

## Class – IX (Science)

### Chapter – 4: Describing Motion Around Us

#### Back Exercise Solution

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?

**Solution:**

**Journey of father:**

1. Home → Shop = 250 m
2. Shop → Home = 250 m
3. Home → Shop = 250 m
4. Shop → Home = 250 m

**Total Distance Travelled** = 250 + 250 + 250 + 250 = **1000 m**

Displacement depends only on initial and final position.

- Starting point = Home
- Final point = Home

Since the initial and final positions are the same:

**Displacement = 0 meters**

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.

**Solution:**

**Upward movement (Ground → 4th floor)**

Number of floors climbed = 4

Vertical distance = 4 × 3 = **12 m**



**Downward movement (4th → 2nd floor)**

Floors descended = 2 (from 4th to 2nd)

Vertical distance =  $2 \times 3 = 6 \text{ m}$

**(i) Total Vertical Distance Travelled**

Total distance = Upward + Downward =  $12 + 6 = 18 \text{ m}$

**(ii) Displacement**

Displacement = Final position – Initial position

- Initial position = Ground floor (0 m)
- Final position = 2nd floor =  $2 \times 3 = 6 \text{ m}$

So, **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?**

**Solution:**

Yes, it is possible for the scooter to be accelerating even when the speedometer shows a constant reading.

**Explanation:**

The speedometer measures only **speed** (magnitude of velocity), not **velocity** (which includes direction).

Acceleration is defined as the **rate of change of velocity**, and velocity can change in two ways:

1. Change in speed
2. Change in direction

Even if the speed remains constant, a change in direction means the velocity is changing, so the scooter is accelerating.

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

**Solution:**

$$\text{Average acceleration, } a = \frac{v-u}{t} = \frac{24-0}{6} = 4 \text{ m/s}^2$$

$$\text{Distance travelled, } s = ut + \frac{1}{2}at^2$$

$$s = 0 \times 6 + \frac{1}{2} \times 4 \times 6^2 = 72 \text{ m}$$

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

**Solution:**

Acceleration:

$$\begin{aligned} v^2 &= u^2 + 2as \\ 0 &= (28)^2 + 2 \times a \times (98) \\ 0 &= 784 + 196a \\ 196a &= -784 \\ a &= -4 \text{ m/s}^2 \end{aligned}$$

Time Taken:

$$\begin{aligned} v &= u + at \\ 0 &= 28 + (-4)t \\ 4t &= 28 \\ t &= 7 \text{ s} \end{aligned}$$

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.

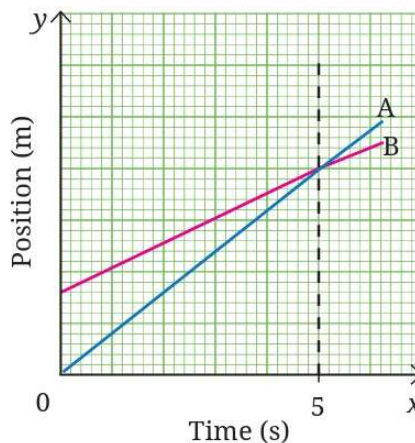


Fig. 4.27

**Solution:**

No, objects A and B do not have equal velocity at any time.

Reason:

In a position–time graph, the slope of the line represents velocity.

- Object A has a steeper straight line → higher constant velocity
- Object B has a less steep straight line → lower constant velocity

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).

- The average velocity of both over the 10 s time interval is equal since they have the same initial and final positions.
- The average speeds of both over the 10 s time interval are equal since both cover equal distance in equal time.
- 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.
- 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.

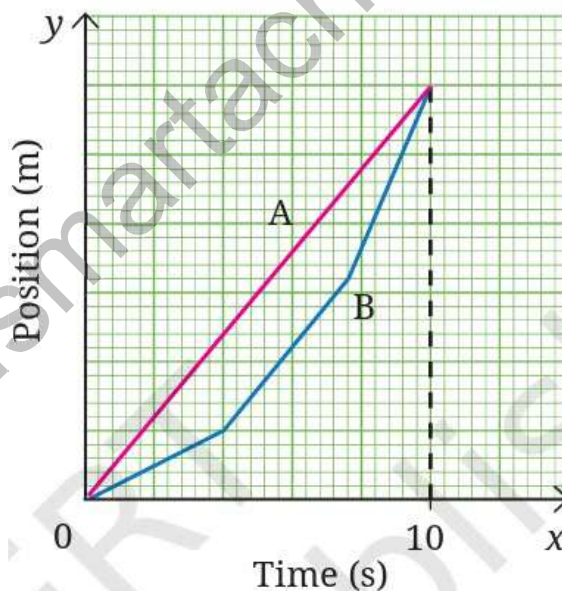


Fig. 4.28

**Solution:**

- Average velocity of both is equal

Average velocity = (displacement) / time

Since both have:

- Same initial position
- Same final position
- Same total time (10 s)

Their displacement is equal, so average velocity is equal.

**Correct**

**(ii) Average speeds are equal**

Average speed = (total distance) / time

Both objects move continuously forward from the same start to the same end point without turning back.

So, distance travelled = displacement for both.

Thus, average speeds are also equal.

**Correct**

**(iii) A's average speed is lower than B**

This would require B to travel more distance, but from the graph:

- Neither object goes backward
- Both cover the same start-to-end path

So, distances are equal.

**Incorrect**

**(iv) A's average speed is greater than B**

Even though B is slower in some parts, it compensates by being faster in others.

Total distance and total time are the same → average speed must be equal.

**Incorrect**

8. A truck driver driving at the speed of  $54 \text{ km h}^{-1}$  notices a road sign with a speed limit of  $40 \text{ km h}^{-1}$  (Fig. 4.29) for trucks. He slows down to  $36 \text{ km h}^{-1}$  in 36 s. What was the



distance travelled by him during this time? Assume the acceleration to be constant while slowing down.

**Solution:**

Initial speed,  $u = 54 \text{ km/h} = 15 \text{ m/s}$

Final speed,  $v = 36 \text{ km/h} = 10 \text{ m/s}$

Time,  $t = 36 \text{ s}$

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

$$s = \frac{(15+10)}{2} \times 36$$

$$s = \frac{25}{2} \times 36 = 12.5 \times 36$$

$$s = 450 \text{ m}$$



Fig. 4.29

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

**Solution:**

**Acceleration phase (0 to  $20 \text{ m/s}$  in 5 s):**

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

$$s_1 = \frac{(0+20)}{2} \times 5 = 10 \times 5 = 50 \text{ m}$$

**Constant speed phase:**

$$s_2 = v \times t = 20 \times 10 = 200 \text{ m}$$

**Retardation phase ( $20 \text{ m/s}$  to 0 in 6 s)**

$$s_3 = \frac{(20+0)}{2} \times 6 = 10 \times 6 = 60 \text{ m}$$

$$\text{Total distance} = s_1 + s_2 + s_3 = 50 + 200 + 60 = 310 \text{ m}$$

10. A bus is travelling at 36 km h<sup>-1</sup> 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<sup>-2</sup>. Will the bus be able to stop before reaching the obstacle?

**Solution:**

Initial speed,  $u = 36 \text{ km/h} = 10 \text{ m/s}$

Reaction time = 0.5 s

Deceleration,  $a = -2.5 \text{ m/s}^2$

Distance to obstacle = 30 m

**Distance covered during reaction time:**

During reaction time, the driver does not brake, so speed remains constant.

$$s_1 = u \times t = 10 \times 0.5 = 5 \text{ m}$$

**Braking distance:**

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

Here,  $v = 0$  (bus stops)

$$0 = (10)^2 + 2(-2.5)s$$

$$0 = 100 - 5s$$

$$5s = 100 \Rightarrow s_2 = 20 \text{ m}$$

$$\text{Total stopping distance} = s_1 + s_2 = 5 + 20 = 25 \text{ m}$$

- Distance available = 30 m
- Distance required to stop = 25 m

Since  $25 < 30$ ,

**The bus will stop before reaching the obstacle.**

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.

**Solution:**

The statement “the Earth moves around the Sun” is correct, but whether an object on Earth is at rest depends on the frame of reference.

Explanation:

- **With respect to the Earth (ground frame):** An object kept on the Earth (like a book on a table) does not change its position relative to its surroundings.

So, it is considered at rest.

- **With respect to the Sun (or outer space):** The Earth is continuously moving around the Sun and also rotating about its axis. Therefore, the same object is also moving along with the Earth.

So, it is not at rest in this frame.

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
- while cyclist is moving with constant velocity.
  - when the velocity of cyclist is decreasing.

Also, calculate the displacement and average acceleration in the 120 s time interval.

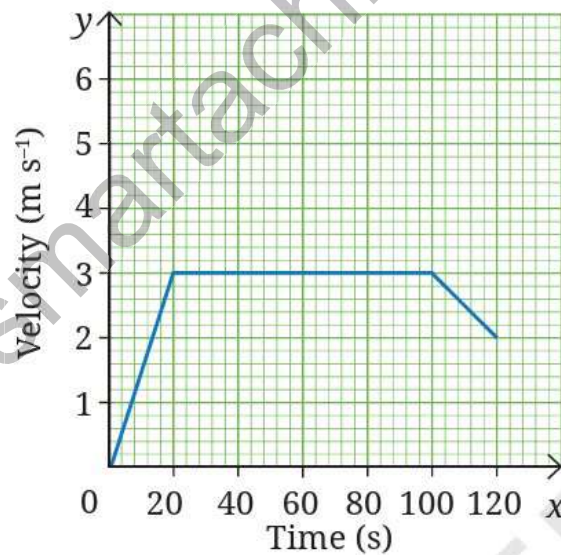
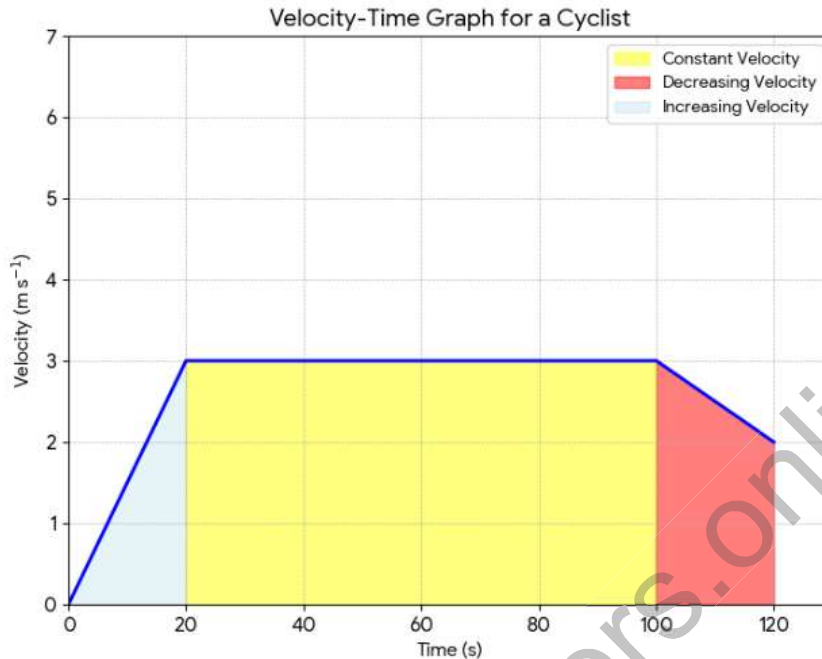


Fig. 4.30

**Solution:**



- **Yellow Shaded Area:** Represents the displacement while the cyclist moves with a constant velocity (from 20 s to 100 s).
- **Red Shaded Area:** Represents the displacement when the velocity of the cyclist is decreasing (from 100 s to 120 s).

To find the total displacement over the 120 s interval, we calculate the total area under the graph. We can break this into three geometric shapes:

**Part A: 0 to 20 s (Triangle):**

$$\frac{1}{2} \times 20 \times 3 = 30 \text{ m}$$

**Part B: 20 to 100 s (Rectangle - Constant Velocity)**

$$80 \times 3 = 240 \text{ m}$$

**Part C: 100 to 120 s (Trapezium - Decreasing Velocity)**

$$\frac{1}{2} \times (3 + 2) \times 20 = 50 \text{ m}$$

$$\text{Total displacement} = 30 + 240 + 50 = 320 \text{ m}$$

**Average acceleration over 120 s:**

$$a = \frac{v - u}{t} = \frac{2 - 0}{120} = 0.0167 \text{ m/s}^2$$

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