CHAPTER

5

Time and Distance

Important Rules and Formulae

Rule 1 $\text{Speed} = \dfrac{\text{Distance}}{\text{Time}}$

or $\text{Time} = \dfrac{\text{Distance}}{\text{Speed}}$

or $\text{Distance} = \text{Time} \times \text{Speed}$

Example 1. An athlete runs 200 m race in 24 s. Then, his speed in km/h is

(a) 20 km/h (b) 30 km/h
(c) 40 km/h (d) 45 km/h

Sol. (*b*) $\text{Speed} = \dfrac{200}{24}\ \text{m/s} = \left(\dfrac{200}{24} \times \dfrac{18}{5}\right)\ \text{km/h} = 30\ \text{km/h}$

Rule 2 $\text{Average speed} = \dfrac{\text{Total distance travelled}}{\text{Total time taken}}$

Example 2. A man completes 30 km of a journey at 6 km/h and the remaining 40 km of the journey in 5 h. Then, his average speed for the whole journey is

(a) 5 km/h (b) 7 km/h
(c) 7.5 km/h (d) None of these

Sol. (*b*) Total distance $= (30 + 40)\ \text{km} = 70\ \text{km}$

$$\text{Total time taken} = \left(\frac{30}{6} + 5\right)\ \text{h} = 10\ \text{h}$$

$$\text{Average speed} = \frac{70}{10}\ \text{km/h} = 7\ \text{km/h}$$

Rule 3 If A travels with speed x km/h for t_1 hours and with speed y km/h for next t_2 hours, then

$$\text{Average speed} = \frac{xt_1 + yt_2}{t_1 + t_2}$$

Example 3. A man walks at the rate of 5 km/h for 6 h and at 4 km/h for 12 h. Find out the average speed of the man (in km/h).

(a) $2\frac{1}{3}$ km/h (b) $5\frac{1}{3}$ km/h
(c) $7\frac{1}{3}$ km/h (d) None of these

Sol. (*d*) Total distance covered $= (5 \times 6 + 4 \times 12)\ \text{km} = 78\ \text{km}$

Total time taken $= (6 + 12)\ \text{h} = 18\ \text{h}$

$\therefore$ Average speed $= \left(\dfrac{78}{18}\right)\ \text{km/h} = 4\frac{1}{3}\ \text{km/h}$

Rule 4 To convert speed from km/h to m/s multiply the speed by $\frac{5}{18}$. *e.g.*, $36\ \text{km/h} = 36 \times \frac{5}{18} = 10\ \text{m/s}$

- To convert speed from m/s to km/h multiply value by $\frac{18}{5}$.

e.g., $5\ \text{m/s} = 5 \times \dfrac{18}{5}\ \text{km/h} = 18\ \text{km/h}$

Rule 5 If a body travels a certain distance at x km/h and the same distance is covered at y km/h, then the average speed during whole journey $= \dfrac{2xy}{x+y}$ km/h.

Example 4. A man covers half of his journey at 6 km/h and the remaining half at 3 km/h. Then, his average speed is

(a) 1 km/h (b) 2 km/h (c) 3 km/h (d) 4 km/h

Sol. (*d*) Average speed $= \dfrac{2 \times 6 \times 3}{6+3} = 4\ \text{km/h}$

Rule 6 If a man changes his speed in the ratio $a : b$, then the ratio of time taken becomes $b : a$.

e.g., If a man is to travel a distance of 30 km, he takes 5 h at 6 km/h and 6 h at 5 km/h. Thus, the ratio of speed is 6 : 5 and the ratio of time becomes 5 : 6.

Rule 7 If two bodies are moving in the same direction with speeds a and b km/h, starting from the same point at the same time, then their relative speed is $(a - b)$ km/h. But, if they are moving in opposite directions it is $(a + b)$ km/h.

e.g., Ram and Shyam travel in the same direction at 9 km/h and 10 km/h, then their relative speed moving in same direction $= (10 - 9) = 1$ km/h and relative speed in opposite direction $= (10 + 9) = 19$ km/h.

Example 5. Two persons, 27 km apart setting out at the same time are together in 9 h, if they walk in the same direction, but in 3 h if they walk in opposite directions. Then their rates of walking (speeds).

(a) 2 km/h and 4 km/h (b) 3 km/h and 5 km/h
(c) 4 km/h and 8 km/h (d) None of these

Sol. (*d*) Let the first person be walking fasted with speed x km/h and second walking with speed y km/h.

Case I Both walking in same directions

Distance travelled by first in 9 h $= 9x$ km

Distance travelled by second in 9 h $= 9y$ km

As both are 27 km apart.

$\therefore \quad 9x - 9y = 27 \Rightarrow x - y = 3$ ...(i)

Case II Both walking in opposite directions

$\therefore$ Distance travelled by faster in 3 h $= 3x$

Distance travelled by slow in 3 h $= 3y$

So, by condition $3x + 3y = 27 \Rightarrow x + y = 9$ ...(ii)

On adding Eqs. (i) and (ii), we get $\Rightarrow 2x = 12 \Rightarrow x = 6$ km/h

Put the value of x in Eq. (i), we get

$6 + y = 9 \Rightarrow y = 3$ km/h

So, their speeds are 6 km/h and 3 km/h.

Rule 8 If a train of length 'l' metres passes a post or pole, it travels a distance equal to its own length *i.e.*, l metres.

Example 6. A 100 m long train is moving at a speed of 60 km/h. In what time will it cross a signal pole?

(a) 6 s (b) 12 s

(c) 15 s (d) None of these

Sol. (*a*) Here, speed of train $= 60$ km/h $\Rightarrow 60 \times \frac{5}{18} = \frac{50}{3}$ m/s

$\therefore$ Time taken to pass the pole = Time taken to cover a distance of 100 m at speed of $\frac{50}{3}$ m/s $= 100 \times \frac{3}{50} = 6$ s

Rule 9 When a train is passing the other train completely (whether moving in the same direction or in opposite direction), the train will cover a distance equal to the sum of the lengths of the two trains.

Example 7. Two trains 130 m and 110 m in length are running towards each other on parallel tracks, one at the rate of 32 km/h and another at 40 km/h, respectively. In what time will they be clear each other from the moment they meet?

(a) 6 s (b) 10 s

(c) 12 s (d) None of these

Sol. (*c*) As trains are moving towards each other so relative speed of the train $= 32 + 40 = 72$ km/h. $= 72 \times \frac{5}{18} = 20$ m/s

Time taken by train in passing each other

$$= \frac{\text{Distance equal to sum of length of times}}{\text{Relative speed}}$$

$$= \frac{(130 + 110)}{20} = \left(\frac{240}{20}\right) \text{s} = 12 \text{ s}$$

Rule 10 If a train of length l_1 metres passes through a bridge, a platform of length l_2 metres, the running train travels a distance $(l_1 + l_2)$ metres.

Rule 11 If a train or body of length l_1 metres and speed v_1 m/s. Another train of length l_2 metres and speed v_2 m/s are running on two parallel tracks in the same direction, then the faster train will over take slower in $\frac{l_1 + l_2}{v_1 - v_2}$ seconds, if $(v_1 > v_2)$ and in $\frac{l_1 + l_2}{v_2 - v_1}$ seconds, if $(v_2 > v_1)$.

Example 8. Two trains 120 m and 140 m long are running towards each other on parallel lines at 32 km/h and 40 km/h, respectively. In what time will they be clear each other from the moment they meet?

(a) 6 s (b) 12 s

(c) 13 s (d) 15 s

Sol. (*c*) Distance travelled by trains

= Length of both trains $= (120 + 140)$ m $= 260$ m

Relative speed of trains $= (32 + 40) = 72$ km/h

(∵ Trains are running in opposite direction)

$$= \left(72 \times \frac{5}{18}\right) \text{m/s} = 20 \text{ m/s}$$

$\therefore$ Time taken to cross each other $= \left(\frac{260}{20}\right) = 13$ s

Example 9. Two trains of length 110 m and other 130 m travel on parallel track. If they move in the same direction, the first one faster takes one minute to pass the other completely. If they move in opposite directions they pass each other in 3 s, then the speed of the trains is

(a) 41 m/s and 39 m/s (b) 32 m/s and 43 m/s

(c) 42 m/s and 38 m/s (d) None of these

Sol. (*c*) Let v_1 be the velocity of fast train and v_2 be the velocity of slower train

$\therefore \quad \frac{110 + 130}{v_1 - v_2} = 60 \text{ s} \Rightarrow v_1 - v_2 = 4$ ...(i)

Again, $\frac{110 + 130}{v_1 + v_2} = 3 \Rightarrow v_1 + v_2 = 80$ ...(ii)

On adding Eqs. (i) and (ii), we get $2v_1 = 84$

$\Rightarrow \quad v_1 = 42$ m/s

and put the value of v_1 in Eq. (ii), we get $v_2 = 38$ m/s

Rule 12 If two trains of lengths l_1 and l_2 km are moving in opposite direction with speed u km/h and v km/h, respectively, then the time taken to cross each other

$$= \left(\frac{l_1 + l_2}{u + v}\right) \text{hour.}$$

Example 10. Two trains 132 m and 108 m long are running in opposite direction, one at the speed of 32 km/h and another at the speed of 40 km/h, respectively. In what time will they clear each other?

(a) 12 s (b) 24 s (c) 36 s (d) 52 s

Sol. (*a*) Length of first train in km $= \frac{132}{1000} = 0.132$ km

Length of second train in km $= \frac{108}{1000} = 0.108$ km

$\therefore$ $l_1 + l_2 = 0.132 + 0.108 = 0.240$ km

and $v_1 + v_2 = 32 + 40 = 72$ km/h

$\therefore$ Time taken to cross each other $= \left(\frac{0.240}{72}\right)$ h

$= \left(\frac{0.240}{72} \times 60 \times 60\right)$ s $= 12$ s

Formulae for Problems on Boat and Stream

Rule 13 If the speed of a boat (or a body) in still water be x km/h and that of stream be y km/h, then

(a) Speed of boat downstream $= (x + y)$ km/h

(b) Speed of boat upstream $= (x - y)$ km/h

Example 11. A sailor goes 8 km downstream in 40 min and returns back in 1 h. Then the speed of the sailor in still water and the speed of the current is

(a) 5 km/h and 3 km/h (b) 10 km/h and 2 km/h

(c) 7 km/h and 10 km/h (d) None of these

Sol. (*b*) Let the speed of the sailor in still water $= x$ km/h

and Speed of the current (stream) $= y$ km/h

$\therefore$ Speed of the sailor downstream $= (x + y)$ km/h

and Speed of the sailor upstream $= (x - y)$ km/h

$\therefore$ Time to travel 8 km downstream $= 40$ min $= \frac{2}{3}$ h

$\Rightarrow$ $\frac{8}{x+y} = \frac{2}{3} \Rightarrow x + y = \frac{24}{2} = 12$

$\Rightarrow$ $x + y = 12$ ...(i)

Time to return $= 1$ h

$\Rightarrow$ $\frac{8}{x-y} = 1 \Rightarrow x - y = 8$ ...(ii)

On adding Eqs. (i) and (ii), we get $x = 10$ and $y = 2$

Here, speed of sailor $= 10$ km/h

Speed of stream $= 2$ km/h

Speed of sailor downstream $= 10 + 2 = 12$ km/h
Speed of sailor upstream $= 10 - 2 = 8$ km/h

Example 12. A boat goes 70 km in 10 h along the stream and returns back the same distance in 14 h. Then speed of boat and the stream is

(a) 6 km/h and 1 km/h

(b) 3 km/h and 2 km/h

(c) 9 km/h and 3 km/h

(d) None of the above

Sol. (*a*) Let the speed of the boat in still water $= x$ km/h

and speed of stream $= y$ km/h

$\therefore$ Speed of boat downstream $= (x + y)$ km/h

Speed of boat upstream $= (x - y)$ km/h

$\therefore$ $\text{Time} = \frac{\text{Distance}}{\text{Speed}}$

Here,

For downstream, $10 = \frac{70}{x+y} \Rightarrow 10x + 10y = 70$

$\Rightarrow$ $x + y = 7$ ...(i)

For upstream, $14 = \frac{70}{x-y} \Rightarrow 14x - 14y = 70$

$\Rightarrow$ $x - y = 5$ ...(ii)

On adding Eqs. (i) and (ii), we get

$2x = 12 \Rightarrow x = 6$

Put the value of x in Eq. (ii), we get

$6 - y = 5 \Rightarrow y = 1$

$\therefore$ Speed of the boat in still water $= 6$ km/h

Speed of the boat in stream $= 1$ km/h

Example 13. The speed of a boat in still water is 10 km/h. If it can travel 26 km downstream and 14 km upstream in the same time, then the speed of the stream is

(a) 2 km/h (b) 2.5 km/h

(c) 3.2 km/h (d) None of these

Sol. (*d*) Let the speed of the stream $= x$ km/h

$\because$ Speed of boat in still water $= 10$ km/h

Speed of boat downstream $= (x + 10)$ km/h

Speed of boat upstream $= (10 - x)$ km/h

$\therefore$ Time taken to travel 26 km downstream $= \frac{26}{10+x}$ h

Time taken to travel 14 km upstream $= \frac{14}{10-x}$ h

$\Rightarrow$ By condition, $\frac{26}{10+x} = \frac{14}{10-x} \Rightarrow 26(10 - x) = 14(10 + x)$

$\Rightarrow$ $260 - 26x = 140 + 14x \Rightarrow 40x = 120$

$\Rightarrow$ $x = 3$ Here, speed of stream $= 3$ km/h

Rule 14 Let the speed of boat in downstream $= u$ km/h

Speed of boat in upstream $= u$ km/h, then

(a) Rate in still water $= \frac{1}{2}(u + v)$ km/h

(b) Rate of current $= \frac{1}{2}(u - v)$ km/h

Example 14. The speed of boat upstream and speed of boat downstream are 7 km/h and 13 km/h, respectively. Then the speed of stream and speed of boat in still water is

(a) 10 km/h and 3 km/h (b) 15 km/h and 9 km/h

(c) 20 km/h and 6 km/h (d) 40 km/h and 12 km/h

Sol. (*a*) Speed of boat in still water

$= \frac{1}{2}(7 + 13) = \frac{1}{2}(20) = 10$ km/h

Speed of the stream $= \frac{1}{2}(13 - 7) = \frac{1}{2}(6) = 3$ km/h

Exercise

1. A car completes a journey in 6 h with a speed of 50 km/h. At what speed must it travel to complete the journey in 5 h?
   (a) 60 km/h (b) 55 km/h (c) 45 km/h (d) 61 km/h

2. Kiran covers a certain distance 80 km/h and returns back to the same point at 20 km/h. Then, the average speed during the whole journey be
   (a) 35 km/h (b) 32 km/h (c) 30 km/h (d) 28 km/h

3. Normally Sarita takes 3 h to travel between two stations with a constant speed. One the her speed was reduced by 12 km/h and she took 45 min more to complete the journey. Then, the distance between the two stations is
   (a) 60 km (b) 120 km (c) 180 km (d) 95 km

4. Rani goes to school at 10 km/h and reaches the school 6 min late. Next day, she covers this distance at 12 km/h and reaches the school 9 min earlier than the scheduled time. What is the distance of her school from her house?
   (a) 16 km (b) 12 km (c) 10 km (d) 15 km

5. A man travels first 50 km at 25 km/h next 40 km 20 km/h and then 90 km at 15 km/h. His average speed for the whole journey (in m/s) is
   (a) 18 (b) 5
   (c) 10 (d) 36

6. A boy is running at a speed of p km/h to cover a distance of 1 km. But due to the slippery ground, his speed is reduced by q km/h ($p > q$). If he takes r hours to cover the distance, then
   (a) $\frac{1}{r} = \frac{pq}{p+q}$ (b) $\frac{1}{r} = p + q$ (c) $r = p - q$ (d) $\frac{1}{r} = p - q$

7. A train passes telegraph post in 40 s moving at a rate of 36 km/h. Then, the length of the train is
   (a) 400 m (b) 500 m (c) 450 m (d) 395 m

8. A scooterist travelled at 21 km/h and the rest at 24 km/h. Then the distance travelled in 10 h is
   (a) 204 km (b) 224 km
   (c) 220 km (d) 422 km

9. A man runs up a stream 13 km and downstream 28 km taking 5 h each time. Then, the velocity of the current is
   (a) 1.5 km/h (b) 2.5 km/h
   (c) 2 km/h (d) None of these

10. A person can run around a circular path of radius 21 m in 44 s. In what time will the same person run a distance of 3 km?
    (a) 18 min 40 s (b) 16 min 30 s
    (c) 18 min 30 s (d) 16 min 40 s

11. A car is ahead of a scooter by 30 km car goes at the rate of 50 km/h and the scooter goes at the rate of 60 km/h. The scooter overtake the car after
    (a) 3 h (b) 3.5 h
    (c) 4 h (d) $3\frac{1}{4}$ h

12. The average speed (correct to one place of decimal) of a train running at the rate of 30 km/h during the first 100 km; at 40 km/h during the second 100 km at 50 km/h during the third 100 km is
    (a) 38.1 km/h (b) 38.2 km/h (c) 38.3 km/h (d) 38.5 km/h

13. A train 700 m long is running at the speed of 72 km/h. If it crosses a tunnel in 1 min, then the length of the tunnel (in metres) is
    (a) 500 (b) 525 (c) 515 (d) 505

14. Two trains whose lengths are 180 m and 220 m, respectively are running in directions opposite to one another with respective speeds of 40 km/h and 50 km/h. Time taken by them in crossing one another will be
    (a) 18 s (b) 16 s (c) 20 s (d) 17 s

15. Two towns A and B are 250 km apart. A bus starts from A to B at 6 am at a speed of 40 km/h. At the same time another bus starts from B to A at a speed of 60 km/h. The time of their meeting is
    (a) 8 : 30 am (b) 8 am (c) 9 am (d) 9 : 15 am

16. A train T_1 leaves a place P at 5 am and reaches another place Q at 9 am another train T_2 leaves the place Q at 7 am and reaches the place P at 10 : 30 am. The time at which the two trains cross each other is
    (a) 8 : 26 am (b) 7 : 56 am (c) 8 : 15 am (d) 8 am

17. Two towns A and B are 160 km apart. A bus starts from A to B at 7 am at a speed of 50 km/h. Another bus starts from B to A at 8 am at a speed of 60 km/h. The time of their meeting is
    (a) 10 am (b) 9 : 30 am
    (c) 9 : 00 am (d) None of these

18. A certain distance is covered at a certain speed. If half of the distance is covered in double time the ratio of the two speeds is
    (a) 4 : 1 (b) 1 : 4 (c) 2 : 1 (d) 1 : 2

19. A boat goes downstream in half the time it takes to go upstream, then the ratio between the speed of the boat in still water to that of stream is
    (a) 3 : 1 (b) 1 : 2 (c) 1 : 3 (d) 2 : 1

20. Two trains start running at the same time from two stations to 210 km apart and going in opposite directions cross each other at a distance of 100 km from one of the station. The ratio of their speed is
    (a) 11 : 9 (b) 10 : 11 (c) 11 : 10 (d) 9 : 11

21. A boat goes 30 km upstream and 44 km downstream in 10 h. In 13 h it can go 40 km upstream and 55 km downstream. The speed of the boat in still water is
    (a) 9 km/h (b) 8 km/h (c) 4 km/h (d) 3 km/h

22. A police car is ordered to chase a speeding car that is 5 km ahead. The car is travelling at an average speed of 80 km/h and the police car pursues it at an average speed of 100 km/h. How long does it take for the police car to overtake the other car?
    (a) 17 min (b) 19 min (c) 13 min (d) 15 min

23. Points A and B are 70 km apart on a highway. A car starts from A and another car starts from B at the same time. If they travel in the same direction they meet in 7 h, but if they travel towards each other they meet in 1 h. What are the speeds of the cars?
(a) 30 km/h, 40 km/h (b) 36 km/h, 40 km/h
(c) 19 km/h, 20 km/h (d) 40 km/h, 50 km/h

24. A student walks from his house at 5 km/h and reaches his school 10 min late. If his speed had been 6 km/h he would have reached 15 min early. The distance of his school from his house is
(a) 12.5 km (b) 25 km (c) 37.5 km (d) 50 km

25. Assume that the distance that a car runs on 1 L of petrol varies inversely as the square of the speed at which it is driven. It gives a run of 25 km/L at a speed of 30 km/h. At what speed should it be driven to get a run of 36 km/L?
(a) 12.5 km/h (b) 25 km/h (c) 30 km/h (d) 40 km/h

26. A man standing on a railway platform observes that a train going in one direction takes 4 s to pass him. Another train of some length going in the opposite direction takes 5 s to pass him. The time taken (in seconds) by the two trains to cross each other will be
(a) $\frac{32}{9}$ (b) $\frac{33}{7}$ (c) $\frac{40}{9}$ (d) $\frac{49}{9}$

27. A motor boat takes 2 h to travel a distance of 9 km down the current and it takes 6 h to travel the same distance against the current. The speed of the boat in still water and that of the current (in km/h), respectively are
(a) 3, 1.5 (b) 3, 2 (c) 3, 2.5 (d) 3, 1

28. A bullock cart has to cover a distance of 80 km in 10 h. If it covers half of the journey in (3/5)th time, what should be its speed to cover the remaining distance in the time left?
(a) 5 km/h (b) 10 km/h (c) 15 km/h (d) 18 km/h

29. A certain distance is covered at a certain speed. If half of this distance is covered in triple the time, the ratio of the two speeds is
(a) 3 : 1 (b) 2 : 1 (c) 6 : 1 (d) 1 : 1

30. A man, on tour, travels first 160 km at 64 km/h and the next 160 km at 80 km/h. The average speed for the first 320 km of the tour, is
(a) 71.11 km/h (b) 71.31 km/h
(c) 71.21 km/h (d) 71.41 km/h

31. By walking at $\frac{3}{4}$ of his usual speed, a man reaches his office 25 min later than usual. His usual time is
(a) 60 min (b) 70 min (c) 75 min (d) 80 min

32. A train covers a distance in 50 min, if it runs at a speed of 48 km/h on an average. The speed at which the train must run to reduce the time of journey to 40 min, will be
(a) 10 km/h (b) 20 km/h (c) 40 km/h (d) 60 km/h

33. A car travels along the four sides of a square at speeds $v, 2v, 3v$ and $4v$, respectively. If u is the average speed of the car in its travel around the square, then which one of the following is correct? **(CDS 2011 II)**
(a) $u = 2.25v$ (b) $u = 3v$
(c) $v < u < 2v$ (d) $3v < u < 4v$

34. A boy walks from his house to school at 2.5 km/h and arrives 12 min late. The next day he walks at 4 km/h and reaches the school 15 min earlier. What is the distance from his house to school? **(CDS 2009 I)**
(a) 2 km (b) 2.5 km (c) 3 km (d) 3.5 km

35. A train of length 150 m takes 10 s to cross another train 100 m long coming from the opposite direction. If the speed of first train is 30 km/h. What is the speed of second train? **(CDS 2009 I)**
(a) 72 km/h (b) 60 km/h (c) 54 km/h (d) 48 km/h

36. A student moves $\sqrt{2}$ x km East from his residence and then moves x km North. He then goes x km North-East and finally he takes a turn of 90° towards right and moves a distance x km and reaches his school. What is the shortest distance of the school from his residence? **(CDS 2011 II)**
(a) $(2\sqrt{2}+1)x$ km (b) $3x$ km
(c) $2\sqrt{2}x$ km (d) $3\sqrt{2}x$ km

37. The speed of a boat in still water is 11 km/h. It can go 12 km upstream and return downstream to the engine point in 2 h 45 min. What is the speed of stream? **(CDS 2010 I)**
(a) 5 km/h (b) 4 km/h (c) 3 km/h (d) 2 km/h

38. A train crosses a telegraph post in 8 s and a bridge 200 m long in 24 s. What is the length of the train? **(CDS 2008 II)**
(a) 100 m (b) 120 m (c) 140 m (d) 160 m

39. Two persons P and Q start at the same time from city A for city B, 60 km away. P travels 4 km/h slower than Q. Q reaches city B and at once turns back meeting P, 12 km from city B. What is the speed of P? **(CDS 2009 I)**
(a) 8 km/h (b) 12 km/h (c) 16 km/h (d) 20 km/h

40. A motor boat takes 2 h to travel a distance of 9 km down the current and it takes 6 h to travel the same distance against the current. What is the speed of the boat in still water in km/h? **(CDS 2010 II)**
(a) 3 (b) 2 (c) 1.5 (d) 1

Answers

1. (a)	2. (b)	3. (c)	4. (d)	5. (b)	6. (d)	7. (a)	8. (b)	9. (a)	10. (d)
11. (a)	12. (c)	13. (a)	14. (b)	15. (a)	16. (b)	17. (c)	18. (a)	19. (a)	20. (c)
21. (b)	22. (d)	23. (a)	24. (a)	25. (b)	26. (c)	27. (a)	28. (b)	29. (c)	30. (c)
31. (c)	32. (d)	33. (c)	34. (c)	35. (b)	36. (b)	37. (a)	38. (a)	39. (a)	40. (b)

Hints and Solutions

1. Distance = Speed × Time

So, let speed be v km/h. Then, $6 \times 50 = 5 \times v$

$$\Rightarrow \quad v = \frac{6 \times 50}{5} = 60 \text{ km/h}$$

2. Average speed $= \frac{2u_1u_2}{u_1 + u_2} = \frac{2 \times 80 \times 20}{80 + 20} = 32$ km/h

3. Let her speed be u and distance is constant. Then,

$$\therefore \quad u \times 3 = (u - 12)\frac{15}{4}; \left[3\text{h} + 45\text{ min} = \frac{15}{4}\text{h}\right]$$

$$u = \frac{45 \times 4}{3} = 60 \text{ km/h}$$

$\therefore$ Distance = Speed × Time = $60 \times 3 = 180$ km

4. Let distance be x km and the difference of two times is 15 min.

So, $\quad \frac{x}{10} - \frac{x}{12} = \frac{15}{60}$

$$6x - 5x = 15$$

$$x = 15 \text{ km}$$

5. Total distance covered = $50 + 40 + 90 = 180$ km

$$\text{Total time taken} = \left(\frac{50}{25} + \frac{40}{20} + \frac{90}{15}\right) = 10 \text{ h}.$$

$\therefore$ Average speed for the whole journey

$$= \frac{180}{10} = 18 \text{ km/h}$$

$$18 \text{ km/h} = \frac{18 \times 5}{18} \text{ m/s} = 5 \text{ m/s}$$

6. Actual speed of boy $= (p - q)$ km/h

Time taken to cover 1 km $= \frac{1}{p - q}$

$$\therefore \quad \frac{1}{p - q} = r$$

or $$\frac{1}{r} = p - q$$

7. Length of train = Distance covered in 40 s at rate 36 km/h.

$$\therefore \quad \text{Length of train} = 40 \times 36 \times \frac{5}{18} = 400 \text{ m}$$

8. Average speed $= \frac{2 \times 24 \times 21}{24 + 21} = 22.4$ km/h

So, distance travelled in 10 h $= 10 \times 22.4$ km $= 224$ km

9. Let speed of boat $= x$ km/h and

Speed of current $= y$ km/h

Speed in upstream $= x - y$

Speed in downstream $= x + y$

So, $\quad 5(x - y) = 13 \quad \ldots(i)$

$$5(x + y) = 28 \quad \ldots(ii)$$

On solving Eqs. (i) and (ii), we get

$$10y = 15$$

$$y = 1.5 \text{ km/h}$$

10. Distance travelled in 44 s $= 2\pi r$

$$= 2 \times \frac{22}{7} \times 21 = 132 \text{ m}$$

So, $\quad \text{speed} = \frac{132}{44} = 3$ m/s

Time taken to travel 3 km $= \frac{3000}{3}$

$$= 1000 \text{ s}$$

$$= 16 \text{ min } 40 \text{ s}$$

11. Distance between car and scooter = 30 km

Difference of velocity $= 60 - 50 = 10$ km/h

So, the time taken by scooter to travel 30 km extra, then a c

when its speed 10 km/h more $= \frac{30}{10} = 3$ h

12. Average speed $= \frac{300}{\frac{100}{30} + \frac{100}{40} + \frac{100}{50}}$

$$= \frac{300}{\frac{10}{3} + \frac{5}{2} + \frac{2}{1}} = \frac{300 \times 6}{47} = 38.3 \text{ km/h}$$

13. Speed $= \left(72 \times \frac{5}{18}\right)$ m/s $= 20$ m/s

Let the length of tunnel be x metres.

Then, $\quad \frac{700 + x}{20} = 60 \Rightarrow x = 500$

So, length of the tunnel = 500 m

14. Speed of trains is 40 km/h and 50 km/h.

So, relative speed = (50 + 40) km/h

$$= \left(90 \times \frac{5}{18}\right) \text{m/s} = 25 \text{ m/s}$$

Distance to be covered = $180 + 220 = 400$ m

So, $\quad \text{time taken} = \frac{400}{25} = 16$ s

15. Let the buses meet x hours after 6 am.

So, the distance covered by the two buses is 250 km.

$$\therefore \quad 40x + 60x = 250$$

$$x = \frac{250}{100} = 2.5 \text{ h} = 2 \text{ h and } 30 \text{ min}$$

So, they will meet at 8 : 30 am.

16. Let the distance between P and Q be x km and let t

two trains meet y hours after 7 am.

So, T_1 covers x km in 4 h and T_2 covers in $3\frac{1}{2}$ h.

$$\therefore \quad \text{Speed of train } T_1 = \frac{x}{4} \text{ km/h}$$

$$\text{Speed of train } T_2 = \frac{2x}{7} \text{ km/h}$$

By question,

$$\frac{x(y+2)}{4}+\frac{2xy}{7}=x$$

or $$\frac{(y+2)}{4}+\frac{2y}{7}=1$$

or $$y=\frac{14}{15}\text{ h}=56\text{ min}$$

So, trains will meet at 7 : 56 am.

17. Let they meet x hours after 7 am.

$\therefore$ $50x+60(x-1)=160$

or $110x=160+60=220\Rightarrow x=2$ h

So, they will meet at 9 am.

18. Let x km distance be covered in y hours.

So, Speed in this case $=\frac{x}{y}$ km/h

Speed in second case $=\frac{x}{2}\div 2y=\frac{x}{2}\times\frac{1}{2y}=\frac{x}{4y}$ km/h

$\therefore$ Ratio of first and second speed

$$=\frac{x}{y}:\frac{x}{4y}=1:\frac{1}{4}=4:1$$

19. Let the speed of the boat in still water be x km/h and that of the stream be y km/h. Also, let k be the distance travelled, then

$$\frac{k}{x+y}=\frac{1}{2}\left(\frac{k}{x-y}\right)$$

or $$2x-2y=x+y\Rightarrow x=3y\Rightarrow x:y=3:1$$

20. Let their respective speeds be x km/h and y km/h, respectively. Then, the time taken by first train to cover 110 km = Time taken by second train to cover 100 km.

Thus, $$\frac{x}{110}=\frac{y}{100}$$

or $$\frac{x}{y}=\frac{110}{100}\quad\therefore\quad x:y=11:10$$

21. Let speed of boat in still water $=x$ km/h

Let speed of current $=y$ km/h

$\therefore$ Downstream speed $=(x+y)$ km/h

Upstream speed $=(x-y)$ km/h

According to question,

$$\frac{30}{x-y}+\frac{44}{x+y}=10 \qquad ...(i)$$

$$\frac{40}{x-y}+\frac{55}{x+y}=13 \qquad ...(ii)$$

Let $\frac{1}{x-y}=u$ and $\frac{1}{x+y}=v$

Then, $30u+44v=10$

$40u+55v=13$

On solving the above equations then, we get

$$u=\frac{1}{5},v=\frac{1}{11}$$

$\therefore$ $x-y=5$ and $x+y=11$

On solving the above equations then, we get

$x=8, y=3$

Thus, the speed of boat in still water = 8 km/h

22. Distance travelled by thief car in one hour = 80 km

Distance travelled in one hour by police car = 100 km

So, police travels extra 20 km in 1 h.

So, to overtake thief, police car has to travel 5 km extra.

$\therefore$ Time $=\frac{5}{20}=\frac{1}{4}$ h = 15 min

23. Let the speed of car at A be x km/h.

Let the speed of car at B be y km/h.

Distance cover by car A in one hour $=x$ km

Distance cover by car B in one hour $=y$ km

$\therefore$ $x+y=70$ ...(i)

Distance travelled by car A in 7 h $=7x$

Distance travelled by car B in 7 h $=7y$

$\therefore$ $7x-7y=70\Rightarrow x-y=10$ ...(ii)

So, adding Eqs. (i) and (ii), we get $2x=80$

$\therefore$ $x=40$ km/h and $y=30$ km/h

24. Let the distance of school from house be x km.

The difference of time taken = 25 min

$\therefore$ Time in first case be $T_1=\frac{x}{5}$

Time in second case be $T_2=\frac{x}{6}$

$\therefore$ $T_1-T_2=\frac{25}{60}\Rightarrow\frac{x}{5}-\frac{x}{6}=\frac{25}{60}$

$\Rightarrow$ $\frac{6x-5x}{30}=\frac{25}{60}\Rightarrow x=\frac{25}{2}\Rightarrow x=12.5$ km

25. Let the speed of car be v and distance covered by car in one litre A.

$\therefore$ $A\propto\frac{1}{v^2}\Rightarrow A=\frac{K}{v^2}$

Then, $A=25$ and $v=30$

So, $$25=\frac{K}{(30)^2}\Rightarrow K=900\times 25$$

$\Rightarrow$ $K=22500$

$\therefore$ $A=\frac{22500}{v^2}$

Now, when $A=36$

$$v^2=\frac{22500}{36}\Rightarrow v=\sqrt{\frac{22500}{36}}=\frac{150}{6}$$

Speed of $v=25$ km/h

26. Let the length of each train be l metres.

$\Rightarrow$ Speed of first train $=\left(\frac{l}{4}\right)$ m/s

Speed of second train $=\left(\frac{l}{5}\right)$ m/s

As both trains are moving in opposite direction.

$\Rightarrow$ Relative speed $=\left(\frac{l}{4}+\frac{l}{5}\right)$ m/s

$$=\frac{9l}{20}\text{ m/s}$$

Time taken to cross each other

$= \text{Time taken to cover } 2l \text{ m at speed } \left(\frac{9l}{20}\right) \text{ m/s}$

$= \left(\frac{2l}{\frac{9l}{20}}\right) \text{s} = \left(\frac{20 \times 2}{9}\right) = \frac{40}{9} \text{ s}$

27. Speed of boat in downstream $= \frac{9}{2} = 4.5$ km/h

Speed of boat in upstream $= \frac{9}{6} = 1.5$ km/h

$\therefore$ Speed of boat in still water $= \frac{1}{2}(4.5 + 1.5) = 3$ km/h

Speed of current $= \frac{1}{2}(4.5 - 1.5) = \frac{3}{2} = 1.5$ km/h

28. Total distance to cover in 10 h = 80 km

If it covers 40 km in $\frac{3}{5}$th of time i.e., 40 km in 6 h.

$\therefore$ Remaining time $= 10 - 6 = 4$ h

Remaining distance = 40 km

$\therefore$ Required speed $= (40 \div 4)$ km/h $= \frac{40}{4} = 10$ km/h

29. Let a km be covered in b hours.

Then, speed of object in first case $= \frac{a}{b}$ km/h

As half of this distance is covered in triple the time.

Then, speed of object in second case $= \frac{a/2}{3b} = \left(\frac{a}{6b}\right)$ km/h

$\therefore$ Ratio of speed $= \frac{a}{b} : \frac{a}{6b} = \frac{1}{1} : \frac{1}{6} = 6 : 1$

30. ***Case I*** Distance = 160 km, Speed = 64 km/h

Case II Distance = 160 km, Speed = 80 km/h

$\therefore$ Average speed for 320 km of tour

$= \frac{2 \times 64 \times 80}{64 + 80} = \frac{2 \times 64 \times 80}{144} = 71.11$ km/h

31. Let initial time taken $= t$ hours

Time taken when travelled at speed $\frac{3}{4}$ of usual speed

$= \frac{4}{3}t$ hours

$\therefore \quad \frac{4}{3}t - t = 25$

$\Rightarrow \quad \frac{t}{3} = 25 \Rightarrow t = 75$ min

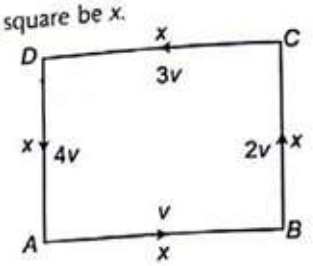
32. Distance travelled in one hour = 48 km

$\therefore$ Distance travelled in 50 min $= \frac{48}{60} \times 50 = 40$ km

Time to be reduced in 40 min $= \frac{40}{60}$ h

Required speed $= \frac{40}{40/60} = \frac{40 \times 60}{40} = 60$ km/h

33. Let side of a square be x.



To cover x distance in a side AB, time will be $= \frac{x}{v}$

Similarly,

To cover x distance in a side BC, time will be $= \frac{x}{2v}$

To cover x distance in a side CD, time will be $= \frac{x}{3v}$

and to cover x distance in a side DA, time will be $= \frac{x}{4v}$

$\because$ Average speed $(u) = \frac{\text{Total distance}}{\text{Total time}}$

$= \frac{(x + x + x + x)}{\frac{x}{v} + \frac{x}{2v} + \frac{x}{3v} + \frac{x}{4v}}$

$= \frac{4 \times v}{1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4}} = \frac{48v}{25} = 1.92v$

Which lies in the interval $v < u < 2v$.

34. Let the normal speed of boy was x km/h and his normal time was t hours.

By given condition, $d = \left(t + \frac{12}{60}\right) \times 2.5$ ...(i)

and $d = \left(t - \frac{15}{60}\right) \times 4$ ...(ii)

On dividing Eq. (i) by Eq. (ii), we get

$\frac{1}{1} = \frac{\left(t + \frac{1}{5}\right) \times 2.5}{\left(t - \frac{1}{4}\right) \times 4}$

$\Rightarrow 8\left(t - \frac{1}{4}\right) = 5\left(t + \frac{1}{5}\right) \Rightarrow 8t - 2 = 5t + 1 \Rightarrow 3t = 3 \Rightarrow t = 1$ h

On putting the value of t in Eq. (ii), we get

$d = \left(1 - \frac{15}{60}\right) \times 4 = \frac{3}{4} \times 4 = 3$ km

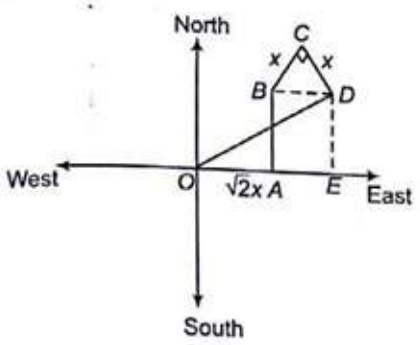
35. Time taken to cross the trains $= \frac{150 + 100}{\frac{25}{3} + x}$, where x is the speed of second train.

$\Rightarrow \quad 10 = \frac{250 \times 3}{25 + 3x} \Rightarrow 250 + 30x = 750$

$\Rightarrow \quad 30x = 500 \Rightarrow x = \frac{50}{3}$ m/s

$\therefore \quad x = \frac{50}{3} \times \frac{18}{5} = 60$ km/h

36. In ΔBCD,



$$BD^2 = BC^2 + CD^2 = x^2 + x^2$$

$\Rightarrow \quad BD = \sqrt{2}x$

$\Rightarrow \quad BD = AE = \sqrt{2}x$

$\therefore \quad OE = OA + AE$

$$= \sqrt{2}\cdot x + \sqrt{2}\cdot x = 2\sqrt{2}x$$

$\because \quad BA = DE = x$

$\therefore$ In ΔODE,

$$OD^2 = OE^2 + DE^2$$

$\therefore$ Minimum distance,

$$OD = \sqrt{(2\sqrt{2}\cdot x)^2 + x^2}$$

$$= \sqrt{8x^2 + x^2} = 3x \text{ km}$$

37. Let speed of boat, $S_1 = 11$ km/h

and speed of stream be S_2.

In upstream, $11 - S_2 = \dfrac{12}{t_1}$

$\Rightarrow \quad t_1 = \dfrac{12}{11 - S_2}$

and in downstream, $11 + S_2 = \dfrac{12}{t_2}$

$\Rightarrow \quad t_2 = \dfrac{12}{11 + S_2}$

Also, $t_1 + t_2 = 2 + \dfrac{45}{60}$

$\Rightarrow \quad \dfrac{12}{11 - S_2} + \dfrac{12}{11 + S_2} = 2.75$

$\Rightarrow \quad 12\left(\dfrac{22}{121 - S_2^2}\right) = 2.75$

$\Rightarrow \quad 121 - S_2^2 = \dfrac{22 \times 12}{2.75}$

$\Rightarrow \quad 121 - S_2^2 = 96$

$\Rightarrow \quad S_2^2 = 25$

$\Rightarrow \quad S_2 = 5$ km/h

38. Let the speed of a train be x m/s and length be y metres.
Ist condition, When $t = 8$ s

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}} \Rightarrow 8 = \frac{y}{x} \Rightarrow y = 8x \quad \ldots(i)$$

IInd condition, When $t = 24$ s, speed $= x$

Relative distance $= y + 200$

$\because \quad \text{Time} = \dfrac{\text{Relative distance}}{\text{Speed}}$

$\therefore \quad 24 = \dfrac{y + 200}{x} \Rightarrow 24x = y + 200$

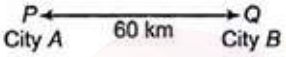
$\Rightarrow \quad 24x = 8x + 200$ [from Eq. (i)]

$\Rightarrow \quad 16x = 200 \Rightarrow x = \dfrac{25}{2}$

$\therefore$ From Eq. (i), we get

$$y = 8x = 8 \times \frac{25}{2} = 100 \text{ m}$$

39. Distance between P and $Q = 60$ km



Let the speed of $Q = x$ km/h

and the speed of $P = (x - 4)$ km/h

Distance travelled by Q till they meet $= 60 + 12 = 72$ km

Time taken by Q till they meet $= \dfrac{72}{x}$

Distance travelled by P till they meet $= 60 - 12 = 48$ km

Time taken by P till they meet $= \dfrac{48}{x - 4}$

Since, time taken by both will be equal.

$\therefore \quad \dfrac{72}{x} = \dfrac{48}{x - 4}$

$\Rightarrow \quad 72x - 288 = 48x$

$\Rightarrow \quad 24x = 288 \Rightarrow x = 12$ km/h

Speed of $P = x - 4 = 12 - 4 = 8$ km/h

40. Let the speed of motor boat $= x$ km/h

and the speed of water $= y$ km/h

By given condition,

$$\frac{9}{x + y} = 2 \Rightarrow 2x + 2y = 9 \quad \ldots(i)$$

and $\dfrac{9}{x - y} = 6 \Rightarrow 6x - 6y = 9 \quad \ldots(ii)$

On solving Eqs. (i) and (ii), we get

$x = 3$ km/h and $y = 1.5$ km/h

Hence, the speed of boat $= 3$ km/h