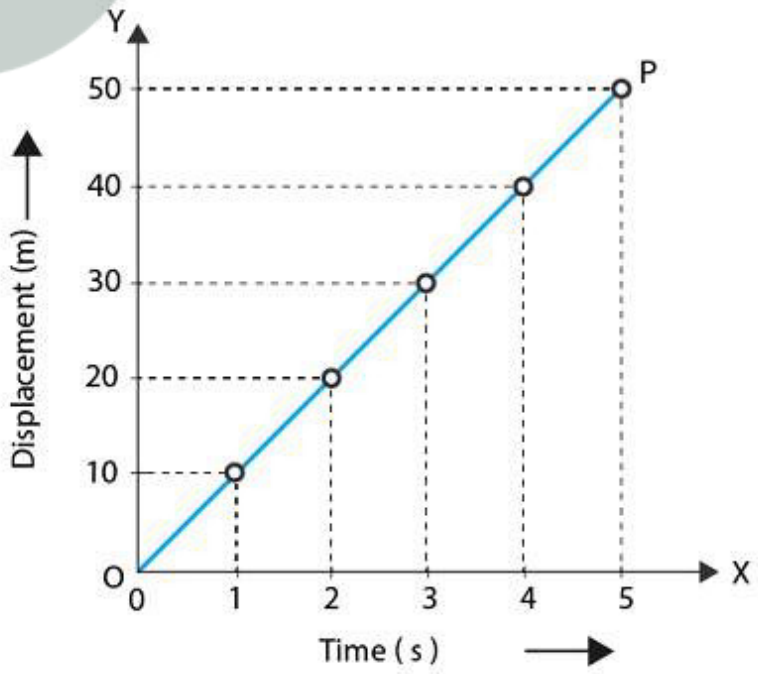
Exercise -2(B)

1. **For the motion with uniform velocity, how is the distance travelled related to the time?**
   Solution:
   Distance is directly proportional to time.

2. **What information about the motion of a body are obtained from the displacement-time graph?**
   Solution:
   The displacement-time graph gives us as idea about the motion of an object/body. With the help of displacement-time graph, a slope can be obtained, through which we can fetch the value of velocity of the body at any point of time that can also be used to trace the velocity-time graph.

3. **(a) What does the slope of a displacement-time graph represent?**
   (b) Can displacement-time sketch be parallel to the displacement axis? Give reason to your answer.
   Solution:
   (a) The slope of a displacement-time graph gives the velocity. If the slope is positive, it indicates that the body is moving away from the reference or the starting point. If the slope is negative, the body is reverting to the initial point.
   (b) No, the displacement-time sketch cannot be parallel to the displacement axis. A line parallel to the displacement axis would indicate that the time is at rest, which is not practically possible, as time is not constant.

4. **Draw a displacement-time graph for a boy going to school with a uniform velocity.**
   Solution:



5. State how the velocity-time graph can be used to find (i) the acceleration of a body, (ii) the distance travelled by the body in a given time, and (iii) the displacement of the body in a given time.

Solution:

The velocity-time graph can be used to determine the following:

(i) Acceleration of a body

The slope or gradient of the velocity-time graph gives the acceleration of the body as acceleration is the ratio of rate of change of velocity and time taken.

(ii) Distance travelled by body in a given time

The total distance travelled by the body can be obtained by the arithmetic sum of the distance travelled away from the starting point and the distance travelled towards the starting point.

(iii) Displacement of the body

It can be obtained by the area enclosed between the velocity-time sketch and x-axis.

6. What can you say about the nature of motion of a body if its displacement-time graph is

(a) A straight line parallel to time axis?

(b) A straight line inclined to the time axis with an acute angle?

(c) A straight line inclined to the time axis with an obtuse angle?

(d) A curve

Solution:

The following can be deduced about the nature of motion of a body, if its displacement-time graph is;

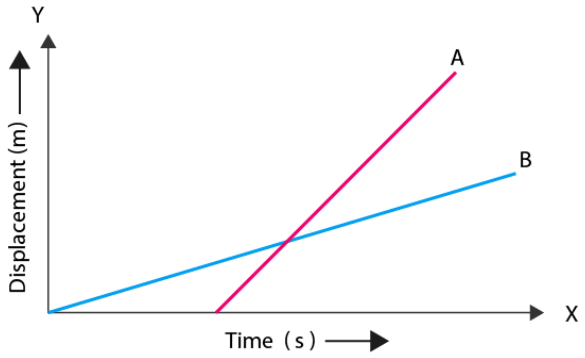
(a) A straight line parallel to time axis – it depicts that the body is at rest. There is no motion

(b) A straight line inclined to the time axis with an acute angle – this indicates that there is motion but away from the reference or starting point, with a uniform velocity

(c) A straight line inclined to the time axis with an obtuse angle – it conveys that there is motion towards the reference or the start point with a uniform velocity

(d) A curve – It depicts that there is motion along with variable velocity

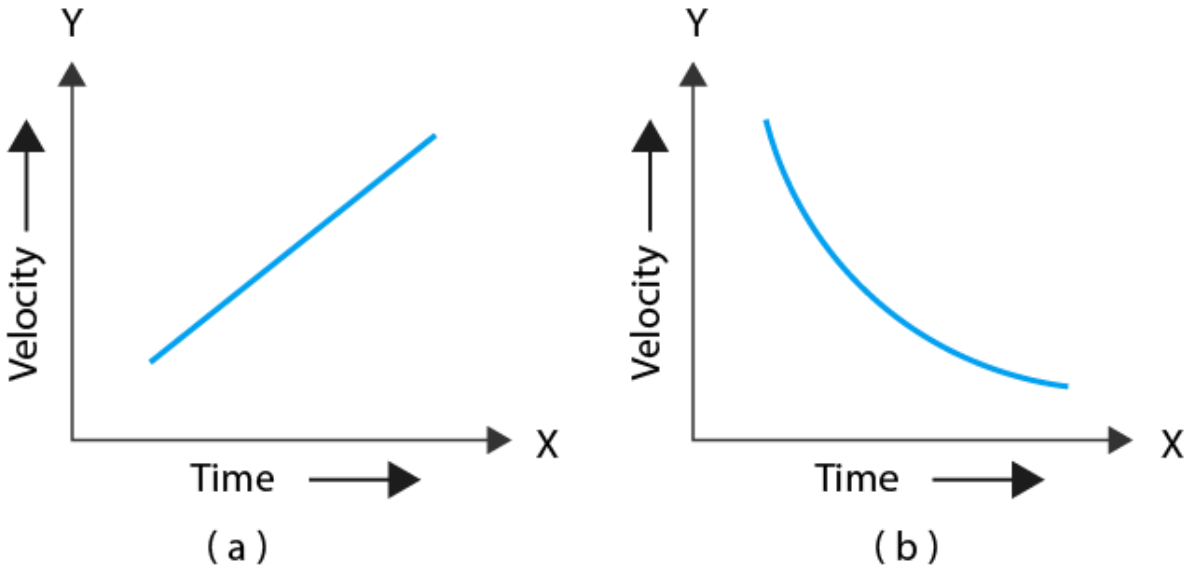
7. The figure shows displacement-time graph of two vehicles A and B along a straight road. Which vehicle is moving faster? Give reason.



Solution:

From the graph given it is evident that Vehicle A is moving faster than Vehicle B. It is because, the slope that Vehicle A fetches is more compared to that of Vehicle B.

8. State the type of motion represented by the following sketches in the figure. Give example of each type of motion.



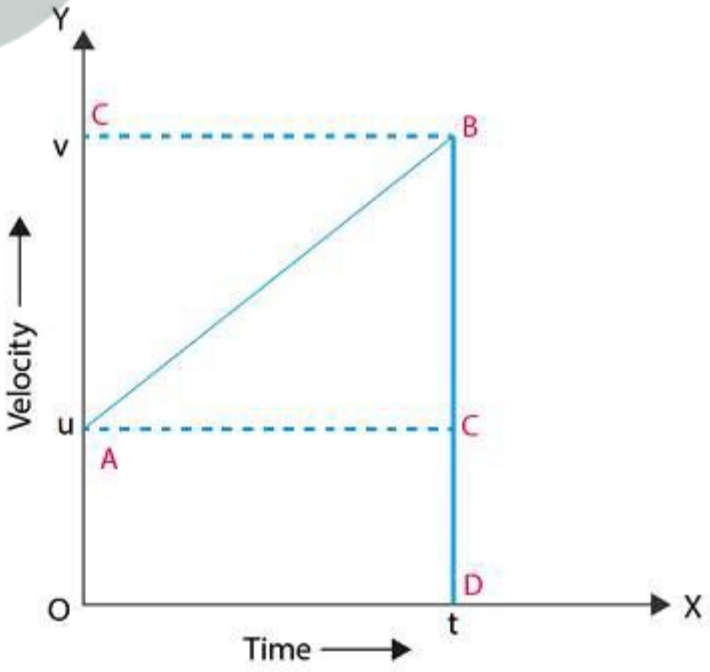
Solution:

(a) The graph depicts uniform accelerated motion.
Example - It is the motion of a body that is liberated downwards.

(b) The graph indicates the motion of a body with variable retardation.
Example – a car reaching its destination.

9. Draw a velocity-time graph for a body moving with an initial velocity u and uniform acceleration a. Use this graph to find the distance travelled by the body in time t.

Solution:



Let, 'u' be the initial velocity,
'v' be the velocity at time 't' and 'a' be the acceleration.

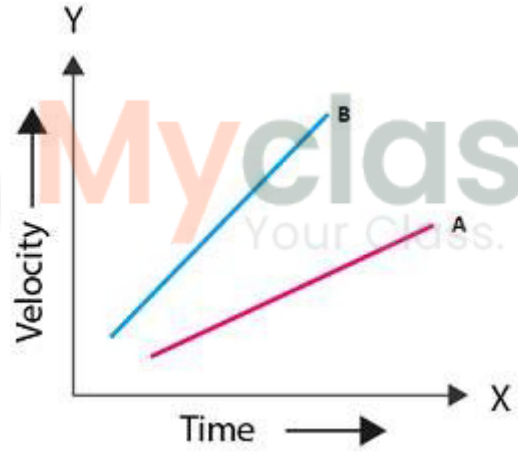
The distance travelled by the body in 't' seconds = area enclosed between the velocity-time graph and x-axis
Or
distance travelled by the body in 't' seconds = area of trapezium OABD
= ½ x (sum of parallel sides) x height
= ½ x (u+v) x t
$= \frac{(u+v)t}{2}$

10. What does the slope of velocity-time graph represent?

Solution:

The slope of the velocity-time graph indicates the acceleration.

11. Figure shows the velocity-time graph for two cars A and B moving in same direction. Which car has the greater acceleration? Give reason to your answer.



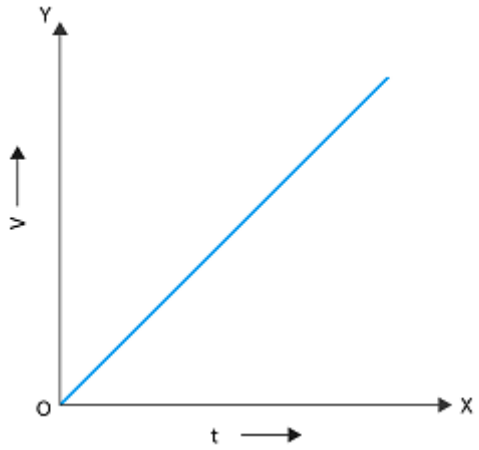
Solution:

From the graph, we can deduce that car B has greater acceleration than car A as the slope of straight line for Car B in the graph is more compared to car A as seen in the graph.

12. Draw the shape of the velocity-time graph for a body moving with (a) uniform velocity, (b) uniform acceleration.

Solution:

Velocity-time graph for a body with uniform velocity and uniform acceleration is

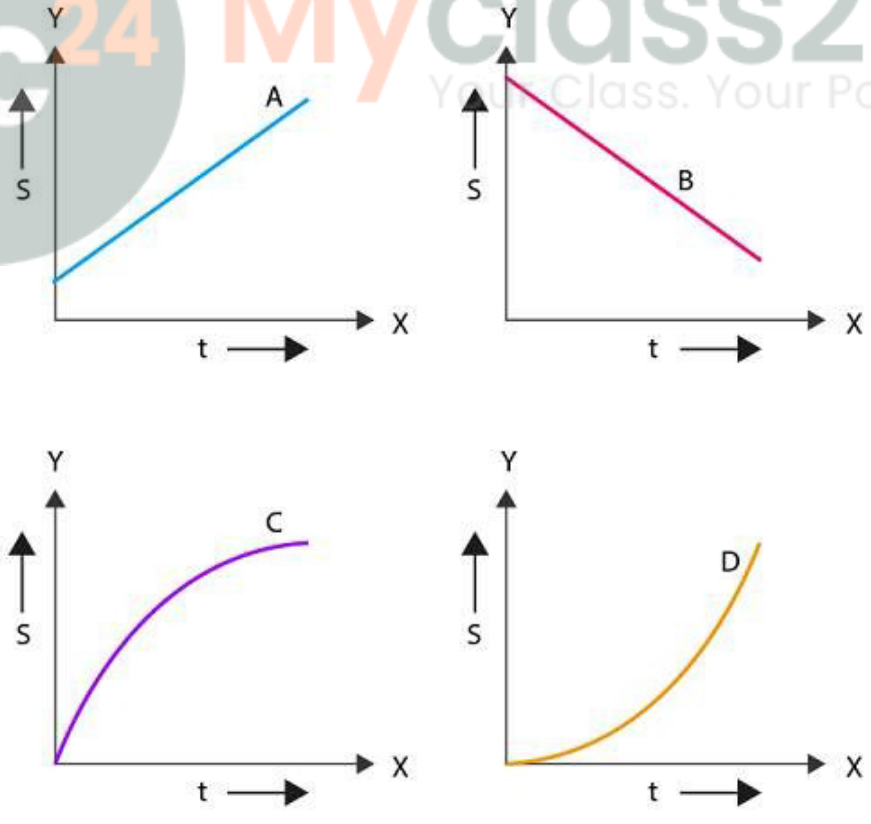


13. The velocity-time graph for a uniformly retarded body is a straight line inclined to the time axis with an obtuse angle. How is retardation calculated from the velocity-time graph?

Solution:

In order to calculate the retardation from the velocity-time graph, a negative slope should be obtained.

14. Figure shows the displacement-time graph for four bodies A, B, C and D. In each case state what information do you get about the acceleration (zero, positive or negative).



Solution:

The following information can be obtained about acceleration:

A – The slope here is constant, velocity is constant hence the acceleration is 0.

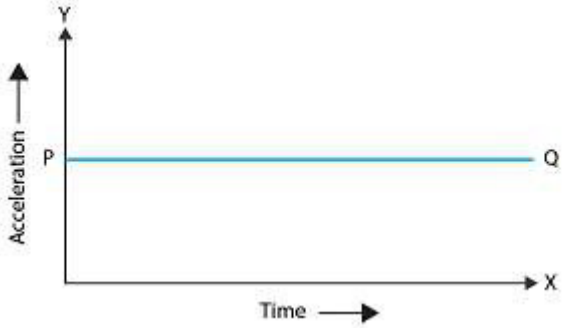
B – Since graph B has a slope that is constant, the acceleration is 0.

C – Graph C shows a slope that is decreasing with time. Hence the acceleration is negative, which is referred to as retardation.

D – Graph D shows a slope that is increasing with time. The acceleration is positive.

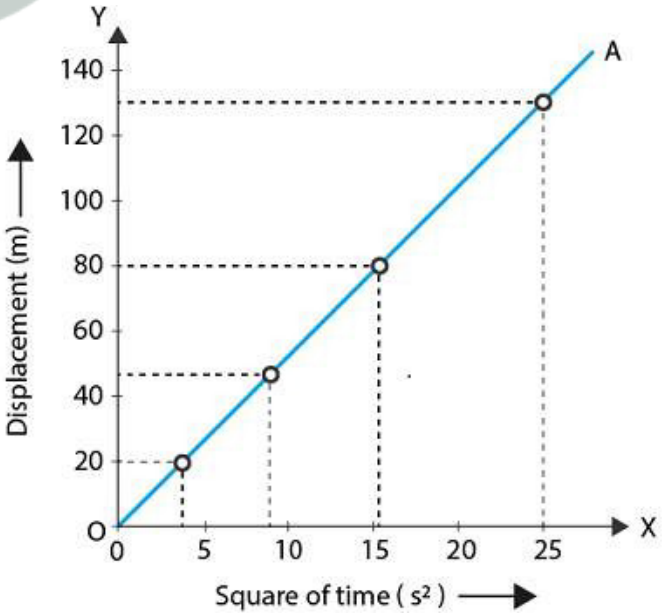
15. Draw a graph for acceleration against time for a uniformly accelerated motion. How can it be used to find the change in speed in a certain interval of time?

Solution:



Changing speed at a particular interval of time can be obtained by the area enclosed between the straight line and the time axis for that interval of time.

16. Draw a velocity-time graph for the free fall of a body under gravity, starting from rest. Take g=10ms^{-2}



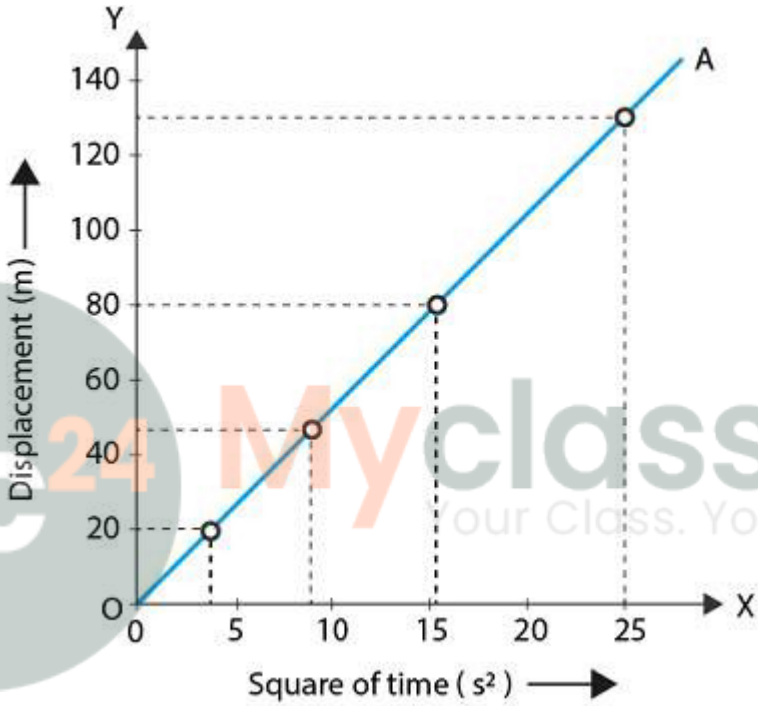
17. How is the distance related with time for the motion under uniform acceleration such as the motion of a freely falling body?

Solution:

For a freely falling body, the displacement is directly proportional to the square of time ($S \propto t^2$).

18. A body falls freely from a certain height. Show graphically the relation between the distance fallen and square of time. How will you determine g from this graph?

Solution:



For a freely falling body, the doubling of the slope of the displacement-time graph can fetch the value of acceleration due to gravity (g).

Multiple choice type:

1. The velocity-time graph of a body in motion is a straight line inclined to the time axis. The correct statement is:

(a) Velocity is uniform
(b) Acceleration is uniform
(c) Both velocity and acceleration are uniform
(d) Neither velocity nor acceleration is uniform

Solution:

(b) Acceleration is uniform

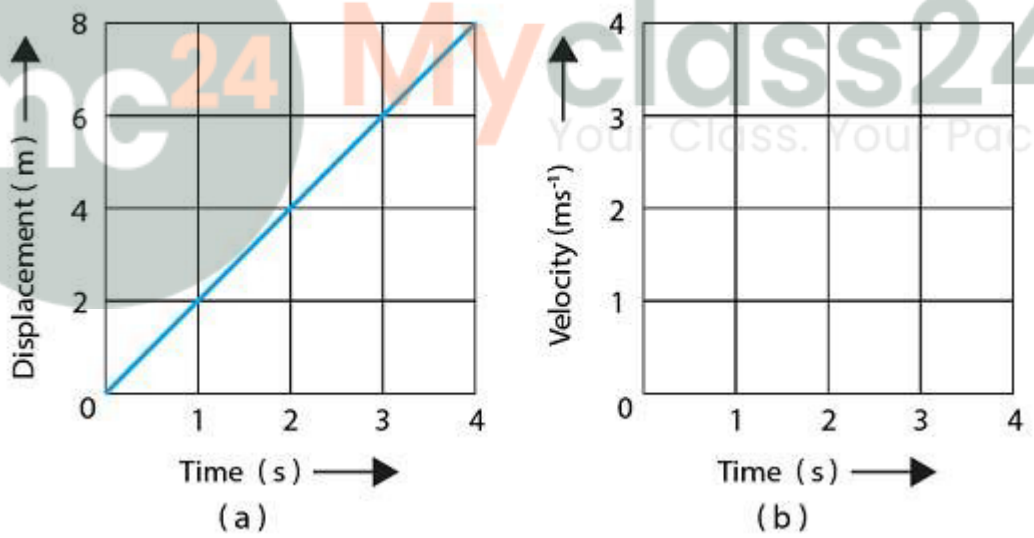
If the velocity-time graph is a straight line inclined to the time axis, the motion is with uniform acceleration.

2. **For a uniformly retarded motion, the velocity-time graph is:**
   (a) A curve
   (b) A straight line parallel to the time axis
   (c) A straight line perpendicular to the time axis
   (d) A straight line inclined to the time axis
   Solution:
   (d) A straight line inclined to the time axis

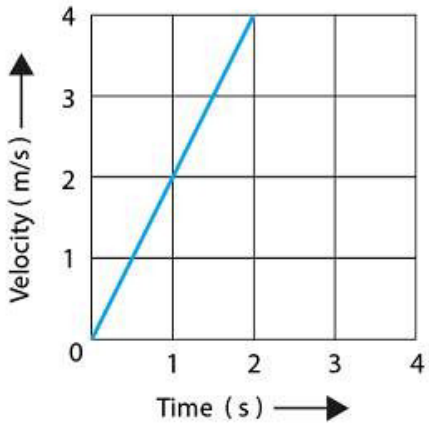
3. **For the uniform motion:**
   (a) The distance-time graph is a straight line parallel to the time axis
   (b) The speed-time graph is a straight line inclined to the time axis
   (c) The speed-time graph is a straight line parallel to the time axis
   (d) The acceleration-time graph is a straight line parallel to the time axis.
   Solution:
   (c) The speed-time graph is a straight line parallel to the time axis

Numericals:

1. **Figure shows the displacement-time graph for the motion of a body. Use it to calculate the velocity of body at t=1s, 2s and 3s, then draw the velocity-time graph for it in figure (b).**



Solution:
From the graph given, the velocity can be observed,
At time,
t=1s, velocity is $2ms^{-1}$
t=2s, velocity is $4\ ms^{-1}$
t=3s, velocity is $6\ ms^{-1}$



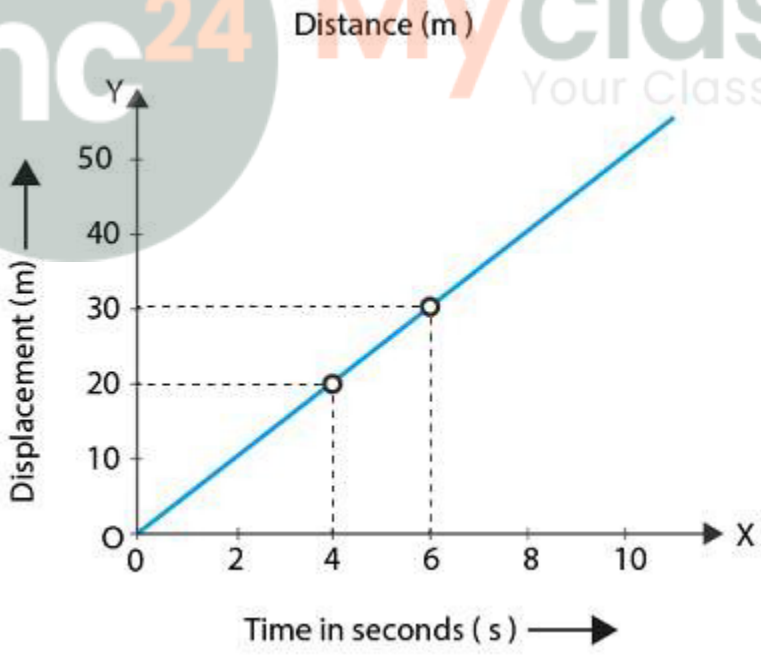
2. Following table gives the displacement of a car at different instants of time.

Time (s)	0	1	2	3	4
Displacement (m)	0	5	10	15	20

(a) Draw the displacement-time sketch and find the average velocity of car.
(b) What will be the displacement of car at (i) 2.5s and (ii) 4.5s?

Solution:

(a) Figure is as follows:



As per the graph,

Average velocity of car $= \frac{\text{displacement at point B – displacement at point A}}{\text{time taken}}$

$= \frac{30-20}{6-4} = 5$ m/s

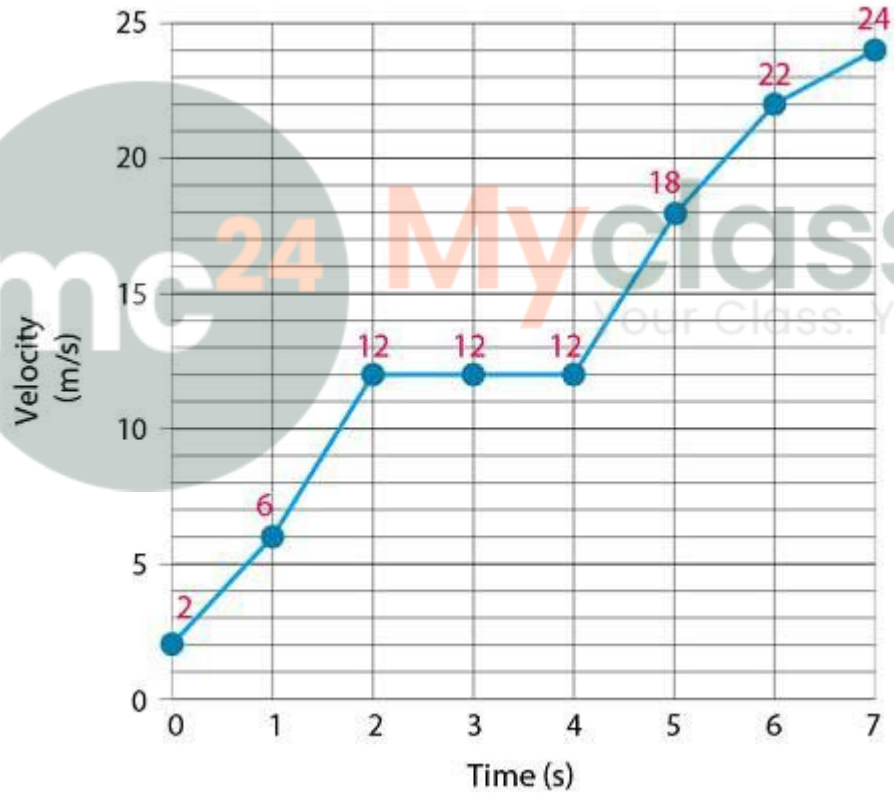
(b) We can observe from the graph, the displacement of the car at various points,
At t=2.5s, displacement is 12.5m
At t=4.5s, displacement is 22.5m

3. A body is moving in a straight line and its displacement at various instants of time is given in the following table:

Time (s)	0	1	2	3	4	5	6	7
Displacement (m)	2	6	12	12	12	18	22	24

Plot displacement-time graph and calculate:
(i) Total distance travelled in interval 1s to 5s,
(ii) Average velocity in time interval 1s to 5s.

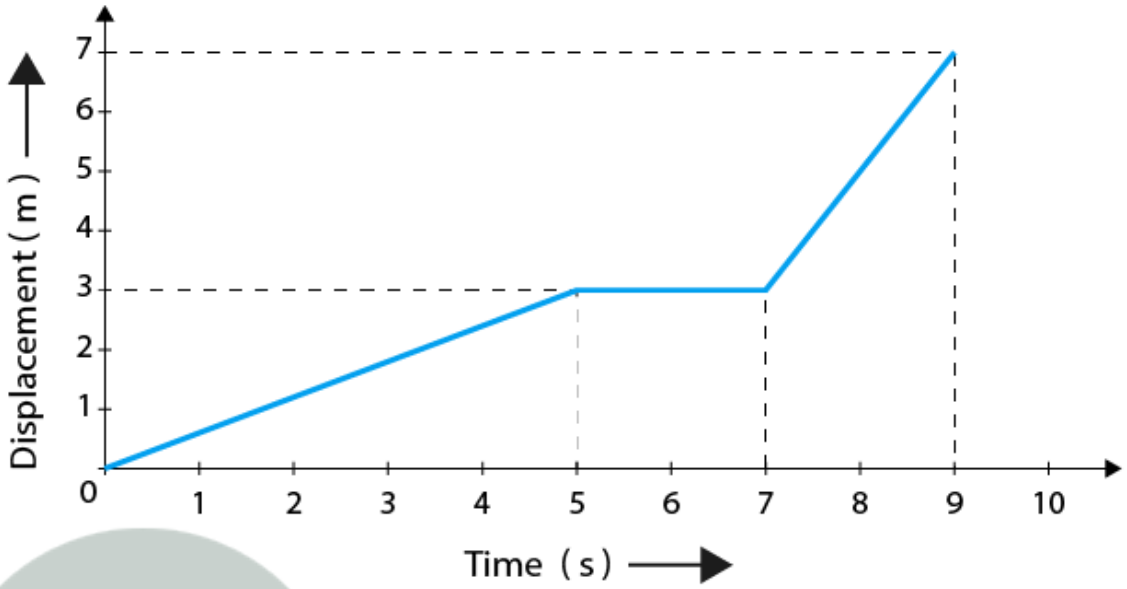
Solution:



(i) The total distance that is covered in interval 1s to 5s = 18m-6m = 12m

(ii) Average velocity $= \frac{\text{displacement in given time interval}}{\text{time interval}} = \frac{12}{4} = 3\text{m/s}$

4. Figure shows the displacement of a body at different times.



(a) Calculate the velocity of the body as it moves for time interval (i) 0 to 5s, (ii) 5s to 7s and (iii) 7s to 9s.

(b) Calculate the average velocity during the time interval 5s to 9s.

[Hint: From 5s to 9s, displacement=7m -3m = 4m]

Solution:

(a) Velocity = displacement/time

(i) at time interval 0s to 5s

velocity = 3/5 = 0.6m/s

(ii) at time interval 5s to 7s

velocity = 0/2 = 0m/s

(iii) at time interval 7s to 9s

velocity = (7-3)/(9-7) = 4/2 = 2m/s

(b) Displacement = 7m-3m=4m, time interval = 9s-5s=4s

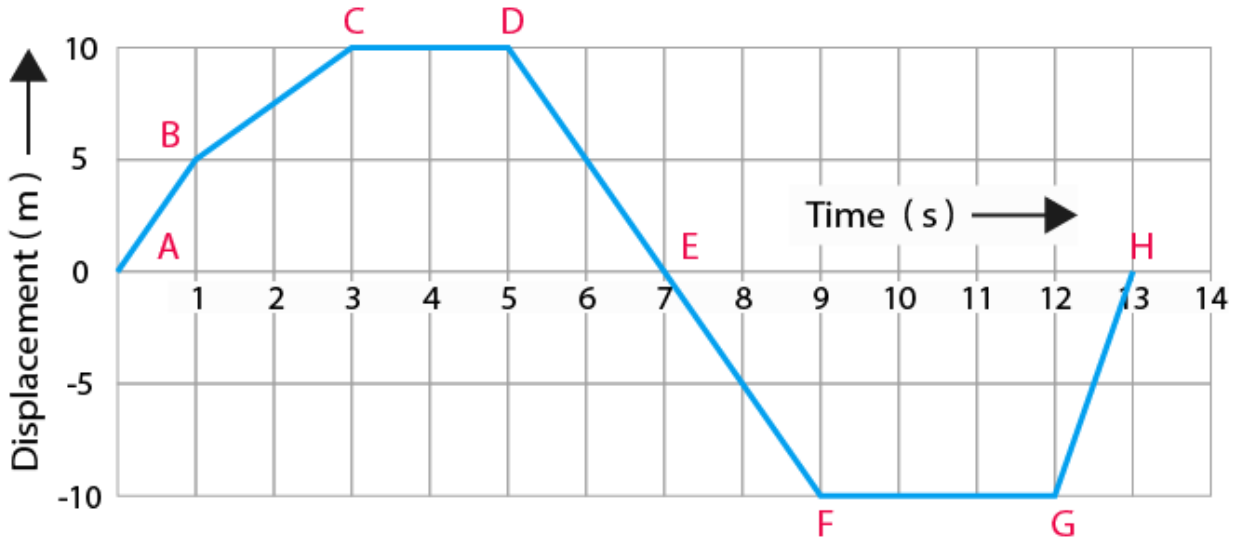
$$\text{Average velocity} = \frac{\text{displacement in given time interval}}{\text{time interval}} = \frac{4m}{4s} = 1\text{m/s}$$

5. From the displacement-time graph of a cyclist, given in figure, find:

(i) The average velocity in the first 4s,

(ii) The displacement from the initial position at the end of 10s

(iii) The time after which he reaches the starting point.



Solution:

(i) As per the graph, displacement in 4s=10m,

Average velocity = displacement/time = 10/4 = 2.5m/s

(ii) The displacement at initial point = 0m

Final position at the end of 10s = -10m

Displacement = final position – initial point = (-10)m – 0 = -10m

(iii) The cyclist would reach the start point at two instances, one at the 7^{th} second and the other at the 13^{th} second.

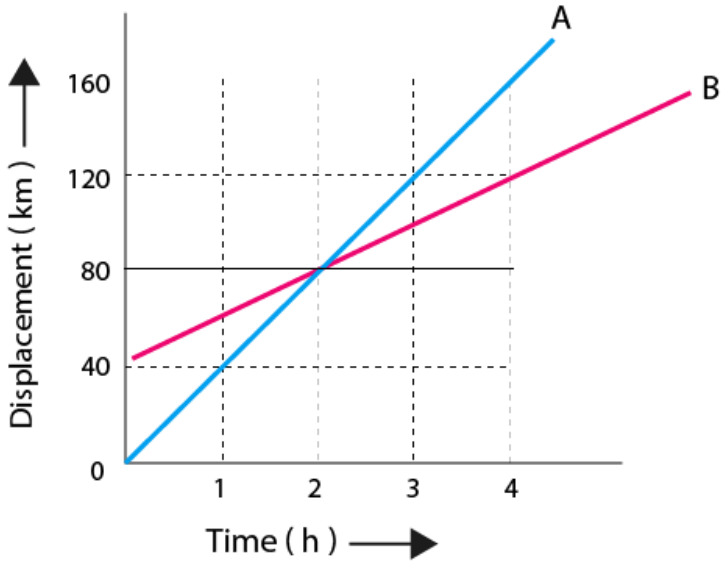
6. Figure ahead represents the displacement-time sketch of motion of two cars A and B. Find:

(i) The distance by which the car B was initially ahead of car A.

(ii) The velocities of car A and car B

(iii) The time in which car A catches car B

(iv) The distance from start when the car A will catch the car B



Solution:

(i) As per the graph, the car B was ahead of car A by 40km

(ii) The lines of car A and B as per the graph are straight indicating they have uniform velocities.

Displacement of car A:

Time = 1hour, distance = 40km

Velocity = displacement/time

= 40/1 = 40km/h

Displacement of car B:

Time=4 hour, distance = (120-40) = 80km

Velocity = displacement/time

= 80/4=20km/h

(iii) As per the graph, both cars A and B intersect at a point, it is at this point the car A catches car B, i.e., 2hours

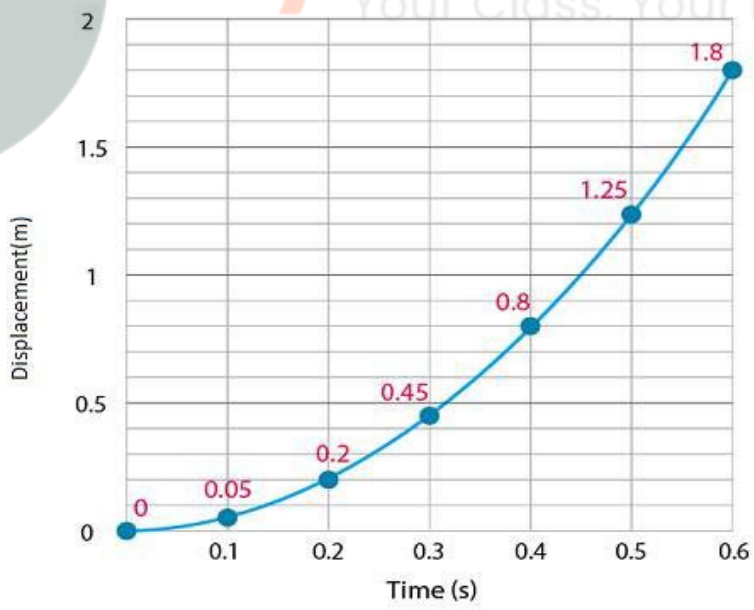
(iv) As observed in the graph, the distance from the start when car A will catch car B is 80km.

7. A body at rest is made to fall from the top of a tower. Its displacement at different instants is given in the following table:

Time (in s)	0.1	0.2	0.3	0.4	0.5	0.6
Displacement (in m)	0.05	0.20	0.45	0.80	1.25	1.80

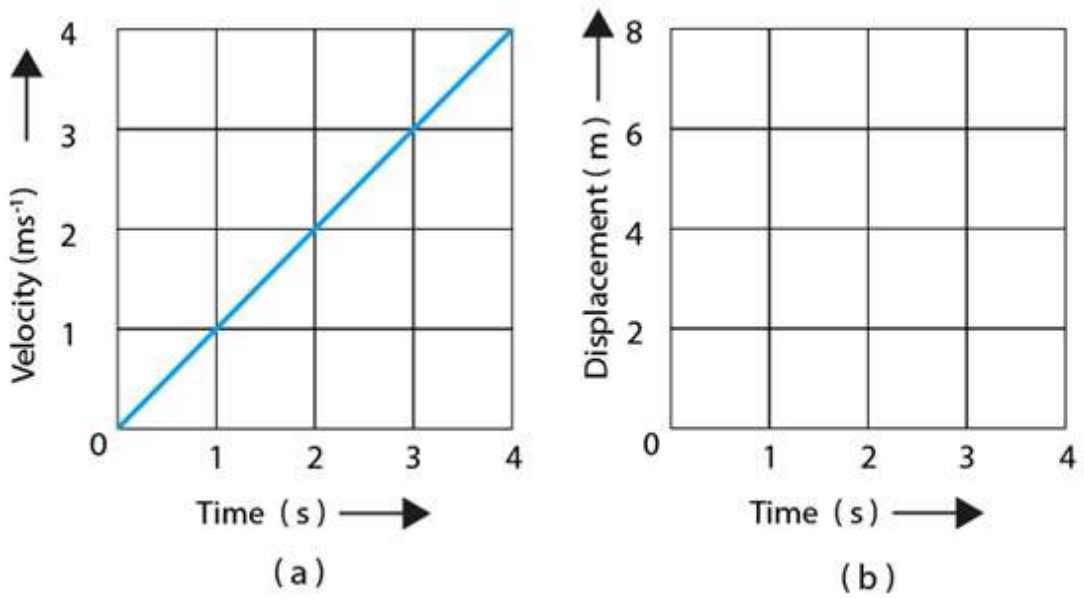
Draw a displacement-time graph and state whether the motion is uniform or non-uniform?

Solution:



The motion is non-uniform as the displacement-time graph is a curve.

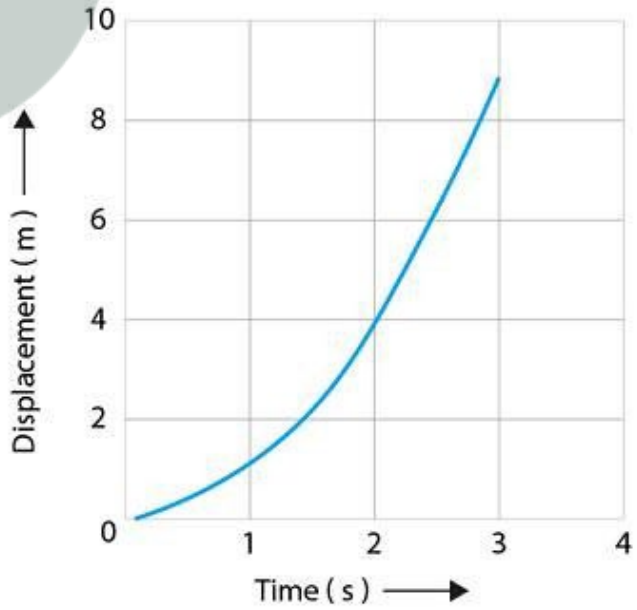
8. Figure shows the velocity-time graph for the motion of a body. Use it to find the displacement of the body at t=1s, 2s, 3s and 4s, then draw the displacement-time graph for it on figure (b).



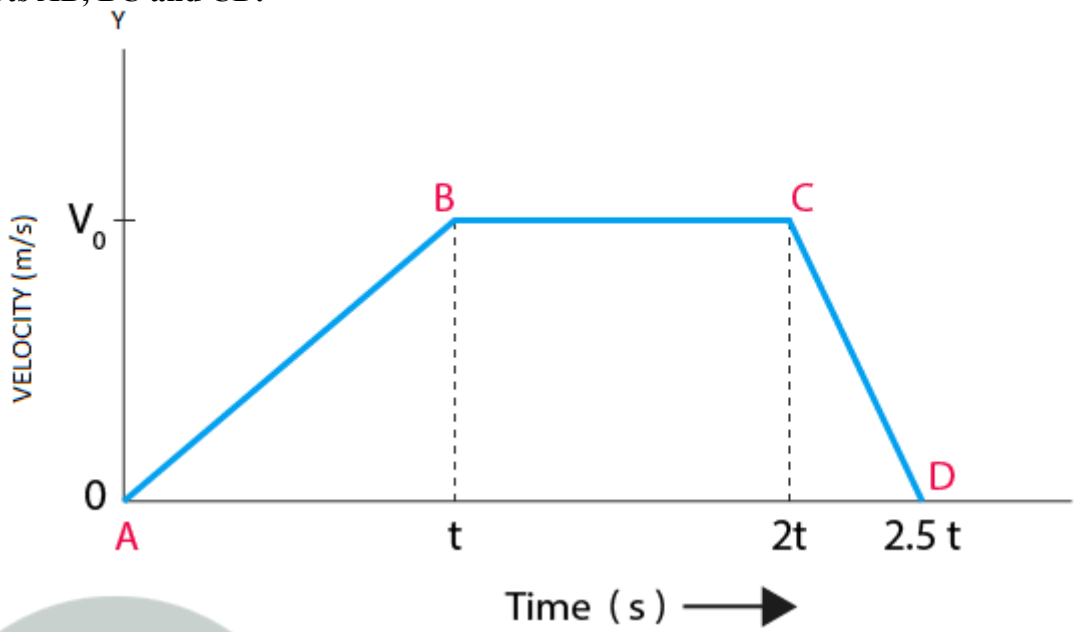
Solution:

As per the graph,

Velocity(m/s)	Time(s)	Displacement(m)= velocity x time
1	1	1
2	2	4
3	3	9



9. Figure below shows a velocity-time graph for a car starting from rest. The graph has three parts AB, BC and CD.



(i) State how is the distance travelled in any part determined from this graph
(ii) Compare the distance travelled in part BC with the distance travelled in part AB.
(iii) Which part of graph shows motion with uniform (a) Velocity (b) acceleration (c) retardation?
(iv) (a) Is the magnitude of acceleration higher or lower than that of retardation? Give a reason.
(b) Compare the magnitude of acceleration and retardation.

Solution:

(i) The distance travelled in any part of the graph can be determined by finding the area that is covered by the graph in that part with the time axis

(ii) As per the graph,

Distance travelled in part BC = Area of rectangle tBC2t
= length x breadth
= (2t-t) x v_0
= v_0t

Distance travelled in part AB = Area of triangle ABt
= ½ x base x height
= ½ x t x v_0
= $v_0t/2$

The distance travelled in part BC can be compared to the distance travelled in part AB, it is in the ratio, 2:1.

(iii) (a) Uniform velocity is shown at BC
(b) Uniform acceleration is shown at AB
(c) Uniform retardation is shown at CD

(iv) (a) The magnitude of acceleration is lower than that of retardation as the slope of line AB is

less in comparison to the line CD.

(b) Slope of line AB gives magnitude of acceleration while slope of line CD gives magnitude of retardation

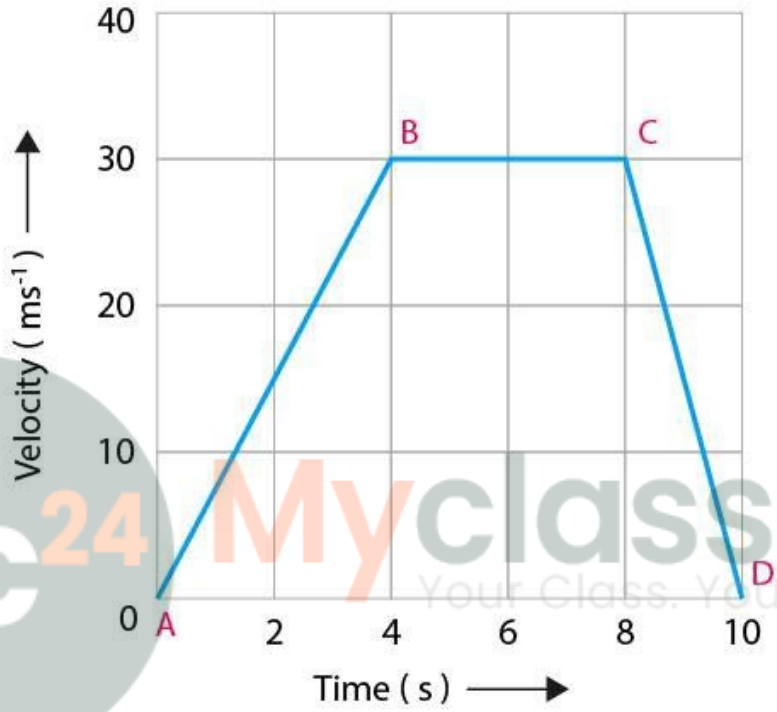
Slope of line AB = v_0 / t

Slope of line CD = $v_0/0.5t$

The magnitude of acceleration and retardation = Slope of line AB/ Slope of line CD

$= (v_0 / t) / (v_0/0.5t) = 1:2$

10. The velocity-time graph of a moving body is given below in figure



Find:

(i) The acceleration in parts AB, BC and CD.

(ii) Displacement in each part AB, BC, CD, and

(iii) Total displacement.

Solution:

(i) The acceleration in the mentioned parts are given below:

Acceleration in AB=slope of AB

$= \tan (\angle BAD) = 30 \div 4 \text{ m/s}^2 = 7.5 \text{ m/s}^2$

Acceleration in BC is zero

Acceleration in CD=slope of CD

$= \tan (\angle CDA) = - (30 \div 2) \text{ m/s}^2 = -15 \text{ m/s}^2$

(ii) Displacement in each part can be expressed as area of rectangle and triangle.

Displacement of part AB= Area of triangle AB4

= ½ x base x height

= ½ x 4 x 30

= 60m

Displacement of part CD= Area of triangle CBD

= ½ x base x height

= ½ x 2 x 30

= 30m

Displacement of part BC= Area of rectangle 4BC8

= length x breadth

= 30 x 40

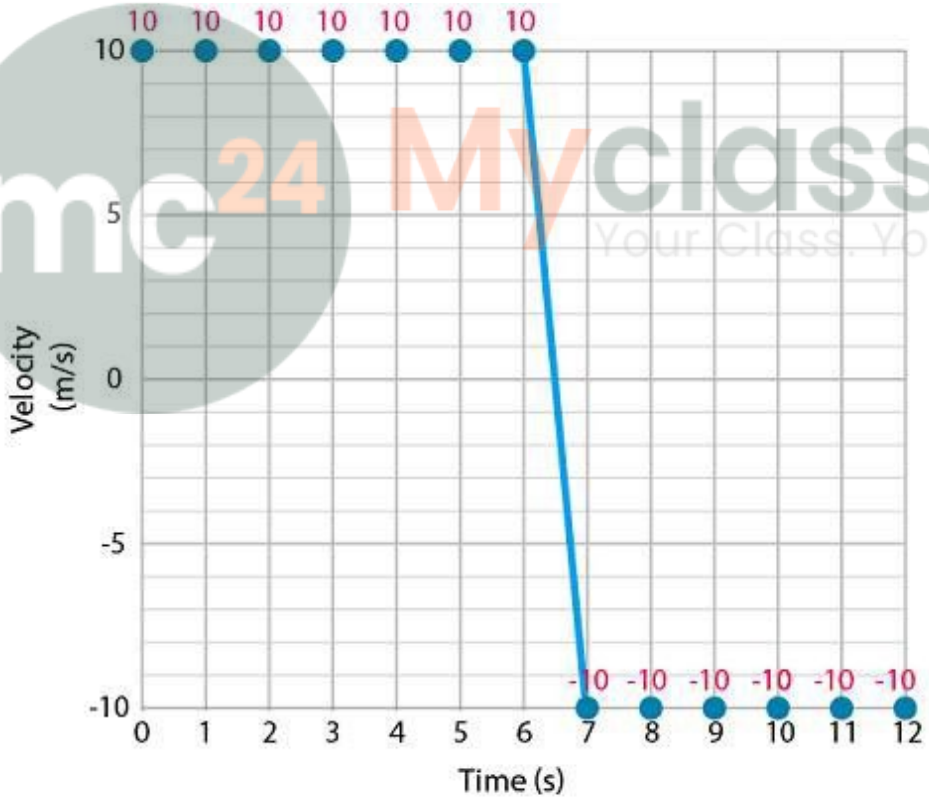
= 120m

(iii) Total displacement = Displacement of part AB + Displacement of part CD + Displacement of part BC

= 60 + 120 + 30 = 210m

11. A ball moves on a smooth floor in a straight line with a uniform velocity 10m/s for 6s. At t=6s, the ball hits a wall and comes back along the same line to the starting point with same speed. Draw the velocity-time graph and use it to find the total distance travelled by the ball and its displacement.

Solution:



To find the total distance, distance travelled in the first 6 seconds and next 6 seconds must be calculated.

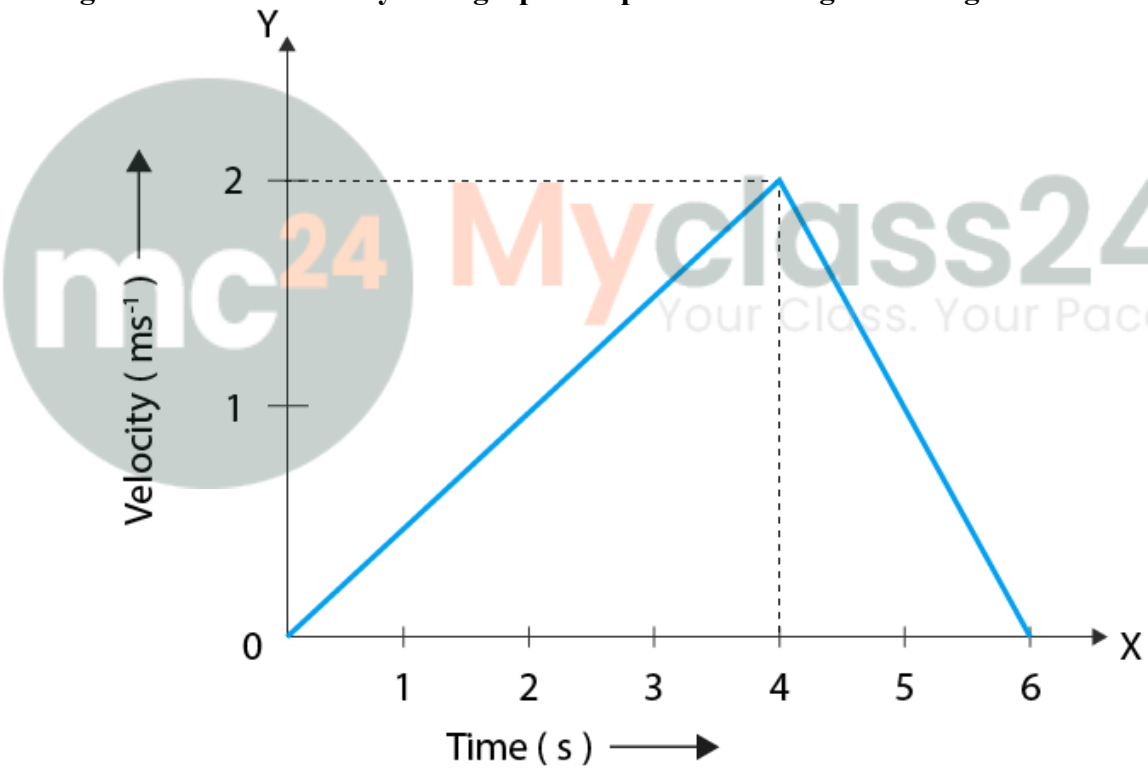
Distance covered in 6s = velocity x time
= 10 x 6 = 60 m/s

Distance covered in the next 6s = velocity x time
= 10 x 6 = 60 m/s

Total distance covered in a matter of 6+6= 12 seconds is
= 60 + 60 = 120m

As the ball returns to the initial point, the displacement is zero.

12. Figure shows the velocity-time graph of a particle moving in a straight line.



(i) State the nature of motion of particle.
(ii) Find the displacement of particle at t=6s.
(iii) Does the particle change its direction of motion?
(iv) Compare the distance travelled by the particle from 0 to 4s and from 4s to 6s.
(v) Find the acceleration from 0 to 4s and retardation from 4s to 6s.

Solution:

(i) The nature of motion of particle is that from 0s to 4s, particles are uniformly accelerated and then from 4s to 6s, particles are uniformly retarded.

(ii) Given: t=6s

Displacement = area of triangle
= ½ x 6 x 2 = 6m

(iii) No, the particle does not change its direction of motion

(iv) Distance travelled from 0s to 4s = area of triangle = ½ x 4 x 2 = 4m
Distance travelled from 4s to 6s = area of triangle = ½ x 2 x 2 = 2m
Comparing both distances obtained, ratio is 4:2 = 2:1

(v) The acceleration from 0s to 4s = velocity/ time taken = 2/4 = 0.5 m/s^2
Retardation from 4s to 6s = velocity/ time taken = 2/2 = 1 m/s^2