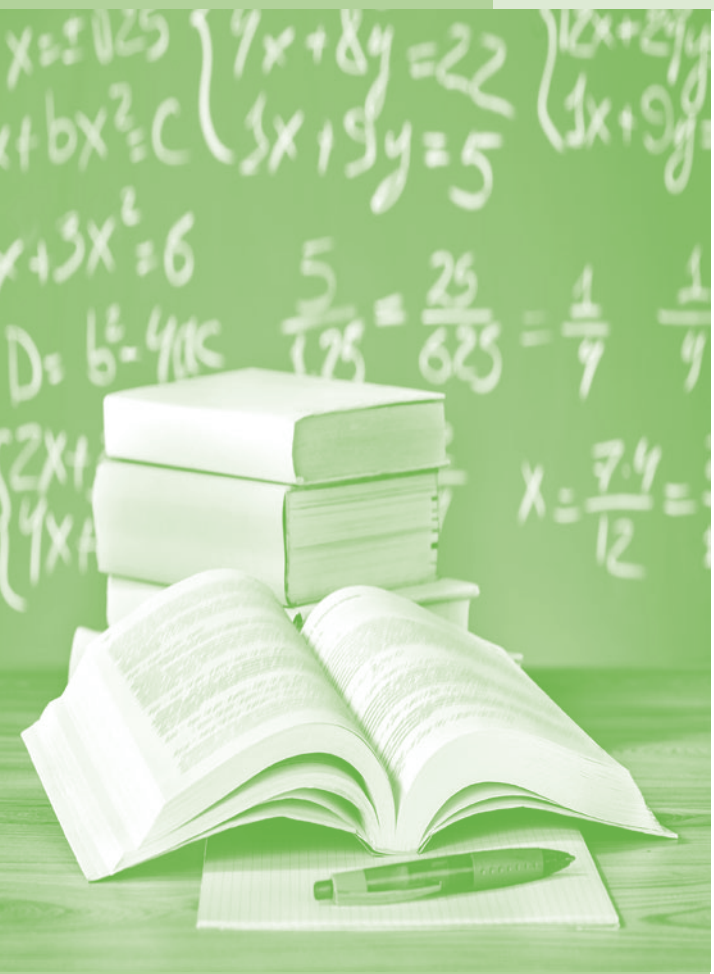
Chapter

23

Time and Distance



REMEMBER

Before beginning this chapter, you should be able to:

- Know the definitions of speed, velocity, acceleration
- Understand the concepts of distance travelled by an object
- Relate motion of an object with time and distance

KEY IDEAS

After completing this chapter, you should be able to:

- Calculate the value of speed and velocity using formulae
- Understand average speed and relative speed
- Solve word-problems based on time and distance
- Calculate the speed of moving objects such as boats, streams, trains and cars

INTRODUCTION

Let us consider an object moving uniformly. It covers equal distances in equal intervals of time. For example, if in 1 second it covers 5 m, in the next second it covers another 5 m, i.e., in 2 seconds it covers 10 m, in 3 seconds it covers 15 m and so on. The distance in which the object covers in unit time, is called its speed. Hence, the speed of the object whose motion is described above is 5 m per second.

SPEED

The distance covered per unit time is called **speed**.

That is, $$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

The above relationship between the three quantities–distance, speed and time can also be expressed as follows:

$$\text{Distance} = \text{Speed} \times \text{Time (or) Time} = \frac{\text{Distance}}{\text{Speed}}$$

If two bodies travel with the same speed, the distance covered varies directly as time and it is written as Distance $\propto$ Time. Further, if two bodies travel for the same period of time, the distance covered varies directly as the speed, i.e., Distance $\propto$ Speed. If two bodies travel the same distance, time varies inversely as speed, i.e., $\text{Time} \propto \frac{1}{\text{Speed}}$.

Distance is usually measured in kilometres, metres or miles; time in hours, minutes or seconds and speed in kmph (also denoted by kmph) or miles/h (also denoted by mph) or metres/second (denoted by m/sec).

$$1 \text{ km per hour} = \frac{1 \times 1000 \text{ m}}{3600 \text{ sec}} = \frac{5}{18} \text{ m/s}.$$

Note To convert speed in kmph to m/sec, multiply it with $\frac{5}{18}$. And to convert speed in m/sec to kmph multiply it with $\frac{18}{5}$.

Average Speed

The average speed of a body travelling at different speeds for different time periods is defined as follows:

$$\text{Average speed} = \frac{\text{Total distance travelled}}{\text{Total time taken}}$$

Note that the average speed of a moving body is not equal to the average of the speeds.

Consider a body travelling from point A to point B, (a distance of d units) with a speed of p units and back to point A (from point B) with a speed of q units.

Total distance covered = $2d$ units.

$$\text{Total time taken} = \frac{d}{p} + \frac{d}{q} = d\left(\frac{p+q}{pq}\right).$$

$$\therefore \text{Average speed} = \frac{2d}{d\left(\frac{p+q}{pq}\right)} = \frac{2pq}{p+q}.$$

Note that the average speed does not depend on the distance between A and B. If a body covers part of the journey at a speed p units and the remaining part of the journey at a speed q units and the distances of the two parts of the journey are in the ratio $m : n$, then the average speed for the entire journey is $\frac{(m+n)pq}{mq+np}$ units.

EXAMPLE 23.1

Express 54 kmph in m/sec.

SOLUTION

$$54\ \frac{\text{km}}{\text{hr}} = 54\frac{(1000)}{(3600)}\ \frac{\text{m}}{\text{s}} = 15\ \text{m/s} \quad \text{or}$$

$$\text{or,}\ 54\left(\frac{5}{18}\right) = 15\ \text{m/s}.$$

EXAMPLE 23.2

A car can cover 350 km in 4 hours. If its speed is decreased by $12\frac{1}{2}$ kmph, how much time does the car take to cover a distance of 450 km?

SOLUTION

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} = \frac{350}{4} = 87\frac{1}{2}\ \text{kmph}$$

Now this is reduced by $12\frac{1}{2}$ kmph. Hence, the speed is 75 kmph. Travelling at this speed, the time taken by the car $= \frac{450}{75} = 6$ hours.

EXAMPLE 23.3

A person covers a certain distance at a certain speed. If he increases his speed by 25%, then he takes 12 minutes less to cover the same distance. Find the time taken by him to cover the distance initially, travelling at the original speed.

SOLUTION

When the speed is increased by 25%, the increased speed is 125% of the original speed; it is $\frac{5}{4}$ times the original speed. Since speed and time vary inversely, if the increased speed is $\frac{5}{4}$ times the original speed, then the time taken decreases to $\frac{4}{5}$ times the original time.

This means that the decreased time is $\left(1-\frac{4}{5}\right)$ or $\frac{1}{5}$ part less than the original time.

But, we know that the reduced time is less by 12 minutes. This means $\frac{1}{5}$ of original time is 12 minutes; so, the original time = 5(12) = 60 minutes = 1 hour.

EXAMPLE 23.4

A car covers a certain distance travelling at a speed of 60 kmph and returns to the starting point at a speed of 40 kmph. Find the average speed for the entire journey.

SOLUTION

We know that the average speed is $\frac{2pq}{p+q}$, where p and q are the speeds in both directions, for equal distances.

$$\therefore \text{Average speed} = \frac{2(60)(40)}{(60+40)} = 48 \text{ kmph.}$$

EXAMPLE 23.5

A worker reaches his work place 15 minutes late when he walks at a speed of 4 kmph from his house. The next day he increases his speed by 2 kmph and reaches his work place on time. Find the distance from his house to workplace.

SOLUTION

Let the distance be x km.

Then the time taken on the 1st day = $\frac{x}{4}$ hours

Time taken on the 2nd day = $\frac{x}{6}$ hours

We are given,

$$\frac{x}{4}-\frac{x}{6}=\frac{15}{60}$$

$$\Rightarrow x=\frac{15}{60}(12)=3\,\text{km.}$$

In general, if a person travelling between two points reaches p hours late travelling at a speed of u kmph and reaches q hours early, travelling at v kmph, then the distance between the two points is given by $\frac{vu}{(v-u)}(p+q)$.

EXAMPLE 23.6

A person leaves his house and travelling at 4 kmph, reaches his office 10 minutes late. Had he travelled at 6 kmph, he would have reached 20 minutes early. Find the distance from his house to the office.

SOLUTION

Let the distance be d km.

Time taken to travel at 6 kmph $= \frac{d}{6}$ hours

Time taken to travel at 4 kmph $= \frac{d}{4}$ hours

Given that, $\frac{d}{4} - \frac{d}{6} = \frac{30}{60}$

$$\Rightarrow d = 6 \text{ km.}$$

Alternate method:

As per the formula given,

$$\text{Distance} = \frac{4 \times 6}{6 - 4}\left(\frac{10}{60} + \frac{20}{60}\right)$$

$$= \frac{24}{2} \times \frac{30}{60}$$

$$= 6 \text{ km.}$$

EXAMPLE 23.7

When a person travelled at 25% faster than his usual speed, he reached his destination 48 minutes early. By how many minutes would he be late if he travelled at 20% less than his usual speed? Choose the correct answer from the following options:

(a) 48 **(b)** 54 **(c)** 60 **(d)** 72

HINTS

(i) Find the ratio of the speeds and corresponding times taken.

(ii) Let his usual speed be x kmph and distance travelled be d km.

(iii) Use $\frac{d}{x} - \frac{4d}{x} = 48$ and find $\frac{d}{x}$.

(iv) Speed $= x - \frac{20x}{100} = \frac{4x}{5}$, Time $= \frac{5d}{4x}$.

(v) Now, find the time taken using the value of $\frac{d}{x}$.

Relative Speed

The speed of one moving body in relation to another moving body is called the relative speed of these two bodies, i.e., it is the speed of one moving body as observed from the second moving body. If two bodies are moving in the same direction, then the relative speed is equal to the difference of the speeds of the two bodies.

If two bodies are moving in the opposite direction, then the relative speed is equal to the sum of the speeds of the two bodies.

Trains

In time and distance topic, we come across many problems on trains. While passing a stationary point or a telegraph/telephone pole completely, a train has to cover its entire length. Hence, the distance travelled by the train to pass a stationary point or a telegraph/telephone pole is equal to its own length.

While passing a platform, bridge or another stationary train, a train has to cover its own length as well as the length of the platform, the bridge or the other train. Hence, the distance travelled by the train to pass these objects is equal to the total length of the train and the length of the platform/bridge/the other train.

While overtaking another train (when the trains move in the same direction) or while crossing another moving train (when the trains move in the same or opposite directions) a train has to cover its own length as well as the length of the other train. Hence, in this case, the distance travelled by the train, is equal to the total length of the two trains, but the speed at which this distance is covered is the relative speed of the trains.

EXAMPLE 23.8

What is the time taken by a 180 m long train running at 54 kmph to cross a man standing on a platform?

SOLUTION

Speed of train = 54 kmph = $54\left(\frac{5}{18}\right)$ = 15 m/sec.

Distance = Length of the train = 180 m.

$\therefore$ Time taken to cross the man $= \frac{\text{Distance}}{\text{Speed}} = \frac{180}{15} = 12$ seconds.

EXAMPLE 23.9

How long will a train 100 m long and travelling at a speed of 45 kmph, take to cross a platform of length 150 m?

SOLUTION

Distance = Length of the train + Length of the platform = 100 + 150 = 250 m.

Speed of the train = 45 kmph = $45\left(\frac{5}{18}\right)$ = 12.5 m/sec

$\therefore$ Time taken $= \frac{250}{12.5} = 20$ second.

EXAMPLE 23.10

Find the length of a bridge on which a 120 m long train, travelling at 54 kmph, completely passes in 30 seconds.

SOLUTION

Speed of the train = 54 kmph = $54 \times \left(\frac{5}{18}\right)$ = 15 m/sec

Distance covered in 30 sec = $15 \times 30 = 450$ m

Length of the bridge = Distance covered – Length of the train = 450 – 120 = 330 m.

EXAMPLE 23.11

Find the time taken by a train 150 m long, running at a speed of 63 kmph to cross another train of length 100 m running at a speed of 45 kmph in the same direction.

SOLUTION

Total distance covered = The sum of the lengths of the two trains = 100 + 150 = 250 m

The relative speed of the two trains = 63 – 45 = 18 kmph = $18\left(\frac{5}{18}\right) = 5$ m/sec.

(Since the trains are running in the same direction, the relative speed will be the difference in the speeds.)

$\therefore$ Time to cross each other = $\frac{250}{5} = 50$ seconds.

EXAMPLE 23.12

A train crosses two persons who are cycling in the same direction as the train, in 12 seconds and 18 seconds, respectively. If the speeds of the two cyclists are 9 kmph and 18 kmph, respectively, find the length and the speed of the train.

SOLUTION

The relative speed while overtaking the first cyclist = $(s - 9)$ kmph, where s kmph being the speed of the train. The time the train took to overtake the first cyclist = 12 seconds.

Hence, the length of the train = $(12)(s-9)\left(\frac{5}{18}\right)$ (1)

Similarly, considering the case of overtaking the second cyclist,

The length of the train = $(18)(s-18)\left(\frac{5}{18}\right)$ (2)

Equating Eqs. (1) and (2),

$$(12)(s-9)\left(\frac{5}{18}\right) = (18)(s-18)\left(\frac{5}{18}\right)$$

$$\Rightarrow 2s - 18 = 3s - 54 \Rightarrow s = 36.$$

That is, the speed of the train is 36 kmph.

$$\text{Length} = (12)(s-9)\left(\frac{5}{18}\right) = (12)(27)\left(\frac{5}{18}\right) = 90\,\text{m}.$$

EXAMPLE 23.13

Two trains running at 45 kmph and 54 kmph crosses each other in 12 seconds, when they run in opposite directions. When they run in the same direction, a person in the faster train observes that he crosses the other train in 32 seconds. Find the lengths of the two trains.

SOLUTION

Let p and q be the lengths of the slower and the faster trains respectively. When the trains are travelling in the opposite directions, their relative speed = 45 + 54 = 99 kmph = 27.5 m/sec.

The distance covered = The sum of the lengths of the two trains = $p + q$

Then we have, $p + q = 12(27.5) \Rightarrow p + q = 330$ m (1)

When the trains are travelling in the same direction, since we are given the time noted by a person in the faster train as 32 seconds, the distance covered is equal to the length of the slower train, i.e., distance covered = p.

The relative speed = 54 – 45 = 9 = 2.5 m/sec

$\therefore p = (2.5)\ 32 = 80$ m (2)

From Eqs. (1) and (2), we get $q = 250$ m.

EXAMPLE 23.14

Two trains of lengths 150 m and 250 m run on parallel tracks. When they run in the same direction, it takes 20 seconds to cross each other and when they run in the opposite direction, it takes 5 seconds. Find the speeds of the two trains.

SOLUTION

Let the speeds of the two trains be p m/sec and q m/sec.

The total distance covered = The sum of the lengths of the two trains = 150 + 250 = 400 m

When they run in the same direction, the relative speed $(p - q)$ is given by,

$$p - q = \frac{400}{20} = 20 \quad (1)$$

When they run in the opposite direction, their relative speed is given by

$$p + q = \frac{400}{5} = 80 \quad (2)$$

Solving Eqs. (1) and (2), we get,

$$p = 50 \text{ and } q = 30 \Rightarrow P = 50 \times \frac{18}{5} \text{kmph and } q = 30 \times \frac{18}{5} \text{kmph.}$$

$\therefore$ The speeds of the two trains are 180 kmph and 108 kmph.

EXAMPLE 23.15

Two trains take one minute to cross each other when travelling in opposite directions. The speeds of the trains are 54 kmph and 36 kmph. The length of the faster train is 50% more than that of the second. Find the length (in m) of the slower train from the following options:

(a) 450 **(b)** 750 **(c)** 600 **(d)** 500

HINTS

(i) Use relative speed concept.

(ii) Let the length of the slower train be L meters.

(iii) Solve $\dfrac{L + \dfrac{3L}{2}}{(54 + 36)\dfrac{5}{18}} = 60$, for L.

EXAMPLE 23.16

Two trains are travelling in the same direction at 70 kmph and 50 kmph. The faster train passes a man sitting in the slower train in 36 seconds. What is the length of the faster train? Choose the correct answer from the following options:

(a) 100 m **(b)** 150 m **(c)** 200 m **(d)** Cannot be determined

HINTS

(i) To pass a man in the slower train, the faster train has to travel its own length.

(ii) $\frac{\text{Length of the faster train}}{\text{Relative speed}} = 36$ seconds.

(iii) Relative speed = Difference of the speeds.

Boats and Streams

Problems related to boats and streams are different in the computation of relative speed from those of trains/cars.

When a boat is moving in the same direction as the stream or water current, the boat is said to be moving **with the stream or downstream**.

When a boat is moving in a direction opposite to that of the stream or water current, it is said to be moving **against the stream or upstream**.

If the boat is moving with a certain speed in water that is not moving, the speed of the boat is then called the **speed of the boat in still water**.

When the boat is moving upstream, the speed of the water opposes (and hence reduces) the speed of the boat.

When the boat is moving downstream, the speed of the water aids (and thus increases) the speed of the boat. Thus, we have

Speed of the boat against stream = Speed of the boat in still water – Speed of the stream

Speed of the boat with the stream = Speed of the boat in still water + Speed of the stream

These two speeds, the speed of the boat against the stream and the speed of the boat with the stream, are speeds with respect to the bank.

If u is the speed of the boat downstream and v is the speed of the boat upstream, then we have the following two relationships.

$$\text{Speed of the boat in still water} = \frac{u+v}{2}$$

$$\text{Speed of the water current} = \frac{u-v}{2}$$

In some problems, instead of a boat, it may be a swimmer. But the approach is exactly the same.

EXAMPLE 23.17

A boat travels 24 km upstream in 6 hours and 20 km downstream in 4 hours. Find the speed of the boat in still water and the speed of the water current.

SOLUTION

$$\text{Upstream speed} = \frac{24}{6} = 4 \text{ kmph}$$

$$\text{Downstream speed} = \frac{20}{4} = 5 \text{ kmph}$$

$$\text{Speed in still water} = \frac{(4+5)}{2} = 4.5 \text{ kmph}$$

$$\text{Speed of the water current} = \frac{(5-4)}{2} = 0.5 \text{ kmph.}$$

EXAMPLE 23.18

A man can row 8 km in one hour in still water. The speed of the water current is 2 kmph and it takes 3 hours for him to go from point P to go to point Q and return to P. Find the distance PQ.

SOLUTION

Let the distance be x km.

$$\text{Upstream speed} = 8 - 2 = 6 \text{ kmph}$$

$$\text{Downstream speed} = 8 + 2 = 10 \text{ kmph}$$

$$\text{Total time} = \text{Time taken travelling upstream} + \text{Time taken travelling downstream}$$

$$= \frac{x}{6} + \frac{x}{10} = 3 \text{ hours (given)}$$

$$\therefore \frac{8x}{30} = 3$$

$$\Rightarrow x = \frac{90}{8} = 11\frac{1}{4} \text{ km.}$$

EXAMPLE 23.19

A man can row a distance of 6 km in 1 hour in still water and he can row the same distance in 45 minutes with the current. Find the total time taken by him to row 16 km with the current and return to the starting point.

SOLUTION

$$\text{Speed in still water} = \frac{6}{1} = 6 \text{ kmph}$$

$$\text{Upstream speed} = \frac{6}{\frac{45}{60}} = 6 \times \frac{60}{45} = 8 \text{ kmph}$$

$\therefore$ The speed of water current $= 8 - 6 = 2$ kmph

$\therefore$ The speed against the stream $= 6 - 2 = 4$ kmph

Hence, time taken to travel 16 km and back

$$= \frac{16}{8} + \frac{16}{4} = 2 + 4 = 6 \text{ hours.}$$

EXAMPLE 23.20

The distance travelled by a boat downstream is $1\frac{1}{2}$ times the distance travelled by it upstream in the same time. If the speed of the stream is 3 kmph, then find the speed of the boat in still water.

SOLUTION

If the distance covered downstream is $1\frac{1}{2}$ times that covered upstream, the speed downstream will also be $1\frac{1}{2}$ times the speed upstream.

Let the speeds of the boat in still water be u.

We get,

$$\frac{(u+3)}{(u-3)} = \frac{3}{2} \Rightarrow u = 15 \text{ kmph.}$$

EXAMPLE 23.21

A man can row $\frac{2}{3}$rd of a kilometre downstream in 5 minutes and return to the starting point in another 10 minutes. Find the speed of the man in still water.

SOLUTION

$$\text{Downstream speed} = \frac{2}{3} \times \frac{60}{5} = 8 \text{ kmph}$$

$$\text{Upstream speed} = \frac{2}{3} \times \frac{60}{10} = 4 \text{ kmph}$$

$$\text{Speed in still water} = \frac{8+4}{2} = 6 \text{ kmph.}$$

EXAMPLE 23.22

A boat would cover the journey from A to B in a river in 12 hours if the river was still. If the speed of the river is $\frac{1}{5}$ times the speed of the boat in still water, find the time (in hours) taken by it to cover around trip journey between A and B. Choose the correct answer from the following options:

(a) 20 **(b)** 30 **(c)** 25 **(d)** 24

HINTS

(i) Let distance be d km and speed of boat in still water be s kmph.

(ii) Given, $\frac{d}{s} = 12$

(iii) The required distance $= \frac{d}{\left(s + \frac{s}{5}\right)} + \frac{d}{\left(s - \frac{s}{5}\right)}$.

EXAMPLE 23.23

A man drove from town A to B. If he had driven 4 kmph faster, he would have reached his destination 2 hours earlier. If he had driven 6 kmph slower, he would have reached his destination 6 hours late. Find the distance between A and B (in kilometres) from the given options:

(a) 120 **(b)** 140 **(c)** 150 **(d)** 160

HINTS

(i) Distance = Speed × Time.

(ii) Let the distance, speed and time be d, s and t.

(iii) From the given data $d = st = (s + 4)(t - 2) = (s - 6)(t + 6) = d$.

(iv) Solve the above equation and find d.

Races

When two persons P and Q are running a race, they can start the race at the same time or one of them may start a little later than the other. In the second case, suppose P starts the race and after 5 seconds Q starts, then we say P has a 'start' of 5 seconds. In a race between P and Q, P starts first and then when P has covered a distance of 10 m, Q starts. Then we say that P has a 'start' or 'head start' of 10 m.

In a race between P and Q, where Q is the winner, by the time Q reaches the winning post, if P still has another 15 m to reach the winning post, then we say that Q has won the race by 15 m. Similarly, if P reaches the winning post 10 seconds after Q reaches it, then we say that Q has won the race by 10 seconds.

In problems on races, we normally consider a 100 m race or a 1 kilometre race. The length of the track need not necessarily be one of the two figures mentioned above but can be as given in the problem.

EXAMPLE 23.24

In a race of 1000 m, A beats B by 50 m or 5 seconds. Find

(a) B's speed.
(b) The time taken by A to complete the race.
(c) A's speed.

SOLUTION

(a) Since A beats B by 50 m, it means by the time A reaches the winning post, B is 50 m away and as A beats B by 5 seconds, it means B takes 5 seconds more than A to reach the winning post. This means B covers 50 m in 5 seconds, i.e., B's speed is 50/5 = 10 m/sec.

(b) Since A wins by 50 m, by the time A covers 1000 m, B covers 950 m at 10 m/sec, B can cover 950 m in 950/10, i.e., 95 seconds or 1 minute 35 seconds.
∴A completes the race in 1 minute 35 seconds.

(c) ∴A's speed is $\frac{100}{95} = 10\frac{10}{19}$ m/s.

EXAMPLE 23.25

Rakesh runs $1\frac{1}{3}$ times as fast as Mukesh. In a race, Rakesh gives a head start of 60 m to Mukesh. After running for how many metres does Rakesh meet Mukesh?

SOLUTION

Since Rakesh runs $1\frac{1}{3}$ times as fast as Mukesh, in the time Mukesh runs 3 meters, Rakesh has run 4 meters, i.e., Rakesh gains 1 m for every 4 meters he runs.

Since he has given a lead of 60 m, he will gain this distance by covering $4 \times 60 = 240$ m.

Hence, they will meet at a point 240 m from the starting point.

EXAMPLE 23.26

In a 100 m race, Tina beats Mina by 20 m and in the same race Mina beats Rita by 10 m. By what distance does Tina beat Rita?

SOLUTION

$$\text{Tina : Mina} = 100 : 80$$

$$\text{Mina : Rita} = 100 : 90$$

$$\text{Tina : Rita} = \frac{100}{80} \times \frac{100}{90} = \frac{100}{72}.$$

$\therefore$ Tina beats Rita by 100 – 72, i.e., 28 m.

EXAMPLE 23.27

In a 500 m race, the ratio of speeds of two runners, P and Q is 3 : 5. P has a start of 200 m. Who wins the race and by what distance does he win?

SOLUTION

Since the ratio of speeds of P and Q is 3 : 5, by the time P runs 300 m, Q runs 500 m.

Since, P has a start of 200 m, by the time Q starts at the starting point, P has already covered 200 m and he has another 300 m to cover. In the time P covers this 300 m, Q can cover 500 m, thus reaching the finishing point exactly at the same time as P.

$\therefore$ Both P and Q reach the finishing point at the same time.

EXAMPLE 23.28

In a 200 m race, Lokesh gave Rakesh a start of at most 20 m and was beaten by him by at least 20 m. Both have distinct speeds. Which of the following can be the ratio of the speeds of Lokesh and Rakesh?

(a) 2 : 1 **(b)** 4 : 3 **(c)** 5 : 4 **(d)** 5 : 6

SOLUTION

Lokesh gave Rakesh a headstart of atmost 20 m

$\therefore$ Rakesh would have run atleast (200 – 20) m = 180 m

Lokesh was beaten by Rakesh by at least 20 m

$\therefore$ When Rakesh finished, Lokesh would have run atmost (200 – 20) = 180 m

Given that their speeds of both are distinct.

$\therefore$ Rakesh run more distance than Lokesh.

$\therefore$ Rakesh must be faster than Lokesh.

Only choice (d) satisfies this condition.

TEST YOUR CONCEPTS

Very Short Answer Type Questions

1. Speed of a person is 45 kmph. What is the distance covered by him in 8 minutes? (in km)
2. Some telegraphic poles are placed 50 m apart. How many such poles can a train cross in 12 minutes travelling at a speed of 36 kmph?
3. If the speed is increased by 20%, then the time taken to cover a certain distance decreases by 20%. [True/False]
4. If the ratio of speeds is $\frac{1}{a}:\frac{1}{b}:\frac{1}{c}$, then the time taken to cover a certain distance is in the ratio of $c : b : a$. [True/False]
5. A person travelled half the distance at 20 kmph and the remaining distance at 30 kmph in a total of 10 hours. Find the distance travelled.
6. A person covered two equal distances at 20 kmph and 30 kmph respectively. The average speed in covering the total distance is 25 kmph. [True/False]
7. A person travelled at a speed of 20 kmph for 3 hours and an equal distance at a speed of 15 kmph. What is the average speed of the person?
8. In what time does a train of length 300 m, running at 36 kmph cross an electric pole?
9. The time taken by two trains of lengths x m and y m running at p kmph and q kmph in opposite directions to cross each other is_____.
10. The ratio of speeds of A and B is 8 : 7. In a 1000 m race, by how many meters does A beat B?
11. In a race of 1 km A gives B a start of 100 m and still beats him by 80 m. What is the ratio of speeds of A and B?
12. Speed upstream is x kmph and speed of stream is y kmph. Speed downstream is_____.
13. For a boat, speed downstream and speed upstream are 18 kmph and 14 kmph respectively. Find the speed of the boat in still water.
14. A is $1\frac{2}{3}$ times as fast as B. In a race, A gives B a start of 200 m and still beats him by 120 m. What is the length of the race?
15. In a race of 1 km race A beats B by 40 m or 8 seconds. Is the speed of A 5 m/sec more than that of B?
16. Anand covers a certain distance in 10 hours. If he increases his speed by 5 kmph he takes 2 hours less to cover the same distance. Find the distance.
17. For a boat, ratio of speed downstream to speed upstream is 9 : 5. What is the ratio of speed of boat in still water to the speed of stream?
18. Speed of sound in air is 330 m/sec and in steel is 5960 m/sec. If sound travels 132 km in air, then how many km can it travel in steel in the same time?
19. Time taken by a train to cross a platform is more than the time taken to cross a person moving in opposite direction. [True/False]
20. A bus can cover 75 km in one hour without stoppages. If it covers 60 km in one hour with stoppages, then how many minutes does it stop per hour?
21. A is twice as fast as B and B is one-third as fast as C. If A and C run a race, C beats A by 500 meters. Find the distance of the race.
22. Pavan covered three equal distances at a speed of 20 kmph, 30 kmph and 50 kmph respectively. Find the average speed in covering the total distance.
23. A train crossed a 350 m long platform in 46 second and 725 m long platform in 58.5 second. Find the speed of the train.
24. A train takes 18 seconds to overtake a person travelling at 18 kmph and 27 seconds to overtake another person travelling at 36 kmph. Find the length of train.
25. Varun and Varma travelled from A to B at speeds of 6 kmph and 4 kmph respectively. Varun reaches B, returns immediately and meets Varma at point C. What is the distance between A and C, given that distance between A and B is 20 km?
26. The time taken by a man to row downstream is $\frac{5}{9}$ of the time taken to row upstream. If the product of speeds of the man and the stream, taken in kmph, is 224, find the speed of the man in still water.

27. Travelling at 80 kmph a person can reach his destination in a certain time. He covers $\frac{3}{4}$ of the journey in $\frac{4}{5}$ of the total time. At what speed should he travel the remaining distance to reach his destination on time?

28. Travelling at $\frac{3}{4}$ of his usual speed, a man is 20 minutes late. What is his usual time to cover the same distance?

29. A person travelled at a speed of 50 kmph and missed the bus by 40 minutes. Had he travelled at 60 kmph he would have still missed the bus by 20 minutes. At what minimum speed should he travel to catch the bus?

30. Travelling at 80% of his usual speed a man is late by 3 hours. In what time does he reach his destination travelling at 40% less than his usual speed?

Short Answer Type Questions

31. The poles on the road are 40 m apart. How many poles will be passed by a car in $2\frac{1}{4}$ hours if the speed of the car is 72 kmph?

32. Travelling at 25% less than his usual speed a person reaches his destination 14 minutes late. If he travels at 40% more than his usual speed, then in how many minutes can he reach his destination?

33. The speeds of two trains are in the ratio of 4 : 3. If the first train takes 15 seconds less to cover a distance, what is the time taken by the second train to cover the same distance?

34. Train A is 50% longer and twice as fast as train B, train B takes 40 seconds to cross a 200 m platform. Find the time taken by A to cross a 300 m platform. (in seconds)

35. A wooden log floating in a river took 48 hours to travel from P to Q. Find the time taken by a boat to make a round trip journey between P and Q. If its speed is seven times the speed of the river. (in hours)

36. In a 100-m race, Chetan gives Dinesh a start of atmost 10 m and is beaten by Dinesh by atmost 10 m. Which will be a possible ratio of the speeds of Chetan and Dinesh if their speeds are distinct?

37. In a race of 1 km A beats B by 20 seconds and B beats C by 10 seconds. If A beats C by 300 meters, then A beats B by how many meters?

38. A car travelling in fog crossed a person who is walking at a speed of 6 kmph in the same direction. The person can see the car only for 6 minutes and up to a distance of 150 meters. What is the speed of the car?

39. Car A started from P towards Q at 7 am at 30 kmph. Car B started from Q towards P at 9 am at 60 kmph. The distance between P and Q is 255 km. A did not stop anywhere on its journey but B stopped for 35 minutes at a point R after it had travelled 120 km from Q. Find the distance of the point where both cars meet from P. (in km)

40. A person covered 60 km travelling for 3 hours by foot and 2 hours by cycling. Had he travelled 2 hours on foot and 3 hours by cycling he would have travelled 5 km more. Find his speed when cycling.

41. In a race A beats B by 200 m and C by 300 m. In the same race B beats C by 125 m. What is the length of the race track?

42. A boat travelled from A to B and returned to A in 10 hours. The speed of boat in still water and speed of water is 10 kmph and 2 kmph respectively. Find the distance between A and B.

43. A person travelled from Hyderabad to Cuddapah. If he had travelled 15 kmph faster he would have reached Cuddapah 2 hours earlier. If he had travelled 10 kmph slower he would have reached Cuddapah 2 hours late. Find the distance between Hyderabad and Cuddapah.

44. A and B start at the same time from X and Y respectively and travel towards Y and X respectively. After they meet, they exchange their speeds and travel towards their respective destinations. If A takes 140 minutes to travel from X to Y, then find the time taken by B to travel from Y to X.

45. Two trains are 120 km apart and travelling in opposite directions at a speed of 20 kmph and 10 kmph respectively. A bird flew from one train engine and reaches other train engine at a speed of 25 kmph. This process repeated till the two trains crash. What is the total distance travelled by the bird?

Essay Type Questions

46. A and B started from P and Q towards each other. They met after 6 hours. After meeting A increased his speed by 2 kmph and B decreased his speed by 2 kmph. Both proceeded to their destinations at their new speeds and reached them simultaneously. Twice the initial speed of B was 18 kmph more than the initial speed of A. Find the initial speed of A. (in kmph)

47. The sum of the average of the speeds of Ram and Shyam and the average of the speeds of Ram and Tarun equals the sum of the average of the speeds of Shyam and Tarun and the average of the speeds of the three. If the three run a race and their speeds are distinct, who cannot be the winner of the race?

48. There are two points 10 km apart in a river. Ram took 8 hours more to cover the distance between these points upstream than to cover this distance downstream. If the boat's speed in still water had doubled, he would have taken $1\frac{1}{4}$ hours more to cover the same distance. Find the ratio of the speed of the boat in still water and the speed of the river.

49. Two trains are travelling at speeds of 20 kmph and 25 kmph on parallel tracks. And the distance between the trains is 45 km. A bird starts flying between the two trains at a speed of 30 kmph. What is the distance (in km) travelled by the bird when the two trains cross each other in opposite directions?

50. In a 100 m race, Ajay gives Bala a start of at least 10 m and is beaten by Bala by almost 10 m. Which of the following can be a possible ratio of the speeds of Ajay and Bala if their speeds are distinct?

(a) 4 : 5 (b) 4 : 3

CONCEPT APPLICATION

Level 1

1. Travelling at 60 kmph, a person reaches his destination on time. If he travels half the distance in $\frac{3}{4}$ of the time, then at what speed should he travel the remaining distance to reach his destination on time?

(a) 140 kmph (b) 120 kmph

(c) 100 kmph (d) 160 kmph

2. A car covers a distance of 260 km at a constant speed. It would have taken 1 h 5 minutes less to travel the same distance, if its speed was 20 kmph more. Find the speed of the car. (in kmph)

(a) 60 (b) 80

(c) 75 (d) 70

3. A car covers a distance of 420 km at a constant speed. If its speed is 10 kmph less, it would have taken one hour more to travel the same distance. Find the speed of the car.

(a) 50 kmph (b) 75 kmph

(c) 60 kmph (d) 70 kmph

4. Ram and Shyam started from A and B respectively. They travelled towards each other with speeds of 30 kmph and 20 kmph respectively. After their meeting, Shyam took 5 hours more to reach A than the time Ram took to reach B. Find the distance between A and B. (in km)

(a) 250 (b) 300

(c) 350 (d) 400

5. When speed is increased by 6 kmph, time taken to cover certain distance is decreased by 4 hours. If speed decreased by 4 kmph, then time taken to cover the same distance increases by 4 hours. Find the distance.

(a) 480 km (b) 360 km

(c) 240 km (d) Cannot be determined

6. A boy is late to his school by 20 minutes, if he travels at a speed of 4 kmph. If he increases his speed to 6 kmph, he is still late to his school by 10 minutes. At what speed should he travel to reach the school on time?

(a) 8 kmph (b) 10 kmph

(c) 12 kmph (d) 9 kmph

PRACTICE QUESTIONS

7. Two friends Rohan and Mohan start cycling from a place at speeds of 20 kmph and 17 kmph respectively in the same direction at 9 o'clock in the morning. By how many kilometres would Mohan be behind Rohan by 5 pm?

(a) 18 (b) 20

(c) 24 (d) 22

8. If a man increases his speed by 25%, he would take 10 minutes less to reach his destination. If he increases his speed by $11\frac{1}{9}\%$, find the number of minutes he saves to reach his destination.

(a) 4 (b) 5

(c) 6 (d) 8

9. If a person increased his speed by 2 kmph, he would take 2 hours less to reach his destination. If he increased his speed by 6 kmph, he would take 4 hours less to reach his destination. Find the distance (in km) he has to travel to reach his destination.

(a) 24 (b) 36

(c) 48 (d) 54

10. A train takes 50 seconds to cross a motorcyclist travelling at 36 kmph. It would take a minute to cross a stationary pole, if its speed was increased by 5 m/sec. Find its length (in m).

(a) 1000 (b) 1250

(c) 1500 (d) 1750

11. Uday and Aryan started from P and Q respectively towards each other with speeds of 50 kmph and 75 kmph respectively. After meeting, Uday took $3\frac{1}{3}$ hrs more to reach Q than the time Aryan took to reach P. Find the distance between A and B (in km).

(a) 400 (b) 600

(c) 500 (d) 550

12. A train takes 20 seconds to overtake a cyclist travelling at 9 kmph. It takes 30 seconds to overtake another cyclist travelling at 18 kmph. Find the length of the train. (in m)

(a) 75 (b) 100

(c) 125 (d) 150

13. A person travels from A to B at a speed of 60 kmph for 80 minutes and travels from B to C at a constant speed for 120 minutes. If his average speed from A to C is 48 kmph, then find the constant speed from B to C.

(a) 40 kmph (b) 50 kmph

(c) 70 kmph (d) 80 kmph

14. Trains A and B have lengths of 300 m and 200 m. They take 50 seconds to cross each other when travelling in the same direction. They take 10 seconds to cross each other when travelling in opposite directions. Find the speed of the faster train. (in m/sec)

(a) 35 (b) 40

(c) 45 (d) 30

15. Two cars are 80 km apart. If they travelled in the same direction, they would take 4 hours to meet. If they travelled in opposite directions, they would take one hour to meet. Find the speed of the slower car. (in kmph)

(a) 30 (b) 20

(c) 10 (d) 115

16. A log floating in a river took 12 hours to travel from A to B. Find the time (in hours) taken by a boat to make a round trip journey between A and B, if its speed in still water is five times the speed of the river.

(a) 6 (b) 4

(c) 7 (d) 5

17. A train leaves Hyderabad at 6 am, travelling at uniform speed reaches Chennai at 2 pm. Another train leaves Chennai at 7 am, travelling at a uniform speed reaches Hyderabad by 3 pm. When do the two trains meet?

(a) 10 am (b) 10:30 am

(c) 11 am (d) 11:30 am

18. Two cars are 120 km apart. If they travelled in the same direction, they would take 2 hours to meet. If they travelled in opposite directions, they would take $\frac{3}{2}$ hours to meet. Find the speed (in kmph) of the faster car.

(a) 70 (b) 80

(c) 60 (d) 50

19. An escalator moves up at the rate of 6 ft/second and its length is 20 ft. If a person walks up on the moving escalator at the rate of 2 ft/second, how much time does he take to cover the entire length?

(a) 1.5 seconds (b) 2 seconds

(c) 2.5 seconds (d) 3 seconds

20. Train A can cross a 180 m long platform in 90 seconds. Train B has a speed which is twice that of A. A's length is 90% of that of B. B can cross a 200 m long platform in x seconds. Find x.

(a) 40 (b) 45

(c) 50 (d) 60

21. Train A started from station P at 60 kmph at 9:00 am. Train B started from the same station at 80 kmph at 11:00 am. Both the trains travelled in the same direction and met at station Q. Find the time of their meeting.

(a) 4:00 pm (b) 6:00 pm

(c) 7:00 pm (d) 5:00 pm

22. In a 100 m race, Ashok is given by Bala a start of 20 m. Ashok beats Bala by 10 m. Which of the following represents the ratio of the speeds of Ashok and Bala?

(a) 6 : 5 (b) 8 : 9

(c) 5 : 6 (d) 2 : 1

23. In a 100 m race, Alok gives Bala a start of 10 m and beats him by 10 m or 2 seconds. Find Alok's speed (in m/sec).

(a) $6\frac{1}{4}$ (b) $5\frac{5}{9}$

(c) $6\frac{2}{3}$ (d) $5\frac{1}{3}$

24. In a 100 m race, Ravi beats Ramu by 4 m or by 2 seconds. Find the approximate speed of Ravi.

(a) 2.08 m/sec (b) 3.08 m/sec

(c) 3.18 m/sec (d) 2.18 m/sec

25. An escalator has 50 steps. Ajay starts walking up on it at 3 steps/second. If the escalator moves up at 2 steps/second, then find the time (in seconds) he would take to reach its top.

(a) 8 (b) 10

(c) 12.5 (d) 16

26. A train, running at a uniform speed, crosses a platform in 45 seconds and another longer platform in 1 minute. What is the ratio of the length of the longer platform to that of the smaller platform?

(a) 3 : 4 (b) 4 : 3

(c) 1 : 2 (d) Cannot be determined

27. If a person travels three equal distances at speeds of 15 kmph, 30 kmph and 20 kmph respectively, then the average speed during his whole journey is _____ kmph.

(a) 22.5 (b) 2.5

(c) 25 (d) 20

28. Raj travelled along a square plot ABCD. He travelled along AB, BC, CD and DA at speeds of 1 kmph, 2 kmph, 1 kmph and 2 kmph respectively using the route A → D → C → B → A. His average speed from A to C is $\frac{4}{3}$ kmph. Find his average speed (in kmph) from D to B.

(a) $\frac{2}{3}$ (b) $\frac{4}{3}$

(c) $\frac{8}{3}$ (d) None of these

29. In a 100 m race, Ram gives Shyam a start of 10 m and is beaten by Shyam by 10 m. What is the ratio of the speeds of Ram and Shyam?

(a) 9 : 11 (b) 5 : 4

(c) 1 : 1 (d) 9 : 10

Level 2

30. In a 200 m race, Ajay gives Vijay a start of 10 m and beats him by 10 m. If Ajay started 16 m before the start line and Vijay started at the start line, Ajay would

(a) be beaten by Vijay by 0.8 m.
(b) have beaten Vijay by 5.6 m.
(c) have finished simultaneously with Vijay.
(d) None of these

PRACTICE QUESTIONS

31. A boat can travel at a speed of 8 kmph upstream and 10 kmph downstream. If it travels a distance of 40 km upstream and 50 km downstream, then the average speed for the entire journey is _____.

(a) 8 kmph (b) 10 kmph

(c) 12 kmph (d) 9 kmph

32. A train takes 60 seconds to cross a 480 m long platform. If the speed of the train had been 5 m/sec less, it would have taken 48 seconds to cross a stationary pole. Find the speed of the train in m/sec.

(a) 20 (b) 22

(c) 25 (d) 28

33. Mahesh and Nitin started from P and Q respectively towards each other. They meet after 5 hours. After meeting, Mahesh increased his speed by 1 kmph and Nitin decreased his speed by 1 kmph. Both proceeded to their destinations at their new speeds and reached them simultaneously. Thrice the initial speed of Nitin was 12 kmph more than the initial speed of Mahesh. Find the initial speed of Mahesh. (in kmph)

(a) 3.5 (b) 6.5

(c) 5.5 (d) 4.5

34. Suraj and Chand started from P and Q towards Q and P respectively with speeds of 10 m/sec and 15 m/sec respectively. The distance between P and Q is 75 m. On reaching their destinations, they proceeded towards their starting points with their speeds unchanged. Find the total distance Suraj would have travelled before meeting Chand for the second time (in m).

(a) 180 (b) 90

(c) 105 (d) 45

35. In a race, Prakash beats Pramod by 20 m. If the length of the race was 50 m less, Prakash would have beaten Pramod by 15 m. Find the length of the race (in m).

(a) 100 (b) 200

(c) 150 (d) 250

36. Ramesh and Suresh started from A and B towards B and A and with speeds of 3 m/sec and 5 m/sec respectively. The distance between A and B is 8 m. On reaching their destinations, they turn back towards their starting points with their speeds unchanged. Find the total distance Ramesh would have travelled before meeting Suresh for the second time. (in m)

(a) 9 (b) 10

(c) 11 (d) 12

37. An escalator is moving downwards. Ganga takes 270 steps to reach the top of the escalator from its bottom. Malik takes 108 steps to reach the bottom from the top of the escalator. Time taken by Malik to reach the bottom is same as the time in which Ganga takes 216 steps. How many steps are there from the bottom to the top of the escalator?

(a) 162 (b) 180

(c) 240 (d) 250

38. In a race on a track of a certain length, Raja beats Ramesh by 20 m. When Raja was 10 m ahead of the mid-point of the track Ramesh was 2 m behind it. Find the length of the track. (in m)

(a) 150 (b) 200

(c) 250 (d) 100

39. Saurav and Gaurav started from two towns A and B and travelled towards each other simultaneously. They met after 4 h. After meeting Saurav took 6 hours less to reach B than what Gaurav took to reach A. Find the ratio of the speeds of Saurav and Gaurav.

(a) 3 : 2 (b) 2 : 3

(c) 4 : 3 (d) 2 : 1

40. In a 500 m race, if A gives B a 50 m start, B wins by 5 seconds but if A gives B a 5 second start, A wins by 30 m. Find the time that B takes to run 500 m race.

(a) 240 seconds (b) 125 seconds

(c) 250 seconds (d) 120 seconds

41. A boat covers a round trip in a river in a certain time. If its speed in still water is doubled and the speed of the stream tripled, it would take the same time for the round trip journey. Find the ratio of the speed of the boat in still water and the speed of the stream.

(a) $\sqrt{3} : \sqrt{2}$ (b) $\sqrt{5} : \sqrt{2}$

(c) $\sqrt{7} : \sqrt{2}$ (d) $3 : \sqrt{2}$

42. Train X leaves Hyderabad at 5 pm and reaches Bangalore by 5 am. Train Y leaves Bangalore at 6 pm and reaches Hyderabad at 6 am. Both trains travel their entire journeys at uniform speeds. Find their meeting time.

(a) 12 pm (b) 11:30 pm

(c) 10:30 pm (d) 1 pm

43. For a boat, ratio of speed downstream to speed upstream is 9 : 5. What is the ratio of the speed of boat in still water to the speed of stream?

(a) 6 : 5 (b) 7 : 2

(c) 8 : 3 (d) 9 : 4

44. Speed of sound in air is 330 m/sec and in steel is 5960 m/sec. If sound travels 132 km in air, then how many km can it travel in steel in the same time?

(a) 2384 (b) 2469

(c) 2218 (d) 2513

45. A person travelled at a speed of 20 kmph for 3 hours and an equal distance at a speed of 15 kmph. What is the average speed of the person (in kmph)?

(a) $17\frac{1}{7}$ (b) $17\frac{1}{2}$

(c) $16\frac{1}{3}$ (d) $16\frac{1}{2}$

46. For a boat, speed downstream and speed upstream are 18 kmph and 14 kmph respectively. Find the speed of the boat in still water (in kmph).

(a) 14 (b) 15

(c) 16 (d) 17

Level 3

47. Two trains of length 270 m and 300 m travelling at 54 kmph and 36 kmph respectively, enter a two track tunnel 430 m long simultaneously on different tracks and from the opposite directions. After they cross each other, in how much time will the tunnel be free of the trains?

(a) 25 second (b) 30 second

(c) 33 second (d) 41 second

48. In a 1000 m race, A gives B a head start of 100 m and still he beats B by 100 m or 20 second. Find the speed of A.

(a) 15 m/sec (b) 6.25 m/sec

(c) 10 m/sec (d) 12.5 m/sec

49. An escalator is moving downwards. A takes 140 steps to reach the top from the bottom of an escalator. B takes 60 steps to reach the bottom from the top of the escalator. Time taken by B to reach the bottom is same as the time during which A takes 20 steps. How many steps are there from the bottom to the top of the escalator?

(a) 70 (b) 60

(c) 90 (d) 80

50. Ramesh and Satish started simultaneously from two towns P and Q and travelled towards each other. They met after 2 hours. After meeting, Ramesh took 3 hours less to reach Q than what Satish took to reach P. Find the ratio of Ramesh's speed and Satish's speed.

(a) 3 : 1 (b) 2 : 1

(c) 3 : 2 (d) 4 : 1

51. Rohan travelled from P to Q at a speed of 80 kmph for 60 minutes and travelled from Q to R at a certain speed for 60 minutes. His average speed of travel from P to R was 84 kmph. Find his travel speed from Q to R. (in kmph)

(a) 96 (b) 88

(c) 90 (d) 100

52. A car covered a distance of 600 km at a constant speed. If its speed was 50 kmph more, it would have taken 2 hours less to cover the same distance. Find its speed. (in kmph)

(a) 125 (b) 75

(c) 200 (d) 100

53. Two cars are 360 km apart. If they started in the same direction, then they will take 9 hours to meet. If they started simultaneously in opposite directions to each other, then they will take 3 hours to meet. Find the speed of the faster car. (in kmph)

(a) 70 (b) 80

(c) 65 (d) 75

54. A boy walks from home to school. One day, he walked 20% slower than his usual speed and reached 9 minutes late. Find the time taken to reach the school with usual speed. (in minutes)

(a) 30 (b) 36

(c) 45 (d) 60

55. Train P has a length 25% more than train Q. It is thrice as fast as Q. P would take 30 seconds to cross a 175 m long platform. Find the time that Q would take to cross a 140 m long platform. (in seconds)

(a) 48 (b) 90

(c) 72 (d) 63

56. If Hari increases his speed by 5 kmph, he would reach his destination 1 hour early. If he decreases his speed by 2.5 kmph, he will reach his destination 48 minutes late. Find the distance to be travelled by him. (in km)

(a) 45 (b) 60

(c) 75 (d) 90

57. Ram, Shyam and Tarun ran a race. The average of the speeds of the three when doubled would equal the sum of the average of the speeds of Ram and Shyam and the average of the speeds of Ram and Tarun. The speeds of the three are distinct. The winner cannot be

(a) Ram (b) Shyam

(c) Tarun (d) Cannot be determined

58. Ramesh and Suresh started simultaneously from P and Q respectively. Each of them started towards the starting point of the other. The speeds of Ramesh and Suresh throughout their journeys were 50 kmph and 40 kmph respectively. After meeting, Suresh took $(x + 9)$ hours to reach P while Ramesh took x hours to reach Q. Find PQ. (in km)

(a) 2160 (b) 1800

(c) 2070 (d) 2340

59. Ravi travelled from P to Q at 12 kmph. He then travelled from Q to R at 32 kmph and then from R to S at 10.8 kmph. 2PQ = 3QR = 4RS. Find Ravi's average speed for his entire journey. (in kmph)

(a) $\frac{64}{5}$ (b) $\frac{72}{5}$

(c) $\frac{54}{5}$ (d) $\frac{66}{5}$

60. Anil and Sunil started simultaneously from X and Y respectively. Each person started towards the starting point of the other. XY = 18 km. The speeds of Anil and Sunil throughout their journeys were 5 kmph and 4 kmph respectively. On reaching X or Y, each turned back immediately to resume the journey to his starting point. Find the total distance travelled by Anil before meeting Sunil for the second time. (in m)

(a) 30 (b) 27

(c) 24 (d) 33

61. Ganesh and Harish started simultaneously from A and B respectively travelling towards each other. They met after 6 hours. After meeting, Ganesh took $y + 5$ hours to reach B while Harish took y hours to reach A. Find the ratio of the speeds of Ganesh and Harish.

(a) 3 : 2 (b) 2 : 3

(c) 1 : 2 (d) 1 : 3

62. In a race, Ramu beats Somu by 10 m. When Ramu was 4.5 m ahead of the mid-point of the race track, Somu was 1 m behind it. Find the length of the race. (in m)

(a) 90 (b) 108

(c) 120 (d) 75

63. In a 1200 m race, Rohan beats Sohan by 40 seconds and Sohan beats Mohan by 80 seconds. In the same race, Rohan beats Mohan by 400 m. Find the time taken by Rohan to run the race. (in seconds)

(a) 480 (b) 240

(c) 360 (d) 300

64. A log was floating in a river. It took 36 hours to travel from a point P in the river to point Q in it. A boat has its speed in still water equal to 9 times the speed of the river. Find the time it would take to cover a round trip journey between P and Q. (in hours)

(a) 7.5 (b) 7.8

(c) 8.1 (d) 8.4

65. Two trains of lengths 360 m and 540 m have speeds of 97.2 kmph and 108 kmph respectively. They entered a 450 m long tunnel simultaneously. Find the time taken for the tunnel to be free of traffic. (in seconds)

(a) 33 (b) 36

(c) 30 (d) 39

66. Anil travelled from P to Q at f kmph. He returned to Q at r kmph. His average speed for the entire-journey was $\frac{f+r}{2}$ kmph. PQ = 240 km. His total travel time was 6 hours. Find f.

(a) 120 (b) 90

(c) 80 (d) 60

67. A boat covers a round trip journey between two points A and B in a river in T hours. If its speed in still water triples and the speed of the river doubles, it would take $\frac{9}{32}T$ hours for the same journey. Find the ratio of its speed in still water to the speed of the river.

(a) 3 : 1 (b) 3 : 2

(c) 2 : 1 (d) 4 : 3

68. Amish and Bala started simultaneously from X and Y respectively towards each other. They met after 4 hours. After meeting, Amish decreased his speed by 10 kmph while Bala increased his speed by 10 kmph. Each of them proceeded towards the starting point of the other. Both reached their destinations simultaneously. XY = 200 km. Find the initial speed of Amish (in km)

(a) 40 (b) 35

(c) 25 (d) 30

69. In a race, Ram beats Shyam by 30 m in the same race, Shyam beats Tarun by 60 m while Ram beats Tarun by 84 m. Find the length of the race. (in m)

(a) 360 (b) 270

(c) 300 (d) 450

TEST YOUR CONCEPTS

Very Short Answer Type Questions

1. 6 km
2. 145
3. False
4. False
5. 240 km
6. False
7. $17\frac{1}{7}$ kmph
8. 30 second
9. $\frac{18(x+y)}{5(p+q)}$ second
10. 125 m
11. 50 : 41
12. $(x + 2y)$ kmph
13. 16 kmph
14. 800 m
15. Yes
16. 200 km
17. 7 : 2
18. 2384 km
19. True
20. 12 minutes
21. 1500 m
22. $29\frac{1}{31}$ kmph
23. 108 kmph
24. 270 m
25. 16 km
26. 28 kmph
27. 100 kmh
28. 1 hour
29. 75 kmph
30. 20 hours

Shot Answer Type Questions

31. 4050
32. 30
33. 60 second
34. 30
35. 14
36. 4 : 5
37. $222\frac{2}{9}$ m
38. 7.5 kmph
39. 135
40. 15 kmph
41. 1000 m
42. 48 km
43. 600 km
44. 140 minutes
45. 100 km

Essay Type Questions

46. 14
47. Ram
48. 45
49. 30
50. 4 : 3

CONCEPT APPLICATION

Level 1

1. (b)	**2.** (a)	**3.** (d)	**4.** (b)	**5.** (a)	**6.** (c)	**7.** (c)	**8.** (b)	**9.** (c)	**10.** (c)
11. (c)	**12.** (d)	**13.** (a)	**14.** (d)	**15.** (a)	**16.** (d)	**17.** (b)	**18.** (a)	**19.** (c)	**20.** (c)
21. (d)	**22.** (b)	**23.** (a)	**24.** (a)	**25.** (b)	**26.** (d)	**27.** (d)	**28.** (b)	**29.** (c)	

Level 2

30. (b)	**31.** (d)	**32.** (a)	**33.** (d)	**34.** (b)	**35.** (b)	**36.** (a)	**37.** (b)	**38.** (d)	**39.** (d)
40. (c)	**41.** (c)	**42.** (b)	**43.** (b)	**44.** (a)	**45.** (a)	**46.** (c)			

Level 3

47. (c)	**48.** (b)	**49.** (a)	**50.** (b)	**51.** (b)	**52.** (d)	**53.** (b)	**54.** (b)	**55.** (c)	**56.** (b)
57. (a)	**58.** (b)	**59.** (b)	**60.** (a)	**61.** (b)	**62.** (a)	**63.** (b)	**64.** (c)	**65.** (a)	**66.** (c)
67. (c)	**68.** (d)	**69.** (c)							

CONCEPT APPLICATION

Level 1

1. He has to travel half of the distance in $\frac{1}{4}$ of the time.

2. Let the speed be x kmph, and the difference between the times taken $= \frac{13}{12}$ hours.

3. Let the speed be x kmph and difference in the times taken in two cases be 1 hour.

4. Let the distance be d km and difference between their total time taken is 5 hours.

5. (i) Speed × Time = Distance.

(ii) Let the distance, speed and time be d, s and t respectively.

(iii) From the given data, $d = st$, $(s + 6)\ (t - 4) = d$ and $(s - 4)\ (t + 4) = d$.

(iv) Solve the above equations and find d.

6. Let the distance be d km and difference in the times taken in two cases be 10 minutes.

7. Find the relative speed.

8. Find the ratio of speeds in both the cases.

9. Let usual speed be x kmph and usual time be y hours and frame the equations.

10. (i) Length of the train = Time × Relative speed.

(ii) Let the length of train be L m and its speed be s m/sec.

(iii) Solve $\frac{L}{s+10} = 50$ and $\frac{L}{s+5} = 60$ for L.

11. Let the total distance be k km.

12. Find the length of the train with respect to speed and time in two cases.

13. Use the formula to find average speed.

14. (i) Use relative speed concept.

(ii) Let the speeds of the faster and the slower trains be f m/sec and s m/sec respectively.

(iii) Now, solve $\frac{300 + 200}{f - s} = 50$ and

$\frac{300 + 200}{f + s} = 10$.

15. Use the concept of relative speed.

16. (i) Let the speed of the river be x kmph, then $AB = 12x$ km.

(ii) Let the distance between A and B be d km.

(iii) Speed of river $= \frac{d}{12}$ and Speed of boat $= \frac{5d}{12}$.

(iv) Time taken for round journey

$$= \frac{d}{\frac{5d}{12} - \frac{d}{12}} + \frac{d}{\frac{5d}{12} + \frac{d}{12}}.$$

17. Both trains take 8 hours each to reach their respective destinations.

18. Use the concept of relative speed.

19. Time taken = Total distance/Relative speed.

20. Form the equations using the given data.

21. Distance that A would have travelled by 11:00 am is 120 km.

22. Ashok has to run a distance of 80 m and Bala has to run a distance of 90 m.

23. Speed of Bala $= \frac{10}{2} = 5$ m/s.

24. Speed of Ramu $= \frac{4}{2} = 2$ m/s.

25. Use the concept of relative speed.

26. (i) The length or the speed of the train are not given.

(ii) Let the length of the train, the smaller platform and the longer platform be l, l_1 and l_2 respectively.

(iii) Speed of the train $= \frac{(l + l_1)}{45} = \frac{(l + l_2)}{60}$.

(iv) As the length of the train is not given, check whether we get $l_2 : l_1$ or not.

27. (i) If a person covers three equal distances, then average speed $= \frac{3xyz}{xy + yz + zx}$, where x, y, z are the speeds.

(ii) Let the distance in each case be d km.

(iii) Total distance travelled = $3d$ km and the total time taken $= \left(\frac{d}{15} + \frac{d}{30} + \frac{d}{20}\right)$ hours.

(iv) Use, average speed $= \frac{\text{Total distance travelled}}{\text{Total time taken}}$.

28. (i) Average speed from D to B = Average speed from A to C.

(ii) Average speed from A to C is equal to the average speed from D to B.

29. Shyam has to run 90 m and Ram has to run 90 m.

Level 2

30. (i) The ratio of the speeds of Ajay and Vijay $= \frac{200}{200-20} = \frac{10}{9}$.

(ii) As Ajay gives Vijay a start of 10 m and beats him by 10 m, Vijay finished 180 m when Ajay finished 200 m.

(iii) Find the distance covered by Vijay when Ajay covered 216 m.

(iv) Consider, Vijay is 16 m ahead of Ajay.

31. Use the formula to find average speed.

32. (i) Find the length of the train in both the cases.

(ii) Let the length and speed of the train be l m and s m/sec.

(iii) $\frac{l+480}{s} = 60$ and $\frac{l}{(s-5)} = 48$. Solve for s.

33. (i) $\frac{5m}{n-1} = \frac{5n}{m+1}$, where m and n are speeds of Mahesh and Nithin.

(ii) In 5 hours Mahesh covers a distance of $5m$ km and Nitin covers a distance of $5n$ km.

(iii) Now solve, $\frac{5n}{m+1} = \frac{5m}{n-1}$ and $3n = m + 12$.

34. (i) Suraj and Chand travel a distance of (3×75) m when they meet for the second time.

(ii) They have to cover a distance of (3×75) m to meet for the second time.

(iii) Time taken $= \frac{(3 \times 75)}{\text{Relative speed}}$. (say t)

(iv) Distance travelled by Suraj = Speed $\times$ t.

35. (i) Find the ratio of speeds of Prakash and Pramod.

(ii) Let the length of the track be x m.

(iii) If Prakash covers x m, then Pramod covers $(x - 20)$ m.

(iv) If Prakash covers $(x - 50)$ m, then Pramod covers $(x - 50 - 15)$ m.

(v) Solve $\frac{(x-20)}{x} = \frac{(x-65)}{(x-50)}$, for x.

36. (i) When they meet for the second time, the total distance covered by the two = 8 + 8 + 8 = 24 m.

(ii) They have to cover a distance of (3×8) m to meet for the second time.

(iii) Time taken $= \frac{(3 \times 8)}{\text{Relative speed}}$ (say t)

(iv) Distance travelled by Suraj = Speed $\times$ t.

37. (i) Let the escalator move x steps while Malik takes 160 steps.

(ii) The ratio of speeds of Ganga and Malik = 216 : 108 = 2 : 1.

(iii) Let the speeds of Ganga and Malik be $2x$ steps/second and x steps/second. Let the speed of the escalator be e steps/second

(iv) Ganga's effective speed = $(2x - e)$ steps/second. Malik effective speed = $(x - e)$ steps/second.

38. (i) Find the ratio of the speeds of Raja and Ramesh.

(ii) Let the length of the track be $2x$ m.

(iii) For $2x$ m, Raja beats Ramesh by 20 m. For $x + 10$ m, Raja beats Ramesh by (10 + 2) m.

(iv) Solve $\frac{20}{2x} = \frac{12}{x+10}$, for $2x$.

39. (i) Let the speeds of Sourav and Gaurav be s m/sec and g m/sec.

(ii) In 4 hours, Sourva travels $4s$ m and Gourav travels $4g$ m.

(iii) $\frac{4s}{g} - \frac{4g}{s} = 6$.

HINTS AND EXPLANATION

(iv) Let $\frac{s}{g} = a$ and solve for a.

40. If A gives B, a 50 m start, then the time B takes to run 450 m is 5 seconds less the time A takes to run 500 m. If A gives B, a 5 second start, it is 5 seconds more.

41. (i) Distance covered in both the cases is same.

(ii) Let the speeds of the boat in still water and that of the stream be b m/sec and s m/sec respectively.

(iii) $\frac{d}{b+s} = \frac{d}{b-s} = \frac{d}{2b+3s} + \frac{d}{2b-3s}$.

Simplify this equation to get $b : s$.

42. Let the distance between Hyderabad and Bangalore be d km.

Travel times of X and Y are 12 hours each.

Speed of X $= \frac{d}{12}$ kmph and speed of Y $= \frac{d}{12}$ kmph.

At 6 pm, X would have covered $\frac{d}{12}$ km while Y would start its journey. Distance between them at 6 pm $\left(d - \frac{d}{12}\right)$ km $= \frac{11d}{12}$ km.

They would meet in another $\frac{\frac{11d}{12}}{\frac{d}{12} + \frac{d}{12}}$ hours

= 5.5 hours.

∴ Meeting time = 11:30 pm.

43. Let the speed in still water and speed of the stream be x kmph and y kmph respectively.

$\frac{x+y}{x-y} = \frac{9}{5}$

$5x + 5y = 9x - 9y$

$\Rightarrow 4x = 14y \Rightarrow x : y = 7 : 2$.

44. Distance covered in steel $= 132 \times \frac{5960}{330} = 2384$ km.

45. Total distance covered $= 2(20 \times 3) = 120$ km.

Total time taken $= 3 + \frac{60}{15} = 7$ hours.

Average speed $= \frac{120}{7}$ kmph $= 17\frac{1}{7}$ kmph.

46. Speed of the boat in still water $= \frac{18+14}{2} = 16$ kmph.

Level 3

47. (i) Find the time taken by each train to cross the tunnel.

(ii) Find the time taken in which the tunnel is free of the two trains, i.e., $\frac{(270+300+430)}{\text{Relative Speed}} = t$. (say)

(iii) Now find the difference between time taken by the slower train to cross the tunnel and t.

48. (i) B takes 20 second to cover 100 m.

(ii) Speed of B $= \frac{100}{20}$ m/s.

(iii) Find the time taken (say t) by B to run 800 m.

(iv) Time taken by A $= (t - 20)$s

(v) Speed of A $= \frac{100}{(t-20)}$ m/s.

49. (i) The ratio of the speeds of A and B = 20 : 60 = 1 : 3. Let the speeds of A and B be x steps/second and $3x$ steps/second. Let the speed of the escalator be e steps/second.

(ii) A's effective speed $= (x - e)$ steps/second.

B's effective speed $= (3x + e)$ steps/second.

(iii) Time taken by A to travel 140 steps $= \frac{140}{x}$ second. Time taken by B to travel 60 steps $= \frac{60}{3x}$ second.

(iv) Number of steps of escalator $(d) = \frac{60}{3x}$

$(3x + e) = \frac{140}{x}(x - e)$.

(v) Use the relation between x and e and then proceed.

50. (i) $\frac{2s}{r} = \frac{2r}{s} - 3$, where s and r are speeds of Ramesh and Satish.

(ii) Let the speeds of Ramesh and Suresh be r m/sec and s m/sec respectively.

(iii) In two hours, Ramesh travels $2r$ m and Suresh travels $2s$ m.

(iv) $\therefore \frac{2r}{s} - \frac{2s}{r} = 3$

(v) Let $\frac{r}{s} = a$, then solve for a.

51. $PQ = (80)\left(\frac{60}{60}\right)\text{km} = 80\,\text{km}$

$PR = (84)\left(\frac{60+60}{60}\right)\text{km} = 168\,\text{km}$

$QR = PR - PQ = 88$ km

$\therefore$ Travel speed $= \frac{88}{\left(\frac{60}{60}\right)}\text{kmph} = 88\,\text{kmph}$

52. Let its speed be s kmph

Time taken $= \frac{600}{s}$ hours

$$\frac{600}{s} - \frac{600}{s+50} = 2$$

$$\frac{600(s+50-s)}{s(s+50)} = 2$$

$30000 = 2(s^2 + 50s)$

$s^2 + 50s - 15000 = 0$

$(s + 150)(s - 100) = 0$

$s > 0$

$s = 100$.

53. Let the speeds of the faster and the slower cars be f kmph and s kmph respectively.

$360 = 9(f - s) = 3(f + s)$

$f - s = 40$ and $f + s = 120$

Adding these and then simplifying, $f = 80$.

54. Let the distance be d km

Let his usual speed be u kmph.

Let his usual time be t hours.

$\frac{d}{u} = t$

$$\frac{d}{\left(\frac{4}{5}\right)u} = t + \frac{9}{60} \Rightarrow \frac{t}{\frac{4}{5}} = t + \frac{9}{60}$$

$\Rightarrow \frac{t}{4} = \frac{9}{60} \Rightarrow t\frac{36}{60}$ hours or 36 minutes

55. Let the length of Q be l m.

Let its speed be q m/sec

Length of $P = l\left(1 + \frac{25}{100}\right)\text{m} = \frac{5}{4}l\,\text{m}$

Its speed = $3q$ m/sec

$$\frac{\frac{5}{4}l + 175}{3q} = 30$$

$$\frac{\frac{5}{4}(l + 140)}{3q} = 30$$

$$\frac{l + 140}{q} = 72$$

Required time $= \frac{l+140}{q}$ seconds

= 72 seconds.

56. Let the usual speed of Hari be u kmph.

Let his usual time be t hours.

Distance (in km) = $(u + 5)(t - 1)$

$= (u - 2.5)\left(t + \frac{48}{60}\right) = ut$

$(u + 5)(t - 1) = ut$

$\therefore ut + 5t - u - 5 = ut$

$5t - 5 = u$ (1)

$$(u - 2.5)\left(t + \frac{48}{60}\right) = ut$$

$$ut - 2.5t + \frac{4}{5}u - 2 = ut$$

$$\frac{4}{5}u = 2.5t + 2 \quad (2)$$

$4t - 4 = 2.5t + 2$ (From Eqs. (1) and (2))

$1.5t = 6$

$t = 4$

$\therefore u = 15$

$\therefore ut = 60$

57. Let the speeds of Ram, Shyam and Tarun be r m/sec, s m/sec and t m/sec respectively.

$$2\left(\frac{r+s+t}{3}\right) = \frac{r+s}{2} + \frac{r+t}{2}$$

HINTS AND EXPLANATION

$$2\left(\frac{r+s+t}{3}\right)=\frac{2r+s+t}{2}$$

$4r + 4s + 4t = 6r + 3s + 3t\ s + t = 2r$

$$\therefore r=\frac{s+t}{2} \qquad (1)$$

Given: r, s and t are distinct.

(1) $\Rightarrow$ r is the average of s and t

$\therefore$ r must lie between s and t.

$\therefore$ Ram cannot be the winner.

58. Let the meeting point be M.

Let the time taken to meet be t hours.

PM = (50)(t) km = 40(x + 9) km

$\therefore$ $50t = 40(x + 9)$ (1)

MQ = (40)(t) km = 50(x) kmph

$\therefore$ $40t = 50x$ (2)

$$(1) \Rightarrow x+9=\frac{5}{4}t$$

$$\text{i.e., } x=\frac{5}{4}t-9$$

$$(2) \Rightarrow x=\frac{4}{5}t$$

$$\therefore x=\frac{5}{4}t-9=\frac{4}{5}t$$

$$\frac{9}{20}t=9$$

$t = 20$

PQ = PM + MQ

$= 90t = 1800$ km.

59. Times taken by him to travel, PQ, QR and RS were $\frac{PQ}{12}$ hours, $\frac{QR}{32}$ hours and $\frac{RS}{10.8}$ hours respectively.

$2PQ = 3QR = 4RS$

$$\therefore QR=\frac{2}{3}PQ \text{ and } RS=\frac{PQ}{2}$$

Total travel time (in hours)

$$=\frac{PQ}{12}+\frac{\frac{2}{3}PQ}{32}+\frac{\frac{PQ}{2}}{10.8}$$

$$=PQ\left(\frac{1}{12}+\frac{1}{48}+\frac{1}{21.6}\right)=\frac{65PQ}{432}$$

$$\text{Total distance}=\left(PQ+\frac{2}{3}PQ+\frac{PQ}{2}\right)\text{km}$$

$$=\frac{13}{6}PQ\,\text{km}$$

$$\text{Average speed}=\frac{\frac{13}{6}PQ}{\frac{65PQ}{432}}\text{kmph}=\frac{72}{5}\text{kmph}.$$

60. Total distance travelled by them when they met for the second time = 3(XY) = 54 m

Total time taken when they met for the second time $=\frac{54}{5+4}=6$ seconds.

Total distance travelled by Anil (6 second) (5 m/sec) = 30 m

61. Let the speeds of Ganesh and Harish be g kmph and h kmph respectively. Let the meeting point be M.

$AM = 6g$ km and $BM = 6h$ km

$$y=\frac{AM}{h} \text{ and } y+5=\frac{BM}{g}$$

$$\therefore y=\frac{6g}{h} \text{ and } y+5=\frac{6h}{g}$$

$$y+5-y=6\left(\frac{h}{g}-\frac{g}{h}\right)$$

Let $\frac{h}{g}$ be x

$$0=6\left(x-\frac{1}{x}\right)-5$$

$0 = 6x^2 - 5x - 6$

$0 = (3x + 2)(2x - 3)$

$x > 0$

$$\therefore x-\frac{3}{2}$$

$$\therefore \frac{g}{h}=\frac{2}{3}.$$

62. Let the length of the track be L m.

Let the speeds of Ramu and Somu be r m/sec and s m/sec respectively.

Let the time taken by Ramu to run the race be t seconds.

Distance run by Somu when Ramu finishes = $(L - 10)$ m

$$\therefore t = \frac{L}{r} = \frac{L-10}{s}$$

$$\therefore \frac{r}{s} = \frac{L}{L-10} \quad (1)$$

When Ramu had run $\left(\frac{L}{2} + 4.5\right)$ m, Somu had run $\left(\frac{L}{2} - 1\right)$ m

$$\therefore \frac{r}{s} = \frac{\frac{L}{2}+4.5}{\frac{L}{2}-1}$$ ($\because$ this is obtained in a manner similar to the way (1) is obtained)

$$\frac{r}{s} = \frac{\frac{L}{2}+4.5}{\frac{L}{2}-1} = \frac{L}{L-10}$$

$$\frac{L^2}{2} - 0.5L - 45 = \frac{L^2}{2} - L$$

$0.5L = 45$

$L = 90$.

63. Let the time taken by Rohan to run the race be t seconds.

Time taken by Sohan to run the race = $(t + 40)$ seconds.

Time taken by Mohan to run the race = $(t + 40 + 80)$ seconds = $(t + 120)$ seconds.

Distance run by Mohan when Rohan finishes 1200 m = (1200 – 400) m = 800 m

$$\therefore \text{The speed of Mohan} = \frac{800}{t} \text{ m/s}$$

$$= \frac{1200}{t+120} \text{ m/s}$$

$$\frac{800}{t} = \frac{1200}{t+120}$$

$2t + 240 = 3t \Rightarrow t = 240$.

64. Let the speed of the boat in still water be x kmph.

Let the speed of the river be y kmph.

$\therefore PQ = 36y$

$x = 9y$

Total time taken by the boat

$$= \left(\frac{PQ}{9y+y} + \frac{PQ}{9y-y}\right) \text{hours}$$

$$= \left(\frac{36y}{10y} + \frac{36y}{8y}\right) \text{hours} = (3.6 + 4.5) \text{ hours}$$

= 8.1 hours.

65. Time taken for the tunnel to be free of traffic is the maximum of the times taken by the trains to cross the tunnel.

Time taken by the 360 m long train to cross tunnel

$$= \frac{360+450}{(97.2)\left(\frac{5}{18}\right)} \text{seconds} = \frac{810}{27} \text{seconds} = 30 \text{ seconds}$$

Time taken by the 540 m long train to cross the tunnel

$$= \frac{540+450}{(108)\left(\frac{5}{18}\right)} = \frac{990}{30} \text{ seconds} = 33 \text{ seconds}$$

The required time = 33 seconds.

66. Average speed $= \frac{2fr}{f+r}$ kmph

Given:

Average speed $= \frac{f+r}{2}$ kmph

$$\frac{2fr}{f+r} = \frac{f+r}{2}$$

$4fr = (f + r)^2$

$0 = f^2 + r^2 + 2fr - 4fr$

$\therefore 0 = (f - r)^2$

$\therefore f - r = 0$

$\therefore f = r$

$\therefore$ Average speed = f kmph

$$\therefore f = \frac{2(240)}{6} = 80.$$

67. Let the speed of the boat in still water be x kmph.
Let the speed of the river be y kmph.

Let $AB = d$ km

HINTS AND EXPLANATION

$$\frac{d}{x+y}+\frac{d}{x-y}=T$$

$$\frac{d(2x)}{x^2-y^2}=T \qquad (1)$$

$$\frac{d}{3x+2y}+\frac{d}{3x-2y}=\frac{9}{35}T$$

$$\frac{d(6x)}{9x^2-4y^2}=\frac{9}{32}T \qquad (2)$$

$$\frac{(2)}{(1)}=\frac{3(x^2-y^2)}{9x^2-4y^2}=\frac{9}{32}$$

$96(x^2-y^2)=81x^2-36y^2$

$15x^2=60y^2$

$x^2=4y^2$

$x, y>0$

$\therefore x=2y$

$\Rightarrow x:y=2:1.$

68. Let the initial speeds of Amish and Bala be a kmph and b kmph respectively.

$$\frac{200}{a+b}=4$$

$\therefore a+b=50 \qquad (1)$

After meeting, the speeds of Amish and Bala were $(a-10)$ kmph and $(b+10)$ kmph respectively. Distances covered by Amish and Bala after meeting were $4b$ km and $4a$ km respectively. They reached simultaneously

$$\therefore \frac{4b}{a-10}=\frac{4a}{b+10}$$

$$\frac{b}{a-10}=\frac{a}{b+10} \qquad (2)$$

$b^2+10b=a^2-10a$

$a^2-b^2=10(a+b)$

$a-b=10\ (\because a+b\neq 0) \qquad (2)$

From Eqs. (1) and (2),

$a=30.$

69. Let the length of the race be l.

Let the speeds of Ram, Shyam and Tarun be r m/sec, s m/sec and t m/sec respectively.

When Ram finishes, Shyam would have run $(l-30)$ m.

Suppose Ram takes x seconds to run the race.

$$x=\frac{l}{r}=\frac{l-30}{s}$$

$$\therefore \frac{r}{s}=\frac{l}{l-30}$$

Similarly $\frac{s}{t}=\frac{l}{l-60}$ and $\frac{r}{t}=\frac{l}{l-84}$

$$\frac{r}{t}=\left(\frac{r}{s}\right)\left(\frac{s}{t}\right)=\frac{l^2}{(l-30)(l-60)}$$

$$\frac{l}{l-84}=\frac{l^2}{(l-30)(l-60)}$$

$l(l-30)\ (l-60)=l^2(l-84)$

$l(l^2-90l+1800)=l^3-84l^2$

$l^3-90l^2+1800\ l=l^3-84l^2$

$1800l-6l^2=0$

$6l(300-l)=0$

$\because l>0$

$\therefore 6l-0$

$\therefore 300-l=0$

$\therefore l=300.$