NCERT SOLUTIONS

CLASS - 9th

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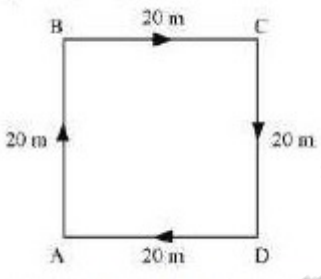
Class : 9th
Subject : Science
Chapter : 8
Chapter Name : Motion

Q1 An object has moved through a distance. Can it have zero displacement? If yes, support your answer with an example?

Answer. Yes. An object that has moved through a distance can have zero displacement. Displacement is the shortest measurable distance between the initial and the final position of an object. An object which has covered a distance can have zero displacement, if it comes back to its starting point, i.e., the initial position. Consider the following situation. A man IS walking in a square park of length 20 m (as shown in the following figure). He staffs walking from point A and after moving along all the corners of the park (point B, C, D), he again comes back to the same point, i.e.,
A.



In this case, the total distance covered by the man is 20 m +20 m + 20 m + 20 m = 80 m. However, his displacement is zero because the shortest distance between his initial and final position is zero.

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Q2 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 from his initial position?

Answer. The farmer takes 40 s to cover 4 x 10 =40 m.
In 2 min and 20 s (140 s), he will cover a distance $\frac{40}{40} \times 140$=40m
Therefore, the farmer completes $\frac{140}{40} = 3.5$ rounds (3 complete rounds and a half round) of the field in 2 min and 20 s.
That means, after 2 min 20 s, the farmer Will be at the opposite end of the starting point.
Now, there can be two extreme cases.
Case I: Starting point is a comer point of the field.
In this case, the farmer will be at the diagonally opposite corner of the field after 2 min 20 s.

Therefore, the displacement will be equal to the diagonal to the field.
Hence, the displacement will be $\sqrt{10^2 + 10^2}$=14.1m
Case II: Starting point is the middle point of any side of the field.
In this case the farmer Will be at the middle point of the opposite side of the field after 2 min 20 s.
Therefore, the displacement will be equal to the side of the field, i.e., 10 m.
For any other starting point, the displacement will be between 14.1 m and 10 m.

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Q3 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.

Answer. (a) Not true.
Displacement can become zero when the initial and final position of the object is the same.
(b) Not true.
Displacement is the shortest measurable distance between the initial and final positions of an object. It cannot be greater than the magnitude of the distance travelled by an object. However, sometimes, it may be equal to the distance travelled by the object.

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Q1 Distinguish between speed and velocity?

Answer.

Speed	**Velocity**
Speed is the distance travelled by an object in a given interval of time. It does not have any direction.	Velocity is the displacement of an object in a given interval of time. It has a unique direction.
Speed is given by the relation: $\text{Speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$	Velocity is given by the relation: $\text{Velocity} = \frac{\text{Displacement}}{\text{Time interval}}$
The speed of an object can never be negative. At the most, it can become zero. This is because distance travelled can never be negative.	The velocity of an object can be negative, positive, or equal to zero. This is because displacement can take any of these three values.

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Q2 Under what condition(s) is the magnitude of average velocity of an object equal to its average speed?

Answer. $\frac{\text{Total distance covered}}{\text{Total time taken}}$
$= \frac{\text{Displacement}}{\text{Total time taken}}$

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Q3 What does the odometer of an automobile measure?

Answer. The odometer an automobile measures the distance covered by an automobile.

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Q4 What does the path of an object look like when it is in uniform motion?

Answer. An object having uniform motion has a straight line path.

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Q5 During an experiment, a signal from a spaceship reached the ground station in five minutes. What was the distance of the spaceship from the ground station? The signal travels at the speed of light, that is, 3×10^8m/s

Answer. Time taken by the signal to reach the ground station from the spaceship.
5 min = 5 x 6O = 300 s
Speed of the signal = $3 \times 10^8 \text{m/sv}$
$= \frac{\text{Distance travelled}}{\text{Time taken}}$
Therefore, distance travelled = Speed X Time taken = $3 \times 10^8 \times 300 = 9 \times 10^{10}\text{m}$
Hence, the distance of the spaceship from the ground station is $9 \times 10^{10}\text{m}$

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Q1 When will you say a body is in
(i) uniform acceleration?
(ii) nonuniform acceleration?

Answer. (i) A body is said to have uniform acceleration if It travels in a straight path in such Way that its velocity changes at a uniform rate, i.e., the velocity of a body increases or decreases by equal amounts in an equal interval of time.
(ii) A body is said to have non-uniform acceleration if it travels in a straight path In such a way that velocity changes at a non-uniform rate, i.e., the velocity of a body increases or decreases in unequal amounts in an equal interval of time.

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Q2 A bus decreases its speed from 80 km h−1 to 60 km h−1 in 5 s. Find the acceleration of the bus?

Answer. Initial speed of the bus, U = 80 km/h = $80 \times \frac{5}{18}$=22.22m/s
Final speed of the bus, V =6O km/h = $60 \times \frac{5}{18}$=16.66 m/s
Time take to decrease the speed, t = 5 s
Acceleration, $a = \frac{v-u}{t} = \frac{16.66-22.22}{5} = -1.112 \mathrm{m/s^2}$
Here, the negative Sign of acceleration indicates that the velocity of the car is decreasing.

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Q3 A train starting from a railway station and moving with uniform acceleration attains a speed 40 km h–1 in 10 minutes. Find its acceleration?

Answer. Initial velocity of the train, = O (since the train is initially at rest)
Final velocity of the train, V =40 km/h = $40 \times \frac{5}{18}$=11.11m/s
Time taken,t=10 min=10x 60=600s
Acceleration, $a = \frac{v-u}{t} = \frac{11.11-0}{600} = 0.0185 \mathrm{m/s^2}$
Hence, the acceleration of the train is $0.0185 \mathrm{m/s^2}$.

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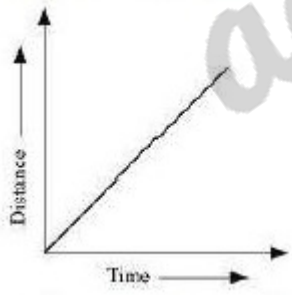
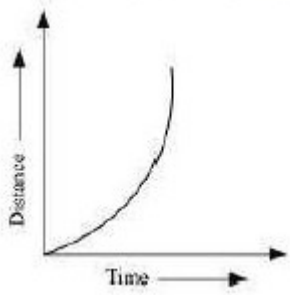
Q1 What is the nature of the distance-time graphs for uniform and non-uniform motion of an object?

Answer. The distance—time graph for uniform motion of an object is a straight line (as shown in the following figure).



The distance—time graph for non-uniform motion of an object is a curved line (as shown in the given figure).



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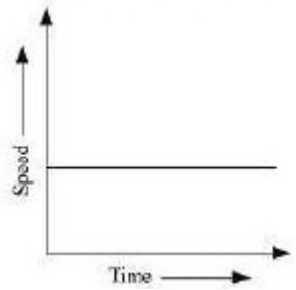
Q2 What can you say about the motion of an object whose distance-time graph is a straight line parallel to the time axis?

Answer. When an object IS at rest, its distance time graph is a straight line parallel to the time axis.



A straight line parallel to the x-axis in a distance—-time graph indicates that with a change in time, there is no change in the position of the object. Thus, the object is at rest.

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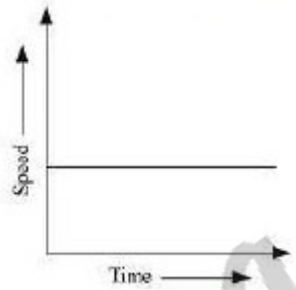
Q3 What can you say about the motion of an object if its speed time graph is a straight line parallel to the time axis?

Answer. Object is moving uniformly.



A straight line parallel to the time axis in a speed—time graph indicates that with a change in time, there is no change in the speed of the object. This indicates the
uniform motion of the object.

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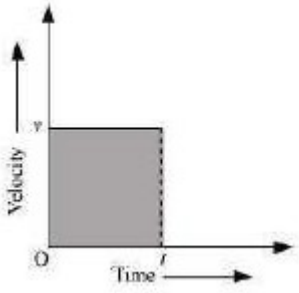
Q4 What is the quantity which is measured by the area occupied below the velocity-time graph?

Answer.



The graph shows the velocity—time graph of a uniformly moving body.
Let the velocity of the body at time (t) be v.
Area of the shaded region = length X breath
Where,
Length = t
Breath = V
We know,
$= \frac{\text{Distance}}{\text{Time}}$
Distance =Velocity x Time ..(ii)
From equations (i) and (ii),
Area = Distance
Hence, the area occupied below the velocity—time graph measures the distance covered by the body.

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Q1 A bus starting from rest moves with a uniform acceleration of 0.1 m $s^{-2}$for 2 minutes. Find:
(a) the speed acquired,
(b) the distance travelled.

Answer. (a) Initial speed of the bus, = O (since the bus is initially at rest)
Acceleration, a = $0.1\text{m}/\text{s}^2$
Time taken, t = 2 minutes = 120 s
Let V be the final speed acquired by the bus.
$a = \frac{v-u}{t}$
$0.1 = \frac{v-0}{120}$
v=12m/s
(b) According to the third equation of motion:
$v^2 - u^2 = 2as$
Where, S is the distance covered by the bus
$(12)^2 - (0)^2 = 2(0.1)s$
s=720m
Speed acquired by the bus is 12 m/s.
Distance travelled by the bus is 720 m.

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Q2 A train is travelling at a speed of 90 kmh^{-1} . Brakes are applied so as to produce a uniform acceleration of – 0.5 m s^{-2}. Find how far the train will go before it is brought to rest.

Answer. Initial speed of the train, U =90 km/h=25m/s
Final speed of the train, V =0 (finally the train comes to rest)
Acceleration = -0.5ms^{-2}
According to third equation of motion:

$v^2 - u^2 = 2as$
$(0)^2 = (25)^2 + 2(-0.5)s$
Where ,S is the distance covered by train
$s = \frac{(25)^2}{2(0.5)} = 625\text{m}$
The train will Cover a distance of 625 m before it comes to rest.

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Q3 A trolley, while going down an inclined plane, has an acceleration of 2 cm s-2. What will be its velocity 3 s after the start?

Answer. Initial velocity of the trolley, U = 0 (since the trolley was initially at rest)
acceleration,a= 2cms^{-2}= 0.02m/s^2
Time, t = 3 s
According to the first equation of motion:
v = u + at
Where, V is the velocity of the trolley after 3 s from start
v = o + 0.02x3=0.06 m/s
Hence, the velocity of the trolley after 3 s from start is 0.06 m/s.

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Q4 A racing car has a uniform acceleration of 4 ms^{-2}. What distance will it cover in 10 s after start?

Answer. Initial velocity of the racing car, U = O (since the racing car is initially at rest)
Acceleration ,a= 4m/s^2
Time taken, t = 10 s
According to the second equation of motion:
$s = ut + \frac{1}{2}at^2$
Where, S is the distance covered by the racing car
$s = 0 + \frac{1}{2} \times 4 \times (10)^2 = \frac{400}{2} = 200\text{m}$
Hence, the distance covered by the racing car after 10 s from start is 200 m.

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Q5 A stone is thrown in a vertically upward direction with a velocity of 5 m s-1. If the acceleration of the stone during its motion is 10 $\text{m}s^{-2}$in the downward direction, what will be the height attained by the stone and how much time will it take to reach there?

Answer. Initially, velocity of the stone,u = S m/s
Final velocity, V = O (since the stone comes to rest when it reaches its maximum height)
Acceleration of the stone, a =acceleration due to gravity, g =10 m/s^2
There will be a change in the sign of acceleration because the stone is being thrown

upwards.
Acceleration , a=$-10\mathrm{m/s}^2$
Let S be the maximum height attained by the stone in time t.
According to the first equation of motion:
v=u+at
o=5+(-10)t
t=$\frac{-5}{-10}$=0.5s
According to the third equation of motion:
$v^2 - u^2 = 2as$
$(0)^2 = (5)^2 + 2(-10)s$
s= $\frac{5^2}{20}$=1.25
Hence, the stone attains a height of 1.25 m in 0.5 s.

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Q1 An athlete completes one round of a circular track of diameter 200 m in 40 s. What will be the distance covered and the displacement at the end of 2 minutes 20 s?

Answer. Diameter of circular track ,d=200m
Radius of a track r= $= \frac{d}{2}$=100m
Circumference = 2nr = 2n (100) = 200n m
In 40 s, the given athlete covers a distance of 200n m.
In 1 s, the given athlete covers a distance $\frac{200\pi}{40}$m
The athlete runs for 2 minutes 20 s = 140 s
TotaI distance covered in $140\mathrm{s} = \frac{200\times22}{40\times7} \times 140$
The athlete covers one round of the circular track in 40 s. This means that after every 40 s, the athlete comes back to his original position. Hence, in 140 s he had completed 3 rounds of the circular track and is taking the fourth round.
He takes 3 rounds in 40 3 = 120 s. Thus, after 120 s his displacement is zero.
Then, the net displacement of the athlete is in 20 s only. In this interval of time, he moves at the opposite end of the initial position. Since displacement is equal to the shortest distance between the initial and final position of the athlete, displacement of the athlete will be equal to the diameter of the circular track.
Displacement of the athlete = 200 m.
Distance covered by the athlete in 2 min 20 s is 2200 m and his displacement is 200 m.

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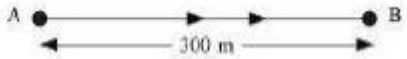
Q2 Joseph jogs from one end A to the other end B of a straight 300 m road in 2 minutes 30 seconds and then turns around and jogs 100 m back to point C in another 1 minute. What are Joseph's average speeds and velocities in jogging (a) from A to B and (b) from A to C?

Answer. (a) 1.765 rn/e, 1,765 m/s

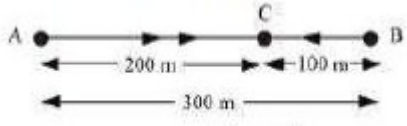
(b) 1.739 m/s, 0.87 m/s

(a) From end A to end B



Distance covered by Joseph while jogging from A to B=300 m.
Time taken to cover that distance = 2 min 50 seconds = 170 s.
$=\frac{\text{Displacement}}{\text{Time interval}}$
Total distance covered = 300 m.
Total time taken = 170 s.
Average speed=$\frac{300}{170}$=1.765m/s.
The average speed and average velocity of Joseph from A to a are the same and equal to 1.765 m/s.

(b) From end A to end C



$=\frac{\text{Total distance covered}}{\text{Total time taken}}$
Total distance covered distance from A to a + Distance from B to C
300 + 100 = 400 m
Total time taken = Time taken to travel from A to B + Time taken to travel from B to c = 170 + 60 = 230 s
Average speed =$\frac{400}{230}$=1.739m/s
$=\frac{\text{Displacement}}{\text{Time interval}}$
Displacement from A to C = AC = AB — ac = 300 — 100 = 200 m
Time interval = time taken to travel from A to a + time taken to travel from to C
170 + 60 = 230 s
Average velocity=$\frac{200}{230}$=0.87m/s
The average speed of Joseph from A to C is 1.739 m/s and his average velocity is 0.87 m/s.

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Q3 Abdul, while driving to school, computes the average speed for his trip to be 20 km h^{-1}. On his return trip along the same route, there is less traffic and the average speed is 30 km h^{-1}. What is the average speed for Abdul's trip?

Answer. Case I: While driving to school
Average speed of Abdul's trip = 20 km/h
$=\frac{\text{Total distance}}{\text{Total time taken}}$
Total distance = Distance travelled to reach school =d
Let total time taken = t.

20=$\frac{d}{t_1}$

$t_1 = \frac{d}{20}$

Case II: While returning from school

Total distance = Distance travelled while returning from school —

Now, total time taken = t_2

$40 = \frac{d}{t_2}$

$t_2 = \frac{d}{40}$

$= \frac{\text{Total distance covered in the trip}}{\text{Total time taken}}$

Where,

Total distance covered in the trip = d + d = 2d

Total time taken, t = Time taken to go to school + Time taken to return to school

t_1+ t_2

Average speed== $\frac{2d}{l_1+t_2}$

From equations (i) and (ii),

Average speed=$\frac{2d}{\frac{d}{20}+\frac{d}{40}}$

$\frac{2}{\frac{2+1}{40}}$

Hence, the average speed for Abdul's trip is 26.67 m/s.

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Q4 A motorboat starting from rest on a lake accelerates in a straight line at a constant rate of 3.0 $\mathrm{m/s^2}$ for 8.0 s. How far does the boat travel during this time?

Answer. Initial velocity, U = O (since the motor boat is initially at rest)

Acceleration of the motorboat, a = $3\mathrm{m/s^2}$

Time taken, t = 8 s

According to the second equation of motion:

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

Distance covered by the motorboat, S

$s = 0 + \frac{1}{2}3 \times (8)^2 = 96\mathrm{m}$

Hence, the boat travels a distance of 96 m.

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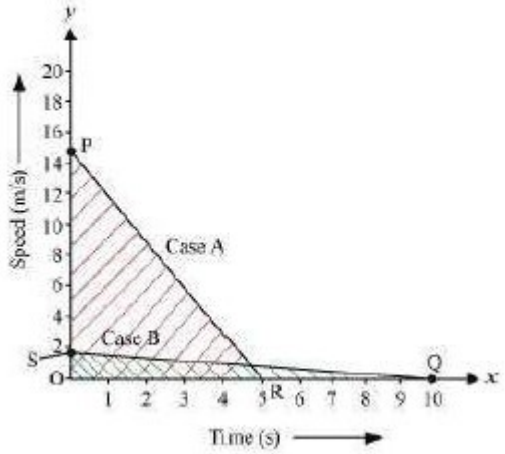
Q5 A driver of a car travelling at 52 km h^{-1} applies the brakes and accelerates uniformly in the opposite direction. The car stops in 5 s. Another driver going at 3 km h^{-1} in another car applies his brakes slowly and stops in 10 s. On the same graph paper, plot the speed versus time graphs for the two cars. Which of the two cars travelled farther after the brakes were applied?

Answer. Case A:

Initial speed of the car, u^{-1} = 52 km/h = 14.4 m/s

Time taken to stop the car, t^{-1} = 5 s
Final speed of the car becomes zero after S s of application of brakes.
Case B:
Initial speed of the car, u^{-2} = 3 km/h = 0.833 m/s= 0.83 m/s
Time taken to stop the car, t^{-1}= 10 s
Final speed of the car becomes zero after 10 s of application of brakes.
Plot of the two cars on a speed—time graph is shown in the following figure:



Distance covered by each car is equal to the area under the speed—time graph.
Distance covered in case A,
$s^{-1}== \frac{1}{2} \times \mathrm{OP} \times \mathrm{OR} = \frac{1}{2} \times 14.4 \times 5 = 36\mathrm{m}$
Distance covered in case B,
$s^{-2}=\frac{1}{2} \times \mathrm{OS} \times \mathrm{OQ} = \frac{1}{2} \times 0.83 \times 10 = 4.15\mathrm{m}$
$\Delta OPR >$ Area of ΔOSQ
Thus, the distance covered in case A is greater than the distance covered in case B.
Hence, the car travelling With a speed of 52 km/h travels faither after brakes were applied.

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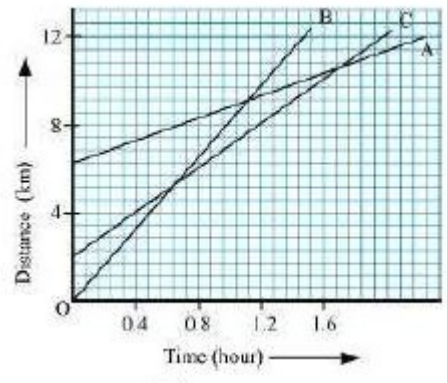
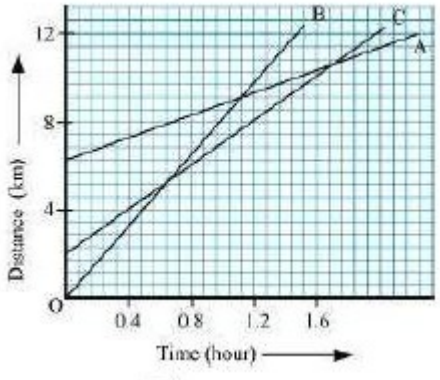
Q6 Fig 8.11 shows the distance-time graph of three objects A, B and C. Study the graph and answer the following questions:



(a) Which of the three is travelling the fastest?
(b) Are all three ever at the same point on the road?
(c) How far has C travelled when B passes A?
(d) How far has B travelled by the time it passes C?

Answer. (a) Object B.
(b) No.
(c) 5,714 km.
(d) 5,143 km.

(a)

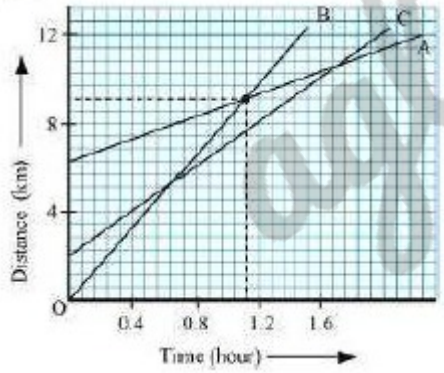


$= \frac{y-\text{axis}}{x-\text{axis}} = \frac{\text{Distance}}{\text{Time}}$

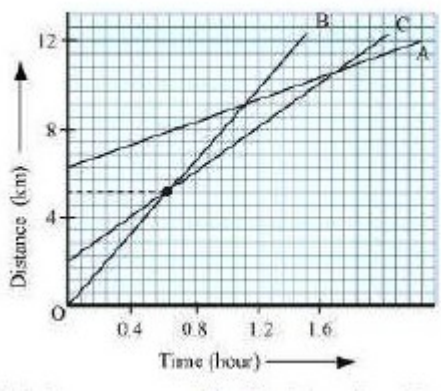
Speed = slope of the graph
Since slope of object a is greater than Objects A and C, it is travelling the fastest.

(b) All three objects A, a and C never meet at a single point. Thus, they were never at the same point on road.

(c)



On the distance axis:
7 small boxes =4 km
1 small box = $\frac{4}{7}$km
Initially, object C is 4 blocks away from the origin.
Initial distance of object C from origin= $\frac{16}{7}$km
distance of object C from origin when a passes A =8 km
Distance covered by C = $8 - \frac{16}{7} = \frac{40}{7}$=5.714 km
Hence, C has travelled a distance of 5.714 km when B passes A.
answer is D



Distance covered by B at the time it passes C =9 boxes
$\frac{4}{7} \times 9 == \frac{36}{7}$=5.143 km
Hence, B has travelled a distance of 5.143 km when B passes A.

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Q7 A ball is gently dropped from a height of 20 m. If its velocity increases uniformly at the rate of$10\text{ms} - 2$, with what velocity will it strike the ground? After what time will it strike the ground?

Answer. Distance covered by the ball, S = 20 m
Acceleration, a = $10\text{ms} - 2$
Initially, velocity, U = O (since the ball was initially at 'rest)
Final velocity of the ball with which it strikes the ground, V
According to the third equation of motion:
$v^2 = u^2 + 2as$
$v^2 = 0 + 2(10)(20)$
v=20 m/s
According to the first equation of motion:
v=u+at
Where,
Time, t taken by the ball to strike the ground is
20 =0+10(t)
t=2
Hence, the ball strikes the ground after 2 s with a velocity of 20 m/s.

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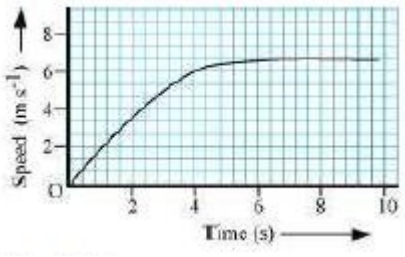
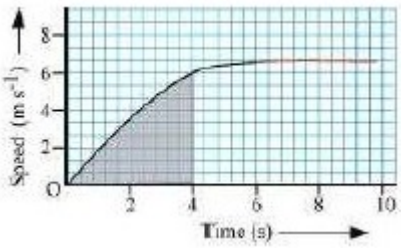
Q8 The speed-time graph for a car is shown is Fig. 8.12



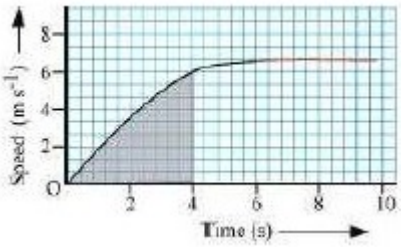
(a) Find how far does the car travel in the first 4 seconds. Shade the area on the graph that represents the distance travelled by the car during the period.
(b) Which part of the graph represents uniform motion of the car?

Answer.
(A)



The shaded area which is equal to $\frac{1}{2} \times 4 \times 6 = 12\text{m}$ represents the distance travelled .

(B)



The part of the graph in red colour between time 6 s to 10 s represents uniform motion of the car.

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Q9 State which of the following situations are possible and give an example for each of these:
(a) an object with a constant acceleration but with zero velocity
(b) an object moving with an acceleration but with uniform speed.

Answer. (a) Possible.
When a ball is thrown up at maximum height, it has zero velocity, although it will have constant acceleration due to gravity, Which is equal to 9.8 m/s2.
(b) Possible.
When a car is moving in a circular track, its acceleration is perpendicular to its d direction.

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Q10 An artificial satellite is moving in a circular orbit of radius 42250 km. Calculate its speed if it takes 24 hours to revolve around the earth.

Answer. Radius of the orbit = 42250 km = 42250 x 1000 m Time taken for one revolution = 24 hours = 24 x 60 x 60 sec, Speed = ?
Speed = = $\frac{\text{distance}}{\text{time}} = \frac{2\pi r}{\text{time}} = 2 \times \frac{22}{7} \times \frac{42250 \times 1000}{24 \times 60 \times 60}$

Speed $= 3073.74 \mathrm{ms}^{-1} = 3.07 \mathrm{kms}^{-1}$

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