CHAPTER 7

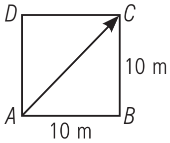
Motion

NCERT FOCUS ANSWERS

Topic 1

1. Yes, an object moving through a distance can have zero displacement. This happens when final position of the object coincides with its initial position. Example : If an object travels from point *A* and reaches to the same point *A*, then its displacement is zero.

2. Let, figure *ABCD* is a square field of side 10 m.



Time taken for one round = 40 s

Total time = 2 min 20 s

$= (2 \times 60 + 20)\text{ s} = 140\text{ s}$

Number of round completed $= \frac{140}{40} = 3.5$

If farmer starts from *A*, it will complete 3 rounds ($A \to B \to C \to D \to A$) at *A*.

In the last 0.5 round starting from *A*, he will finish at *C*.

Displacement of farmer $= AC = \sqrt{AB^2 + AC^2}$

$= \sqrt{10^2 + 10^2} = 10\sqrt{2}\text{ m} = 14.1\text{m}$

3. (a) False, the displacement of an object in a given time can be positive, zero or negative.

(b) False, the displacement of an object in a given time can be equal or less than the distance travelled but never greater than the distance travelled.

4. Speed and velocity differ from each other as follows :

Speed	Velocity
The distance travelled by a moving body per unit time is called its speed.	The distance travelled by a moving body in a particular direction per unit time is called its velocity.
It is a scalar quantity.	It is a vector quantity.
It can never be negative.	It can be negative zero or positive.

5. The magnitude of average velocity of an object is equal to its average speed if the object moves in a straight line in a particular direction.

6. The odometer of an automobile measures the distance travelled by a vehicle.

7. In uniform motion, the path of an object can be a straight line, curved line or a circle. It can have any shape. This is because in uniform motion, speed is constant, the direction of motion may change.

8. Time taken = 5 minutes = $5 \times 60\text{ s} = 300\text{ s}$

Speed of signal, $u = 3 \times 10^8\text{ m s}^{-1}$

$\text{Speed} = \frac{\text{distance}}{\text{time}}$

$\therefore$ Distance = speed $\times$ time

$= 3 \times 10^8 \times 300 = 9 \times 10^{10}\text{ m}$

9. (a) Uniform acceleration : When a body travels with the same velocity in the given time, then the acceleration is said to be uniform.

(b) Non-uniform acceleration : When a body moves with unequal velocity in the equal interval of time, the body is said to be moving with non-uniform acceleration.

10. Initial velocity, $u = 80\text{ km h}^{-1}$

$= \frac{(80 \times 1000)\text{ m}}{(60 \times 60)\text{ s}} = 22.22\text{ m s}^{-1}$

Final velocity, $v = 60\text{ km h}^{-1}$

$= \frac{(60 \times 1000)\text{ m}}{(60 \times 60)\text{ s}} = 16.66\text{ m s}^{-1}$

Time taken, $t = 5\text{ s}$

Acceleration, $a = \frac{v - u}{t} = \frac{16.66 - 22.22}{5} = -1.11\text{ m s}^{-2}$

$\therefore$ The acceleration of bus is -1.11 m s^{-2}.

Negative sign shows retardation.

11. Here, initial speed, $u = 0$

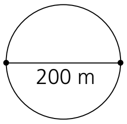
Final speed, $v = 40\text{ km h}^{-1}$

$= \frac{40 \times 1000}{60 \times 60} = 11.11\text{ m s}^{-1}$

Time taken, $t = 10 \times 60\text{ s} = 600\text{ s}$

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

$= \frac{11.11 - 0}{600} = 1.85 \times 10^{-2}\text{ m s}^{-2}$

12. 

Diameter, d = 200 m, So radius, $r = \frac{d}{2} = 100\,\text{m}$

Time taken for one round = 40 s

(No. of completed in) 2 minutes and 20 s (2 × 60 + 20 = 140 s)

$= \frac{140}{40} = 3.5\,\text{rounds}$

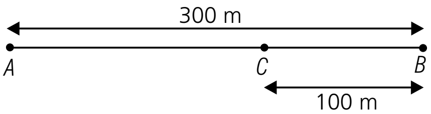
Distance travelled = Circumference of the circle × 3.5

$= 2\pi r \times 3.5$

$= 2 \times \frac{22}{7} \times 100 \times 3.5 = 2200\,\text{m}$

Displacement after 3.5 rounds = diameter of the track = 200 m.

13. (a) From A to B.



Time for A to B = 2 min 30 s

= 2 × 60 + 30 = 150 s

$$\text{Average speed} = \frac{\text{total distance}}{\text{time interval}} = \frac{300}{150} = 2\,\text{m s}^{-1}$$

$$\text{Average velocity} = \frac{\text{displacement}}{\text{time interval}} = \frac{300}{150} = 2\,\text{m s}^{-1}$$

(b) From A to C.

Time taken = A to B + B to C = 150 + 60 = 210 s

Total distance = 300 + 100 = 400 m

$$\therefore \text{ Average speed} = \frac{\text{total distance}}{\text{time interval}} = \frac{400}{210} = 1.9\,\text{m s}^{-1}$$

$$\therefore \text{ Average velocity} = \frac{\text{displacement}}{\text{time interval}} = \frac{200}{210} = 0.95\,\text{m s}^{-1}$$

14. Let the school be at a distance of x km. If t_1 is time taken to reach the school, then

$$t_1 = \frac{\text{distance}}{\text{average speed}} = \frac{x}{20}$$

If t_2 is time taken to reach back, then

$$t_2 = \frac{\text{distance}}{\text{average speed}} = \frac{x}{30}$$

Total time,

$$t = t_1 + t_2 = \frac{x}{20} + \frac{x}{30} = x\left[\frac{1}{20} + \frac{1}{30}\right] = \frac{5x}{60} = \frac{x}{12}$$

Total distance $x + x = 2x$

$$\text{Average speed} = \frac{\text{total distance}}{\text{total time}} = \frac{2x}{x/12} = 24\,\text{km h}^{-1}$$

15. (a) A body with a constant acceleration but with zero velocity is possible. For example, when body is just released for some weight, its initial velocity, u = 0 but acceleration, $a = g = 9.8\,\text{m/s}^2$.

(b) Circular motion is an example of an object with acceleration but also with a uniform speed.

(c) When object moving in a circular path, it has centripetal acceleration directed towards the centre of the circle. The velocity at any instant is along the tangent to the circle.

16. Radius of the orbit, r = 42250 km

= (42250 × 1000) m

Time taken for one revolution, t = 24 hours

= (24 × 60 × 60) s

$$\therefore \text{ Speed} = \frac{\text{distance}}{\text{time}} = \frac{2\pi r}{t} = 2 \times \frac{22}{7} \times \frac{42250 \times 1000}{24 \times 60 \times 60}$$

Speed = 3073.74 m s^{-1} = 3.07 km s^{-1}.

Topic 2

1. When the motion is uniform, the distance-time graph is a straight line with some slope. When the motion is non-uniform, the distance-time graph is not a straight line.

2. When distance-time graph of an object is a straight line parallel to the time axis, distance of the object at every instant of time is the same. Therefore, the object must be at rest.

3. When speed-time graph of a body is a straight line parallel to the time axis, speed of the body at every instant of time is the same. It means the body is moving with a uniform speed. There is no acceleration at all.

4. Area occupied below the velocity-time graph is a measure of the distance travelled by the body or the displacement of the body.

5. Here, u = 0, a = 0.1 m s^{-2},

t = 2 min = 2 × 60 s = 120 s

(a) From $v = u + at$, v = 0 + 0.1 × 120 = 12 m s^{-1}

(b) From $s = ut + \frac{1}{2}at^2$,

$$s = 0 \times 120 + \frac{1}{2} \times 0.1 \times (120)^2 = 7.2 \times 10^2\,\text{m}$$

6. Here, initial speed,

$$u = 90\,\text{km h}^{-1} = \frac{90 \times 1000}{60 \times 60} = 25\,\text{m s}^{-1}$$

Acceleration, a = – 0.5 m s^{-2}, final velocity, v = 0

As $v^2 - u^2 = 2as$,

$$\text{Distance travelled, } s = \frac{v^2 - u^2}{2a} = \frac{0 - (25)^2}{2 \times (-0.5)} = 625\,\text{m}$$

7. Here, acceleration, a = 2 m s^{-2},

Time taken, t = 3 s

Initial velocity, u = 0

Final velocity, $v = u + at$ = 0 + 2 × 3 = 6 cm s^{-1}

8. Here, $a = 4 \text{ m s}^{-2}$, $t = 10$ s, $u = 0$

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

$$= 0 \times 10 + \frac{1}{2} \times 4 \times (10)^2 = 0 + \frac{1}{2} \times 4 \times 100$$

$\therefore \quad s = 200$ m

The distance covered in 10 s by the car is 200 m.

9. $u = 5 \text{ m s}^{-1}$, $v = 0$, $a = -10 \text{ m s}^{-2}$

$v = u + at$

$0 = 5 + (-10)\,t$

$$-5 = -10\,t \quad \therefore \quad t = \frac{5}{10} = 0.5 \text{ s}$$

From third equation of motion

$v^2 - u^2 = 2as$

$(0)^2 - (5)^2 = 2(-10) \times s$

$$-25 = -20 \times s \quad \therefore \quad s = \frac{25}{20} = 1.25 \text{ m}$$

10. $u = 0$, $a = 3.0 \text{ m s}^{-2}$, $t = 8$ s

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

$$s = \frac{1}{2} \times 3 \times 64 = 96 \text{ m}$$

$\therefore$ Boat travelled a distance of 96 m during this time.

11. The data given in this numerical problem are in different units. So, we should first convert km h^{-1} unit into m s^{-1} unit.

For first car :

Initial velocity, $u = 52 \text{ km h}^{-1}$

$$= \frac{52 \text{ km}}{1 \text{ h}} = \frac{52 \times 1000 \text{ m}}{3600 \text{ s}} = 14.4 \text{ m s}^{-1}$$

Final velocity, $v = 0$

Time taken, $t = 5$ s

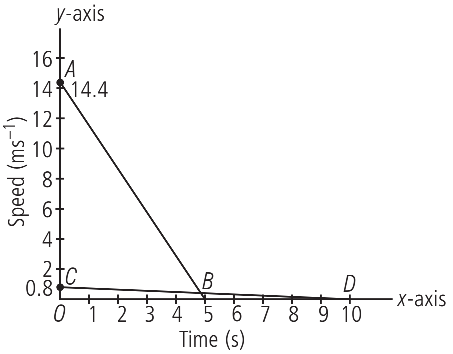
For second car :

Initial velocity, $u = 3 \text{ km h}^{-1}$

$$= \frac{3 \text{ km}}{1 \text{ h}} = \frac{3 \times 1000 \text{ m}}{3600 \text{ s}} = 0.83 \text{ m s}^{-1}$$

Final velocity, $v = 0$

Time taken, $t = 10$ s



The distance travelled by a moving body is given by the area under its speed-time graph.

So, distance travelled by the first car = Area of the triangle *AOB*

$$= \frac{1}{2} \times OB \times AO = \frac{1}{2} \times 5 \text{ s} \times 14.4 \text{ m s}^{-1} = 36 \text{ m}$$

Similarly, distance travelled by the second car

= Area of triangle *COD*

$$= \frac{1}{2} \times OD \times CO = \frac{1}{2} \times 10 \text{ s} \times 0.83 \text{ m s}^{-1}$$

$= 4.15$ m

Thus, the second car travels 4.1 m and the first car travels 36 m before coming to rest. So, the first car travelled farther after the brakes were applied.

12. (a) *B* is travelling fastest.

(b) As three lines do not meet at any point, the three objects never meet on the road.

(c) On distance axis, 4 km = 7 boxes

$$\therefore 1 \text{ box} = \frac{4}{7} \text{ km.}$$

Initial distance of object *C* is $\left(4 \text{ box} \times \frac{4}{7}\right) = \frac{16}{7}$ km

Distance of object *C* when *B* passes *A* = 8 km

$$\therefore \text{Distance covered by } C = 8 - \frac{16}{7} = 5.714 \text{ km}$$

(d) Distance covered by *B* at the time it passes *C* = 10 boxes.

$$= \frac{4}{7} \times 10 \text{ km} = \frac{40}{7} = 5.714 \text{ km}$$

13. Here $s = 20$ m, $u = 0$, $a = 10 \text{ m s}^{-2}$

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

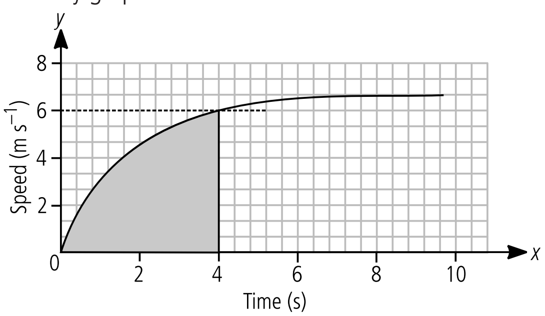
$$\therefore \quad (20) = 0 \times t + \frac{1}{2} \times 10 \times t^2 \Rightarrow 20 = \frac{1}{2} \times 10t^2$$

$$\Rightarrow \quad \frac{20 \times 2}{10} = t^2 \Rightarrow t^2 = 4 \quad \therefore \quad t = 2 \text{ s}$$

$\because \quad v = u + at \Rightarrow v = 0 + 10 \times 2 = 20 \text{ m s}^{-1}$

The ball strike the ground after 2 s with the velocity of 20 m s^{-1}.

14. The motion during first 4 seconds is not uniformly accelerated. So, distance travelled by car in first 4 seconds is calculated by graphical method.



(a) Number of squares in shaded part of the graph = 62

One small square in x-axis represent, $t = \frac{2}{5}$ s

One small square on y-axis represent, $v = \frac{2}{3}\,\text{m s}^{-1}$

$\therefore$ Area of each square, $v \times t = \frac{2}{3} \times \frac{2}{5} = \frac{4}{15}$ m

Total area $= 62 \times \frac{4}{15} = 16.53$ m

(b) The limiting flat portion of the curve describes the constant speed of the car, *i.e.*, a speed of 6.0 m s^{-1}. At this stage, the acceleration of the car is zero.

Therefore, portion of the graph between t = 6 s to 10 s, describes the uniform motion of the car.