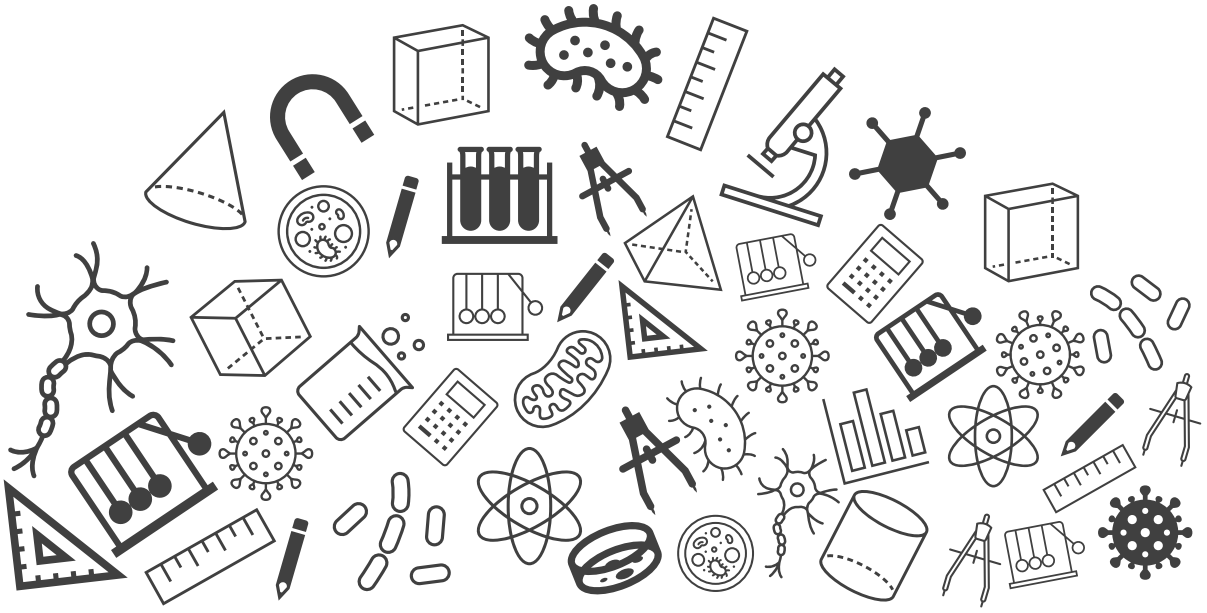
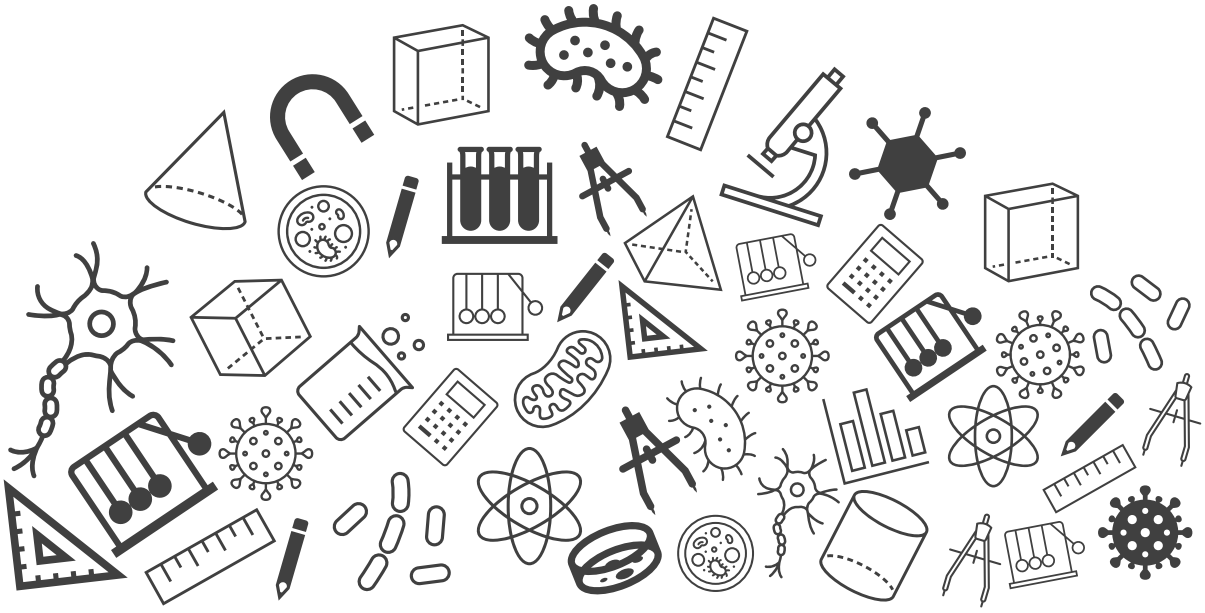
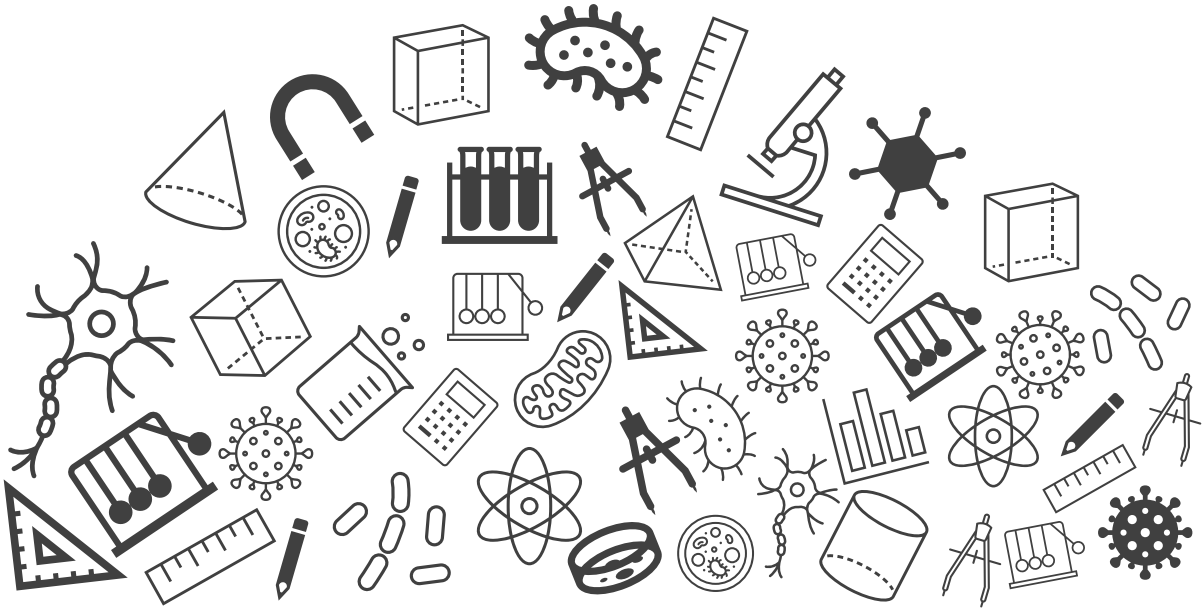
Grade 09
Science Chapter Notes



PHYSICS



Motion



1. Joseph jogs from point A to point B of a straight $300\ m$ road in $2\ \text{min}\ 30\ s$. He turns around and jogs $100\ m$ to reach point C in another $1\ min$. What are the average speeds and velocities of Joseph:
(a) From point A to B?
[2 marks]
[NCERT]

Solution:
(a) From A to B:

To find:
$\text{Average speed} = ?$
$\text{Average velocity} = ?$

Given: $\text{Distance covered} = 300\ m$
$\text{Time taken} = 2\ \text{min}\ 30\ s = 150\ s$

[1 mark]

$$\Rightarrow \text{Average speed} = \frac{\text{Total distance covered}}{\text{Total time taken}}$$
$$\Rightarrow \frac{300}{150} = 2\ ms^{-1}$$

$\text{Displacement} = \text{Shortest distance between A and B} = 300m$

$\text{Time taken between points A and B} = 150s$
$$\Rightarrow \text{Average velocity} = \frac{\text{Displacement}}{\text{Total time taken}}$$
$$\Rightarrow \frac{300}{150} = 2\ ms^{-1}$$

Thus, the average speed and the average velocity of Joseph in jogging from A to B are the same, $2ms^{-1}$.

[1 mark]

2. A motorboat starting from rest on a lake accelerates in a straight line at a constant rate of $3.0\ ms^{-2}$ for $8.0\ s$. How far does the boat travel during this time?
[2 Marks] [NCERT]

Given:
Initial velocity, $u = 0$ (The motorboat is initially at rest.)
Acceleration, $a = 3ms^{-2}$
Time taken, $t = 8s$

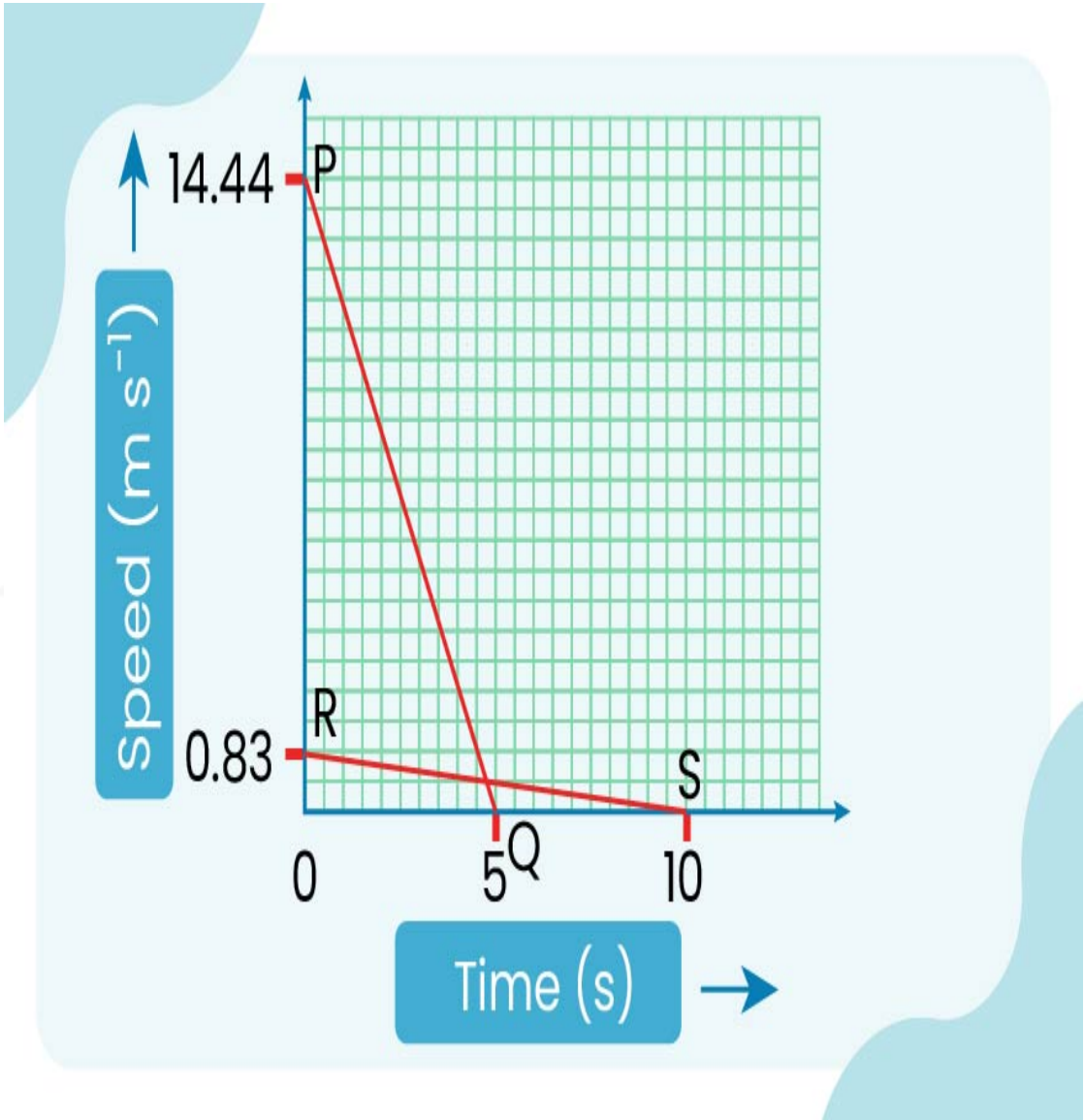
To find : Distance travelled (s)

According to the second equation of motion,

$$s = ut + \frac{1}{2}at^2$$
$$s = 0 \times 8 + \frac{1}{2} \times 3 \times (8)^2$$
$$s = 0 + 3 \times 32$$ [2 Marks]

Thus, the motorboat travels a distance of $96\ m$.

3. A driver of a car travelling at $52\ kmh^{-1}$ applies the brakes and accelerates uniformly in the opposite direction. The car stops in $5\ s$. Another driver travelling at $3\ kmh^{-1}$ in another car applies his brakes slowly and stops in $10\ s$. On the same graph, plot the speed vs. time graphs for the two cars. Which of the two cars travelled farther after the brakes were applied?
The speed vs. time graph for the two cars is shown in the following figure.



[3 marks]
[NCERT]
[Speed vs Time graph]

Solution:
For the first car:

Initial speed, $u_1 = 52\ kmh^{-1} = 52 \times \frac{5}{18} = 14.44\ ms^{-1}$

Time taken to stop the car, $t_1 = 5\ s$

Final speed, $v_1 = 0$

For the second car:

Initial speed, $u_2 = 3\ kmh^{-1} = 3 \times \frac{5}{18} = 0.83\ ms^{-1}$

[1 mark]

Time taken to stop the car, $t_2 = 10\ s$

Final speed, $v_2 = 0$
Distance covered = Area under the speed–time graph
Distance covered by the first car = Area under the graph line PQ
= Area of triangle POQ

$= \frac{1}{2} \times (OQ) \times (OP) = \frac{1}{2} \times (5) \times (14.44)$
= $36.10\ m$

[1 mark]

Distance covered by the second car = Area under the graph line RS
= Area of triangle ROS

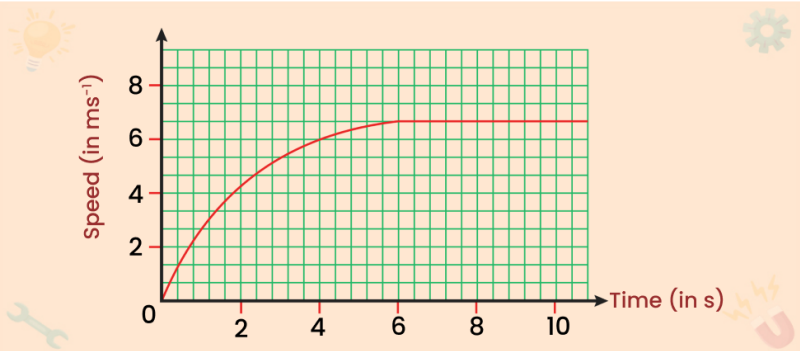
$= \frac{1}{2} \times (OS) \times (OR) = \frac{1}{2} \times (10) \times (0.833)$
$= 4.16\ m$

Thus, area of triangle POQ > area of triangle ROS

Hence, the car travelling with a speed of $52\ kmh^{-1}$ travelled farther after brakes were applied.

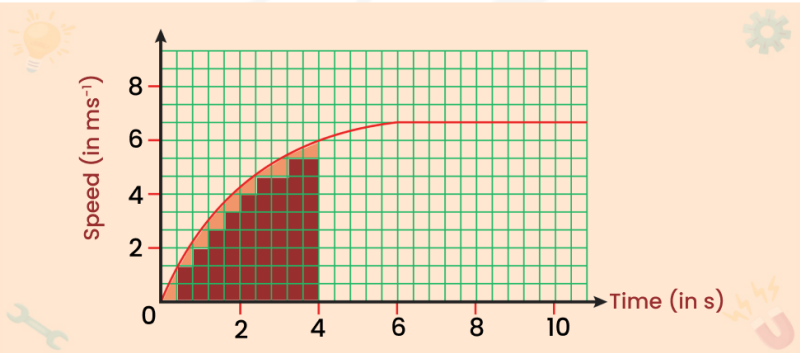
[1 mark]

4. The speed–time graph for a car is shown is in the figure given below.



Find how far the car travels in the first 4 seconds. Shade the area on the graph that represents the distance travelled by the car during the period.
[3 Marks]
[NCERT]

Solution:
The distance travelled by the car in the first 4 seconds is given by the area between the curve and the time axis from $t = 0$ to $t = 4\ s$.



On the time-axis:
5 squares represent $2\ s \Rightarrow$ 1 square represents $\frac{2}{5}s$

On the distance axis:
3 squares represent $2\ m/s \Rightarrow$ 1 square represents $\frac{2}{3}m/s$ [1 Mark]

So, area of 1 square on the graph $= (2/3) \times (2/5) = 4/15$ [1 Mark]

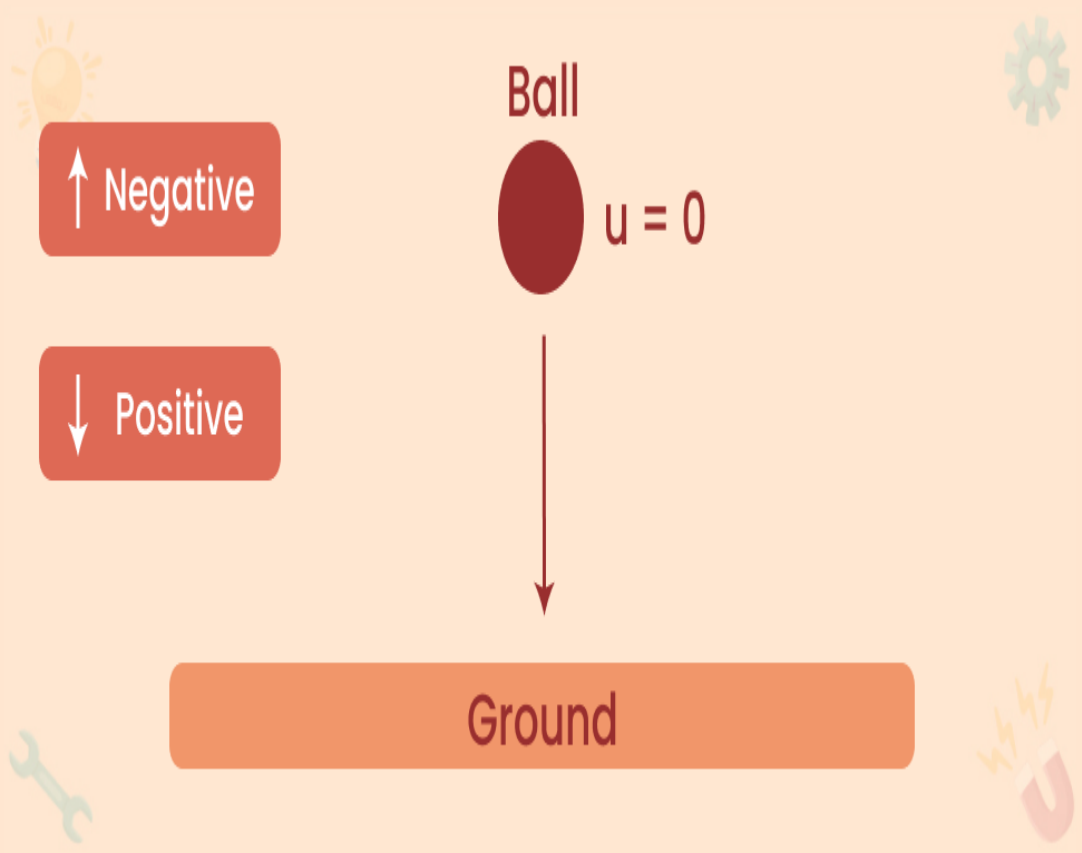
Squares with area less than the area of half squares can be neglected.
Squares with area more than the area of half squares can be counted.
Therefore, approximately the total number of squares = 62

Area = 62× (4/15) = 16.53 [1 Mark]

Thus, the car travels a distance of 16.53 m in the first 4 seconds.

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

Solution:
Given: Initial velocity, u = 0 (Since the ball was initially at rest)
Displacement of the ball, s = +20 m (Sign convention)
Acceleration, a = +10 ms^{-2} (Sign convention)
Final velocity, v = ? [1 Mark]



According to the third equation of motion,

$v^2 = u^2 + 2as$
$v^2 = 0 + 2 \times (+10) \times (+20) = 400$
$v = \pm 20$
$v = 20\ m/s$ [2 Marks]

The ball will strike the ground with a velocity of $20\ m/s$.

According to the first equation of motion,

$v = u + at$
$20 = 0 + (+10)(t)$
$t = 2\ s$ [2 Marks]

Hence, the ball will strike the ground after $2\ s$ with a velocity of $20\ ms^{-1}$.

6. An athlete completes one round of a circular track of diameter $200\ m$ in $40\ s$. What will the distance covered and the displacement at the end of 2 minutes $20\ s$ be?
[2 marks]
[Distance and Displacement]

Solution:
Given: Diameter, $d = 200\ m$
Time required, $T = 40\ s$

Total distance covered $=?$
Displacement $=?$

Circumference of the track
$= 2\pi r = \pi d$
$= 200\pi\ m$

Total time $= 2\ min\ 20\ s = 140\ s$

$i)$
Distance covered in $40\ s = 200\pi\ m$
Distance covered in $140\ s = 200\pi\ m \times \frac{140}{40}$
$= 700\pi = 700 \times \frac{22}{7} = 2200\ m$

[1 mark]

$ii)$
Number of laps $= \frac{140}{40} = 3.5$

So, after 3.5 laps:

Displacement $=$ Final position $-$ Initial position
$=$ Diameter of the track

Hence, displacement $= 200\ m$

The distance covered by the athlete in 2 min $20\ s$ is $2200\ m$ and the displacement is $200\ m$.

[1 mark]

7. A vehicle is accelerating on a staright road.Its velocity at any instant is 30 $km\ h^{-1}$,after 2 s, it is 33.6 $km\ h^{-1}$ and after further 2 s, it is 37.2 $km\ h^{-1}$. Find the acceleration of vehicle in $m\ s^{-2}$. Is the accleration uniform?
[3 Marks]

First part:

Change in velocity = 33.6 kmph - 30 kmph = 3.6 kmph = $3.6 \times \frac{5}{18} m/s = 1\ m/s$

So, acceleration = Change in velocity / Time $= \frac{1\ m/s}{2\ s} = 0.5\ m/s^2$
[1 Mark]

Second part:

Change in velocity = 37.2 kmph - 33.6 kmph = 3.6 kmph = 1 m/s
[1 Mark]

So, acceleration = Change in velocity / Time $= \frac{1\ m/s}{2\ s} = 0.5\ m/s^2$
[1 Mark]

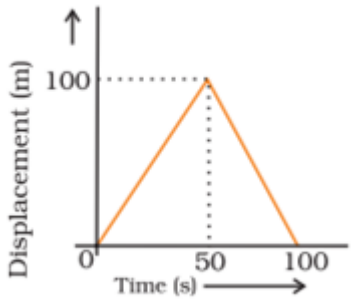
Hence, the acceleration is uniform.

8. State the difference between uniform motion and non-uniform motion. (2 marks)

Solution:

Uniform motion	Non-uniform motion	Mark
(i) In uniform motion, object covers equal distances in equal time intervals.	(i) In non-uniform motion, object covers unequal distances in equal time intervals.	1
(ii) In this case, the average speed is same as the actual speed.	(ii) In this case, average speed is generally different from the actual speed.	1

9. 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 the figure given below. Plot a velocity–time graph for the same.



[5 Marks]

[NCERT Exemplar]

[Velocity-Time graph]

Solution:

Initially, at time $t = 0$, the displacement $= 0$ and at time $t = 50\ s$, displacement $= 100\ m$

We know, $velocity = \frac{displacement}{time} = \frac{100-0}{50-1} = 2\ ms^{-1}$

[1 Mark]

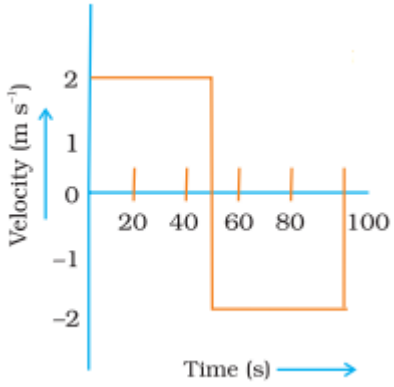
and after time $t = 50\ s$, the velocity is decreasing at a uniform rate.

At $t = 100\ s$, displacement $= 0$

Therefore in this case, $velocity = \frac{0-100}{100-50} = -2\ ms^{-1}$

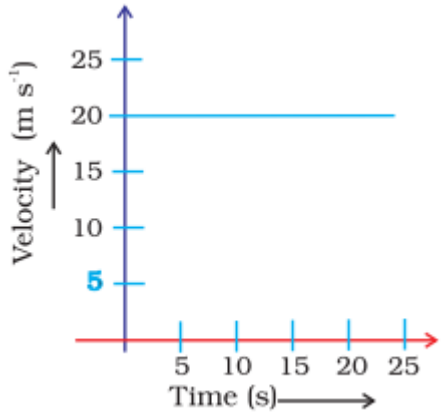
[2 Marks]

Therefore the velocity-time graph for the above-mentioned displacement-time graph will look like



[2 Marks]

10. The velocity-time graph shows the motion of a cyclist. Find (i) its acceleration (ii) its velocity and (iii) the distance covered by the cyclist in 15 seconds.

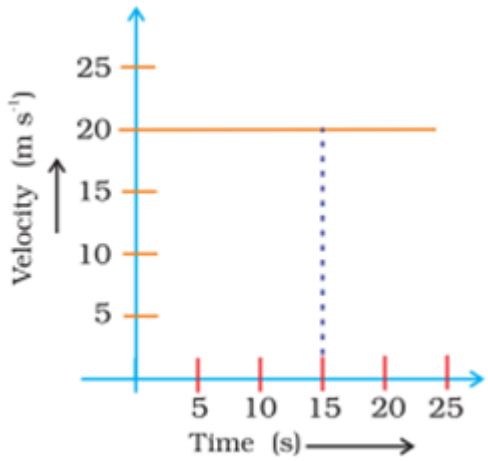


[2 Marks]

Solution:
(i) Since velocity is not changing, acceleration is equal to zero.
[0.5 Marks]

(ii) Reading the graph, velocity = $20\ ms^{-1}$
[0.5 Marks]

(iii) Distance covered in 15 seconds, $s = u \times t = 20 \times 15 = 300\ m$
[1 Mark]



11. A train is travelling at a speed of $90\ \text{kmph}$. Brakes are applied so as to produce a uniform acceleration of $-0.5\ \text{m s}^{-2}$. Find how far the train will go before it is brought to rest.
[3 Marks]

Solution:

Given:
The initial speed of the train, $u = 90\ \text{kmph} = 90 \times \frac{5}{18} = 25\ \text{m s}^{-1}$
$[0.5\ \text{mark}]$

The final speed of the train, $v = 0$ (as the train finally comes to rest)

The acceleration of the train, $a = -0.5\ \text{m s}^{-2}$

Solving for the distance covered by the train:

Let s be the distance covered.

According to the third equation of motion, $v^2 = u^2 + 2as$
$[1\ \text{mark}]$

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

$\Rightarrow s = \frac{-25^2}{2 \times -0.5} = 625\ \text{m}$
$[1.5\ \text{marks}]$

12. How will the equations of motion for an object moving with uniform velocity change? [2 MARKS]

Three equations of motion are:

$v = u + at$

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

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

If an object is moving with uniform velocity, then there would be zero or no acceleration.

[1 MARK]

Therefore, acceleration of the object, a=0,

Hence, by substituting the above value of acceleration in the equations of motion, we get:

$v = u$

$s = ut$

$v^2 - u^2 = 0$

[1 MARK]

13. A lead bullet of mass $0.1\ kg$, travelling with a velocity of $20\ ms^{-1}$, comes to rest after penetrating $20\ m$ in a still target. Find the average acceleration (a) of the bullet.

[2 Marks] [NCERT]

Solution:

Given:

Initial velocity, $u = 20\ ms^{-1}$

Final velocity, $v = 0$

Distance travelled, $s = 20\ m$

From third equation of motion, we have

$v^2 = u^2 + 2as$ [1 Mark]

$0^2 = 20^2 + (2 \times a \times 20)$

$\Rightarrow a = -10\ ms^{-2}$ [1 Mark]

14. An artificial satellite is moving in a circular orbit of radius $42,250\ km$. Calculate its speed if it takes 24 h to revolve around the Earth.
[3 Marks]

Given: Radius of the circular orbit, $r = 42,250\ km$
Time taken to complete one revolution around the Earth, $t = 24\ h$

To find: Speed of the satellite, v

Speed of an object moving in a circular orbit, $v = \frac{2\pi r}{t}$ [1 Mark]

$$v = \frac{2 \times \pi \times 42250\ km}{24\ h}$$

$$v = \frac{2 \times 3.14 \times 42250\ km}{24\ h}$$ [1 Mark]

$$v = 11055.42\ kmh^{-1}$$

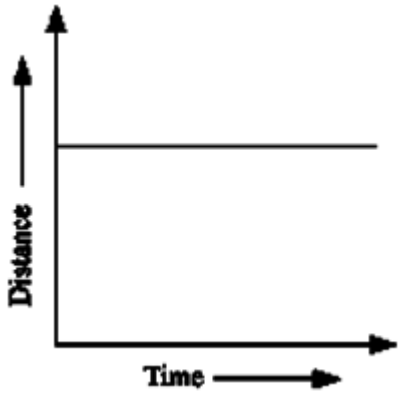
$$v = \frac{11055.42}{3600} kms^{-1}$$

$v = 3.07\ kms^{-1}$ [1 Mark]

Hence, the speed of the artificial satellite is $3.07\ kms^{-1}$,.

15. What can you say about the motion of an object whose distance-time graph is a straight line parallel to the time axis?
[2 Marks]

Solution:
If the distance-time graph is a straight line parallel to the time axis, that means the body is not changing its position with time, the body is at rest.
[1 Mark]



[1 Mark]