NCERT Archive

SOLUTIONS BOOK

CLASS 9

Science · Exploration

CHAPTER 4

Describing Motion Around Us

Complete Questions, Examples and Activities Solutions

In-text Questions | Examples | Revise, Reflect, Refine | The Journey Beyond

Contents

Class 9 Science · Exploration · Chapter 4 — Describing Motion Around Us

4.1 In-text Questions
14 questions · Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 — 3

4.2 Examples
8 questions · Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 — 17

4.3 Revise, Reflect, Refine
16 questions · Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q16 — 25

4.4 The Journey Beyond
5 questions · Q1 Q2 Q3 Q4 Q5 — 42

Every question is followed by its answer. Question numbers above are clickable and the PDF bookmarks panel lets you jump to any exercise set or question. Figures are reproduced from the NCERT textbook (© NCERT) for educational use.

NCERT ARCHIVE

4.1

CLASS 9 SCIENCE · CHAPTER 4

In-text Questions

Solutions · 14 questions

Directions (Questions 1–14): These are the questions that appear inside the chapter (Think It Over, Activities 4.1–4.5 and Pause and Ponder), numbered in the order in which they appear. Where an activity needs a classroom or a device, the expected result and the reasoning are given.

QUESTION 1 *Think It Over · p. 48*

How much distance should we maintain from the truck ahead to avoid a collision if it suddenly applies the brakes?

ANSWER

Our vehicle does not stop the instant the driver sees the truck brake. It first covers some distance during the driver's reaction time and then a further distance while the brakes act. The gap must be at least this stopping distance.

a What decides the distance

- The velocity of our vehicle when the brakes are applied.
- The road surface (wet or dry, etc.).
- The braking capacity of the vehicle (the negative acceleration the brakes produce).
- The driver's reaction time.

b Working out the braking distance

For motion with constant acceleration, Eq. (4.4c) gives $v^2 = u^2 + 2as$. The vehicle stops, so $v = 0$ and the braking distance is $s = u^2 / (2|a|)$.

Example 4.8 ($a = -4$ m s^{-2}) gives $s = 28.1$ m for $u = 54$ km h^{-1} (15 m s^{-1}) and $s = 112.5$ m for $u = 108$ km h^{-1} (30 m s^{-1}).

NCERT ARCHIVE

c The gap to keep

Keep a gap that is not less than the stopping distance of our own vehicle: the reaction distance (speed × reaction time) plus the braking distance. The gap must be larger on a wet road or when the brakes are weaker.

Therefore, the gap must be at least the stopping distance of our vehicle (reaction distance + braking distance), and it grows as our velocity grows.

QUESTION 2 *Think It Over · p. 48*

Does this distance depend upon the speed with which we are moving?

ANSWER

Yes. Both parts of the stopping distance grow with speed. The table uses a = -4 m s^{-2} (Example 4.8) and a reaction time of 0.5 s (as in Revise, Reflect, Refine Q.10).

a Stopping distance at different speeds

Speed	u (m s^{-1})	Reaction distance (u × 0.5 s)	Braking distance ($u^2/8$)	Total stopping distance
36 km h^{-1}	10	5 m	12.5 m	17.5 m
54 km h^{-1}	15	7.5 m	28.1 m	35.6 m
72 km h^{-1}	20	10 m	50 m	60 m
108 km h^{-1}	30	15 m	112.5 m	127.5 m

b Observation

Reaction distance is proportional to the speed, while braking distance is proportional to the square of the speed. Doubling the speed from 54 km h^{-1} to 108 km h^{-1} increases the braking distance from 28.1 m to 112.5 m, i.e. four times.

Therefore, the safe distance depends on the speed: the faster we move, the longer the distance needed to stop and the larger the gap we must keep.

NCERT ARCHIVE

QUESTION 3 *Activity 4.1 · p. 51*

1. As shown in Fig. 4.5, a ball is thrown vertically upwards from O. It moves up straight till B and then falls back to O. Can this be considered a motion in a straight line?

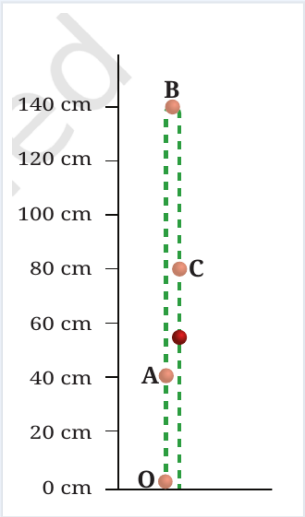


Fig. 4.5: A ball in vertical motion

ANSWER

Yes. The ball moves up and then down along the same vertical straight line, so the whole motion takes place along one straight line.

a Reason

- The path is one vertical line (in Fig. 4.5 two separate lines are drawn only for clarity).
- On a straight line an object can move in only two directions, forward or backward. Going up and then coming down only reverses the direction; the path stays straight.
- Positions can be given by distances above O: upward as positive, downward as negative.

Therefore, the up-and-down motion of the ball is motion in a straight line.

NCERT ARCHIVE

QUESTION 4 *Activity 4.1 · p. 51*

2. For this motion, fill up the values in Table 4.1.
Table 4.1: Distance travelled and displacement of the ball (S. No. 1 and 2 are given in the chapter).

ANSWER

Read the positions from Fig. 4.5 and follow the ball: O → A → B → C → O. Distance is the length of the path travelled; displacement is the change in position from O.

a Positions read from Fig. 4.5

O = 0 cm, A = 40 cm, C = 80 cm and B = 140 cm above O. The ball goes up from O to B (140 cm) and then comes down through C to O.

b Table 4.1 (completed)

S. No.	Position	Total distance travelled by the ball from O till that position	Displacement of the ball from O till that position
1	O	0 cm	0 cm
2	A	40 cm	40 cm in upward direction
3	B	140 cm	140 cm in upward direction
4	C	140 cm + 60 cm = 200 cm	80 cm in upward direction
5	O	140 cm + 140 cm = 280 cm	0 cm

Therefore, at B the distance is 140 cm; at C it is 200 cm with displacement 80 cm; and on returning to O the distance is 280 cm but the displacement is 0.

NCERT ARCHIVE

QUESTION 5 *Activity 4.1 · p. 51*

3. Analyse the data filled in Table 4.1 and choose which of the following is true for displacement:
(i) It is never zero.
(ii) Its magnitude can be greater than the total distance travelled.
(iii) Its magnitude is less than or equal to the total distance travelled.
(iv) Its magnitude is less than the total distance travelled in all cases.

ANSWER

Compare the two columns of Table 4.1 row by row. Only option (iii) agrees with every row.

a Checking each option against Table 4.1

Option	Verdict	Reason from the table
(i) It is never zero	False	Displacement is 0 cm at O (S. No. 1 and 5).
(ii) Magnitude can be greater than distance	False	Never: 0 = 0, 40 = 40, 140 = 140, 80 < 200, 0 < 280.
(iii) Magnitude is less than or equal to distance	True	Holds in all five rows.
(iv) Magnitude is less than distance in all cases	False	At S. No. 1, 2 and 3 the two are equal.

Therefore, option (iii) is correct: the magnitude of displacement is less than or equal to the total distance travelled.

NCERT ARCHIVE

QUESTION 6 *Pause and Ponder · p. 51*

1. In the example of an athlete running back and forth on a straight track (Fig. 4.4), when will the displacement of the athlete be zero? What will be the total distance travelled in that case?

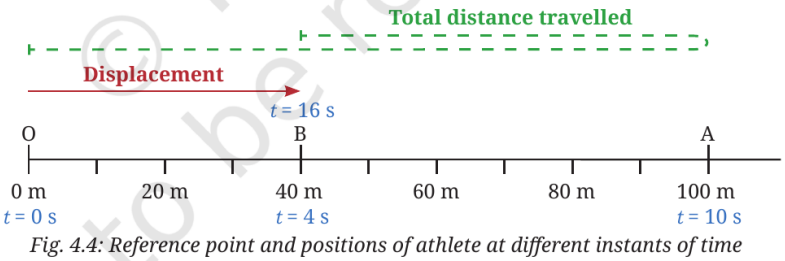


Fig. 4.4: Reference point and positions of athlete at different instants of time

Fig. 4.4: Reference point and positions of athlete at different instants of time

ANSWER

Displacement is the net change in position, so it is zero whenever the athlete's final position is the same as the starting position.

a When is displacement zero?

When the athlete comes back to the point from where she started (the origin O).

b Distance in that case

The distance is not zero. If she runs from O to A and returns to O, then total distance = OA + AO = 100 m + 100 m = 200 m, while the displacement is 0 m. In general the distance is twice the distance to the farthest point reached.

Therefore, displacement is zero when the athlete returns to her starting point; the distance travelled is then twice the one-way distance (200 m for OA = 100 m).

NCERT ARCHIVE

QUESTION 7 *Pause and Ponder · p. 51*

2. Fuel used up in a vehicle depends on which of the following? Justify your answer.
(i) Total distance travelled
(ii) Displacement

ANSWER

The fuel is burnt by the engine for every metre that the vehicle actually moves along its path.

a **Answer: (i) Total distance travelled**

- Distance counts the whole path covered. Displacement only compares the starting and stopping positions.
- Example: a car goes 10 km to a market and 10 km back. Its displacement is 0, yet it has used fuel to travel 20 km.
- Two journeys with the same displacement but different routes need different amounts of fuel.

Therefore, fuel used depends on the total distance travelled, not on the displacement.

NCERT ARCHIVE

QUESTION 8 *Pause and Ponder · p. 51*

3. A ball rolls down an inclined track as shown in Fig. 4.6. Is its motion, a straight line motion? Assuming the starting point of the ball (O) to be the origin, can its motion from O to D be depicted using a horizontal line as shown in Fig. 4.3? Are the values of total distance travelled and magnitude of displacement from O equal or different at positions A, B, C and D?

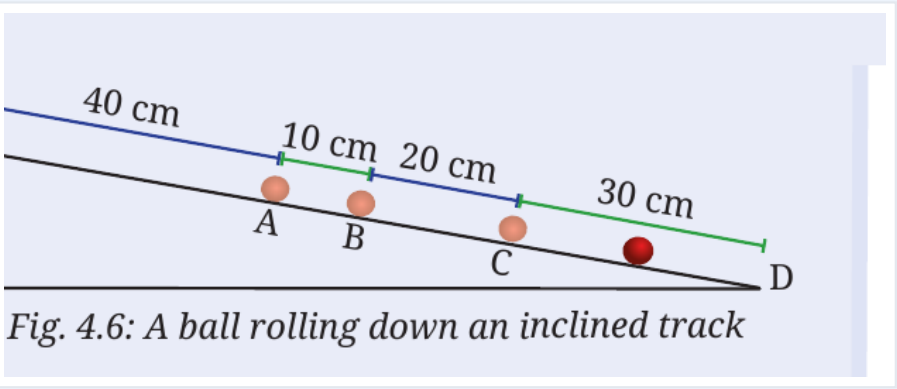


Fig. 4.6: A ball rolling down an inclined track

ANSWER

The track is a straight inclined line, so the ball moves along a straight line and the motion can be represented on a number line.

a Straight line motion?

Yes. The ball moves along the straight track from O to D, so it is motion in a straight line even though the track is inclined.

b Depicting it on a horizontal line

Yes. Take O as the origin and measure positions along the track. From Fig. 4.6: OA = 40 cm, AB = 10 cm, BC = 20 cm and CD = 30 cm, so A, B, C and D are at 40 cm, 50 cm, 70 cm and 100 cm from O on a line like Fig. 4.3.

c Distance and magnitude of displacement

Position	Total distance from O	Magnitude of displacement from O
A	40 cm	40 cm
B	40 + 10 = 50 cm	50 cm
C	50 + 20 = 70 cm	70 cm
D	70 + 30 = 100 cm	100 cm

NCERT ARCHIVE

Therefore, the motion is a straight line motion, and the values are equal at A, B, C and D because the ball moves in one direction without turning back.

QUESTION 9 *Pause and Ponder · p. 53*

4. During a family road trip, you drive 200 km north in three hours. Afterwards, you drive 200 km south in two hours. Find the average speed and average velocity for your entire trip.

ANSWER

Average speed uses the total distance travelled. Average velocity uses the displacement. Both are divided by the total time interval.

a Given

Distance north = 200 km in 3 h; distance south = 200 km in 2 h (back along the same road).

b Average speed

Total distance = 200 km + 200 km = 400 km

Total time interval = 3 h + 2 h = 5 h

Average speed = total distance / time interval = 400 km / 5 h = 80 km h^{-1}

c Average velocity

Displacement = 200 km north − 200 km south = 0 km

Average velocity = displacement / time interval = 0 km / 5 h = 0 km h^{-1}

Therefore, the average speed is 80 km h^{-1} (about 22.2 m s^{-1}) and the average velocity is zero.

NCERT ARCHIVE

QUESTION 10 *Pause and Ponder · p. 53*

5. Under what condition(s) is the
(i) magnitude of average velocity of an object equal to its average speed?
(ii) magnitude of average velocity of an object zero while its average speed is not zero?

ANSWER

Average speed = distance / time interval and the magnitude of average velocity = magnitude of displacement / time interval. They compare distance with the magnitude of displacement.

a (i) Magnitude of average velocity equal to average speed

When the distance travelled equals the magnitude of displacement: the object moves along a straight line in one direction without turning back (see the Note on p. 53).

b (ii) Average velocity zero, average speed not zero

When the object returns to its starting position in the time interval, so the displacement is zero but the distance is not. Examples: Sarang swimming one length of the pool and back (Example 4.2), or the child making one full revolution on a merry-go-round.

Therefore, (i) motion along a straight line in one direction; (ii) the object ends at the position where it started.

QUESTION 11 *Activity 4.2 · p. 55*

1. The magnitude of average acceleration of cars is generally specified as the time taken by the car to go from 0 km h^{-1} to 100 km h^{-1}. Look it up on the internet and find this time for various cars, and record those in Table 4.2.
2. Calculate the magnitude of average acceleration for each car.

ANSWER

The time for each car must be looked up by you. The method is the same for every car; the table below shows it with three sample times (illustrative values, replace them with the ones you find).

NCERT ARCHIVE

a Method

Final velocity = 100 km h^{-1} = 100 × 1000 / 3600 = 27.78 m s^{-1}; initial velocity = 0

Magnitude of average acceleration a = (v − u) / t = 27.78 m s^{-1} / t

b Table 4.2 (with sample times)

Car type	Time interval during which the speed goes from 0 to 100 km h^{-1}	Magnitude of average acceleration (m s^{-2})
Car 1 (sample)	8 s	27.78 / 8 = 3.47
Car 2 (sample)	10 s	27.78 / 10 = 2.78
Car 3 (sample)	12 s	27.78 / 12 = 2.31

Therefore, a car that reaches 100 km h^{-1} in less time has a larger average acceleration.

QUESTION 12 *Activity 4.3 · p. 57*

Plot the position-time graph for the vehicle moving on a straight road using the data in Table 4.3, following the steps of Activity 4.3.

ANSWER

Time is shown along the X-axis and position along the Y-axis, using the scale given in the activity.

a Data (Table 4.3)

Time	0 s	1 s	2 s	3 s	4 s	5 s	6 s
Position	0 m	20 m	40 m	60 m	80 m	100 m	120 m

b Steps

- Draw perpendicular lines OX (time) and OY (position) with origin O.
- Scale: X-axis 5 divisions = 1 s, Y-axis 5 divisions = 20 m.
- Mark (0 s, 0 m), (1 s, 20 m), (2 s, 40 m), ... (6 s, 120 m) by drawing lines parallel to the axes.
- Join the points.

NCERT ARCHIVE

c Result (Fig. 4.11c)

The points lie on a straight line through the origin: the position increases by 20 m every second, so the vehicle moves with constant velocity 20 m s^{-1}.

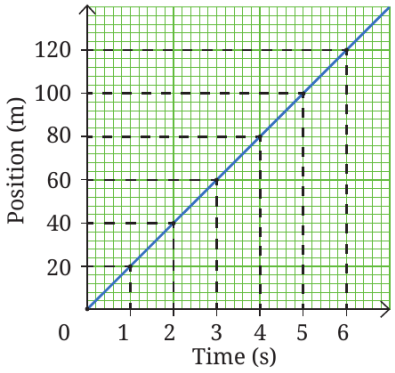


Fig. 4.11(c): Making a graph

Therefore, the position-time graph is a straight line; equal displacements (20 m) in equal intervals of time mean constant velocity.

NCERT ARCHIVE

QUESTION 13 *Activity 4.4 · p. 59*

1. In the position-time graph we plotted (Fig. 4.11c), consider a part (say, AB) of the graph as shown in Fig. 4.14. From A, draw a line parallel to X-axis and another line parallel to Y-axis. Repeat the same from B.
2. Extend the horizontal line from A and a triangle ABC is formed. What do the sides BC and CA of the triangle represent?

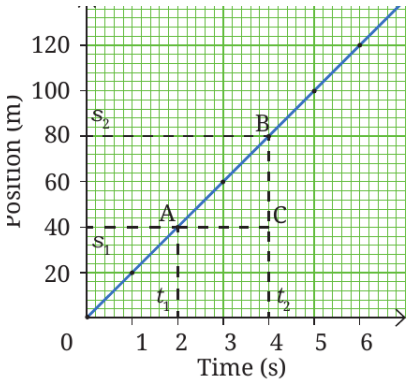


Fig. 4.14: Calculating velocity from a position-time graph

ANSWER

BC is the vertical side and CA is the horizontal side of the triangle. They give the change in position and the change in time between A and B.

a What the sides represent

- BC represents the change in position, $s_2 - s_1$.
- CA represents the change in time, $t_2 - t_1$.

b Average velocity from the graph

$v = (s_2 - s_1) / (t_2 - t_1) = BC / CA$
With A (2 s, 40 m) and B (4 s, 80 m): $v = (80\ m - 40\ m) / (4\ s - 2\ s) = 40\ m / 2\ s = 20\ m\ s^{-1}$

BC / CA is the slope of line AB. Since the graph is a straight line, any two points give the same value.

Therefore, BC is the change in position and CA is the change in time; their ratio, the slope, gives the average velocity (20 m s^{-1}).

NCERT ARCHIVE

QUESTION 14 *Activity 4.5 · p. 67*

3. Predict what will happen if you lift the ring while the marble is moving.
4. Now, after one or two complete revolutions of the marble, pick up the ring without disturbing the motion of the marble. What do you observe? Does the marble continue moving in a circular motion? Or does it move in some other manner?



Fig. 4.24: A marble moving inside a ring

ANSWER

Expected observation: the marble does not continue in a circle. It moves off in a straight line.

a Prediction and observation

Once the ring is lifted, the marble leaves the circle and moves along a straight line; it does not keep moving on a circle. This is the same every time the activity is repeated.

b Why does this happen?

- The ring forced the marble to keep turning. After it is removed, nothing makes the marble change direction.
- The marble continues in the direction in which it was moving at the instant the ring was removed. That direction is along the tangent to the circle at that point (Fig. 4.25).
- In uniform circular motion the speed is constant, but the direction of velocity changes continuously, so the motion is accelerated.

Therefore, the marble moves in a straight line along the tangent at the point where the ring is removed.

NCERT ARCHIVE

CLASS 9 SCIENCE · CHAPTER 4

4.2 Examples

Solutions · 8 examples

Directions (Questions 1–8): These are Examples 4.1 to 4.8 worked in the chapter. Each example is restated and solved step by step, and every result has been checked.

QUESTION 1 *Example 4.1 · p. 52*

Consider two postmen. They start walking towards each other from a distance of 210 yojanas (Yojana is a unit of distance used in ancient India). One travels 9 yojanas per day and the other covers 5 yojanas per day. Can you determine in how many days they will meet each other?

ANSWER

Since they walk towards each other, the distance between them shrinks by the sum of the two daily distances.

a Solution

Distance covered by both in one day = 9 yojanas + 5 yojanas = 14 yojanas

They must cover 210 yojanas together.

Time = 210 / 14 = 15 days

b Check

In 15 days the first postman covers 9 × 15 = 135 yojanas and the second covers 5 × 15 = 75 yojanas; 135 + 75 = 210 yojanas.

Therefore, the postmen will meet each other after 15 days.

NCERT ARCHIVE

QUESTION 2 *Example 4.2 · p. 53*

Sarang takes 50 seconds to swim from one end to the other end and back in the swimming pool shown in Fig. 4.7. Find his average speed and average velocity within the time interval of 50 s.

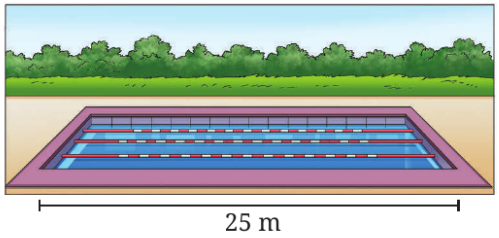


Fig. 4.7: Swimming pool

ANSWER

The pool is 25 m long (Fig. 4.7). Sarang swims one length and returns to the starting end.

a Distance and displacement

Total distance travelled = 25 m + 25 m = 50 m

Displacement = 0 m (he is back at the starting end)

b Average speed and average velocity

Average speed = total distance travelled / time interval = 50 m / 50 s = 1 m s^{-1}

Average velocity = displacement / time interval = 0 m / 50 s = 0 m s^{-1}

Therefore, the average speed is 1 m s^{-1} and the average velocity is 0 m s^{-1}.

NCERT ARCHIVE

QUESTION 3 *Example 4.3 · p. 55*

A bus is moving on a long straight highway (Fig. 4.9) with a velocity of 36 km h^{-1}. The driver presses the accelerator for a time interval of 10 s and velocity of the bus increases to 54 km h^{-1}. For some time, the bus moves at a constant velocity. Then, the driver notices an obstacle on the road ahead and presses the brake. The bus comes to a stop in a time interval of 5 s. Find the average acceleration in the two time intervals, (i) when the accelerator was pressed, and (ii) when the brakes were pressed.



Fig. 4.9: A bus moving on a long straight highway

ANSWER

Convert the velocities to m s^{-1} and use Eq. (4.3c): $a = (v - u) / (t_2 - t_1)$.

a Conversion

36 km h^{-1} = 36 × 1000 / 3600 = 10 m s^{-1}; 54 km h^{-1} = 54 × 1000 / 3600 = 15 m s^{-1}

b (i) When the accelerator is pressed

u = 10 m s^{-1}, v = 15 m s^{-1}, t = 10 s

a = (15 − 10) m s^{-1} / 10 s = 0.5 m s^{-2}

The velocity is increasing, so the acceleration is in the direction of velocity.

c (ii) When the brake is pressed

u = 15 m s^{-1}, v = 0, t = 5 s

a = (0 − 15) m s^{-1} / 5 s = −3 m s^{-2}

The minus sign shows that the acceleration is opposite to the direction of velocity (the velocity is decreasing).

Therefore, a = 0.5 m s^{-2} while accelerating and a = −3 m s^{-2} while braking.

NCERT ARCHIVE

QUESTION 4 *Example 4.4 · p. 56*

As we learnt earlier, when an object is dropped from a height, it takes a straight vertical path downwards before touching the ground. While coming down, the velocity of the object increases as shown in Fig. 4.10 at different instants. Find the magnitude of the average acceleration of the object in every successive interval of a second. Is the average acceleration constant across all intervals? What is the direction of this average acceleration?

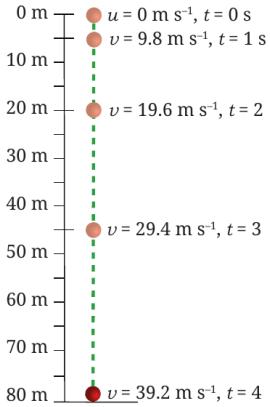


Fig. 4.10: An object dropped from a height

ANSWER

From Fig. 4.10 the velocities are 0, 9.8, 19.6, 29.4 and 39.2 m s^{-1} at t = 0, 1, 2, 3 and 4 s. Use a = change in velocity / time interval.

a Average acceleration in each interval

Interval	Change in velocity	Time interval	Average acceleration
0 s to 1 s	(9.8 − 0) m s^{-1}	(1 − 0) s = 1 s	9.8 m s^{-2}
1 s to 2 s	(19.6 − 9.8) m s^{-1}	(2 − 1) s = 1 s	9.8 m s^{-2}
2 s to 3 s	(29.4 − 19.6) m s^{-1}	(3 − 2) s = 1 s	9.8 m s^{-2}
3 s to 4 s	(39.2 − 29.4) m s^{-1}	(4 − 3) s = 1 s	9.8 m s^{-2}

b Constant? Direction?

Yes, the average acceleration is constant and equal to 9.8 m s^{-2} in every interval. The velocity is increasing in the direction of motion, so the acceleration is in the direction of motion (downwards). It is the acceleration due to gravitational force by the Earth, denoted by g.

NCERT ARCHIVE

Therefore, the average acceleration is constant (9.8 m s^{-2}) and acts downwards, in the direction of motion.

QUESTION 5 *Example 4.5 · p. 58*

For a vehicle starting from rest and speeding up, the data for position and time are given in Table 4.4. Plot the position-time graph corresponding to it.

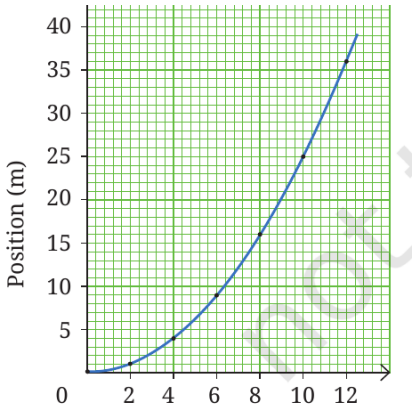


Fig. 4.12: Position-time graph of the vehicle

ANSWER

Show time on the X-axis and position on the Y-axis, and mark each pair of values from Table 4.4.

a Table 4.4

Time	0 s	2 s	4 s	6 s	8 s	10 s	12 s
Position	0 m	1 m	4 m	9 m	16 m	25 m	36 m

b Scale and plotting

Scale: X-axis 5 divisions = 2 s, Y-axis 5 divisions = 5 m. Mark the points (0, 0), (2, 1), (4, 4), (6, 9), (8, 16), (10, 25), (12, 36) as in Activity 4.3 and join them.

c Shape of the graph

Displacements in successive 2 s intervals are 1 m, 3 m, 5 m, 7 m, 9 m and 11 m. They keep increasing, so the points do not lie on a straight line and are joined by a curve (Fig. 4.12). The velocity is increasing.

NCERT ARCHIVE

Therefore, the position-time graph is a curve (not a straight line): the vehicle is in accelerated motion.

QUESTION 6 *Example 4.6 · p. 60*

What does the graph shown in Fig. 4.15 indicate about the nature of motion of the vehicle?

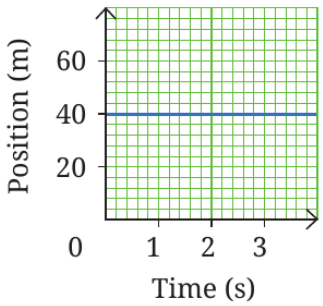


Fig. 4.15: Position-time graph of a vehicle

ANSWER

Read the graph: the position stays at 40 m for all times from 0 s to 3 s.

a Interpretation

The position of the vehicle is 40 m from the origin and is not changing with time. A straight line parallel to the time axis on a position-time graph represents a stationary object. (This is a position-time graph, not a distance-time graph.)

Therefore, the vehicle is at rest at 40 m from the origin.

NCERT ARCHIVE

QUESTION 7 *Example 4.7 · p. 60*

The position-time graphs of two objects A and B are given in Fig. 4.16a. The magnitude of average velocity of which object is higher?

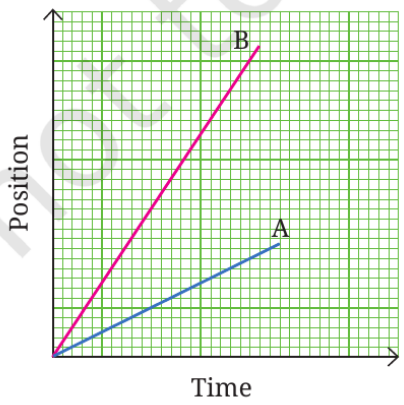


Fig. 4.16(a): Position-time graph of two objects

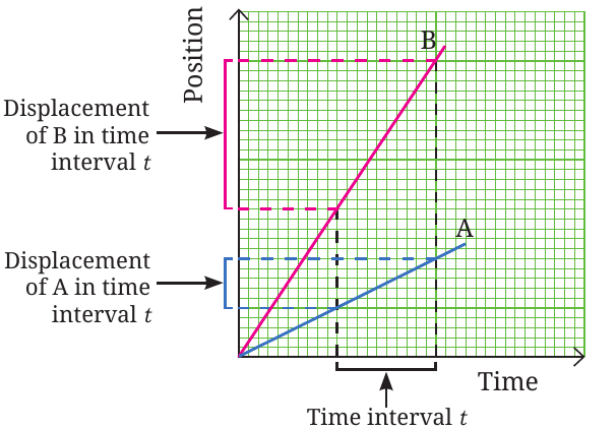


Fig. 4.16(b): Comparing displacement of two objects from position-time graph

ANSWER

Compare the slopes of the two lines. A steeper line means a larger change in position in the same time.

a Comparison

Draw lines parallel to the axes as in Fig. 4.16b. For the same time interval t, the displacement of B is more than the displacement of A. So the slope of the line for B is steeper than the slope of line A.

Therefore, the magnitude of average velocity of B is higher than that of A.

NCERT ARCHIVE

QUESTION 8 *Example 4.8 · p. 65*

Suppose a car is moving on a highway and brakes are applied, which cause an acceleration of $-4\ m\ s^{-2}$. How much will be the distance travelled by the car before coming to a stop, if the car was moving with a velocity of (i) 54 km h^{-1}, and (ii) 108 km h^{-1} when the brakes were applied?

ANSWER

The car stops, so the final velocity is 0. The time is not given, so use Eq. (4.4c): $v^2 = u^2 + 2as$.

a **Given**

$a = -4\ m\ s^{-2}$, $v = 0\ m\ s^{-1}$

(i) $u = 54\ km\ h^{-1} = 15\ m\ s^{-1}$ (ii) $u = 108\ km\ h^{-1} = 30\ m\ s^{-1}$

b **Using $v^2 = u^2 + 2as$**

$0 = u^2 + 2 \times (-4) \times s \Rightarrow s = u^2 / 8$

(i) $s = 15^2 / 8 = 225 / 8 = 28.125\ m \approx 28.1\ m$

(ii) $s = 30^2 / 8 = 900 / 8 = 112.5\ m$

Therefore, the car travels about 28.1 m in case (i) and 112.5 m in case (ii) before stopping. Doubling the velocity makes the stopping distance four times.

NCERT ARCHIVE

4.3

CLASS 9 SCIENCE · CHAPTER 4

Revise, Reflect, Refine

Solutions · 16 questions

Directions (Questions 1–16): These are the questions at the end of the chapter (pages 68–70). Each answer lists the data, the formula, the working and the final result. Where a value is read from a graph, it is marked as an estimate.

QUESTION 1 *Revise, Reflect, Refine · p. 68*

1. My father went to a shop from home which is located at a distance of 250 m on a straight road. On reaching there, he discovered that he forgot to carry a cloth bag. He came home to take it, went to the shop again, bought provisions and came back home. How much was the total distance travelled by him? What was his displacement from home?

ANSWER

Break the journey into legs along the straight road. Each leg is 250 m, and the distance is the sum of all the legs.

a Legs of the journey

Leg	Path	Distance
1	Home → shop	250 m
2	Shop → home (to take the bag)	250 m
3	Home → shop again	250 m
4	Shop → home (with provisions)	250 m

b Distance and displacement

Total distance = 4 × 250 m = 1000 m

Displacement = 0 (he ends at home, from where he started)

NCERT ARCHIVE

Therefore, the total distance travelled is 1000 m (1 km) and the displacement from home is 0 m.

QUESTION 2 *Revise, Reflect, Refine · p. 68*

2. A student runs from the ground floor to the fourth floor of a school building to collect a book and then comes down to their classroom on the second floor. If the height of each floor is 3 m, find:
(i) the total vertical distance travelled, and
(ii) their displacement from the starting point.

ANSWER

Take the ground floor as the origin and upward as positive. The fourth floor is 4 floors above the ground and the second floor is 2 floors above it.

a **(i) Total vertical distance**

Going up: 4 × 3 m = 12 m
Coming down from the 4th to the 2nd floor: 2 × 3 m = 6 m
Total distance = 12 m + 6 m = 18 m

b **(ii) Displacement**

Final position = 2nd floor = 2 × 3 m = 6 m above the ground floor
Displacement = 6 m − 0 = 6 m upward

Therefore, the total vertical distance is 18 m and the displacement from the starting point is 6 m upwards.

QUESTION 3 *Revise, Reflect, Refine · p. 69*

3. A girl is riding her scooter and finds that its speedometer reading is constant. Is it possible for her scooter to be accelerating and if so, how?

ANSWER

Yes. The speedometer shows only the magnitude of velocity. Acceleration depends on the change in velocity, which can be a change in magnitude, in direction, or both.

NCERT ARCHIVE

a How it can happen

- If the scooter moves along a curved path or takes a turn at constant speed, the direction of its velocity keeps changing.
- A change in direction means the velocity changes, so the acceleration is not zero (as in uniform circular motion).
- If it moved in a straight line at constant speed, the acceleration would be zero.

Therefore, the scooter can be accelerating at constant speed if the direction of its motion is changing, e.g. while turning.

QUESTION 4 *Revise, Reflect, Refine · p. 69*

4. A car starts from rest and its velocity reaches 24 m s^{-1} in 6 s. Find the average acceleration and the distance travelled in these 6 s.

ANSWER

The car starts from rest, so u = 0. Use a = (v − u) / t and then s = ut + ½at^2.

a Given

u = 0, v = 24 m s^{-1}, t = 6 s.

b Average acceleration

a = (v − u) / t = (24 − 0) / 6 = 4 m s^{-2}

c Distance travelled

s = ut + ½at^2 = 0 + ½ × 4 × 6^2 = ½ × 4 × 36 = 72 m

Check with $v^2 = u^2 + 2as$: $24^2 = 2 \times 4 \times s \Rightarrow s = 576 / 8 = 72$ m

Therefore, the average acceleration is 4 m s^{-2} and the distance travelled is 72 m.

NCERT ARCHIVE

QUESTION 5 *Revise, Reflect, Refine · p. 69*

5. A motorbike moving with initial velocity 28 m s^{-1} and constant acceleration stops after travelling 98 m. Find the acceleration of the motorbike and the time taken to come to a stop.

ANSWER

The motorbike stops, so v = 0. Time is not given at first, so use $v^2 = u^2 + 2as$, then $v = u + at$.

a Given

u = 28 m s^{-1}, v = 0, s = 98 m.

b Acceleration

$v^2 = u^2 + 2as \Rightarrow 0 = 28^2 + 2 \times a \times 98$

$196a = -784 \Rightarrow a = -4$ m s^{-2}

c Time taken

$v = u + at \Rightarrow 0 = 28 + (-4) \times t \Rightarrow t = 28 / 4 = 7$ s

Check: $s = ut + \frac{1}{2}at^2 = 28 \times 7 + \frac{1}{2} \times (-4) \times 49 = 196 - 98 = 98$ m ✓

Therefore, the acceleration is −4 m s^{-2} (a retardation of 4 m s^{-2}) and the bike stops in 7 s.

NCERT ARCHIVE

QUESTION 6 *Revise, Reflect, Refine · p. 69*

6. Fig. 4.27 shows a position-time graph of two objects A and B that are moving along the parallel tracks in the same direction. Do objects A and B ever have equal velocity? Justify your answer.

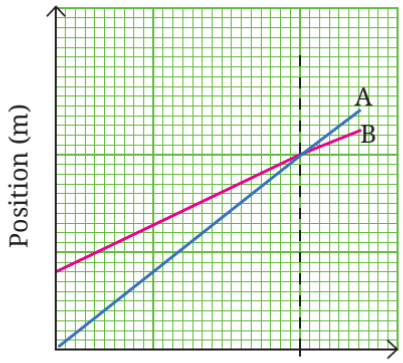


Fig. 4.27

ANSWER

The velocity of each object is the slope of its position-time graph. Equal velocity would need equal slopes.

a Reading Fig. 4.27

- Both graphs are straight lines, so each object moves with constant velocity.
- B starts ahead of A (it is at a larger position at t = 0), but A's line is steeper.
- The lines cross at t = 5 s: the two objects are at the same position at that instant, and after it A is ahead of B.

b Conclusion

The slope of A is greater than the slope of B at every instant, and the slopes never change. Meeting at the same position does not mean having the same velocity.

Therefore, A and B never have equal velocity; A always moves faster than B, and they only meet at t = 5 s.

NCERT ARCHIVE

QUESTION 7 *Revise, Reflect, Refine · p. 69*

7. A graph in Fig. 4.28 shows the change in position with time for two objects A and B moving in a straight line from 0 to 10 seconds. Choose the correct option(s).
(i) The average velocity of both over the 10 s time interval is equal since they have the same initial and final positions.
(ii) The average speeds of both over the 10 s time interval are equal since both cover equal distance in equal time.
(iii) The average speed of A over the 10 s time interval is lower than that of B since it covers a shorter distance than B in 10 seconds.
(iv) The average speed of A over the 10 s time interval is greater than that of B since B's speed is lower than A's in some segments.

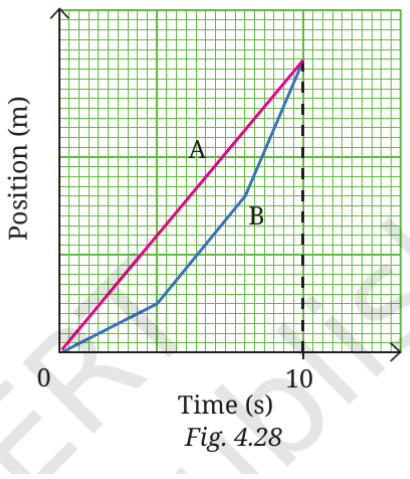


Fig. 4.28

ANSWER

In Fig. 4.28 both objects start from the same position at 0 s and reach the same final position at 10 s. Neither graph ever goes back (the positions keep increasing), so neither object turns back.

NCERT ARCHIVE

a Checking the options

Option	Verdict	Reason
(i)	Correct	Same initial and final positions give the same displacement in the same 10 s, so the same average velocity.
(ii)	Correct	No turning back, so distance = magnitude of displacement for both; equal distance in equal time gives equal average speed.
(iii)	Incorrect	A does not cover a shorter distance; both cover the same distance.
(iv)	Incorrect	B is slower than A in some segments but faster in others (it must catch up to reach the same point), so the average speeds are equal, not greater for A.

Therefore, options (i) and (ii) are correct.

QUESTION 8 *Revise, Reflect, Refine · p. 69*

8. A truck driver driving at the speed of 54 km h^{-1} notices a road sign with a speed limit of 40 km h^{-1} (Fig. 4.29) for trucks. He slows down to 36 km h^{-1} in 36 s. What was the distance travelled by him during this time? Assume the acceleration to be constant while slowing down.



Fig. 4.29

ANSWER

Convert to m s^{-1}. With constant acceleration, $s = ut + \frac{1}{2}at^2$, where a comes from $a = (v - u) / t$.

a Given

$u = 54$ km $h^{-1} = 15$ m s^{-1}, $v = 36$ km $h^{-1} = 10$ m s^{-1}, $t = 36$ s

b Acceleration

$a = (v - u) / t = (10 - 15) / 36 = -5 / 36 \approx -0.14$ m s^{-2}

NCERT ARCHIVE

c Distance

$s = ut + \frac{1}{2}at^2 = 15 \times 36 + \frac{1}{2} \times (-5/36) \times 36^2$

$s = 540 - 90 = 450$ m

Check: s = average velocity × t = ½(15 + 10) × 36 = 12.5 × 36 = 450 m ✓

Therefore, the truck driver travelled 450 m while slowing down.

QUESTION 9 *Revise, Reflect, Refine · p. 69*

9. A car starts from rest and accelerates uniformly to 20 m s^{-1} in 5 seconds. It then travels at 20 m s^{-1} for 10 seconds and finally applies the brake (with uniform acceleration) to stop in 6 seconds. Find the total distance travelled.

ANSWER

Split the motion into three stages and find the displacement of each as the area under the velocity-time graph. The car moves in one direction, so distance equals displacement.

a Distance in each stage

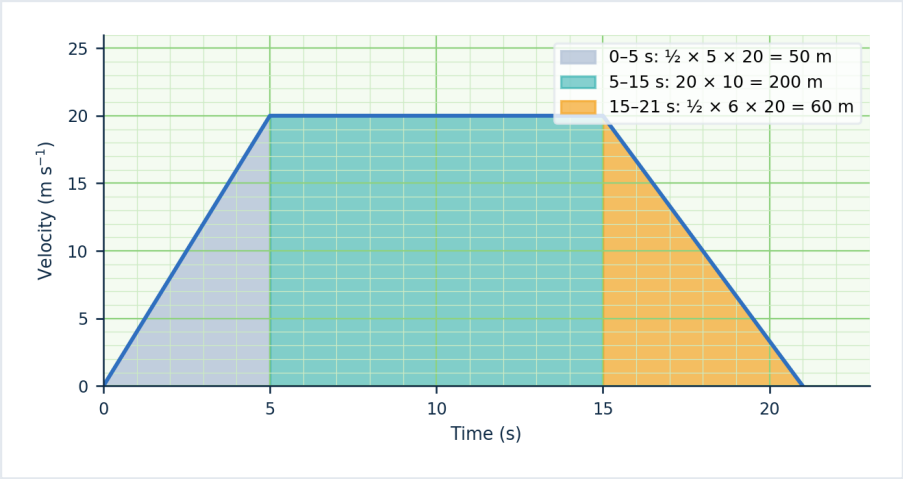
Stage	Motion	Distance
1	Rest to 20 m s^{-1} in 5 s (uniform acceleration)	½ × 5 × 20 = 50 m
2	Constant 20 m s^{-1} for 10 s	20 × 10 = 200 m
3	20 m s^{-1} to rest in 6 s (uniform retardation)	½ × 6 × 20 = 60 m

b Total

Total distance = 50 m + 200 m + 60 m = 310 m

Check: trapezium with parallel sides 21 s and 10 s and height 20: ½ × (21 + 10) × 20 = 310 m ✓

NCERT ARCHIVE



Velocity-time graph of the car (areas give the distances)

Therefore, the total distance travelled by the car is 310 m.

QUESTION 10 *Revise, Reflect, Refine · p. 69*

10. A bus is travelling at 36 km h^{-1} when the driver sees an obstacle 30 m ahead. The driver takes 0.5 seconds to react before pressing the brake. Once the brake is applied, the velocity of the bus reduces with constant acceleration of 2.5 m s^{-2}. Will the bus be able to stop before reaching the obstacle?

ANSWER

The bus keeps moving at constant velocity during the reaction time and only then starts to slow down. Compare the total stopping distance with 30 m.

a Given

u = 36 km h^{-1} = 10 m s^{-1}, reaction time = 0.5 s, retardation = 2.5 m s^{-2}, obstacle at 30 m

b Distance during the reaction time

$s_1 = 10 \times 0.5 = 5$ m

c Braking distance

$v^2 = u^2 + 2as \Rightarrow 0 = 10^2 + 2 \times (-2.5) \times s_2$

$s_2 = 100 / 5 = 20$ m

d Comparison

Total stopping distance = 5 m + 20 m = 25 m < 30 m

NCERT ARCHIVE

Therefore, yes. The bus stops 5 m before the obstacle.

QUESTION 11 *Revise, Reflect, Refine · p. 70*

11. A student said, “The Earth moves around the Sun”. In this context, discuss whether an object kept on the Earth can be considered to be at rest.

ANSWER

Rest and motion are defined with respect to a reference point. An object is at rest if its position with respect to the reference point does not change with time, and in motion if it does.

a With the Earth as the reference

An object kept on the Earth (a book on a table) does not change its position with respect to the Earth or the room, so it is at rest with respect to the Earth.

b With the Sun as the reference

The Earth moves around the Sun and carries the object with it. The position of the object with respect to the Sun changes with time, so it is in motion with respect to the Sun.

Therefore, an object on the Earth is at rest with respect to the Earth but in motion with respect to the Sun; rest and motion depend on the chosen reference point.

NCERT ARCHIVE

QUESTION 12 *Revise, Reflect, Refine · p. 70*

12. The velocity-time graph from 0 s to 120 s for a cyclist is shown in Fig. 4.30. Shade the areas (in different colours) representing the displacement of the cyclist
(i) while cyclist is moving with constant velocity.
(ii) when the velocity of cyclist is decreasing.
Also, calculate the displacement and average acceleration in the 120 s time interval.

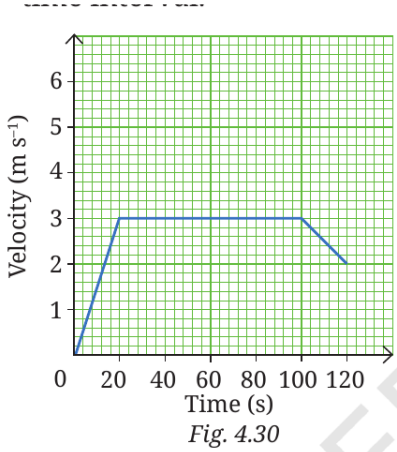


Fig. 4.30

ANSWER

From Fig. 4.30: the velocity rises from 0 to 3 m s^{-1} in 0–20 s, stays at 3 m s^{-1} from 20 s to 100 s, and falls to 2 m s^{-1} at 120 s. The area under the graph gives the displacement.

a Shaded areas

- (i) Constant velocity: the rectangle between 20 s and 100 s (height 3 m s^{-1}), shown in teal.
- (ii) Decreasing velocity: the region under the sloping line between 100 s and 120 s, shown in gold.
- The triangle from 0 to 20 s (speeding up) is shown in grey-blue.

NCERT ARCHIVE

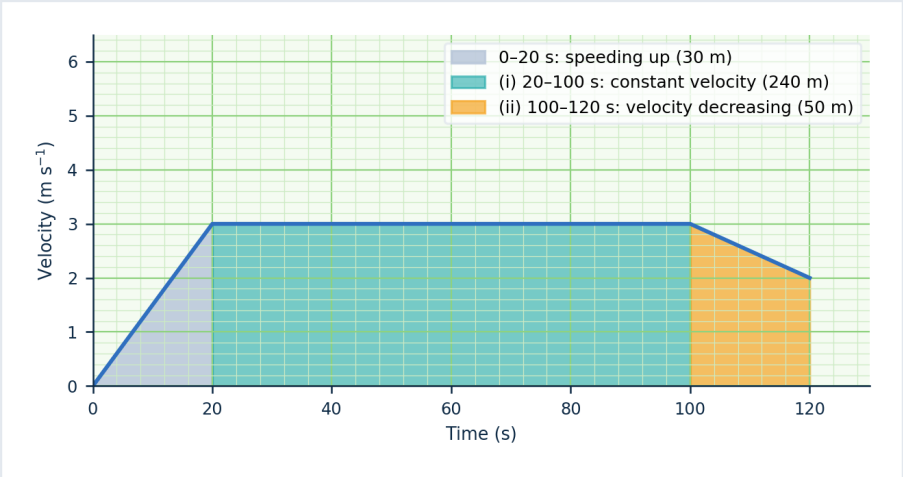


Fig. 4.30 with the areas shaded

b Displacement in 120 s

Part	Area	Displacement
0 s – 20 s (triangle)	½ × 20 × 3	30 m
20 s – 100 s (rectangle)	80 × 3	240 m
100 s – 120 s (trapezium)	½ × (3 + 2) × 20	50 m
Total	30 + 240 + 50	320 m

c Average acceleration in 120 s

$a = (v - u) / t = (2 - 0)\ m\ s^{-1} / 120\ s = 1/60\ m\ s^{-2} \approx 0.017\ m\ s^{-2}$

Therefore, the displacement is 320 m and the average acceleration is about $0.017\ m\ s^{-2}$.

NCERT ARCHIVE

QUESTION 13 *Revise, Reflect, Refine · p. 70*

13. A girl is preparing for her first marathon by running on a straight road. She uses a smartwatch to calculate her running speed at different intervals. The graph (Fig. 4.31) depicts her velocity versus time. Estimate the distance she ran based on the graph.

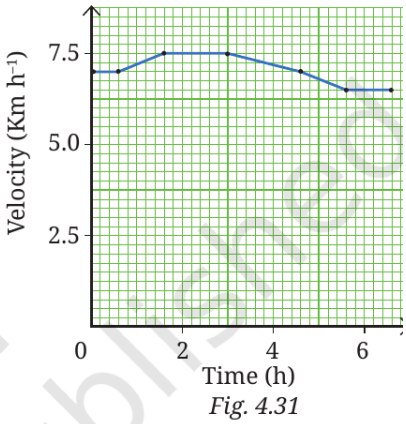


Fig. 4.31

ANSWER

The distance is the area under the velocity-time graph (she runs in one direction). The graph is made of straight pieces, so split the area into rectangles and trapezia. The values below are read from Fig. 4.31, so the answer is an estimate.

a Values read from the graph

(t, velocity in km h^{-1}): (0, 7.0), (0.6, 7.0), (1.6, 7.5), (3.0, 7.5), (4.6, 7.0), (5.6, 6.5), (6.6, 6.5), with t in hours.

b Area of each part

Time interval	Shape	Area (km)
0 – 0.6 h	Rectangle: 7.0 × 0.6	4.20
0.6 – 1.6 h	Trapezium: ½(7.0 + 7.5) × 1.0	7.25
1.6 – 3.0 h	Rectangle: 7.5 × 1.4	10.50
3.0 – 4.6 h	Trapezium: ½(7.5 + 7.0) × 1.6	11.60
4.6 – 5.6 h	Trapezium: ½(7.0 + 6.5) × 1.0	6.75
5.6 – 6.6 h	Rectangle: 6.5 × 1.0	6.50
Total		46.8

NCERT ARCHIVE

Check: her velocity stays between 6.5 and 7.5 km h^{-1} for about 6.6 h, so the distance is about 7 × 6.6 ≈ 46 km, close to the area found.

Therefore, the girl ran about 47 km (estimated from the graph).

QUESTION 14 *Revise, Reflect, Refine · p. 70*

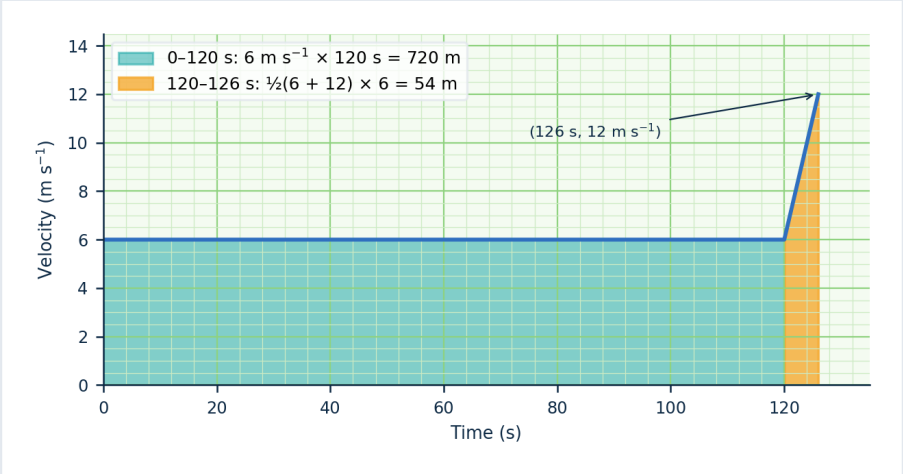
14. On entering a state highway, a car continues to move with a constant velocity of 6 m s^{-1} for 2 minutes and then accelerates with a constant acceleration 1 m s^{-2} for 6 seconds. Find the displacement of the car on the state highway in the 2 min 6 s time interval by drawing a velocity-time graph for its motion.

ANSWER

Draw the velocity-time graph in two parts and find the area under it. Express the time in seconds: 2 min = 120 s, so the whole interval is 126 s.

a Data for the graph

Time	Velocity
0 s	6 m s^{-1}
120 s	6 m s^{-1}
126 s	v = u + at = 6 + 1 × 6 = 12 m s^{-1}



Velocity-time graph of the car

b Area under the graph

Rectangle (0–120 s): 6 × 120 = 720 m

NCERT ARCHIVE

Trapezium (120–126 s): ½ × (6 + 12) × 6 = 54 m

Displacement = 720 m + 54 m = 774 m

Check: $s = ut + \frac{1}{2}at^2 = 6 \times 6 + \frac{1}{2} \times 1 \times 36 = 54$ m for the second part ✓

Therefore, the displacement of the car in the 2 min 6 s interval is 774 m.

QUESTION 15 *Revise, Reflect, Refine · p. 70*

15. Two cars A and B start moving with a constant acceleration from rest, in a straight line. Car A attains a velocity of 5 m s^{-1} in 5 s. Car B attains a velocity of 3 m s^{-1} in 10 s. Plot the velocity-time graphs for both the cars in the same graph. Using the graph, calculate the displacement in the two time intervals mentioned (Hint: Calculate the acceleration in both cases. Then calculate their velocities at five instants of time to plot the graph).

ANSWER

Find each acceleration, then the velocity v = at at five instants, plot the points, and use the area under each line for the displacement.

a Accelerations

Car A: $a = (5 - 0) / 5 = 1$ m s^{-2}

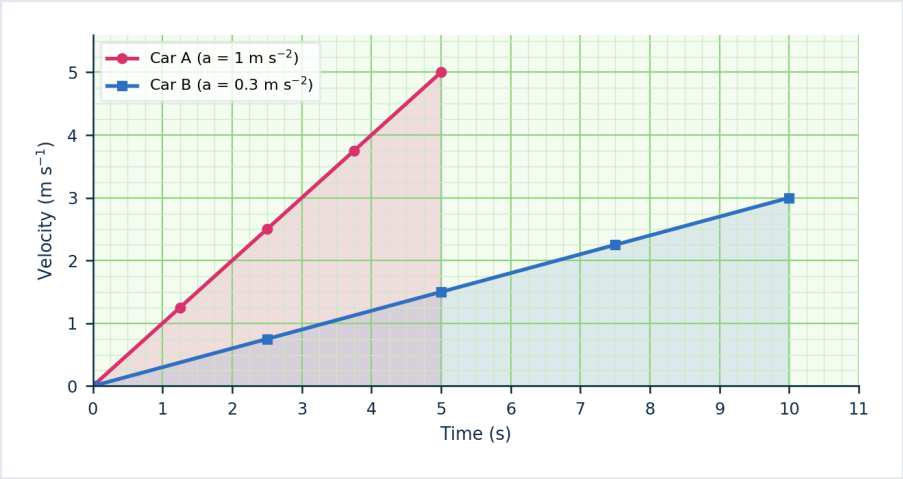
Car B: $a = (3 - 0) / 10 = 0.3$ m s^{-2}

b Velocities at five instants (v = at)

Car A: t (s)	0	1.25	2.5	3.75	5
v (m s^{-1})	0	1.25	2.5	3.75	5

Car B: t (s)	0	2.5	5	7.5	10
v (m s^{-1})	0	0.75	1.5	2.25	3

NCERT ARCHIVE



Velocity-time graphs of cars A and B

c **Displacement = area under each graph (a triangle)**

Car A (0–5 s): ½ × 5 s × 5 m s^{-1} = 12.5 m
Car B (0–10 s): ½ × 10 s × 3 m s^{-1} = 15 m
Check: s = ½at^2 gives ½ × 1 × 25 = 12.5 m and ½ × 0.3 × 100 = 15 m ✓

Therefore, the displacement is 12.5 m for car A in 5 s and 15 m for car B in 10 s.

QUESTION 16 *Revise, Reflect, Refine · p. 70*

16. Rohan studies science from 6 PM to 7:30 PM at home. Consider the tip of the minute's hand of the wall clock. During the given time interval, what is its:
(i) distance travelled,
(ii) displacement,
(iii) speed, and
(iv) velocity.
The length of the minute's hand is 7 cm (Fig. 4.32).



Fig. 4.32

ANSWER

Radius R = 7 cm. Time interval = 6:00 PM to 7:30 PM = 90 min = 5400 s = 1½ revolutions.

NCERT ARCHIVE

a **(i) Distance travelled**

Distance = 1.5 × 2πR = 1.5 × 2 × 3.14 × 7 ≈ 65.9 cm ≈ 66 cm (using π = 22/7 it is exactly 66 cm)

b **(ii) Displacement**

At 6:00 PM the tip is at the 12 mark. After 1½ revolutions (at 7:30 PM) it is at the 6 mark, diametrically opposite. So the displacement is the diameter: 2R = 14 cm, directed from the 12 mark towards the 6 mark.

c **(iii) Speed**

Average speed = distance / time = 66 cm / 5400 s ≈ 0.012 cm s^{-1} (1.2 × 10^{-2} cm s^{-1})

d **(iv) Velocity**

Average velocity = displacement / time = 14 cm / 5400 s ≈ 0.0026 cm s^{-1} (2.6 × 10^{-3} cm s^{-1}), directed from the 12 mark towards the 6 mark

Therefore, distance ≈ 66 cm, displacement = 14 cm, speed ≈ 0.012 cm s^{-1} and average velocity ≈ 0.0026 cm s^{-1} in the direction from 12 to 6.

NCERT ARCHIVE

4.4

CLASS 9 SCIENCE · CHAPTER 4

The Journey Beyond

Solutions · 5 questions

Directions (Questions 1–5): These are the tasks at the end of the chapter (page 71). Where a task is a hands-on activity or a project, the expected result and the reasoning are given.

QUESTION 1 *The Journey Beyond · p. 71*

Take a cardboard disc (radius ~ 8 cm) (Fig. 4.33). Write numbers 1 to 12 on the outer part (7 cm from the centre) and the letters 'ABCDEF' on the inner part (4 cm from the centre), using the same font size. Spin the disc slowly, then faster, and observe how the numbers and letters appear. Why do the numbers fade or disappear while the letters remain visible? Are the speeds of the numbers and letters the same or different? Justify your answer.

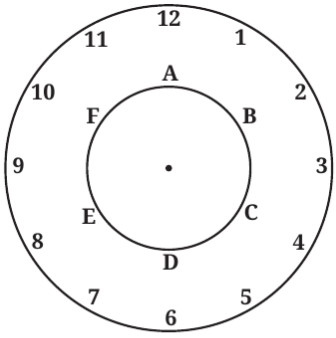


Fig. 4.33

ANSWER

Expected observation: when the disc spins fast, the numbers on the outer ring blur and fade first, while the letters on the inner ring stay readable. The reason is that the two rings move with different speeds.

a Are the speeds the same?

No, they are different. All points of the disc take the same time T for one revolution, but they travel different distances in that time. By Eq. (4.5), average speed = 2πR / T.

NCERT ARCHIVE

Numbers (R = 7 cm): $v_1 = 2\pi \times 7 / T$
Letters (R = 4 cm): $v_2 = 2\pi \times 4 / T$
$v_1 / v_2 = 7 / 4 = 1.75$

b Why the numbers fade

The numbers move 1.75 times faster than the letters, so they sweep past the eye much more quickly and their shapes smear into a blur. The slower letters stay clearer. The speed of each mark is constant and only its direction changes, so this is uniform circular motion.

Therefore, the speeds are different (outer numbers faster, in the ratio 7 : 4), which is why the numbers fade first.

QUESTION 2 *The Journey Beyond · p. 71*

Many smartphones have an inbuilt accelerometer that can detect very small accelerations. Install an app, such as Phyphox (phyphox.org) and open 'Accelerometer (without g)'. Note the readings when (i) the phone is on an outstretched palm, and (ii) the phone is kept on the floor. What differences do you observe? What does this tell you about motion and acceleration in real situations? (Such tiny, involuntary movements are also studied in medical research, for example, in movement disorders) This activity is recommended to be performed as a classroom group activity facilitated by teacher.

ANSWER

This is a hands-on activity, so the readings come from your own phone. The result to expect, and what it means, is given below.

a Expected observations

- (i) Phone on an outstretched palm: the readings keep changing and are not zero, because the hand shakes slightly and moves in tiny involuntary ways.
- (ii) Phone kept on the floor: the readings stay almost at zero (only a very small noise), as the phone is at rest.

b What it tells us

- Even when we think an object is at rest, tiny changes in velocity (small accelerations) can be present.

NCERT ARCHIVE

- Real motions are rarely perfectly uniform; perfectly steady speed or direction is an idealised model.
- An accelerometer detects any change in velocity, however small.

Therefore, the palm gives small non-zero fluctuating readings and the floor gives nearly zero: real motion always has small accelerations unlike an idealised motion.

QUESTION 3 *The Journey Beyond · p. 71*

For motion in a straight line with constant acceleration, we derived two primary equations given by Eq. (4.4a) and (4.4b). Using these two equations, three more equations can be derived, out of which we derived one given in Eq. (4.4c). Derive the remaining two equations given below
$s = vt - \frac{1}{2}at^2$ $s = \frac{1}{2}(u + v)t$
In mathematics, you have learnt the formula for calculating the area of a trapezium. Using that formula, derive the second equation given above.

ANSWER

The two primary equations are $v = u + at$ (4.4a) and $s = ut + \frac{1}{2}at^2$ (4.4b). Eliminate u or a from them.

a Derivation of $s = vt - \frac{1}{2}at^2$

From (4.4a): $u = v - at$
Put in (4.4b): $s = (v - at)t + \frac{1}{2}at^2$
$s = vt - at^2 + \frac{1}{2}at^2 = vt - \frac{1}{2}at^2$

b Derivation of $s = \frac{1}{2}(u + v)t$

From (4.4a): $at = v - u$
Put in (4.4b): $s = ut + \frac{1}{2}(at)t = ut + \frac{1}{2}(v - u)t$
$s = \frac{1}{2}t\,(2u + v - u) = \frac{1}{2}(u + v)t$

c Using the area of a trapezium

In the velocity-time graph (Fig. 4.19) the displacement is the area of the trapezium OABD. Its parallel sides are OA = u and DB = v, and the distance between them is OD = t.

Area = ½ × (sum of parallel sides) × distance between them = ½ × (u + v) × t

NCERT ARCHIVE

So $s = \frac{1}{2}(u + v)t$

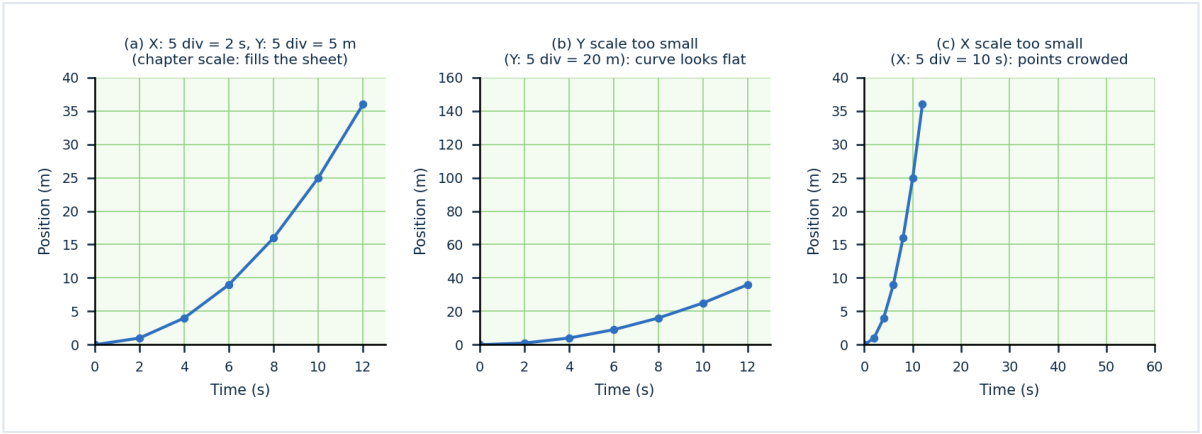
Therefore, $s = vt - \frac{1}{2}at^2$ and $s = \frac{1}{2}(u + v)t$, and the second also follows from the area of the trapezium.

QUESTION 4 *The Journey Beyond · p. 71*

Plot graphs for data given in Table 4.4, using different X and Y scales, on different graph papers. Compare the graphs to find how the appearance of graph is affected by the choice of scales and decide which scale is better and why. Now repeat this with any graph plotting app. Such apps generally automatically adjust the axes to fit the data well on the screen.

ANSWER

The same data (0, 0), (2, 1), (4, 4), (6, 9), (8, 16), (10, 25), (12, 36) is plotted with three scales. The three graphs below show how the choice of scale changes the look of the graph.



The same data plotted with different scales

a What we observe

- (a) X: 5 divisions = 2 s and Y: 5 divisions = 5 m (the scale used in the chapter): the points use the whole sheet and the curve shape is clear.
- (b) If the Y scale is too small, the curve looks flat and the increase in velocity is hard to see.
- (c) If the X scale is too small, the points crowd into one corner and the curve is hard to read.

NCERT ARCHIVE

b **Which scale is better, and why**

Scale (a) is better. A good scale uses most of the graph paper, is easy to read (convenient numbers of divisions per unit) and shows the shape of the curve clearly. Graph plotting apps adjust the axes automatically to fit the data on the screen, so they give a well-fitted graph without manual choice of scale.

Therefore, the appearance of a graph depends on the scale; choose one that fills the paper and makes the trend clear.

QUESTION 5 *The Journey Beyond · p. 71*

Talk to a motor mechanic about how a vehicle's braking or stopping distance is affected by: (i) wet roads, (ii) worn-out tyres, (iii) higher vehicle mass, (iv) driving at night, (v) fog, (vi) severe weather (rain, snow, storm), and (vii) driver reaction time. Using this information, design safety posters for your school and prepare a short skit to present it in the assembly.

ANSWER

This is a project built on a talk with a mechanic. The factors below follow from the chapter: stopping distance = reaction distance + braking distance, and braking distance = $u^2 / (2|a|)$ (Example 4.8).

NCERT ARCHIVE

a How each factor changes the stopping distance

Factor	Effect	Reason
(i) Wet roads	Longer	The wet surface gives weaker braking, so the retardation $\|a\|$ is smaller and $u^2/(2\|a\|)$ is larger.
(ii) Worn-out tyres	Longer	Worn tyres grip the road less well, so the retardation is smaller.
(iii) Higher vehicle mass	Longer	A heavier vehicle is harder to bring to rest, so it stops over a longer distance.
(iv) Night driving	Longer	Hazards are seen later, so there is less distance in which to stop.
(v) Fog	Longer	Visibility is low, so the driver reacts later.
(vi) Rain, snow, storm	Longer	Slippery roads reduce braking and poor visibility delays the reaction.
(vii) Driver reaction time	Longer	The vehicle moves at its full velocity during the reaction time: distance = velocity × reaction time (5 m in 0.5 s at 10 m s^{-1}).

b Ideas for the posters and skit

- Poster messages: “Keep a safe distance”, “Slow down on wet roads”, “Doubling the speed makes the braking distance four times”.
- Skit: two vehicles on a wet road at different speeds, showing that the faster one needs a much longer distance to stop.

Therefore, wet roads, worn tyres, heavy loads, poor visibility and slow reactions all lengthen the stopping distance, so drive slowly and keep a safe gap.

NCERT ARCHIVE