8. Motion

Check Point 01

1. Question

Write the SI unit of the both distance and displacement

Answer

Displacement refers to the measure of the shortest path between any two points whereas distance is the measurement of path between two points. The SI unit of both distance and displacement is meter (m).

2. Question

State whether displacement is a scalar or a vector quantity.

Answer

Displacement is a vector quantity as it has both magnitude and direction.

3. Question

What is the displacement of a satellite when it makes a complete round along its circular path?

Answer

Displacement along a circular path is zero as the final and the initial points meet each other that is both the points are same.

4. Question

In which one of the following cases will the distance covered and the magnitude of the displacement are not the same? Justify.

(i) A passenger in a train travels from Delhi to Kolkata.

(ii) A raindrop falling in still air.

(iii) An athlete completes one lap in a race.

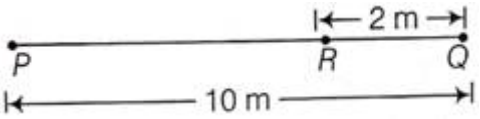
Answer

(iii) An athlete completes one lap in a race

As the track is circular, the displacement would be zero but distance will be equal to the circumference of the track.

5. Question

After studying the motion of a ball rolling on a straight line as shown in the figure.



Find its distance and displacement covered.

(i) when it rolls from P to Q and then to R (i.e., P to Q to R)

(ii) Finally comes back to P (i.e., P to P)(take, P as reference point).

Answer

(i) Distance would be PQ+QR = 12m whereas displacement is path PR= 8m as displacement is the shortest distance between two points.

(ii) In this case displacement is zero as initial and final point is same but distance would be PQ+QP= 20m.

Check Point 02

1. Question

Define average speed, write any one point of difference between average speed and average velocity.

Answer

Average speed of the object in an interval of time is the distance travelled by the object divided by the duration of interval of time. Average speed is a scalar quantity while average velocity is a vector quantity.

2. Question

The maximum speed of a train is 80 km/h. It takes 10 h to cover a distance of 400 km. Find the ratio of its maximum speed to its average speed.

Answer

Maximum speed = 80 km/hr

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

= $\frac{400\ \text{km}}{10\ \text{hr}}$ = 40 km/hr

Ratio = $\frac{\text{maximum speed}}{\text{average speed}} = \frac{80\ \text{km/hr}}{40\ \text{km/hr}}$ = 2

3. Question

Which of the two can be zero under certain conditions: average speed of a moving body or average velocity of a moving body?

Answer

Average speed is a scalar quantity and hence it cannot be zero but average velocity is a vector quantity and it can be zero if the object is moving in a circular path.

4. Question

(i) Give two factors on which acceleration depends.

(ii)Mention the formula and SI unit of acceleration.

Answer

(i) Acceleration depends on the change in the velocity and the time taken by the object to travel.

(ii) Acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$

= $\frac{\text{final velocity (v)} - \text{initial velocity(u)}}{\text{time taken (t)}}$

SI unit of acceleration is meter per second square (m/s^2).

5. Question

Fill in the blanks.

(i) ……..is the term used for negative acceleration.

(ii) A bus starting from rest attains a velocity of 54 km/h in 60 s, its acceleration is …….. .

Answer

(i) Retardation is the term used for negative acceleration.

Explanation: If the velocity of an object is decreasing, it is said to have negative acceleration.

(ii) A bus starting from rest attains a velocity of 54 km/h in 60 s, its acceleration is $0.25\ m/s^2$.

Explanation: initial velocity = 0

time = 60 secs

final velocity = 54 km/hr = $\frac{54 \times 1000}{60 \times 60}$ m/s = 15 m/s

Acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$

= $\frac{\text{final velocity (v)} - \text{initial velocity(u)}}{\text{time taken (t)}}$

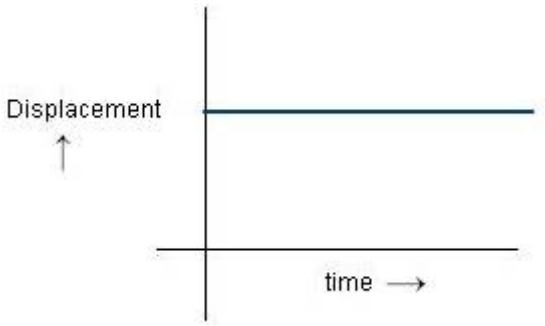
= $\frac{15\frac{m}{s} - 0}{60\ secs}$ = $0.25\ m/s^2$

Check Point 03

1. Question

If the distance-time graph of a particle is parallel to time axis, then how much is the velocity of the particle?

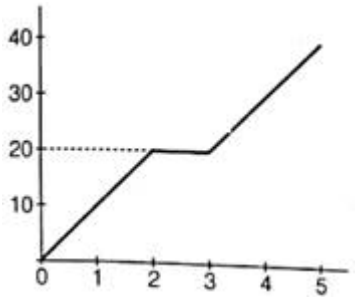
Answer



The velocity of the particle will be zero because the distance is constant and the time is increasing and this will happen only when the particle is stationary.

2. Question

In the figure below is shown the time-distance graph of cyclist.



Find out from the graph average speed in the whole journey.

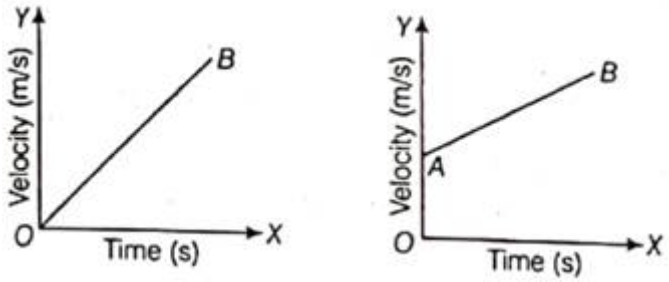
Answer

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

$= \frac{20\text{ m}}{2\text{ secs}} + \frac{20}{2}\text{ m/s}$ =10 m/s + 10 m/s = 20 m/s

3. Question

Give one similarity and one dissimilarity between the two graphs:

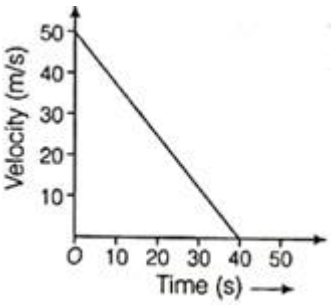


Answer

Similarity is that both the graphs shows uniform acceleration and dissimilarity is that in the first graph the object starts from rest whereas in the second graph the object has some initial velocity.

4. Question

What is the value of acceleration in the following graph:



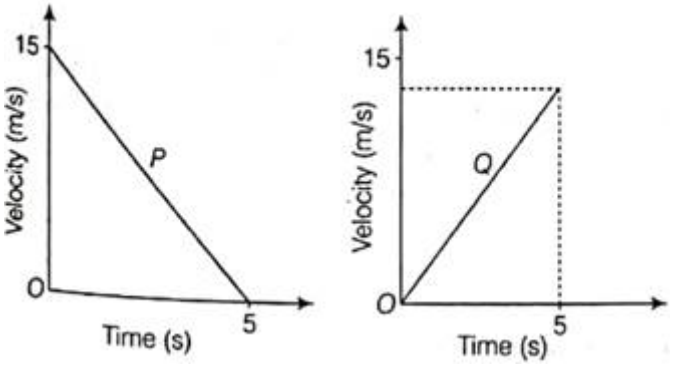
Answer

The acceleration would be the area under the graph.

Acceleration = $\frac{vf - vi}{tf - ti} = \frac{(0-50)\,m/s}{(40-0)\,s}$ = -1.25 m/s^2

5. Question

Given figures represent the motion of two objects P and Q. Which of the objects has positive acceleration and which one has negative acceleration?

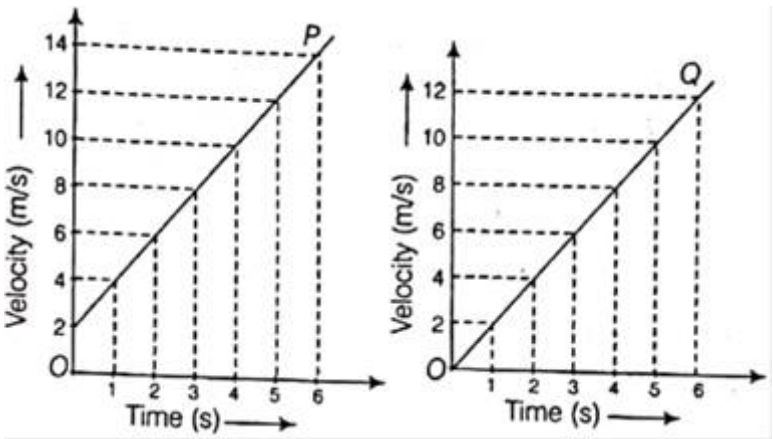


Answer

Graph P is having negative acceleration as the time is increasing, velocity is decreasing and finally comes to rest which shows retardation whereas Graph Q represents positive acceleration as the time is increasing velocity is also increasing.

6. Question

Velocity-time graphs of two objects P and Q are as given below:



(i) Which object starts from rest?

(ii)Which object has more velocity after 5 s?

Answer

(i) The object in Graph Q starts from rest as when time is zero, velocity is also zero.

(ii) Graph P will have more velocity after 5 secs as from the graphs we can infer that in Graph P after 5 secs the velocity is 14 m/s whereas in Graph Q the velocity reaches 12 m/s. Both the graph shows uniform acceleration but object in graph P has an initial velocity of 2 m/s and object in graph Q starts from rest.

Check Point 04

1. Question

A body is moving with a velocity of 10 m/s. If it starts acceleration with the rate of 2.5 m/s^2. Find out its velocity after 10s.

Answer

Using the first equation of motion: v = u + at

where: v = final velocity

u = initial velocity = 10 m/s

a = acceleration = 2.5 m/s^2

t = time = 10s

v = 10 m/s + 2.5 m/s^2 x 10s = 10+25 m/s = **35 m/s**

2. Question

If a car travels 50 m distance in 4s with a acceleration of 5 m/s^2, then what was its initial speed?

Answer

Using the second equation of motion: $s = ut + \frac{1}{2}at^2$

where: s = distance covered =50 m

u = initial velocity = ?

a = acceleration = 5 m/s^2

t = time = 4s

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

$50 = u \times 4s + \frac{1}{2} \times 5 \times 4^2$

$50 = u \times 4s + 40$

$50 - 40 = u \times 4s$

$10 = u \times 4s$

$u = \frac{10}{4}$ m/s = 2.5 m/s

3. Question

A cyclist is moving with a speed of 14 m/s. He starts accelerating with a rate of 6 m/s^2 and acquired the speed of 18 m/s. Calculate, what distance did he move in acquiring that speed?

Answer

Using the third equation of motion: $v^2 - u^2 = 2$

as

where: s = distance covered =?

v = final velocity = 18 m/s

u = initial velocity = 14 m/s

a = acceleration = 6 m/s^2

$18^2 - 14^2 = 2 \times 6 \times s$

$324 - 196 = 12 \times s \frac{128}{12} = s$

s = 10.67 m

4. Question

A bus is moving with a speed 72 km/h can be stopped by brakes after at least 10 m. What will be the minimum stopping distance, if the same bus is moving at a speed of 144 km/h?

Answer

We have to first find the retardation.

Using the third equation of motion: $v^2 - u^2 = 2$

as

where: s = distance covered = 10 m

v = final velocity = 0 m/s (brakes are applied so that buscomes to rest)

u = initial velocity = 72 km/

h = 20 m/s

a = acceleration = ? m/s^2

$v^2 - u^2 = 2$

as

$0 - 20^2 = 2 \times a \times 10$

$-400 = 20 \times a$

$-\frac{400}{20} = a$

a = **$-20\ m/s^2$**

Now, u = initial velocity = 144 km/h = 40 m/s

s = distance covered = ?? m

v = final velocity = 0 m/s (brakes are applied so that bus comes to rest)

a = acceleration = -20 m/s^2

Using the third equation of motion: $v^2 - u^2 = 2$

as

$0 - 40^2 = 2 \times -20 \times s$

$-1600 = -40 \times s$

$-\frac{1600}{-40} = s$

s = **40 m**

5. Question

What do you understand by a uniform circular motion?

Answer

Uniform circular motion is defined as the motion of an object in a circle at a constant speed. As an object moves in a circle, it is constantly changing its direction. In all instances, the object is moving tangentially to the circle. For example an artificial satellite moving along its axis around the earth, the car taking a curve in a circular track.

Chapter Exercise

1. Question

If the acceleration of the particle is constant in magnitude but not in direction, then what type of path does the particle follow?

Answer

The particle is moving in a circular path because at every point the direction is changing along the path and is always tangential to the circular path.

2. Question

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

Answer

Uniform Motion means that the object covers the equal distance in equal interval of time that is the speed is constant. So path can be straight or curved but the magnitude remains the same.

3. Question

The velocity of a body increases by 10 m/s in every one second. What physical quantity does the body represent and what is its magnitude?

Answer

The given quantity represents change of velocity per unit time that is acceleration and its magnitude is 10 m/s^2.

4. Question

Area under the velocity-time graph line is 40 m. What physical quantity does this area represent?

Answer

The area under the velocity time graph gives the displacement of the object and its value is 40 m.

5. Question

Does the motion of second's hand of a watch represent uniform velocity or uniform speed?

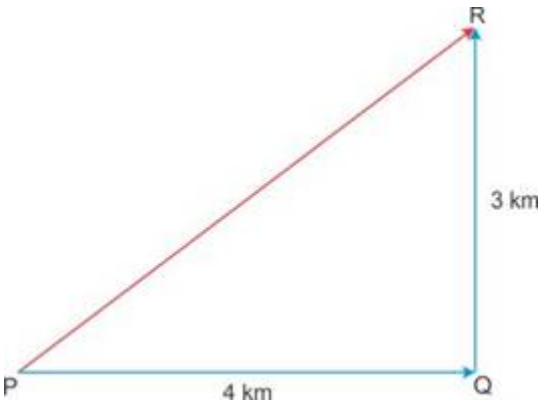
Answer

The motion of second's hand represent uniform speed because as it is moving in a circular motion, its direction is changing at every point and hence uniform velocity will not be the case.

6. Question

A cyclist travels a distance of 4 km from P to Q and then moves a distance of 3 km at right angle to PQ. Find his resultant displacement graphically.

Answer



Using Pythagoras theorem: $PQ^2 + QR^2 = PR^2$

$4^2 + 3^2 = PR^2$

$PR^2 = 16 + 9 = 25$

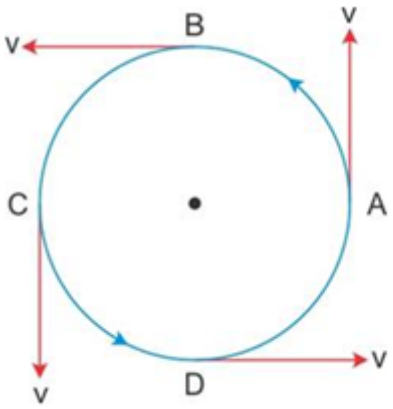
PR = 5 km

7. Question

Draw a diagram to show the motion of a body whose speed remains constant but the velocity changes continuously.

Answer

A body moving in a circular path having uniform speed is a true example where speed remains constant but velocity changes because every point, the direction changes at every point and is tangentially to the circular path.



8. Question

A car is moving on a straight road with a uniform acceleration. The following table gives the speed of the car at various instants of time.

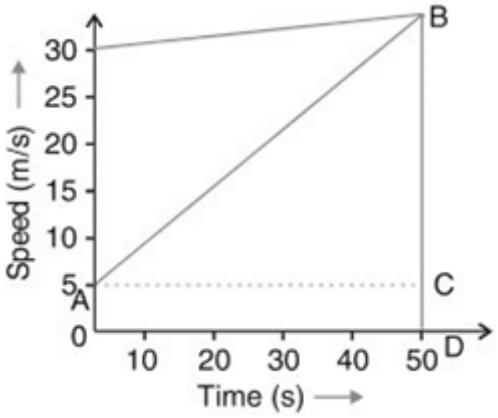
Time (s)	0	10	20	30	40	50
Speed (m/s)	5	10	15	20	25	30

(i) Draw the shape of speed-time graph representing the above sets of observations.

(ii)Find the acceleration of the car.

Answer

(i)



(iii) Acceleration of car = slope of line AB = $\frac{BC}{AC} = \frac{30-5}{50-0} = \frac{25}{50} = 0.5\ m/s^2$

9. Question

How can you calculate the following?

(i) Speed from distance-time graph?

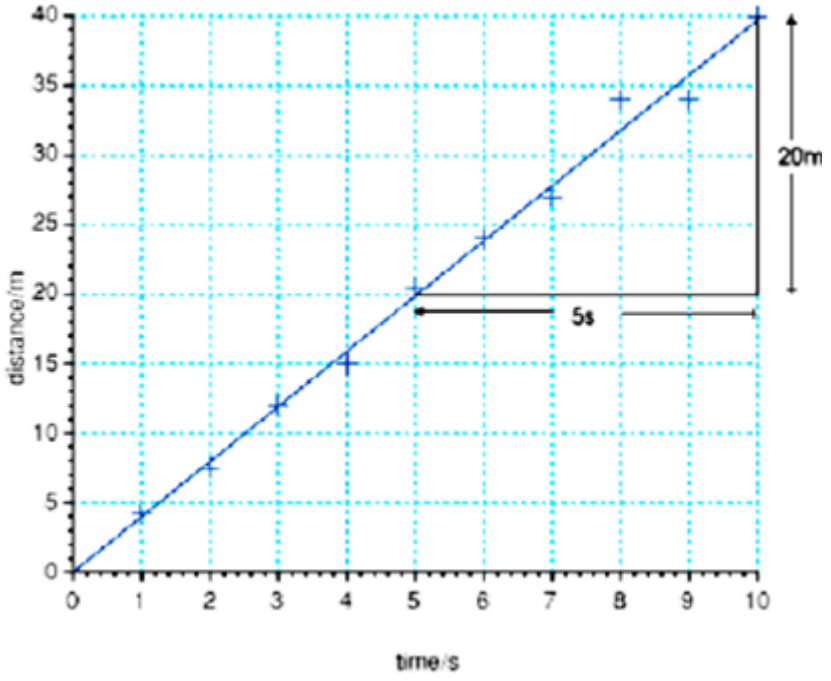
(ii) Acceleration from velocity-time graph.

(iii) Displacement from velocity-time graph.

Answer

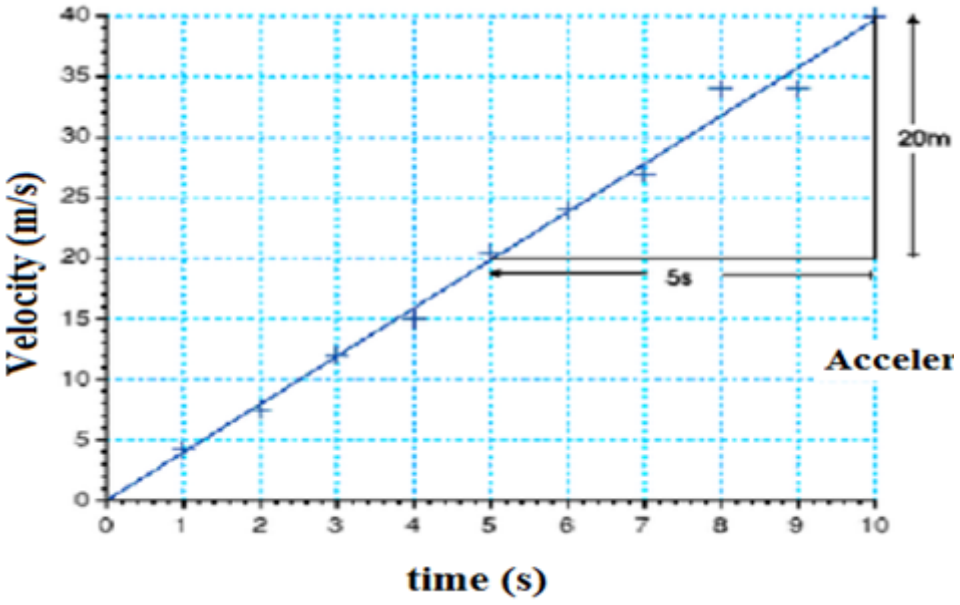
(i) Speed is equal to the slope of the distance-time graph.

Slope = Speed= $\frac{\text{change in distance}}{\text{change in time}}$

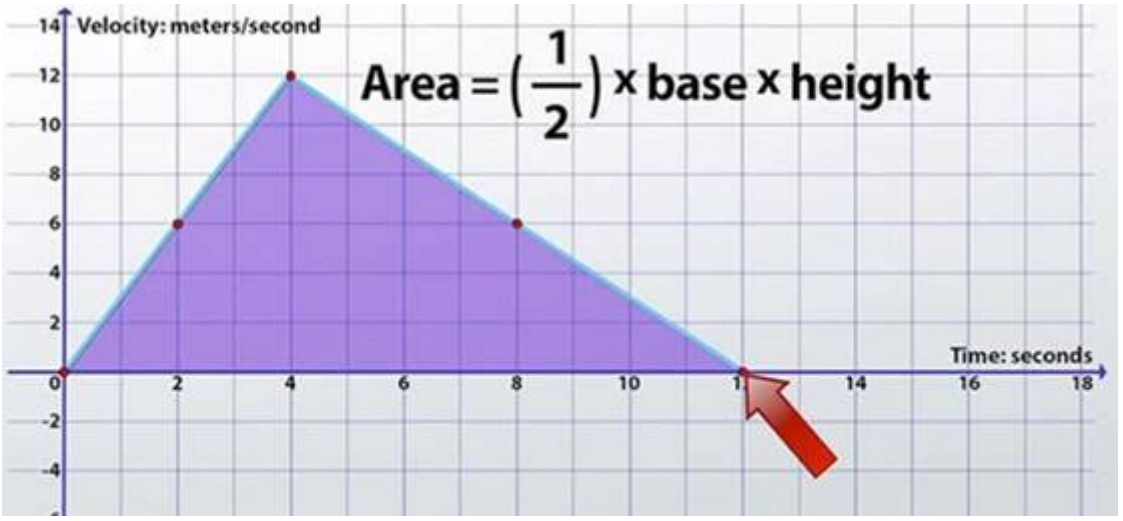


(ii) Acceleration is also the slope of the velocity-time graph.

Slope = Acceleration= $\frac{\text{change in velocity}}{\text{change in time}}$



(iii) The Magnitude of Displacement is the area under the curve of velocity time graph.



10. Question

How will you show that the slope of the displacement-time graph gives the velocity of the body?

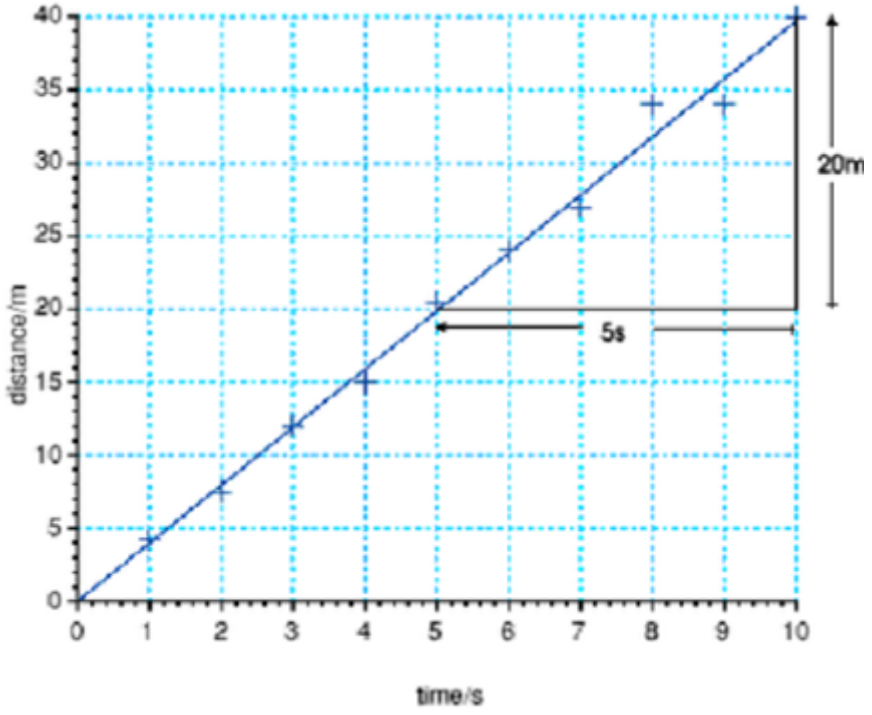
Answer

Velocity is equal to the slope of the distance-time graph.

$$\text{Slope} = \text{Velocity} = \frac{\text{change in distance}}{\text{change in time}}$$

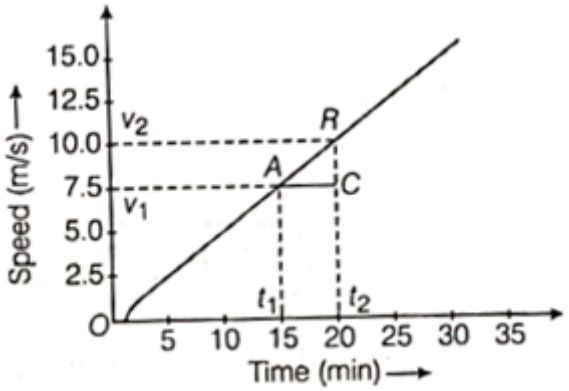
$$= \frac{40-20}{10-5} \text{ m/s}$$

$$= \frac{20}{5} \text{ m/s} = 4 \text{ m/s}$$



11. Question

Given below is the velocity-time graph for the motion of the car. What does the nature of the graph show? Also, find the acceleration of the car.



Answer

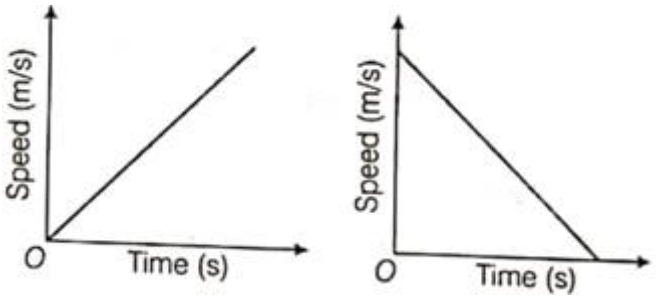
The graph represents a straight line which means that the object is moving with uniform acceleration.

$$\text{Acceleration} = \frac{\text{change in velocity}}{\text{change in time}} = \frac{10 - 7.5}{(20-15)\times 60} = \frac{2.5}{300}\ \text{m/s}^2$$

12. Question

(i) If the velocity-time graph of an object is parallel to X-axis, then what does it mean? Can it be parallel to Y-axis?

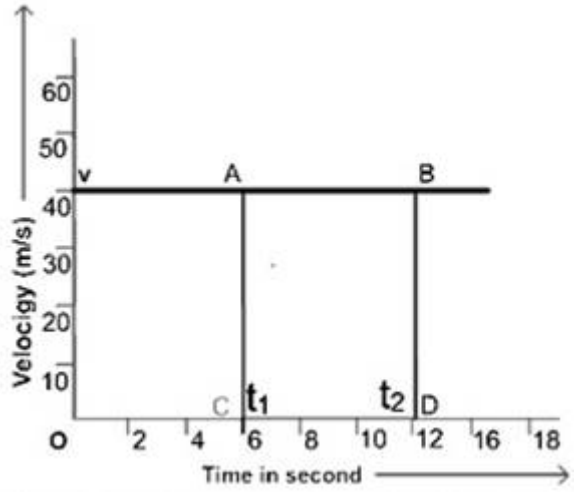
(ii) What type of motion is represented by each one of the following graphs?



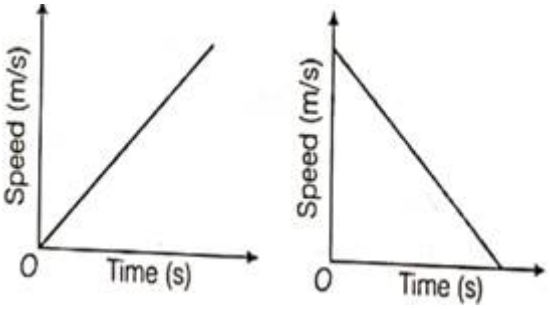
(iii) A bus increases its speed from 36 km/h to 54 km/h in 10 s. Find its acceleration.

Answer

(i) If the line is parallel to X-axis in a velocity-time graph that means that with increase in time velocity remains constant. There will be no acceleration and the body will move with constant velocity. It cannot be parallel to Y-axis because it will mean that time is constant but velocity is increasing which is practically not possible.



(ii)



The first graph represents a body which is moving with a uniform acceleration and the second graph represents a body which is moving with uniform retardation.

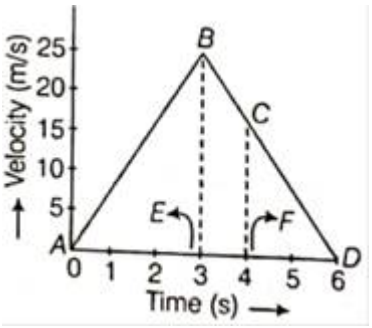
(iii) Initial velocity = 36 km/h = 10 m/s

Final velocity = 54 km/h = 15 m/s

Acceleration= $\frac{\text{change in velocity}}{\text{change in time}} = \frac{15-10}{10} = \frac{5}{10} = 0.5\ m/s^2$

13. Question

Study the velocity-time graph and calculate.



(i) the acceleration from A to B.

(ii) the acceleration from B to C.

(iii) the distance covered in the region ABE.

(iv) the average velocity from C to D.

(v) the distance covered in the region BCFE.

Answer

(i) Acceleration from A to B = $\frac{\text{change in velocity}}{\text{change in time}} = \frac{25-0}{3-0} = 8.33\ m/s^2$

(ii) Acceleration from B to C = $\frac{15-25}{4-3} = -10\ m/s^2$

(iii) Distance covered in the region ABE = $\frac{1}{2}$ × base × height

= $\frac{1}{2}$ × 3s × 25 m/s

= 37.5 m

(iv) Average velocity from C to D = $\frac{\text{initial velocity+final velocity}}{2}$

= $\frac{15+0}{2} = 7.5$ m/s

(v) Distance covered in the region BCFE = $\frac{1}{2}$ × sum of parallel sides x distance between them = $\frac{1}{2}$ × (25+15) × 1 = 20 m

14. Question

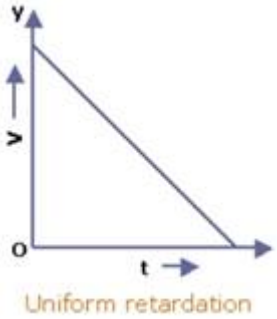
Plot velocity-time graph of a body.

(i) moving with a uniform retardation.

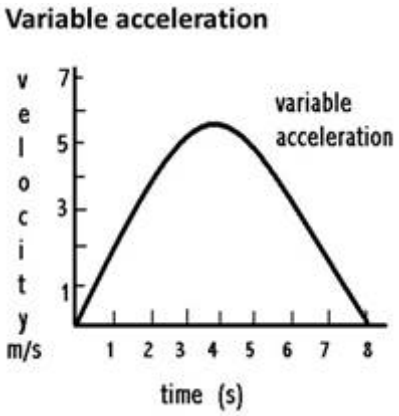
(ii) moving with a variable acceleration.

Answer

(i) moving with a uniform retardation



(ii) moving with a variable acceleration



15. Question

A body starts to slide over a horizontal surface with an initial velocity of 0.5 m/s. Due to friction, its velocity decreases at the rate 0.105 m/s^2. How much time will it take for the body to stop?

Answer

Using the first equation of motion: v = u + at

where: v = final velocity = 0 m/s

u = initial velocity = 0.5 m/s

a = acceleration = -0.105 m/s^2

t = time = ??

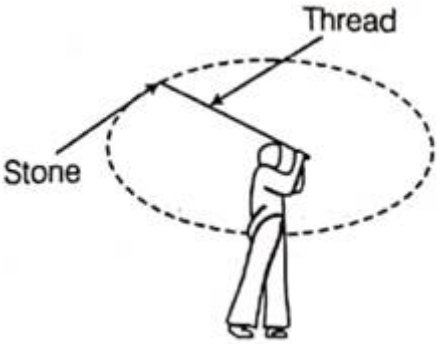
v = u + at

0 = 0.5 - 0.105 x t0.105 x t = 0.5

t = $\frac{0.5}{0.105}$ s =4.76 s

16. Question

Look at the figure below and answer the following questions:



(i) Name the kind of motion of the stone.

(ii) It this an example of accelerated motion? Why?

(iii)Name the force that keeps the stone in its path.

(iv) What is the direction of this force? Draw it in your answer sheet.

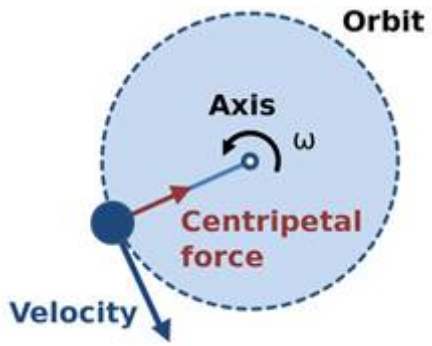
Answer

(i) The stone is moving with circular motion.

(ii) Yes it is an example of accelerated motion. Though the velocity is constant but as the thread is moving it is changing its direction at each point which is tangential to the circular path.

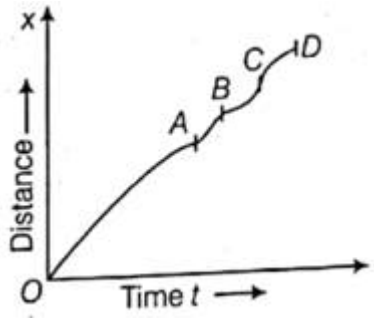
(iii) Centripetal force keeps the stone in its path.

(iv) The force is directed towards the centre of the circular path.



17. Question

The figure shows an x-t graph of a particle moving along a straight line. What is the sign of the acceleration during the intervals OA, AB, BC, and CD?



Answer

a) From the graph we can infer that in the interval OA, it's almost a straight line with a positive slope. Therefore velocity is positive that is with increase in time distance also increases and thus acceleration is also positive as well as uniform.

b) In the interval AB, the line has a negative slope as with increase in time distance decreases. Here velocity is negative and it shows retardation.

c) BC represents more downfalls in the slope of the line which means velocity will become more negative and hence it shows retardation with greater magnitude than AB.

d) CD shows that with increase in time distance is increasing again with a positive slope. Therefore velocity is positive which implies acceleration is also positive.

18. Question

Write three equations of uniformly accelerated motion. Also, state the symbols used.

Answer

a) The first equation of motion: $v = u + at$

where: v = final velocity (m/s)

u = initial velocity (m/s)

a = acceleration (m/s^2)

t = time (s)

b) The second equation of motion: $s = ut + \frac{1}{2}at^2$

where: s = distance covered (m)

u = initial velocity (m/s)

a = acceleration (m/s^2)

t = time (s)

c) The third equation of motion: $v^2 - u^2 = 2$

as

where: s = distance covered (m)

v = final velocity (m/s)

u = initial velocity (m/s)

a = acceleration (m/s^2)

19. Question

An object starting from rest travels 20 m in the first 2s and 160 m in next 4s. What will be the velocity after 7s from the start?

Answer

Using the second equation of motion: $s = ut + \frac{1}{2}at^2$

where: s = distance covered = 20 m

u = initial velocity = 0 m/s

a = acceleration = ? m/s^2

t = time = 2s

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

$20 = 0 \times 2 + \frac{1}{2} \times a \times 2^2$

$20 = 0 + 2 \times a$

$a = \mathbf{10\ m/s^2}$

Final velocity, v after 2s

The first equation of motion: v = u + at

where: v = final velocity = ?

u = initial velocity = 0 m/s

a = acceleration = 10 m/s^2

t = time = 2s

v = u + at

$v = 0 + 10 \times 2 = \mathbf{20\ m/s}$

Now it is given that in next 4s it covers 160 m. But now the vehicle has gained some velocity. So the final velocity of the previous case will become the initial velocity in this case.

Using the second equation of motion: $s = ut + \frac{1}{2}at^2$

where: s = distance covered = 160 m

u = initial velocity = 20 m/s

a = acceleration = ? m/s^2

t = time = 4s

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

$160 = 20 \times 4 + \frac{1}{2} \times a \times 4 \times 4$

$160 = 80 + a \times 8160 - 80 = a \times 880 = a \times 8a = \mathbf{10\ m/s^2}$

This shows that acceleration is uniform.

The first equation of motion: v = u + at

where: v = final velocity = ?

u = initial velocity = 0 m/s

a = acceleration = 10 m/s^2 t = time = 7s

v = u + at

v = 0 + 10 × 7

v = **70 m/s**

20. Question

Obtain a relation for the distance travelled by an object moving with a uniform acceleration in the interval between 4^{th} and 5^{th} second.

Answer

Using the second equation of motion: $s = ut + \frac{1}{2}at^2$

where: s = distance covered

u = initial velocity

a = acceleration

t = time = 4s

Distance covered in 4s :

$s_1 = ut + \frac{1}{2}at^2$

$s_1 = u \times 4 + \frac{1}{2}a \times 4^2$

$s_1 = 4u + \frac{16}{2}a$ …… equation 1

Distance covered in 5s:

$s_2 = ut + \frac{1}{2}at^2$

$s_2 = u \times 5 + \frac{1}{2}a \times 5^2$

$s_2 = 5u + \frac{25}{2}a$ …… equation 2

Distance travelled by an object between 4^{th} and 5^{th} sec:

equation 2 – equation 1

$(s_2 - s_1) = (5u + \frac{25}{2}a) - (4u + \frac{16}{2}a)$

$(s_2 - s_1) = 5u - 4u + \frac{25}{2}a - \frac{16}{2}a)$

$\mathbf{(s_2 - s_1) = u + \frac{9}{2}a}$

21. Question

Manan and Sharman went to Agra through Yamuna-Expressway. Manan started the car and accelerated, so highly that the car was running at 180 km/h within the 20s. Sharma stopped him from doing so and told him that over speeding on road was a straight invitation to life staking situation. Though Manan wanted the adventure of speeding but he was convinced by Sharman.

(i) Why do you think it is dangerous to drive fast on road?

(ii) Which values of Sharman are worth appreciating?

(iii) Find Manan's speed in m/s.

(iv) What is the acceleration of car?

(v) What would you suggest to Manan, if you were in that car?

Answer

(i) Over speeding on roads increases the chances of accidents which could be fatal also. Some serious injuries may happen due to this. Also they could hit some other car on the road as well.

(ii) Sharman behaved as a responsible citizen and patiently he convinced his friend not to drive like this. He is smart, intelligent, responsible as well as patient.

(iii) Speed = 180 km/h

1 km = 1000 m and 1 hour = 3600 secs

speed = $\frac{180 \times 1000}{3600} = \frac{18000}{3600}$ = 5 m/s

(iv) The first equation of motion: v = u + at

where: v = final velocity = 5 m/s

u = initial velocity = 0 m/s

a = acceleration = ? m/s^2

t = time = 20s

v = u + at

5 = 0 + a × 20

$a = \frac{5}{20} = 0.25\ m/s^2$

(v) I would also suggest him to drive in the speed limit and try to make him realize the importance of life.

22. Question

Manoj was travelling by Metro train while Rajnish was travelling by his car towards the same destination. Manoj was surprised to reach much before Rajnish and said, since his motion was uniform, he could reach on time. However, Rajnish said that Manoj's motion was also not uniform.

(i) Who gave a correct explanation of types of motion?

(ii) How did Manoj reach early?

(iii) Give the characteristic values of Manoj.

Answer

(i) Rajnish gave the correct explanation as for a uniform motion the velocity should be uniform. But the metro has stopped at various stations which means that it had come to rest and its velocity at that point is zero.

(ii) Manoj had used metro which is free from the traffic jam and thus manages to reach early.

(iii) Manoj is a responsible citizen as he had used a public transport instead of the personal car which helps in conservation of fuel.

23. Question

Neha and Priya went to market. There was no parking space left. Neha parked the car on road side and came out. Priya, however, was very concerned about traffic rules and said that the car should not be

standing in 'Tow Away Zone'. She made Neha drive to the next parking slot which was a little for from the market area.

(i) Compare and contrast the values of Neha and Priya.

(ii) What type of motion is exhibited by a car moving in the market area?

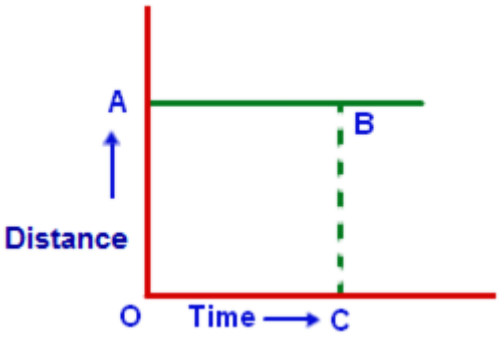
(iii) Represent a car parked in a parking area graphically on a distance-time graph.

Answer

(i) Neha is not concerned about the traffic rules and hence does not care about the problems faced by other people. On the other hand, Priya being a responsible citizen follows the traffic rules. She understands that car being parked in a tow away zone can lead to traffic jams and can lead to chaos.

(ii) Non-uniform motion is exhibited by the car in the market area as Neha has to sometimes stop the car, sometimes move the car. The velocity is not uniform.

(iii) With the increase in time, distance remains the same which implies that the object is at rest.



Challengers

1. Question

A 100 m sprinter increases her speed from rest uniformly at the rate of 1 m/s^2 upto 40 m and covers the remaining distance with a uniform speed. The sprinter covers the first half of the run in t_1s and second half in t_2s, then

A. $t_1 > t_2$

B. $t_1 < t_2$

C. $t_1 = t_2$

D. information given is incomplete

Answer

For the first 40 m:

Using the third equation of motion: $v^2 - u^2 = 2$]

as

where: s = distance covered = 40 m

v = final velocity = ? m/s

u = initial velocity = 0 m/s

a = acceleration = 1 m/s^2

$v^2 - u^2 = 2$

as

$v^2 - 0 = 2 \times 1 \times 40$

$v^2 = 80$

v = 8.94 m/s

Using the first equation of motion: v = u + at

where: v = final velocity = 8.94 m/s

u = initial velocity = 0 m/s

a = acceleration = 1 m/s^2

t_1 = time = ?s

$v = u + at_1$

$8.94 = 0 + 1 \times t_1$

$t_1 = 8.94s$

Here its given the speed is uniform not velocity, therefore

acceleration will be 1 m/s^2 and speed will be 8.94 m/s everywhere.

Using the third equation of motion: $v^2 - u^2 = 2$

as

where: s = distance covered = 60 m

v = final velocity = ?? m/s

u = initial velocity = 8.94 m/s

a = acceleration = 1 m/s^2

$v^2 - u^2 = 2$

as

$v^2 - (8.94)^2 = 2 \times 1 \times 60$

v^2- 80 = 120

$v^2 = 120 + 80 = 200$

v = 14.14 m/s

Using the first equation of motion: v = u + at

where: v = final velocity = 14.14 m/s

u = initial velocity = 8.94 m/s

a = acceleration = 1 m/s^2

t_2 = time = ?s

$v = u + at_2$

$14.14 = 8.94 + 1 \times t_2$

$t_2 = 14.14 - 8.94$

t_2 = 5.2 secs

2. Question

Particles P and Q are undergoing uniform horizontal circular motions along concentric circles of different radii in clockwise sense P completes each round in 2 min while Q does it is 5 min time required by Q to make one revolution around P is

A. 3 min

B. 10 min

C. $\frac{10}{3}$ min

D. This is not possible as Q is moving slower than P

Answer

Time taken by Q to make one revolution around P = Time taken by Q to complete one revolution – time taken by P to complete one revolution = 5 mins – 2 mins = 3 mins

3. Question

You are sitting in a stationary car. There is a helium balloon tied to its floor. You accelerate and obviously feel like you are being pushed backwards (against the direction of your accelerations). The balloon.

A. will move forward

B. will move backward

C. will remain state

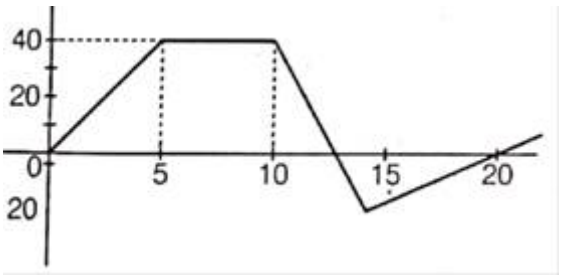
D. None of these

Answer

Helium is less denser than the air and so it is lighter then the air, so when the car is accelerated the air starts moving backwards but as the helium is lighter it is pushed forward by the air collecting at its back.

4. Question

A boy begins to walk eastward along a street in front of his house and the graph of his position from have is shown in the following figure. His average speed for whole time interval in equal to



A. 8 m/min

B. 6 m/min

C. $\frac{8}{3}$ m/ min

D. 2 m/min

Answer

Average speed = $\frac{\text{(total distance travelled)}}{\text{total time taken}} = \frac{120}{20}$ m/min = 6 m/min

5. Question

A bus is travelling the first one-third distance at a speed of 10 km/h, the next one-fourth at 20 km/h and the remaining at 40 km/h. What is the average speed of the bus?

A. 17 km/h

B. 17.8 km/h

C. 18 km/h

D. 20 km/h

Answer

Let the total distance be 100 km

One third of 100 km = 33.33 km

time = $\frac{\text{distance}}{\text{speed}}$

$t_1 = \frac{33.33}{10}$ = 3.33 hr

Distance left = 100 km – 33.33 km = 66.67 km

One fourth of 66.67 km = 16.67 km

$t_2 = \frac{16.67}{20}$ = 0.83 hr

Remaining distance = 100 km – 33.33 km – 16.67 km = 50 km

$t_3 = \frac{50}{40}$ = 1.25 hr

$t_1+t_2+t_3$ = 5.41 hr

Average speed = $\frac{\text{(total distance travelled)}}{\text{total time taken}} = \frac{100}{5.41}$ = 18.4 km/hr

6. Question

A car A is travelling on a straight level road with a uniform speed of 60 km/h. It is followed by another car B. Which is moving with a speed of 70 km/h. When the distance between them is 2.5 km, the car B is given a deceleration of 20 km/h^2. After how much time will B catch up with A?

A. 1 h

B. $\frac{1}{2}$ h

C. $\frac{1}{4}$ h

D. $\frac{1}{8}$ h

Answer

Distance covered by car A in time t is, s_1 = 60 t

For car B:

Using the second equation of motion: s = ut + $\frac{1}{2}$ at^2

where: s = distance covered = s_2

u = initial velocity = 70 km/h

a = acceleration = -20 km/h

t = time = t

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

s_2 = 70t + $\frac{1}{2}$ (-20) × t^2

s_2 = 70t – 10 t^2

But it is given that s_2 – s_1 =2.5 km

$70t - 10\,t^2 - 60\,t = 2.5$

$10t - 10\,t^2 = 2.5$

$t - t^2 = 0.25$

$t - t^2 - 0.25 = 0$

$t^2 - t + 0.25 = 0$

$(t - 0.5)^2 = 0$

$t = 0.5$ hr

7. Question

A sprinter has to cover a total run of 100 m. She increases her speed from rest under a uniform acceleration of 1.0 m/s^2 up to three quarters of the total run and covers the last quarter him uniform speed. The time she takes to cover the first half, and to cover the second half of the run will be

A. 3.25 s

B. 4.25 s

C. 5.25 s

D. 6.25 s

Answer

Using the second equation of motion: $s = ut + \frac{1}{2}at^2$

where: s = distance covered = 75 m

u = initial velocity = 0 m/s

a = acceleration = 1 m/s^2

t = time = ts

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

$75 = 0 + \frac{1}{2} \times 1 \times t^2$

$75 \times 2 = t^2$

$150 = t^2$

$t = 12.24$ s

Using the third equation of motion: $v^2 - u^2 = 2$

as

where: s = distance covered = 75 m

v = final velocity = ?? m/s

u = initial velocity = 0 m/s

a = acceleration = 1 m/s^2

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

$v^2 = 2 \times 1 \times 75 = 150$

$v = 12.24$ m/s

For second part distance is 25 m.

Using the second equation of motion: $s = ut + \frac{1}{2}at^2$

where: s = distance covered = 25 m

u = initial velocity = 12.24 m/s

a = acceleration = 1 m/s^2

t = time = ts

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

$25 = 12.24t + \frac{1}{2}1 \text{ x } t^2$

$t^2 + 24.48t - 50 = 0$

$t = 1.99$ s

8. Question

A bus begin to move with an acceleration of 1 m/s^2. A man who is 48 m behind the bus starts running at 10 m/s to catch the bus. The man will be able to catch the bus after.

A. 8 s

B. 5 s

C. 6 s

D. 7 s

Answer

For bus:

Using the second equation of motion: $s = ut + \frac{1}{2}at^2$

where: s_1 = distance covered = ? m

u = initial velocity = 0 m/s

a = acceleration = 1 m/s^2

t = time = ts

$s_1 = ut + \frac{1}{2}at^2$

$s_1 = 0 \times t + \frac{1}{2} \times 1 \times t^2 = t^2/2$

Distance travelled by the man, $s_2 = 10t$

$s_2 - s_1 = 48$ m

$10t - t^2/2 = 48$

$20t - t^2 = 96$

$20t - t^2 - 96 = 0$

$t^2 - 20t + 96 = 0$

$(t-12)(t-8) = 0$

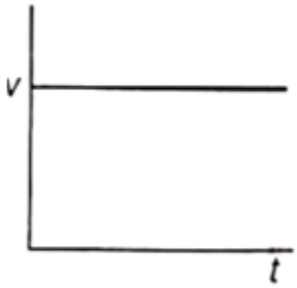
t = 12s or 8s

9. Question

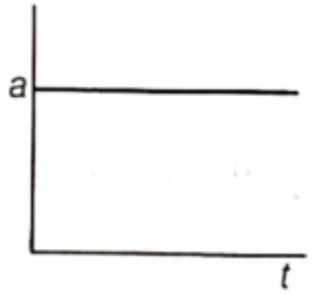
Which graph represents a state of rest for an object?

A.

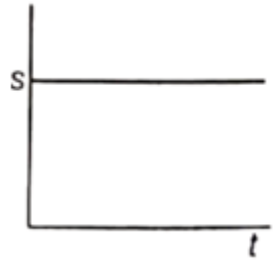
B.



C.



D.



Answer

With increase in time distance remains constant which means it is not moving.