Very Short Answer Type Questions

[1 Mark]

Q. 1. The phenomenon of motion was placed on a sound scientific footing by two scientists. Write their names.

Ans. Galileo Galilei and Isaac Newton.

Q. 2. Are rest and motion absolute or relative terms?

Ans. They are relative terms.

Q. 3. Suppose a ball is thrown vertically upwards from a position P above the ground. It rises to the highest point Q and returns to the same point P. What is the net displacement and distance travelled by the ball?

Ans. Displacement is zero. Distance is twice the distance between position P and Q.

Q. 4. Which speed is greater: 30 m/s or 30 km/h?

Ans. 30 m/s

Q. 5. What do you mean by 2 m/s^2?

Ans. The velocity of the body increases by 2 m/s after every second.

Q. 6. Can uniform linear motion be accelerated?

Ans. No

Q. 7. Define one radian.

Ans. It is the angle which is subtended at the centre by an arc having a length equal to the radius of the circle.

Q. 8. What is the relation between linear velocity and angular velocity?

Ans. Linear velocity = Angular velocity × Radius of circular path.

Q. 9. Give an example when we infer the motion indirectly.

Ans. We infer the motion of air by observing the movement of dust particles or leaves and branches of trees, or simply by feeling the blowing air on our face.

Q. 10. What is essential to describe the position of an object?

Ans. We need to specify a reference point called the origin.

Q. 11. What is the simplest type of motion?

Ans. Motion in a straight line.

Q. 12. What indicates the motion of the earth?

Ans. The phenomenon like day and night indicates the motion of the earth.

Q. 13. If the displacement of a body is zero, is it necessary that the distance covered by it is also zero?

Ans. No. When the body comes back to the same position after travelling a distance, its displacement is zero though it has travelled some distance.

Q. 14. Can the displacement be greater than the distance travelled by an object?

Ans. No, it is always either equal to or less than the distance travelled by the object.

Q. 15. When do the distance and displacement of a moving object have the same magnitude?

Ans. The magnitude of distance and displacement of a moving object are same when the object moves along the same straight line in the same fixed direction.

Q. 16. Does the speedometer of a car measure its average speed?

Ans. No. It measures its instantaneous speed.

Q. 17. A body is moving with a velocity of 10 m/s. If the motion is uniform, what will be the velocity after 10 s?

Ans. As the motion is uniform, the velocity remains 10 m/s after 10 s.

Q. 18. Can a body have constant speed but variable velocity?

Ans. Yes, *e.g*. a body in uniform circular motion has constant speed but due to the change in the direction of motion, its velocity changes at every point.

Q. 19. When is the acceleration taken as negative?

Ans. Acceleration is taken as negative if it is in the direction opposite to the direction of velocity.

Q. 20. What is uniform acceleration?

Ans. Acceleration of an object is said to be uniform if it travels in a straight line and its velocity increases or decreases by equal amounts in equal intervals of time. For example, motion of a freely falling body.

Q. 21. Give an example of non-uniform acceleration.

Ans. A car is travelling along a straight road increases its speed by unequal amounts in equal intervals of time.

Q. 22. How are the distances travelled by an object related to the time taken when an object travels equal distances in equal intervals of time?

Ans. In this case, distance travelled by the object is directly proportional to the time taken.

Q. 23. What would be acceleration of a body if its velocity-time graph is a line parallel to the time axis?

Ans. Zero, as the body possesses uniform velocity.

Q. 24. Is the motion of a body uniform or accelerated if it goes round the sun with constant speed in a circular orbit?

Ans. It is accelerated, as its velocity changes due to change in direction.

Short Answer Type Questions – I

[2 Marks]

Q. 1. Give an example of a body which may appear to be moving for one person and stationary for the other.

Ans. The passengers in a moving bus observe that the trees, buildings as well as the people on the roadside appear to be moving backwards. Similarly, a person standing on the roadside observes that the bus (along with its passengers) is moving in forward direction. But, at the same time, each passenger in a moving bus or train observes, his fellow passengers sitting and not moving. Thus, we can tell that motion is relative.

Q. 2. How can we describe the location of an object?

Ans. The describe the position of an object we need to specify a reference point called the origin. For example, suppose that a library in a city is 2 km north of the railway station. We have specified the position of the library with respect to the railway station i.e., in this case, the railway station acts as the reference point.

Q. 3. What do you mean by average speed? What are its units?

Ans. Average speed is defined as the average distance travelled per unit time and is obtained by dividing the total distance travelled by the total time taken.
The unit of average speed is the same as that of the speed, that is, ms^{-1}.

Q. 4. What is the difference between uniform velocity and non-uniform velocity?

Ans. Uniform velocity: An object with uniform velocity covers equal distances in equal intervals of time in a specified direction, *e.g.*, an object moving with speed of 40 kmh^{-1} towards west has uniform velocity.

Non-uniform velocity: When an object covers unequal distances in equal intervals of time in a specified direction, or if the direction of motion changes, it is said to be moving with a non-uniform or variable velocity, *e.g.*, revolving fan at a constant speed has variable velocity.

Q. 5. What do you understand by instantaneous velocity?

Ans. Instantaneous velocity is the velocity of a body at any particular instant during its motion. For example, the instantaneous velocity of a motorcycle at a particular instant is 40 kmh^{-1} if it is moving at 40 kmh^{-1} at that particular instant. It is measured by the speedometers on the vehicles.

Q. 6. What is negative acceleration?

Ans. If the velocity of a body decreases with time, then its final velocity is less than the initial velocity and thus its acceleration is negative. Negative acceleration is called

retardation or deceleration. For example, when brakes are applied to a moving truck, its velocity gradually decreases. In other words, it is under retardation.

Q. 7. How will the equations of motion for an object moving with a uniform velocity change?

Ans. Acceleration $a = 0$, $v = u$

So, the equations of motion will become

$s = ut$

$v^2 - u^2 = 0$

Q. 8. Express average velocity when the velocity of a body changes at a non-uniform rate and a uniform rate.

Ans. When the velocity of a body changes at a non-uniform rate, its average velocity is found by dividing the net displacement covered by the total time taken.

i.e., $$\text{Average velocity} = \frac{\text{Net displacement}}{\text{Total time taken}}$$

In case the velocity of a body changes at a uniform rate, then the average velocity is given by the arithmetic mean of initial velocity and final velocity for a given period of time.

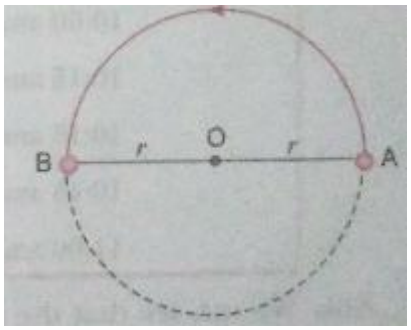
i.e., $$\text{Average velocity} = \frac{\text{Initial velocity} + \text{final velocity}}{2}$$

Q. 9. A particle is moving in a circular path of radius r. What would be the displacement after half a circle?

Ans. Displacement = AB

= Shortest distance between initial and final positions

$= r + r = 2r$



Short Answer Type Questions – II

[3 marks]

Q. 1. Differentiate between distance and displacement.

Ans.

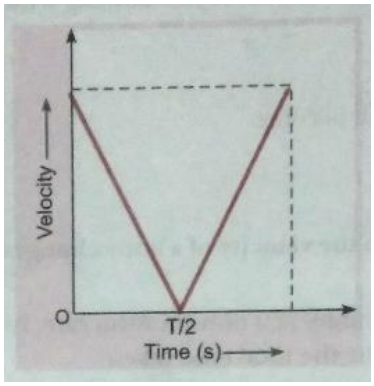
Distance	Displacement
1. It is the length of the actual path covered by an object, irrespective of its direction of motion.	**1.** Displacement is the shortest distance between the initial and final positions of an object in a given direction.
2. Distance is a scalar quantity.	**2.** Displacement is a vector quantity.
3. Distance covered can never be negative. It is always positive or Zero.	**3.** Displacement may be positive, negative or zero.
4. Distance between two given points may be same or different for different path chosen.	**4.** Displacement between two given points is always the same.

Q. 2. What are the uses of a distance-time graph?

Ans. The various uses of a distance-time graph are as follows:
(a) It tells us about the position of the body at any instant of time.
(b) From the graph, we can see the distance covered by the body during a particular interval of time.
(c) It also gives us information about the velocity of the body at any instant of time.

Q. 3. Draw a velocity versus time graph of a stone thrown vertically upwards and then coming downwards after attaining the maximum height.

Ans. During upward motion, acceleration = **-** g and during downward motion acceleration = + g. Times of upward and downward motion is equal. Also initial and final velocities are equal to $\left(g\frac{T}{2}\right)$.



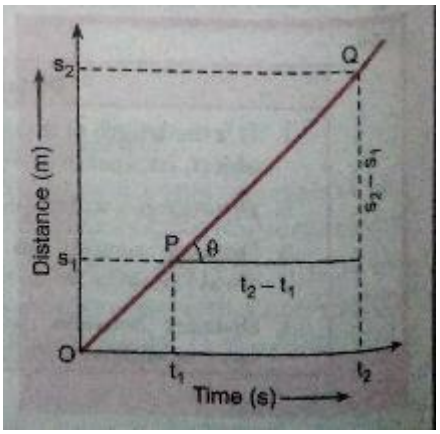
Q. 4. The data regarding the motion of two different objects P and Q is given in the following table. Examine them carefully and state whether the motion of the objects is uniform or non-uniform.

Time	Distance travelled by object P in metres	Distance travelled by object Q in metres
9:30 am	10	12
9:45 am	20	19
10:00 am	30	23
10:15 am	40	35
10:15 am	50	37
10:45 am	60	41
11:00 am	70	44

Ans. We can see that the object P covers a distance of 10 m in every fifteen minutes. In other words, it covers equal distance in equal interval of time. So, the motion of object P is uniform. On the other hand, the object Q covers 7 m from 9:30 am to 9:45 am, 4 m from 9:45 am to 10:00 am, and so on. In other words, it covers unequal distance in equal interval of time. So, the motion of object Q is non-uniform.

Q. 5. How will you show that the slope of displacement-time graph gives velocity of the body?

Ans. The adjoining figure shows the displacement-time graph for a body moving with uniform velocity. Clearly, it covers distance s_1 and s_2 at times t_1 and t_2 respectively.

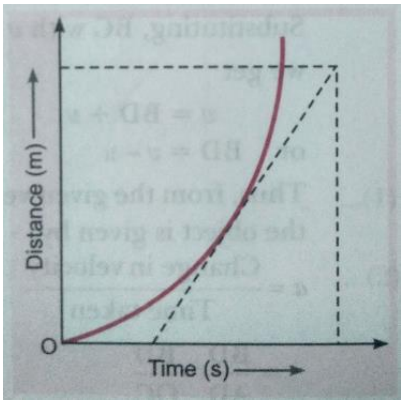


Slope of line PQ = $\tan\theta = \frac{QR}{PR}$

$= \frac{s_2 - s_1}{t_2 - t_1} = \frac{\text{Displacement}}{\text{Time}}$

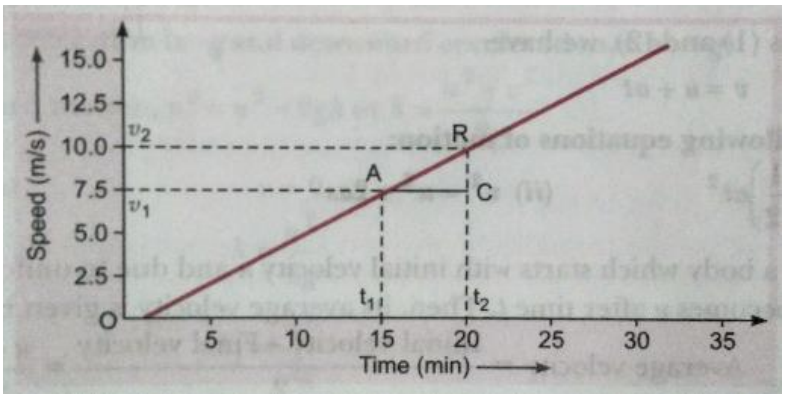
As $\frac{\text{Displacement}}{\text{Time}}$ is velocity, it y, so the slope of the distance-time graph gives velocity of the body.

Q. 6. What are the characteristics of distance-time graph for an object moving with a non-uniform speed?



Ans. The characteristics of distance-time graph for a non - uniform speed are:
(i) It is always a curve (parabola).
(ii) The speed of the moving object at any point is given by the slope of the tangent to the curve at that point.

Q 7. 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.



Ans. The nature of the graph shows that velocity changes by equal amounts in equal intervals of time. For a uniformly accelerated motion, velocity-time graph is always a straight line.
As we know, acceleration is equal to the slope of the graph

i.e, $a = \frac{BC}{AC}$ or $a = \frac{v_2 - v_1}{t_2 - t_1}$

$\therefore$ $a = \frac{(10.0-7.5)\,ms^{-1}}{(20-15)\,s}$

Or $a = \frac{2.5\ ms^{-1}}{5\ s}$

Or $a = 0.5\ ms^{-2}$

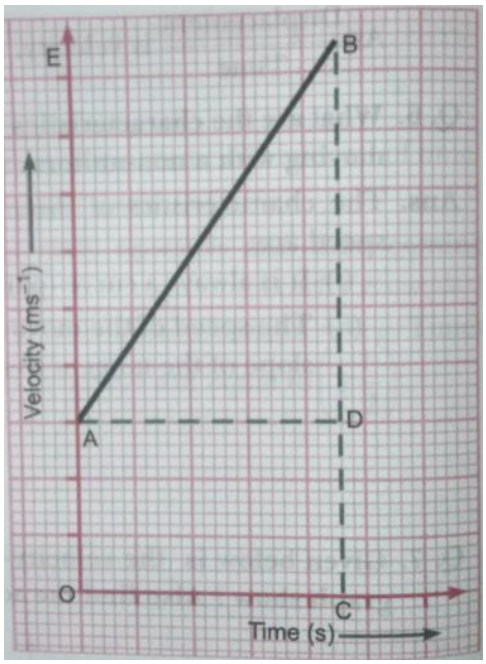
Long Answer Type Questions

[5 marks]

Q. 1. with the help of a graph, derive the relation *v = u + at.*

Ans. Consider the velocity-time graph of an object that moves under uniform acceleration as shown in the figure ($u \neq O$).

From this graph, we can see that initial velocity of the object (at point A) is *u* and then it increases to *v* (at point B) in time *t*. The velocity changes at a uniform rate *a*. As shown in the figure, the lines BC and BE are drawn from point B on the time and the velocity axes respectively, so that the initial velocity is represented by OA, the final velocity is represented by BC and the time interval *t* is represented by OC. BD = BC - CD, represents the change in velocity in time interval *t.* If we draw AD parallel to OC, we observe that



BC = BD + DC = BD + OA

Substituting, BC with v and OA with *u*, we get

v = BD + u

or BD = $v - u$

Thus, from the given velocity-time graph, the acceleration of the object is given by

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

$$= \frac{BD}{AD} = \frac{BD}{OC}$$

Substituting, OC with *t*, we get

$$a = \frac{BD}{t} \text{ or } BD = at$$

From equations (1) and (2), we have

$v - u = at$ **or** $v = u + at$

Q. 2. Deduce the following equations of motion:

(i) $s = ut + \left(\frac{1}{2}\right)at^2$ **(ii)** $v^2 = u^2 + 2as$

Ans. (i) Consider a body which starts with initial velocity *u* and due to uniform acceleration *a*, its final velocity becomes *v* after time *t*. Then, its average velocity is given by

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

∴ The distance covered by the body in time *t* is given by

Distance, s = Average velocity x Time

or $s = \frac{u+v}{2} \times t$ or $s = \frac{u+(u+at)}{2} \times t$

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

(ii) We know that

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

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

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

Putting the value of *t* in (1), we have

$s = u\left(\frac{v-u}{a}\right) + \frac{1}{2}a\left(\frac{v-u}{a}\right)^2$

or $s = \frac{uv-u^2}{a} + \frac{v^2+u^2-2uv}{2a}$

or $2as = 2uv - 2u^2 + v^2 + u^2 - 2uv$

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

Q.3. Obtain a relation for the distance travelled by an object moving with a uniform acceleration in the interval between 4th and 5th seconds.

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

Distance travelled in 5 seconds, $s = u \times 5 + \frac{1}{2}a \times 5^2$

Or $s = 5u + \frac{25}{2}a$ …(1)

Similarly, distance travelled in 4 seconds, $s' = 4u + \frac{16}{2}a$ …(2)

Distance travelled in the interval between 4th and 5th seconds

$= (s-s') = (u + \frac{9}{2}a)$ m

Q. 4. Two stones are thrown vertically upwards simultaneously with their initial velocities u_1 and u_2 respectively. Prove that the heights reached by them would be in the ratio of $u_1^2 : u_2^2$.
(Assume upward acceleration is -g and downward acceleration to be + g).

Ans. We know the upward motion, $u^2 = u^2 - 2gh$ or $h = \frac{u^2+v^2}{2g}$

But at highest point $v = 0$

Therefore, $h = \frac{u^2}{2g}$

For first ball, $h_1 = \frac{u_1^2}{2g}$

and for second ball, $h_2 = \frac{u_2^2}{2g}$

Thus, $\frac{h_1}{h_2} = \frac{\frac{u_1^2}{2g}}{\frac{u_2^2}{2g}} = \frac{u_1^2}{u_2^2}$

Or $h_1 : h_2 = u_1^2 : u_2^2$

Q. 5. The driver of train A travelling at a speed of 54 kmh^{-1} applies brakes and retards the train uniformly. The train stops in 5 seconds. Another train B is travelling on the parallel with a speed of 36 kmh^{-1}. Its driver applies the brakes and the train retards uniformly; train B stops in 10 seconds. Plot speed-time graphs for both the trains on the same axis. Which of the trains travelled farther after the brakes were applied?

Ans. For train A, the initial velocity,

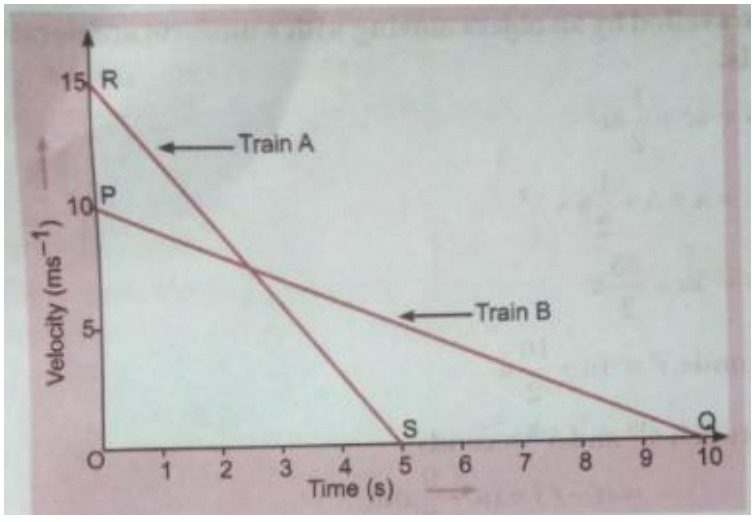
$u = 54\ kmh^{-1} = 54 \times \frac{5}{18} = 15\ ms^{-1}$

Final velocity, $v = 0$ and time, $t = 5s$

For train B, $u = 36\ kmh^{-1} = 36 \times \frac{5}{18} = 10\ ms^{-1}$

$v = 0$; $t = 10$ s

Speed-time graph for train A and B are shown in the figure.



Distance travelled by train A

= Area under straight line graph RS

= Area of ΔORS

$= \frac{1}{2} \times OR \times OS = \frac{1}{2} \times 15\ ms^{-1} \times 5\ s = 37.5\ m$

Distance travelled by train B = Area under PQ = Area of ΔOPQ

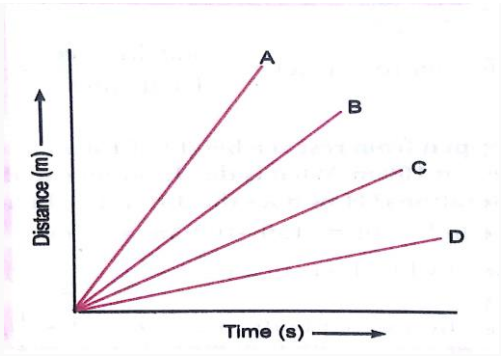
$= \frac{1}{2} \times OP \times OQ = \frac{1}{2} \times 10\ ms^{-1} \times 10\ s = 50\ m$

Thus, train B travelled farther after the brakes were applied.

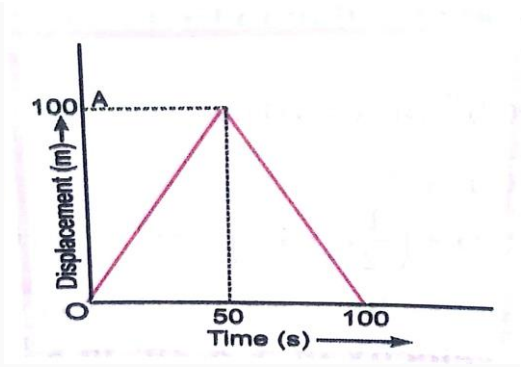
HOTS (Higher Order Thinking Skills)

Q. 1. Four cars A, B, C and D are moving on a levelled road. Their distance versus time are shown in figure. Which car is the slowest?

Ans. Speed = Slope of distance-time graph. The smaller the slope, the smaller is the speed. From the figure, slope is minimum for car D. So, D is the slowest car.



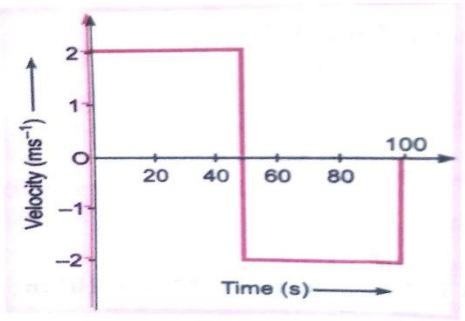
Q. 2. A girl walks along a straight path to drop a letter in the letterbox and comes back to her initial position. Her displacement-time graph is shown in figure. Plot a velocity-time graph for the same.



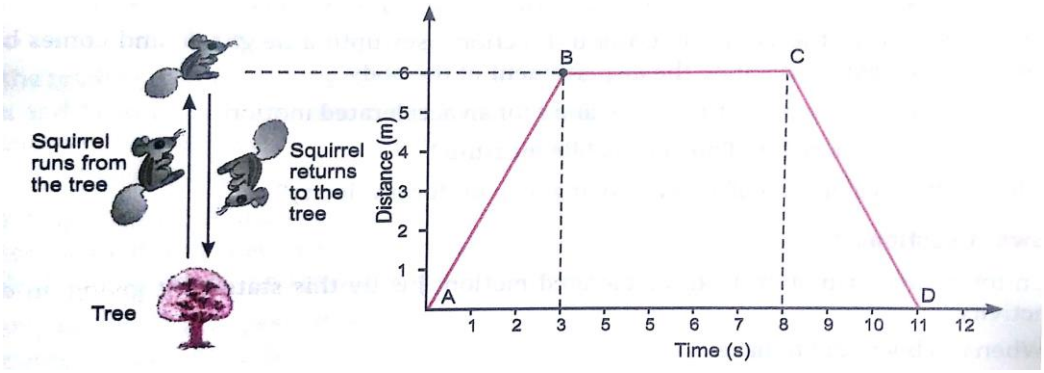
Ans. Velocity from 0 to 50 s is $v_1 = \frac{\Delta s}{\Delta t} = \frac{100-0}{50-10} = 2$ ms^{-1}

Velocity from 50 s to 100 s, $v_2 = \frac{\Delta s}{\Delta t} = \frac{0-100}{100-50} = -2$ ms^{-1}

Accordingly the velocity-time graph is shown in figure below.



Q. 3. Suppose a squirrel is moving at a steady speed from the base of a tree towards some nuts. It then stays in the same position for a while, eating the nuts, before returning to the tree at the same speed. A graph can be plotted with distance on the x-axis and the time on y-axis.



Observe the graph carefully and answer the following questions.
(i) Which part of the graph shows the squirrel moving away from the tree?
(ii) Name the point on the graph which is 6 m away from the base of the tree.
(ii) Which part of the graph shows that the squirrel is not moving?
(iv) Which part of the graph shows that the squirrel is returning to the tree?
(v) Calculate the speed of the squirrel from the graph during its journey.

Ans. (i) Part AB (ii) Part B (iii) Part BC (iv) Part CD

(v) Total distance travelled 6 m + 6 m = 12 m

Time = 11 s.

Speed = $\frac{\text{Total didtance}}{\text{Time}} = \frac{12}{11}$ = 1.09 m/s.

Q. 4. The table given below shows distance (n cm) travelled by bodies A, B and C. Read this data carefully and answer the following questions.

Distance (in cm) covered by different bodies

Time in (s)	Body (A)	Body (B)	Body (C)
1st Second	20	20	20
2nd Second	20	36	60
3rd Second	20	24	100
4th Second	20	30	140
5th Second	20	48	180

(i) Which of the bodies is moving with
(a) constant speed?
(b) constant acceleration?
(c) non-uniform acceleration?

(ii) Which of the bodies covers
(a) maximum distance in 3rd second?
(b) minimum distance in 3rd second?

Ans. (i) (a) Body A (b) Body C (c) Body B
(ii) (a) Body C. Total distance travelled = 100 – 60 = 40 cm
(b) Body B. Total distance travelled = 24 – 36 = (-) 12 cm
The negative sign implies decceleration.

Value Based Questions

1. Rohan and Anirban are students of the same school that is 18 km away from their hostel. One day, they started from their hostel at the same time with an initial velocity of 29.8 km/h. At this speed, it would take 20 min for them to reach the school on time. After 5 min, Rohan stopped due to some problem in his cycle. Anirban didn't wait for him and moved forward. Rohan took another 5 min to repair his cycle. He again started with the same initial velocity as he started from the hostel.

Read the passage carefully and answer the following questions.

(i) What value is not shown by Anirban?

(ii) At what distance from their hostel did Rohan stop?

(ii) What is the required acceleration for Rohan to reach his school on time when he started the second time?

Ans. (i) Value of friendship and caring was not shown by Anirban towards Rohan.

(ii) Initial velocity of both (u_1) = 28.8 km/h = 28.8 x $\frac{5}{18}$ m/s = 8 m/s

$\therefore$ Distance of which Rohan stopped = u x t

= u x (5 min)

= 5 x 60 x 8 m = 2400 m = 2.4 km

(iii) Remaining distance that Rohan had to cover = 18 - 2.4

= 15.6 km = 1560 m

New initial velocity for Rohan (u_2) = 28.8 km/hr = 8 m/s

Time left = 20 - (5 + 5)

= 20 – 10 = 10 mins = 600 s.

According to the question,

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

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

$$\Rightarrow \frac{1}{2}a(600)^2 = 15600 - 4800$$

$$\Rightarrow \frac{1}{2} \cdot a \times 360000 = 10800$$

$$\Rightarrow a \times 180000 = 10800$$

$$\therefore a = \frac{10800}{180000} = \frac{3}{5} \text{ m/s}$$

$\therefore$ Acceleration = 0.6 m/s^2

2. Two Express trains A and B start from two stations 250 km apart from each other with an initial velocity of 72 km/h and 90 km/h respectively. After 1.5 hours, due to some inconvenience, both the trains start running on the same track towards each other. A farmer passing by, watches both the trains coming towards each other and stand on the track and raises his red shirt. Both trains decelerate uniformly by 0.5 m/s^2 and finally stop and the mishap is averted.
Read the passage carefully and answer the questions.
(i) What is the distance between the trains after 1.5 hour?
(ii) How much time do the trains take to stop after applying brakes?
(iii) What values are promoted by the farmer?

Ans. (i) Velocity of train A = 72 km/h = 20 m/s

$\therefore$ Distance covered in 1.5 hours = 72 x 1.5 = 108 km

Velocity of train B = 90 km/h

$= 90 \times \frac{5}{18} = 25$ m/s

$\therefore$ Distance covered in 1.5 hours = 90 x 1.5 = 135 km.

Now total distance covered by both trains out of 250 km.

$\therefore$ Distance between the trains after 1.5 hours

= 250 - 243

= 7 km.

(ii) Initial velocity of train A, u_A = 20 m/s.

Final velocity of train A, u_A = o m/s.

Deceleration by train A, a = - 0.5 m/s^2 = $-\frac{1}{2}$ m/s^2

$\therefore$ $v = u_A + at$ …

(i)

$\Longrightarrow$ $0 = 20 + \frac{(-)1}{2} \times t$

$\Longrightarrow$ t = 20 x 2 = 40s

Again, initial velocity of train B, u_B = 25 m/s

Final velocity of train B, v_B = o m/s

Deceleration by train B, a = - 0.5 m/s^2 = $-\frac{1}{2}$ m/s^2

From equation (i), $0 = u_B + at$

$= 25 + \left(-\frac{1}{2}\right) \times t$

$\therefore$ t = 25 x 2 = 50 s

Hence, train A takes 40 s and train B takes 50 s to stop after applying brakes.

(iii) Awareness, presence of mind, bravery, positive attitude to avoid any serious accident.

3. A bus is moving with a velocity of 60 km/h. The driver sees a child running across the road and he pressed the brakes. The time taken by him to react to the emergency was 1/15th of second. In a second case another bus was coming on the same road at the same speed 60 km/h and the driver also perceives another child passing the road. In this case, the 2nd driver took 0.5 s to respond to the emergency, $i.e.,$ he applied brakes after 0.5s.

Read the passage carefully and answer the following questions:

(i) How much distance did the bus move in the 1st case before the driver could press the brakes?

(ii) How much distance did the bus move in the 2nd case before the driver could apply the brakes?

(iii) What could be the probable reasons that reaction time increases in the case of second driver?

(iv) State two traffic rules which should be followed by the drivers of heavy vehicle.

Ans. (i) Initial velocity of the bus, u = 60 km/h = $\frac{60 \text{ x } 1000}{60 \text{ x } 60}$ = 16.67 m/s

Distance moved by the bus in Is $\frac{1}{15}$s = Velocity of the bus x Time interval

= 16.67 $\frac{1}{15}$ = 1.1 m

Thus the bus would have moved 1.1 m before the driver under normal conditions could press the brakes.

(ii) In the 2nd case distance covered by the bus in 0.5s

= Velocity of the bus x Time interval

= 16.67 x 0.5

= 8.3m

Thus, the bus would have moved 8.3 m before the driver could press the brakes.

(iii) Reaction time, $i.e.,$ the time taken by a person to react to an emergency increases while driving vehicle if the driver is intoxicated under the influence of alcohol.

(iv) Two rules which should be strictly followed are:

(a) The driver should not be drunk.

(b) The vehicle should not carry the load more than the capacity of the vehicle.

4. In a long distance race, five athletes were expected to take four rounds of the track such that the line of finish was same as the line of start. When the athletes were half the way, one athlete fell down unfortunately. Another athelete slows down to help his pear and takes him out of the field.

If the length of the track is 200 m, answer the following questions:

(i) Is the motion of the athletes uniform or non-uniform?

(ii) Is the displacement of the athletes and the distance moved by them at the end of the race equal?

(iii) If the referee is eligible to take any relevant decision, what decision he might have taken about the above said event?
(iv) Which value is shown here by the second athlete?

Ans. (i) Athletes move at different speeds and the speed may be different at different points of time. So, the motion of the athletes is non-uniform.
(ii) The distance and displacement of athletes at the end of the race are not equal. The distance is 200 m while the displacement will be zero.
(iii) If the referee is quite sympathetic in his attitude, he might have postponed the event for the time being.
(iv) We get a valuable lesson from the athlete here that without caring about the academic aspect he is more dutiful and responsible to a person who is in trouble.