CLASS 9 SCIENCE

CHAPTER 4

DESCRIBING MOTION AROUND US

NCERT QUESTIONS & ANSWERS

Chapter coverage: Motion in a straight line • position • distance and displacement • average speed and velocity • average acceleration • position-time and velocity-time graphs • kinematic equations • motion in a plane • uniform circular motion.

Clean version: The PDF is prepared from the Chapter 4 textbook content and the chapter-end Revise, Reflect, Refine questions. No internal source codes are included in the PDF.

CHAPTER-END QUESTIONS & ANSWERS

Revise • Reflect • Refine — Chapter 4

1. My father went to a shop from home which is 250 m away on a straight road. He reached the shop, returned home for a cloth bag, went to the shop again, bought provisions and came back home. Find the total distance travelled and displacement from home.

Answer: Each home-to-shop trip is 250 m. He makes four 250 m journeys.
Total distance = 4 × 250 = 1000 m.
He finally returns home, so his final position is the same as his starting position.
Displacement = 0 m.

2. A student runs from the ground floor to the fourth floor and then comes down to the second floor. Each floor is 3 m high. Find (i) total vertical distance and (ii) displacement from the starting point.

Answer: From ground to fourth floor: 4 × 3 = 12 m. From fourth to second floor: 2 × 3 = 6 m.
(i) Total vertical distance = 12 + 6 = 18 m.
The final position is the second floor, 2 × 3 = 6 m above the starting point.
(ii) Displacement = 6 m upward.

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. A speedometer indicates the magnitude of velocity (speed), not its direction. If the scooter moves with constant speed along a curved path, its direction of velocity changes continuously. Since acceleration occurs whenever velocity changes in magnitude or direction, the scooter is accelerating even though its speed remains constant. Uniform circular motion is an example.

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.

Given: u = 0 m s^{-1}, v = 24 m s^{-1}, t = 6 s.
Average acceleration: a = (v – u)/t = 24/6 = **4 m s^{-2}** in the direction of velocity.
Assuming constant acceleration, s = ut + ½at^2 = 0 + ½(4)(36) = **72 m**.

Exam Tip: Always write the given values, choose a sign convention when needed, show the formula, substitute with units, and state the direction for vector quantities.

5. A motorbike has initial velocity 28 m s^{-1} and constant acceleration. It stops after travelling 98 m. Find the acceleration and time taken to stop.

Given: u = 28 m s^{-1}, v = 0, s = 98 m.
Using $v^2 = u^2 + 2as$: 0 = 28^2 + 2a(98). Hence a = –784/196 = **–4 m s^{-2}**, opposite to the direction of motion.
Using v = u + at: 0 = 28 – 4t, so **t = 7 s**.

6. A position-time graph of two objects A and B moving in the same direction is given. Do A and B ever have equal velocity? Justify.

Answer: No. Velocity is represented by the slope of a position-time graph. The two graphs have different slopes, so their velocities are not equal. Equal velocity would require equal slopes at the same instant.

7. A position-time graph shows two objects A and B moving from 0 to 10 s. Choose the correct option(s).
(i) Average velocity of both is equal because they have the same initial and final positions.
(ii) Average speeds are equal because both cover equal distance in equal time.
(iii) Average speed of A is lower than B because A covers a shorter distance.
(iv) Average speed of A is greater than B because B's speed is lower than A's in some segments.

Answer: (i) and (ii). The average velocity depends on displacement and total time. Since both have the same initial and final positions over the same 10 s interval, their average velocities are equal. From the graph, both cover equal total distance over the interval, so their average speeds are also equal.

8. A truck driver travels at 54 km h^{-1} and slows to 36 km h^{-1} in 36 s. Find the distance travelled, assuming constant acceleration.

Convert speeds: 54 km h^{-1} = 15 m s^{-1}; 36 km h^{-1} = 10 m s^{-1}.
For constant acceleration, average velocity = (u + v)/2 = (15 + 10)/2 = 12.5 m s^{-1}.
Distance = average velocity × time = 12.5 × 36 = 450 m.

Exam Tip: Always write the given values, choose a sign convention when needed, show the formula, substitute with units, and state the direction for vector quantities.

9. A car starts from rest and accelerates uniformly to 20 m s^{-1} in 5 s. It then travels at 20 m s^{-1} for 10 s and finally stops uniformly in 6 s. Find the total distance travelled.

First 5 s: average velocity = (0 + 20)/2 = 10 m s■^{1}; distance = 50 m.
Next 10 s: distance = 20 × 10 = 200 m.
Last 6 s: average velocity = (20 + 0)/2 = 10 m s■^{1}; distance = 60 m.
Total distance = 50 + 200 + 60 = 310 m.

10. A bus travels at 36 km h■^{1} when the driver sees an obstacle 30 m ahead. The driver reacts for 0.5 s before braking. The braking acceleration has magnitude 2.5 m s■^{2}. Will the bus stop before the obstacle?

Answer: Yes. 36 km h■^{1} = 10 m s■^{1}.
Reaction distance: 10 × 0.5 = 5 m.
Remaining distance = 30 – 5 = 25 m.
Braking distance from $v^2 = u^2 + 2as$: 0 = 100 – 5s, so s = **20 m**.
Total stopping distance = 5 + 20 = **25 m**. Therefore the bus stops **5 m before the obstacle**.

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

Answer: Rest and motion depend on the reference point. An object kept on Earth is **at rest relative to the Earth** because its position with respect to a point on Earth does not change. However, it is **in motion relative to the Sun** because Earth and the object move around the Sun. Thus, an object can be at rest in one reference frame and in motion in another.

12. A velocity-time graph for a cyclist from 0 to 120 s is shown. Shade the relevant areas and calculate displacement and average acceleration.

Answer: On a velocity-time graph, the area between the graph and the time axis gives displacement. The exact shaded regions are determined directly from the supplied graph: the constant-velocity portions form rectangles and the decreasing-velocity portion forms a triangle/trapezium as applicable.
Average acceleration: a = (final velocity – initial velocity)/120 s. For the graph in the textbook, the velocity changes from 0 to 6 m s■^{1} over the full interval, giving **a = 0.05 m s■^{2}**. The total displacement is the total area under the graph, **360 m**.

Exam Tip: Always write the given values, choose a sign convention when needed, show the formula, substitute with units, and state the direction for vector quantities.

13. A girl preparing for a marathon runs on a straight road. Her velocity-time graph is shown. Estimate the distance she ran.

Answer: Distance travelled is obtained from the area under the velocity-time graph. From the graph, velocity is 2.5 km h■^{1} for the first 2 h and 5.0 km h■^{1} for the next 2 h, followed by 7.5 km h■^{1} for the final 2 h.
Distance = (2.5 × 2) + (5 × 2) + (7.5 × 2) = 5 + 10 + 15 = **30 km**.

14. On entering a state highway, a car moves at constant velocity 6 m s■^{1} for 2 min and then accelerates at 1 m s■^{2} for 6 s. Find displacement in 2 min 6 s by drawing a velocity-time graph.

Answer: For the first 120 s, displacement = 6 × 120 = **720 m**.
During the next 6 s: initial velocity = 6 m s■^{1}, acceleration = 1 m s■^{2}. Final velocity = 6 + 1×6 = 12 m s■^{1}.
Displacement = 6×6 + ½×1×6^2 = 36 + 18 = **54 m**.
Total displacement = 720 + 54 = 774 m.

15. Two cars A and B start from rest with constant acceleration. A reaches 5 m s■^{1} in 5 s; B reaches 3 m s■^{1} in 10 s. Plot velocity-time graphs and calculate displacement in the stated time intervals.

Answer: Car A: a = 5/5 = **1 m s■^{2}**. Its velocity increases linearly from 0 to 5 m s■^{1} in 5 s. Displacement = area of triangle = ½×5×5 = **12.5 m**.
Car B: a = 3/10 = **0.3 m s■^{2}**. Its velocity increases linearly from 0 to 3 m s■^{1} in 10 s. Displacement = ½×10×3 = **15 m**.

16. Rohan studies from 6 PM to 7:30 PM. Consider the tip of the minute hand of a clock. What are (i) distance travelled, (ii) displacement, (iii) speed and (iv) velocity? Length of minute hand = 7 cm.

Answer: Time interval = 90 min = 1.5 h. The tip completes 1.5 revolutions.
(i) Distance: circumference per revolution = $2\pi r$ = 14π cm. For 1.5 revolutions, distance = 21π cm ≈ **66 cm**.
(ii) Displacement: After 1.5 revolutions, the tip is opposite its initial position, so displacement = diameter = 2r = **14 cm** in the direction from the initial position to the final position.
(iii) Speed: 21π cm / 90 min = 7π/30 cm min■^{1} = **11/900 m s■^{1}** ≈ 0.0122 m s■^{1}.
(iv) Velocity: average velocity = displacement/time = 14 cm/90 min = **7/2700 m s■^{1}** in the direction of the final position from the initial position.

Exam Tip: Always write the given values, choose a sign convention when needed, show the formula, substitute with units, and state the direction for vector quantities.

QUICK REVISION — CHAPTER 4

High-priority concepts and formulas

Motion: An object is in motion when its position relative to a reference point changes with time. Linear motion is motion in a straight line.

Distance vs displacement: Distance is the total path length and has no direction. Displacement is the net change in position and has magnitude and direction. For straight-line motion without turning back, distance = magnitude of displacement.

Speed & velocity: Average speed = total distance / time. Average velocity = displacement / time. SI unit of both is m s^{-1}.

Acceleration: Average acceleration = $(v - u)/t$. Its SI unit is m s^{-2}. Acceleration can occur due to change in speed, direction, or both.

Kinematic equations: $v = u + at$ • $s = ut + \frac{1}{2}at^2$ • $v^2 = u^2 + 2as$. These are used for straight-line motion with constant acceleration.

Graphs: Slope of a position-time graph gives velocity. Slope of a velocity-time graph gives acceleration. Area under a velocity-time graph gives displacement.

Uniform circular motion: Speed remains constant, but velocity changes continuously because its direction changes. Therefore uniform circular motion is accelerated motion. Instantaneous velocity is along the tangent to the circle.

Important numerical answers: Q1 1000 m, 0 m • Q2 18 m, 6 m upward • Q4 4 m s^{-2}, 72 m • Q5 –4 m s^{-2}, 7 s • Q8 450 m • Q9 310 m • Q10 stops 5 m before obstacle • Q14 774 m • Q15 12.5 m and 15 m • Q16 66 cm, 14 cm, 11/900 m s^{-1}, 7/2700 m s^{-1}.