NCERT SOLUTIONS
CLASS IX SCIENCE
CHAPTER 8- MOTION

Questions:

1) A man walks around a square street of side 10 m in 40 sec. Calculate the displacement of the man at the end of 2 minutes 20 seconds.

Soln:

The man takes 40 sec to cover (4 * 10) 40 metres. This shows he covers one metre in one sec.

In 2 min 20 sec (140 sec) , he will cover a distance of 140 metres.

Thus he completes $\frac{140}{40}$ = 3.5 rounds in 2 min 20 sec.

Hence it is noticed that he will be at the opposite side from where he started.

Now considering two simple cases.

Case (i)

If the man started at a corner of the square street:

In this case, the man would be diagonally opposite to the place from where he started

Displacement = diagonal of square with side 10 metre.

$\sqrt{10^2 + 10^2}$

$\sqrt{100}$

=14.1m

Case (ii)

The man started from the middle of the road.

After the end time, he is in the opposite side of the road.

Hence, the displacement is 10 metre.

2) Explain why the below statements about displacements are not true.

1. ***Displacements cannot be zero***
2. ***The magnitude of displacements are always greater than the distance travelled.***

Soln:

1. The statement is not correct because when the object reaches the same point where it started, after its movement, its displacement is zero as the definition states that it is the distance between the starting point and the ending point.
2. The magnitude of displacement may or equal to the distance travelled but never greater than it because it is the measure of the shortest distance between the initial and final positions of the travelling object.

3) What is the difference between speed and velocity?

Soln:

Speed	Velocity
Defined as the ratio of distance travelled by the object in a given time.	Defined as the ratio of displacement by the object during the given time period.
Doesn't have any direction. A scalar quantity	Has an unique direction. A vector quantity.
Can never be negative because the distance travelled is always positive	Can be a negative quantity as the displacement can be negative

4) State the conditions when the average velocity of an object will be magnetically equal to its average speed.

Soln:

The average speed is defined as, Avg Spd = $\frac{Total\ distance\ covered}{Total\ time\ taken}$

Whereas the average velocity = $\frac{Displacement}{\ }$

$\frac{}{Total\ time\ taken}$

Therefore, for both the quantities to be equal, the numerator of the quantities should be equal. Thus the average speed of the object will be equal to its average velocity when that total distance travelled by the object is equal to its displacement.

5) What parameter is measured using the odometer in an automobile?

Soln:

In an automobile the Odometer is used to measure the total distance travelled by the vehicle.

6) When an object is in uniform motion, what type of path does it follows?

Soln:

An object in an uniform motion will have a straight line path because in a curved path there will be acceleration and deceleration which varies the average speed, thus deviating from the uniformity of speed.

7) From a rocket launch station, a signal sent from the recently launched vehicle reaches the station in 5 minutes. If the speed of the wave is 3 * 10^8 m/s, find the distance at which the rocket sent its signal from.!

Soln:

Total time taken by the signal from the spaceship to reach the ground station is, 300 sec

Speed of the signal = 3 * 10^8 m/s

By, definition; Speed = $\frac{Total\ distance}{Total\ time\ taken}$

Therefore, the total distance = speed * total time taken.

= (3 * 10^8) * (300)

= 900 * 10^8 metres

= 9 * 10^{10} metres

8) How will you determine whether the object is in

1. **Uniform acceleration?**
2. **Non – uniform acceleration?**

Soln:

1. When the velocity of the moving object changes uniformly, that is if it increases or decreases its speed at an uniform rate, it is said to be undergoing an uniform acceleration. This happens when the body is moving in a straight path without bends or curves because they tend to change the rate of acceleration.
2. When the velocity of the moving object changes non uniformly, that is if the rate of change of its velocity is not uniform, then it is said to be undergoing a non uniform acceleration. Objects moving in a circular path or in the curved area tend to move in a non uniform acceleration.

9) While driving, the man observes a cloud of vehicles ahead and reduces his speed. Find the acceleration of the vehicle if the speed changes from 80 km h^{-1} to 60 km h^{-1}.

Soln:

The primary step is to convert the given speed in km h^{-1} to m/s for easier calculation.

Initial speed of the vehicle = u = 80 * (5/18) = 22.22 m/s

Final speed of the vehicle = v = 60 * 5/18) = 16.66 m/s

Total time = 5 sec

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

= $\frac{16.66 - 22.22}{5}$

= -1.112 m/s^2

The negative sign indicates that the acceleration is negative. It is decelerating at the rate of 1.112 m/s^2.

10) A car in a national highways starts after a pit stop and attains a speed of 40 km h^{-1} in 10 minutes. Find its rate of acceleration.

Soln:

Initial velocity = u = 0 (since the car is starting from rest)

Final velocity (given) = v = 40 km h^{-1} = 11.11 m/s (convert into m/s)

Total time taken = t = 10 min = 600 sec

W.k.t a = $\frac{v-u}{t}$

= $\frac{11.11 - 0}{600}$

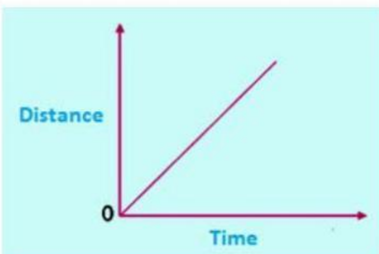
= 0.0185 m/s^2

Hence, the acceleration of the car is 0.0185 m/s^2

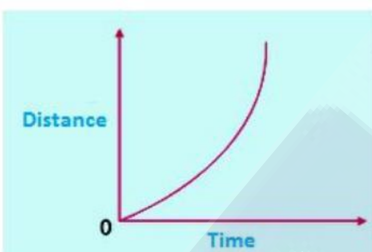
11) Draw the distance time graphs for uniform and non uniform motion of an object. Explain their existence.

Soln:

For an uniform motion the distance time graph is a straight line, as the acceleration in zero and the distance travelled at a particular time is the same.



The distance – time graph for non uniform motion of an object is a curved line since it undergoes an acceleration.



12) Comment on the motion of object whose distance – time graph is a straight line parallel to the time axis.

Soln:

When the distance time graph is parallel to the time axis, it means that the object covers no distance with the progression of time. Hence it is observed that the object is at rest.

13) Comment on the motion of object whose speed time graph is a straight line parallel to the time axis.

Soln:

When the speed time graph is parallel to the time axis, it means that the object does not vary its speed with the change in time. Hence, it is said to be in an uniform motion.

14) What does the area under the velocity time graph represent?

Soln:

W.k.t

Velocity = $\frac{distance}{time}$

Hence, velocity * time gives you the distance covered by the object distance travelled

15) A car starts from the rest with an uniform acceleration of 0.1 m/s^2. In two minutes, find (a) the speed it reaches (b) the distance travelled

Soln:

1. Given:

u = 0

v = ?

a = 0.1 m/s^2

t = 120 sec

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

0.1 = $\frac{v-0}{120}$

= 12 m/s

1. Given:

u = 0

v = 12 m/s

t = 120 sec

a = 0.1 m/s^2

According to the third equation of motion

$v^2 + u^2 = 2as$

$(12)^2 + (0)^2 = 2\,(0.1)s$

On solving the above equation,

s = 720 metres

16) A car is moving with a speed of 90 km h^{-1}. The driver sees a road sign stating that there is a block in the road in 1 km. He applies brake to produce an uniform acceleration of -0.5 m s^{-2}. Find how far before the block the car stops.

Soln:

Initial speed of the car: u = 90 km h^{-1} = 25 m s^{-1}

Final speed of the car: v = 0 m s^{-1} (since it comes to rest)

Acceleration: -0.5 m s^{-2}

Using the third equation of motion

$v^2 = u^2 + 2as$

$(0)^2 = (25)^2 + 2(-0.5)s$

On solving the above equation,

S = 625 m

Therefore, the car stops (1000 – 625) = 375 m before the block.

17) In a supermarket a lady leaves her trolley on an inclined plane and didn't notice. The trolley started moving down with an acceleration of 2 cm s^2 . With what velocity will the trolley be moving at the 3rd second after it started moving?

Soln:

Initial velocity = 0 m/s (since the trolley was at rest)

Acceleration = a = 2 cm s^{-2} = 0.02 m s^{-2}

Time = t = 3 sec

Using the first equation of motion,

v = u + at

$v = u + at$

$v = 0 + (0.02 * 3)$

$v = 0.06 \text{ m s}^{-2}$

18) A horse accelerates at a rate of 4 m s^{-2}. What is the distance it covers after running for 10 sec from the start?

Soln:

Initial velocity = $u = 0 \text{ m s}^{-1}$

Acceleration = $a = 4 \text{ m s}^{-2}$

Time = $t = 10$ sec

Using the second equation of motion,

$S = ut + 0.5\,at^2$

$S = 0 = (0.5 * 4 * 10^2)$

$S = 200$ m

Hence the horse covers 200 metres in the first 10 seconds.

19) 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 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?

Soln:

Initial velocity of stone = $u = 5 \text{ m s}^{-1}$

Final velocity of stone = $v = 0 \text{ m s}^{-1}$ (since at the maximum height, the stone comes to rest)

Acceleration = $a = 10 \text{ m s.}^{-2}$

Using the first equation of motion,

$v = u + at$

$0 = 5 + (-10)t$ (because the acceleration is in the opposite direction to the motion)

$t = 0.5$ sec

Using this answer in the second equation of motion,

$s = ut + 0.5at^2$

$s = (5 * 0.5) + (0.5 * (-10) * 0.5^2)$

$s = (2.5) – (1.25)$

$s = 1.25$ metres

Thus, the stone attains 1.25 m at the maximum accelerating point.

20) A satellite is made to revolve around the earth's orbit of radius 42250 km. With what speed should it be initiated for it to go around the whole orbit in 24 hours?

Soln:

Given radius of earth = $r = 42250$ m

Time taken = 24 hours

Speed of object in circular motion = $v = \frac{2\prod r}{t}$

$= \frac{2*3.14*42250}{24}$

$= 1.105 * 10^4 \text{ km h}^{-1}$

$= 3.069 \text{ km s}^{-1}$

Hence, the speed of the satellite is 3.069 km s^{-1}

21) A man is chased by a dog who runs around a circular park of diameter 200 m. He runs at a speed with which he covers the perimeter in 40 sec. At the end of 2 min 20 sec what will be the distance covered by him. Also find the displacement at the end of the given period.

Soln:

Given:

Diameter of circular park = d = 200 m

Radius = r = 100 m

Circumference = 2$\prod$ r = 2 * 3.14 * 100

= 628 metre

Total time the is running = 2 min 20 sec = 140 sec

Hence, the distance covered in 140 sec = (628/40) * 140 = 2200 metres

He he is running in a circular path and he takes 40 sec for each round, his displacement after each 40 sec will be zero since he is coming to the same place where he started. Thus, he completes three whole rounds in 120 sec and in the next 20 sec covers half the distance.

At the end of 140 sec, he will be in exact opposite spot from where he started. Since the diameter of the circular park is 200 metre, his displacement after 140 sec is 200 metres.

22) Akash jogs from one end A to the other end B of a 400 metre road in 2 min 45 sec and then turns around and jogs 200 metres back to point C in another 1 min 30 sec. What are Akash's average speed and velocities in jogging (a) from A to B and (b) from A to C?

Soln:

From A to B

Distance travelled by akash = 400 m

Time taken to cover the distance = 165 sec

Avg spd = $\frac{Total\ distance}{Total\ time\ taken}$

Speed = $\frac{400}{165}$

= 2.424 m s^{-1}

Velocity =$\frac{Total\ displacement}{Timetaken}$

= 2.424 m s^{-1} (since the shortest distance between A and B is total distance travelled to reach B from A)

Distance travelled = 400 + 200 = 600

Time taken = 4 minutes 15 seconds = 255 seconds

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

= $\frac{600}{255}$

= 2.253 $m\,s^{-1}$

Velocity= $\frac{Total\ displacement}{Timetaken}$

Total displacement = 300 – 100 = 200 m

Time taken = 255 s

$therefore$ Velocity = $\frac{200}{255}$

= 0.7843 $m\,s^{-1}$

23) Seetha rides her bicycle to school. In morning while going to school she averages a speed of 15 km/h. On her return from school at evening along the same route, she averages a speed of 12 km/h. Calculate the average speed of Seetha's trip.

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

Let s be the total distance travelled and t be the time taken

Let t_1 and t_2 be the time taken to ride from home to school and from school to home respectively.

15 = $\frac{s}{t_1}$

t_1= $\frac{s}{15}$

12 = $\frac{s}{t_2}$

t_2 = $\frac{s}{12}$

$therefore$ The average speed of her round trip = $\frac{Total\ distance}{Total\ time\ taken}$

Here total distance travelled is s + s = 2s

Total time taken = Time taken to ride to school + Time taken to return from school

= t_1 + t_2

Average speed = $\frac{2s}{t_1+t_2}$

= $\frac{2s}{\frac{s}{15}+\frac{s}{12}}$

= $\frac{120}{9}$ = 13.33 km h^{-1}

Therefore, the average speed of Seetha in the round trip is 13.33 km h^{-1}

24) A car ,which is at rest, starts to accelerate at a steady rate of 4 m s^{-2}

in a straight line and it continues to do so for 5 seconds. Calculate the distance travelled by car during this time.

Soln:

Here the initial velocity of the car is zero

Therefore, u = 0

Travelling time = t = 5 seconds

Acceleration of the car = a = 4 m s^{-2}

Distance travelled is given by the second equation of motion :

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

S = 0 + $\frac{1}{2} * 4 * (5)^2$

S = 50 m

Therefore, the distance travelled by the car during the time of 5 seconds is 50 meters.

25) A car moving at a speed of 52 km/h, when applied brake comes to a stop in 5 s. Another car which is moving at a speed of 3 km/h come to a stop in 10s, when applied a brake.Plot the speed vs time graphs for both the cars on the same scale. Which among the two cars will travel farther after the braking?

Soln:

Let the two cars be A and B

Initial speed of the car A, u_1 = 52 km/h = 14.4 m/s

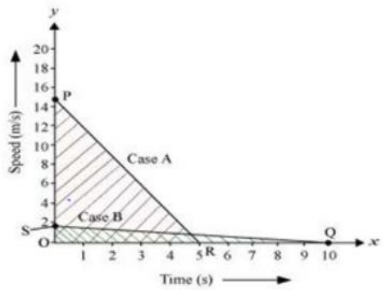
Time duration between the application of brakes and stopping of car A = t_1= 5 s

That is the speed of the car reaches zero 5 s after the application of brakes.

Initial speed of the car B, u_2= 3 km/h = 0.833 m/s

Time duration between the application of brakes and stopping of car B = t_2=10 s

That is the speed of the car reaches zero after 10 s of application of brakes.



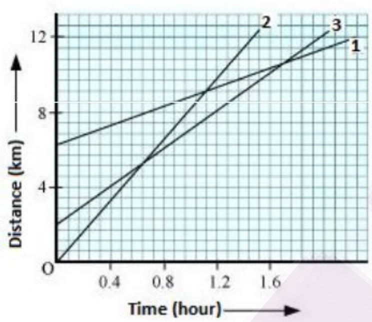
Distance travelled by each car after the application of brakes is given by the area under their respective speed-time graph

For car A, ½ * 5 * 14.4 = 36 m

For car B, ½ * 10 * 0.833 = 4.15 m

Thus the car A has travelled farther than the car B after the application of brakes.

26) Observe the following graph, which shows the distance-time graphs of three objects 1, 2, 3 and answer the questions.



i) Which among the three is faster?

ii) Did all three ever happen to be at the same point?

iii) What is the distance travelled by the 3, when 2 crosses 1.

iv) What is the distance travelled by the 2, when it crosses 3.

Soln:

i)

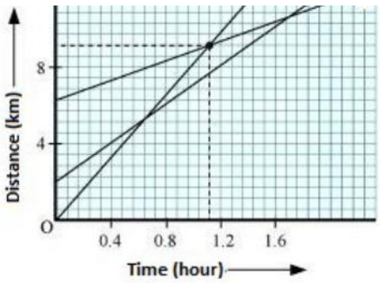
$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$
$$\text{Slope of graph} = \frac{y-\text{axis}}{x-\text{axis}} = \frac{\text{Distance}}{\text{Time}}$$

$therefore$ Speed = Slope of the graph

Since the slope of object 2 is greater than objects 1 and 3, it is the fastest among them.

ii) All three object's distance-time graph never get to meet at the same point. Therefore, they never could have been at the same point at a time.

iii)



In the graph, each box represents a distance of $\frac{4}{7}$ km

As we can see initially, when time is zero, object 3 is four boxes away from the origin.

Therefore, at the start object 3 is $\left(4 * \frac{4}{7}\right) = \frac{16}{7}$ km away from the origin.

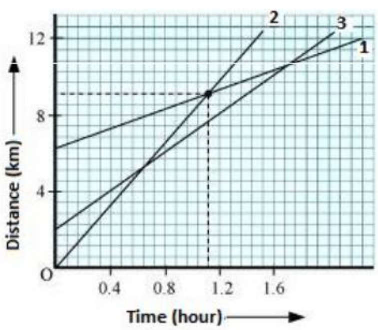
Distance between object 3 and origin, when 2 crosses 1 = 8 km

Therefore, the total distance travelled by object 3, when object number 2 crosses 1

= 8 – $\frac{16}{7}$ = $\frac{40}{7}$

= 5.71 km

iv)



Boxes covered by object 2, when it crosses 3 = 9 boxes

$therefore$ 9 * $\frac{4}{7}$ = $\frac{36}{7}$= 5.143 km

27) A stone is dropped from a building of height of 30m. It accelerates at a rate of 8 m s^{-2}. What will be the velocity of the stone when it hits the ground? How long will it take to reach the ground?

Solution:

Distance travelled by the stone before it reaches the ground = s = 30m

Acceleration = 8 m s^{-2}

Initial velocity = 0 m s^{-1}

Final velocity when it reaches the ground, v, is given by third equation of motion

$v^2 = u^2 + 2as$ Misplaced & $v^2 = 320$ $v = 17.889 ms^{-1}$

Time taken to reach the ground can be found out using first equation of motion

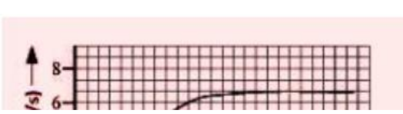
v = u + at

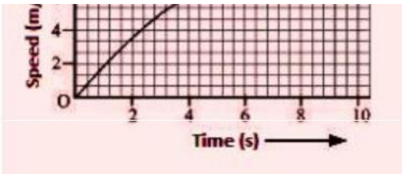
17.899 = 0 + 8 * t

T = $\frac{17.889}{8}$ = 2.236

Hence the stone reaches the ground with a velocity of 17.889 m/s in 2.236 seconds after it is dropped from the building

28) The velocity- time graph of a bike is given below

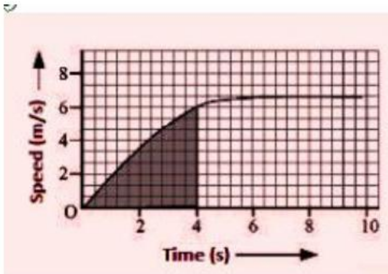




1. ***Calculate the distance travelled by the bike in first four hour of its travel. Show the area in the graph that stands for the distance travelled by the bike in that first four hours.***
2. ***Mention the region of the graph that represents uniform motion of the bike***

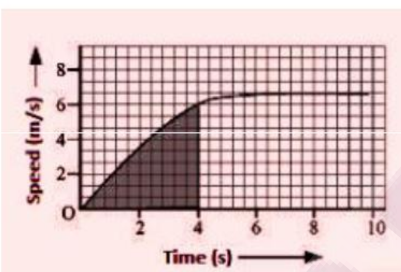
Solution:

i)



The greyed out region of the graph that is equal to 0.5 * 4 * 6 = 12m, stands for the distance travelled by the bike in first four kilometers.

ii)



The region of the graph between 6s and 10s of the time scale represents the uniform motion of the bike.

29) State if the following conditions are possible and if possible give an example.

i) To have a constant acceleration with zero velocity

ii) To have an acceleration in one direction and move in a perpendicular direction.

Solution:

1) Possible condition

Example: Consider a ball thrown up and when it reaches its maximum height attains zero velocity, but it experiences a constant acceleration due to gravity , that is 9.8 m/ s^2
.

2) Possible condition

Example: A car moving in a circular track accelerates in the perpendicular direction.

30) A man- made satellite is orbiting around the earth in a circular path of radius 52350 km. Find the velocity of the satellite if it takes 20 hrs to finish one revolution around the earth.

Soln

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

Distance = $2 * \pi * r$ = 2 * 3.14 * 52350 = 328758 km

Time = 20 hours

Speed = Distance/time

Speed = 328758 / 20 = 16437.6 km/h