# SPEED, DISTANCE AND TIME

## 8.1 REVIEW

**1. Speed**

The distance covered by an object, in unit time, is called its **speed.**

*e.g.*, If the speed of a car is 65 km/hr this means, the car covers a distance of 65 kilometre in one hour.

***Conversely,*** if an object covers a distance of 20 cm in one second, its speed = 20 cm/sec.

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

**2.** From the formula, $\text{Speed} = \frac{\text{Distance}}{\text{Time}}$ we can deduce :

(i) $\text{Distance} = \text{Speed} \times \text{Time}$ and (ii) $\text{Time} = \frac{\text{Distance}}{\text{Speed}}$

**3. Units**

Relations between the units of distance covered, speed and time are :

| | Speed | Distance | Time |
|---|---|---|---|
| (i) | km/hr | km (kilometre) | hr (hour) |
| (ii) | m/min | m (metre) | min (minute) |
| (iii) | m/sec | m (metre) | sec (second) |
| (iv) | cm/sec | cm (centimetre) | sec (second) and so on. |

## 8.2 AN IMPORTANT RESULT

Since, **1 km/hr** $= \frac{1\text{km}}{1\text{hr}} = \frac{1000\text{ m}}{60 \times 60\text{ sec}} = \frac{5}{18}$ **m/s**

**∴ To convert speed from km/hr to m/s; multiply by $\frac{5}{18}$.**

***Conversely,* to convert speed from m/s to km/hr, multiply by $\frac{18}{5}$.**

***Example* 1 :**

An aeroplane flies 450 km in 20 minutes. Find :

(i) its speed in km/hr.

(ii) time taken by it to cover 1800 km.

(iii) distance covered by it in 0·6 hours.

***Solution :***

(i) Since, distance = 450 km and time = 20 min $= \frac{20}{60}$ hr $= \frac{1}{3}$ hr

$$\therefore \quad \textbf{Speed} = \frac{\text{Distance}}{\text{Time}} = \frac{450\text{ km}}{\frac{1}{3}\text{hr}} = \textbf{1350 km/hr} \qquad \textbf{(Ans.)}$$

(ii) **Time taken to cover 1800 km**

$$= \frac{\text{Distance}}{\text{Speed}} = \frac{1800}{1350}\text{ hr} = \frac{4}{3}\text{ hr} = \textbf{1 hr 20 minutes} \qquad \textbf{(Ans.)}$$

(iii) **Distance covered in 0·6 hours** = Speed × Time

= 1350 km/hr × 0·6 hr = **810 km** **(Ans.)**

| | |
|---|---|
| **1. Uniform speed** | If an object covers equal distances in equal intervals of time, its **speed is** said to be **uniform.** |
| **2. Variable speed** | When the speed of a body is not uniform, it is **variable.**<br>*i.e.* if an object covers unequal distances in equal intervals of time, its speed is variable.<br>Unless mentioned, the speed is always taken as uniform. |
| **3. Average speed** | Usually, a moving object (car, motor-cycle, etc.) does not cover its entire distance with the same (uniform) speed. Sometimes it increases its speed, sometimes it reduces its speed and sometimes it stops also.<br>Under such circumstances, the total distance covered by the moving object divided by the time, taken by it to cover this distance, gives the average speed of the object.<br>$\therefore$ Average speed $= \frac{\text{Total distance travelled}}{\text{Total time taken}}$ |

***Example 2 :***

A man covers a distance of 60 km at a speed of 40 km/hr and another distance of 50 km at a speed of 30 km/hr. Calculate his average speed for the whole journey.

***Solution :***

(i) Time taken to cover 60 km $= \frac{60}{40}$ hrs $= \frac{3}{2}$ hrs $\quad \left[\because \text{Time} = \frac{\text{Distance}}{\text{Speed}}\right]$

and, time taken to cover 50 km $= \frac{50}{30}$ hrs $= \frac{5}{3}$ hrs

Total distance travelled = 60 km + 50 km = 110 km

and, total time taken $= \frac{3}{2}$ hrs $+ \frac{5}{3}$ hrs $= \frac{9+10}{6}$ hrs $= \frac{19}{6}$ hrs

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

$= \frac{110\text{ km}}{\frac{19}{6}\text{hrs}} = \frac{110 \times 6}{19}$ km/hr $= \mathbf{34\frac{14}{19}}$ **km/hr** **(Ans.)**

***Example 3 :***

A distance of 450 km is covered in $6\frac{1}{2}$ hrs. If the first two-thirds of the distance is covered at the speed of 75 km/hr, at what speed the remaining distance is covered ?

***Solution :***

Since, two-thirds of the whole distance $= \frac{2}{3} \times 450$ km = 300 km

And, the speed with which this distance is covered = 75 km/hr

$\therefore$ The time taken to cover this distance

$= \frac{\text{Distance}}{\text{Speed}} = \frac{300}{75}$ hrs = **4 hrs**

***For the remaining distance :***

Distance to be covered = (450 – 300) km = 150 km

and, time taken = $(6\frac{1}{2} - 4)$ hrs = $2\frac{1}{2}$ hrs = $\frac{5}{2}$ hrs

$\therefore$ **Speed** = $\frac{150\text{ km}}{\frac{5}{2}\text{hrs}}$ = **60 km/hr** **(Ans.)**

***Example 4 :***

The distance between two towns is covered in 5 hours at the speed of 60 km/hr. How much time will be saved if the speed is increased by 15 km/hr ?

***Solution :***

Distance between the two towns = Speed × Time = 60 km/hr × 5 hr = 300 km

***In the second case :***

The distance = 300 km

and, the speed = (60 + 15) km/hr = 75 km/hr

$\therefore$ The time taken = $\frac{\text{Distance}}{\text{Speed}} = \frac{300\text{ km}}{75\text{ km/hr}}$ = 4 hrs

$\therefore$ **Time saved** = 5 hours – 4 hours = **1 hour** **(Ans.)**

***Example 5 :***

The first 300 km of a journey is covered in $3\frac{1}{3}$ hours and the remaining of the journey is covered in $2\frac{2}{3}$ hours at 75 km/hr. Find the average speed of the whole journey.

***Solution :***

**For the 1st part :** Distance = 300 km and time = $3\frac{1}{3}$ hrs

**For the 2nd part :** Speed = 75 km/hr and time = $2\frac{2}{3}$ hrs

$\therefore$ The distance covered = Speed × Time = 75 km/hr × $\frac{8}{3}$ hr = 200 km

**For the whole journey :**

The total distance = 300 km + 200 km = 500 km

and, the total time taken = $3\frac{1}{3}$ hrs + $2\frac{2}{3}$ hrs = 6 hrs

$\therefore$ **The average speed** = $\frac{\text{Total distance covered}}{\text{Total time taken}}$

= $\frac{500\text{ km}}{6\text{ hrs}}$ = **$83\frac{1}{3}$ km/hr** **(Ans.)**

***Example 6 :***

A man cycles from P to Q, a distance of 21 km, in 1 hour 40 minutes. The road from P is level for 13 km and then it is uphill to Q. The man's average speed on the level road is 15 km per hour. Find his average uphill speed.

***Solution :***

**For the level road :** Distance = 13 km and speed = 15 km per hour.

$\therefore$ Time taken $= \frac{\text{Distance}}{\text{Speed}} = \frac{13}{15}$ hours.

**For the uphill :** Distance = (21 – 13) km = 8 km

And, time taken $= \left(\frac{5}{3} - \frac{13}{15}\right)$ hours [1 hr. 40 min. $= \left(1 + \frac{40}{60}\right)$ hrs $= \frac{5}{3}$ hrs]

$= \left(\frac{25-13}{15}\right)$ hours $= \frac{12}{15}$ hours $= \frac{4}{5}$ hours.

$\therefore$ **Speed** $= \frac{\text{Distance covered}}{\text{Time taken}} = \frac{8}{\frac{4}{5}}$ km/hr $= 8 \times \frac{5}{4}$ km/hr

$=$ **10 km/hr** **(Ans.)**

**TEST YOURSELF**

1. If distance is in km and time in hours, the speed is in .....
2. If speed is in m/sec and distance is in metre ; the time is in .....
3. If time is in min. and speed is in km/min. ; the distance is in .....
4. 36 km/hr = 36 × ..... m/s = ..... m/s and 5.4 km/hr = ..... m/s = ..... m/s.
5. 15 m/s = 15 × ..... km/hr = ..... km/hr and 4·5 m/s = ..... km/hr = ..... km/hr.

## EXERCISE 8 (A)

1. (i) A car covers a distance of 60 km in 40 minutes. Find the speed of the car in km/hr.
   (ii) A distance of 800 m is covered in 30 minutes, find the speed in km/hr.
   (iii) A boy runs a distance of 16 km in $1\frac{1}{3}$ hrs; find his speed in m/sec.
2. (i) Find the distance covered by a bus in 50 minutes at the speed of 42 km/hr.
   (ii) Find the distance covered by an object in 2 minutes at the speed of 13·5 m/sec.
3. (i) Find the time taken to cover a distance of 120 km at the speed of 10 m/sec.
   (ii) Find the time taken to cover a distance of 660 m at the speed of 72 km/hr.
4. An aeroplane flies 750 km in 40 min. Find :
   (i) its speed in km/hr;
   (ii) time taken by it to cover a distance of 900 km.
5. A man takes 150 steps in walking 120 metres. Find his speed in (i) m/s (ii) km/hr, if he takes 3 steps in one second.
6. Out of a total distance covered of 200 km, first half is covered at the speed of 60 km per hr and the remaining half is covered at 75 km/hr. Find :
   (i) the total time taken to cover the whole journey.
   (ii) the average speed for the whole journey.
7. A part of a journey is covered in 1 hour 40 minutes at 75 km/hr and the remaining part of it is covered in 2 hours 50 minutes at 60 km/hr. Find :
   (i) the total length of the journey;
   (ii) the average speed during the whole journey.
8. Ramesh goes from station A to station B at the speed of 40 km/hr and returns from station B to station A at the speed of 60 km/hr. Find his average speed for the whole journey.
9. A journey of 540 km is completed in 7 hours 30 minutes. If two-third of the journey is completed at 80 km/hr, at what speed is the remaining journey completed ?
10. The total distance between two stations is 570 km out of which, 224 km is covered at 56 km/hr, 210 km is covered at 70 km/hr and the remaining is covered in 2 hours. Find the average speed during the whole journey.
11. A distance of 33 km is covered in one hour 12 minutes. If the first 15 km is covered at the speed of 25 km per hour, find the speed during the remaining distance.
12. X and Y are two towns. A man goes from town X to town Y at an average speed of 30 km per hour and returns at the average speed of 20 km per hour. Find the distance between the two towns if the man takes 10 hours on the whole.

13. A man takes 40 minutes to cover a certain distance at the speed of 6 km $h^{-1}$. How much should he increase his speed to cover the same distance in 30 minutes ?

14. In how much time will a car, running at 60 km $h^{-1}$, cover a distance of 600 km if it stops for half an hour after every 100 km ?

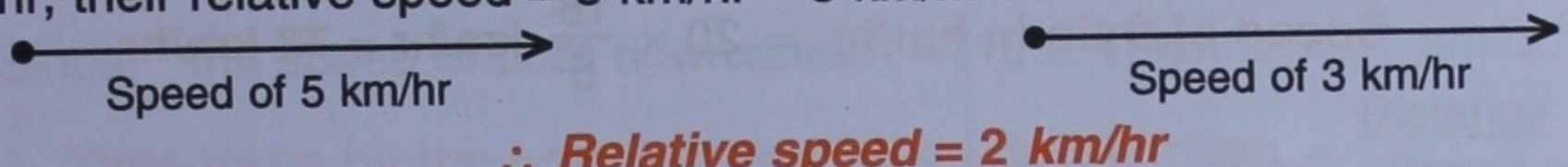
## 8.3 RELATIVE SPEED

*Relative speed between two objects means, the speed of one object with respect to the other.*

(i) When two objects are moving in the *same* direction;

their relative speed = *difference* of their speeds

*i.e.* if two objects are moving in the same direction with speeds 5 km/hr and 3 km/hr, their relative speed = 5 km/hr – 3 km/hr = 2 km/hr

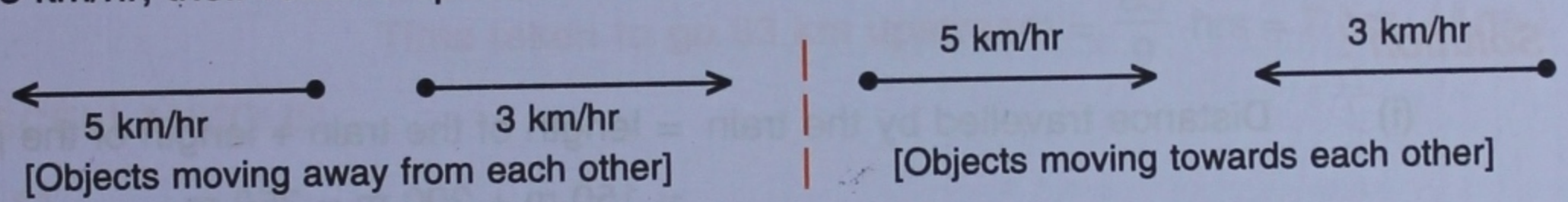



***∴ Relative speed = 2 km/hr***

(ii) When two objects are moving in the opposite directions;

their relative speed = *sum* of their speeds

*i.e.* if two objects, moving in the opposite directions, with speeds 5 km/hr and 3 km/hr, their relative speed = 5km/hr + 3 km/hr = 8 km/hr.




***∴ Relative speed = 8 km/hr***

***Example 7 :***

A and B are two places, 500 km apart. A car starts from A for B at a speed of 55 km/hr and another car starts, at the same time, from B for A at a speed of 45 km/hr. Find the distance from A where they will meet and how much time will the two cars take to reach the meeting point ?

***Solution :***

Clearly, the cars are moving in opposite directions, so relative speed between the two cars = 55 km/hr + 45 km/hr = 100 km/hr.

Since, $\text{time} = \dfrac{\text{distance}}{\text{speed}}$

$\therefore$ Time after which the two cars meet = $\dfrac{500}{100}$ hrs = 5 hrs

Also, distance travelled by first car in this time = speed × time

= 55 km/hr × 5 hrs = 275 km

**∴ Two cars will meet after 5 hrs at a distance of 275 km from A (Ans.)**

## 8.4 TRAIN

(i) If a train is to pass a man or a telegraph post, etc. ; the train has to travel equal to its own length.

(ii) If it is to pass a railway platform or a bridge, etc. ; train has to travel equal to its own length **plus** the length of the platform (or bridge).

(iii) If a train passes another train going in the opposite direction or overtakes another train going in the same direction, in both the cases, the train has to travel equal to the sum of the lengths of both the trains.

**Example 8 :**

A train 120 m long passes a telegraph post in 6 seconds. Find its speed in :

(i) m/s (ii) km/hr

**Solution :**

(i) Distance travelled by the train = its own length = 120 m

and, time taken by it = 6 sec

$\therefore$ **Speed of train** $= \frac{\text{Distance}}{\text{Time}} = \frac{120\text{ m}}{6\text{ sec}} =$ **20 m/s** **(Ans.)**

(ii) **Speed of train in km/hr** $= 20 \times \frac{18}{5}$ km/hr = **72 km/hr** **(Ans.)**

**Example 9 :**

A passenger train, 150 m long, passes a railway platform, 200 m long, in 35 seconds.
Find : (i) speed of the train in km/hr;

(ii) the time taken by the train to pass a stationary man;

(iii) the time taken by the train to pass a man cycling in the direction of train at the rate of 9 km/hr.

**Solution :**

(i) Distance travelled by the train = length of the train + length of the platform

= 150 m + 200 m = 350 m

Since, time taken = 35 seconds

$\therefore$ **Speed of the train** $= \frac{350\text{ m}}{35\text{ sec}}$

$= 10$ m/s $= 10 \times \frac{18}{5}$ km/hr = **36 km/hr** **(Ans.)**

(ii) Distance travelled by the train to pass the stationary man = the length of the train

= 150 m

and, speed of the train = 10 m/s

$\therefore$ **Time taken to pass the stationary man**

$= \frac{\text{Distance}}{\text{Speed}} = \frac{150\text{ m}}{10\text{ m/s}} =$ **15 sec** **(Ans.)**

(ii) In this case, the train and the man both are in motion; so their relative speed should be taken.

Relative speed between the train and the man

= 36 km/hr – 9 km/hr

$= 27$ km/hr $= 27 \times \frac{5}{18}$ m/s $= 7{\cdot}5$ m/s

Since, distance travelled by the train to pass the man

= its own length = 150 m

$\therefore$ **Time taken** $= \frac{150}{7{\cdot}5}$ sec = **20 sec** **(Ans.)**

## 8.5 STREAMS

If the speed of a boat in the still water = x km/hr

and, the speed of stream (current of water) = y km/hr

then, the speed of boat in the direction of the current

(*i.e.* down stream) = (x + y) km/hr

and, the speed of boat in the direction opposite to the current

(*i.e.* up steam) = (x – y) km/hr

***Example* 10 :**

A boat can travel with a speed of 13 km/hr in still water. If the speed of stream is 4 km/hr; find : (i) time taken by the boat to go 68 km downstream.

(ii) time taken by the boat to go 63 km upstream.

***Solution* :**

(i) Since, the speed of boat downstream = (13 + 4) km/hr = 17 km/hr

$\therefore$ **Time taken by the boat to travel 68 km downstream** = $\frac{\text{Distance}}{\text{Speed}}$

$= \frac{68}{17}$ hrs = **4 hrs (Ans.)**

(ii) Since, speed of boat upstream = (13 – 4) km/hr = 9 km/hr

$\therefore$ **Time taken to go 63 km upstream** = $\frac{63}{9}$ hrs = **7 hrs (Ans.)**

## 8.6 MISCELLANEOUS

***Example* 11 :**

A train travelling 50 km an hour leaves Delhi at 8.00 a.m. and another train travelling 70 km an hour leaves Delhi at 11.00 a.m. in the same direction. How many kilometres from Delhi will they be together ?

***Solution* :**

Since, 11.00 a.m. – 8.00 a.m. = 3 hours

$\therefore$ The first train has a start of 50 × 3 km *i.e.* 150 km.

And, the second train gains (70 – 50) = 20 km in each hour.

$\therefore$ The second train will gain 150 km in $\frac{150}{20}$ hours = $\frac{15}{2}$ hours

$\Rightarrow$ **The required distance from Delhi** = $\frac{15}{2} \times 70$ km = **525 km (Ans.)**

***Alternative method :***

Let the two trains be together at a distance of $x$ km from Delhi.

$\therefore$ Time taken by first train to cover $x$ km = $\frac{x}{50}$ hours

And, time taken by 2nd train to cover $x$ km = $\frac{x}{70}$ hours

Since, 11.00 a.m. – 8.00 a.m. = 3 hours

$\Rightarrow$ The first train takes 3 hours more to cover $x$ km.

$\Rightarrow \quad \frac{x}{50} - \frac{x}{70} = 3 \quad$ *i.e.* $\quad \frac{7x - 5x}{350} = 3$

$\Rightarrow \quad 2x = 3 \times 350$ and $x = \frac{3 \times 350}{2} = 525$

$\Rightarrow$ **The required distance from Delhi = 525 km (Ans.)**

**Example 12 :**

Walking at $\frac{3}{4}$ of his usual speed, a man is $1\frac{1}{2}$ hours too late. Find his usual time.

**Solution :**

It can easily be observed that :

(i) to walk at **half of the usual speed**, the time required to cover a certain distance is **double of the usual time**.

(ii) to run at $\frac{3}{5}$ of the usual speed, the time required to cover a certain distance is $\frac{5}{3}$ of the usual time and so on.

Since, the man walks at $\frac{3}{4}$ of the usual speed, the time taken is $\frac{4}{3}$ of his usual time.

$\Rightarrow$ $\frac{4}{3}$ of usual time = usual time + $1\frac{1}{2}$ hours

$\Rightarrow$ $\left(\frac{4}{3}-1\right)$ of usual time = $\frac{3}{2}$ hours

*i.e.* $\frac{1}{3}$ of usual time = $\frac{3}{2}$ hours

and, **usual time** = $\frac{3}{2} \times \frac{3}{1}$ hours = $4\frac{1}{2}$ **hours** **(Ans.)**

**TEST YOURSELF**

**6.** Two objects are moving with speeds 20 m $s^{-1}$ and 30 $ms^{-1}$. The maximum relative speed between them will be = ..... = ..... ; when they move in ..... directions and the minimum relative speed between them will be ..... ..... = ..... ; when they move in ..... direction.

**7.** With $\frac{8}{15}$ of the usual speed, the time required, to cover the same ..... , will be ..... of the usual time.

**8.** $\frac{2}{3}$ times of the usual distance means time taken will be ..... times of the usual time, provided ..... .

## EXERCISE 8 (B)

1. A policeman follows a thief who is 600 m ahead of him. If they run at the speeds of 6 km $h^{-1}$ and 5 km $h^{-1}$ respectively, how long will the policeman take to catch the thief ?
2. Two persons A and B are 350 m apart. If A can run at the speed of 7 m/sec and B can run at the speed of 3 m/sec; find in how much time will they meet each other, if :
   (i) they run in the same direction ?
   (ii) they run in the opposite directions ?
3. Two boys start running together from the same place at the speeds of 6 km/hr and 4 km/hr. Find the distance between them after 6 minutes, if they run :
   (i) in the same direction;
   (ii) in the opposite directions.
4. P and Q are two railway stations 560 km apart. An express train leaves station P to station Q at a speed of 55 km/hr and a passenger train leaves station Q to station P at the same time and at the speed of 25 km/hr. Find, when and where will they meet.
5. A man walks at the speed of 5 km $h^{-1}$ along a railway track. A train coming from behind him at 23 km $h^{-1}$ passes by him in 35 s. Find the length of the train.
6. A train, 125 m long, travelling at a uniform speed, passes a stationary man in 3·75 seconds. Find the speed of the train in km/hr.
7. A train 225 m long, travels at a uniform speed of 54 km/hr. How much time will it take to pass:

(i) a telegraph post ?
(ii) a platform 150 m long ?
(iii) a bridge 105 m long ?

8. A train, 140 m long, passes a telegraph post in 14 sec. Find :
(i) its speed in km/hr.
(ii) time taken by it to pass a platform 160 m long.

9. A person is cycling, parallel to a railway track, at a speed of 10 km/hr. A train travelling in the same direction at 46 km/hr, passes him in 22 seconds. Find the length of the train.

10. A person is walking parallel to a railway line, at a speed of 5 km/hr. A train, travelling in the opposite direction at 49 km/hr, passes him in 12 seconds. Find the length of the train.

11. The speed of a boat in still water is 8 km/hr and the speed of the stream is 3 km/hr. Find:
(i) time taken by the boat to go 55 km downstream;
(ii) time taken by the boat to go 30 km upstream;
(iii) the distance covered by the boat in 12 hrs downstream.

12. A boat can travel with a speed of 22 km/hr in still water. If the speed of the stream is 8 km per hr; find :
(i) time taken by it to go 135 km downstream;
(ii) time taken by it to go 105 km downstream and return.

13. A train running at a uniform speed passes a bridge 275 m long in 15 seconds and another bridge 425 m long in 21 seconds. Find :
(i) the length of the train;
(ii) the speed of the train in km/hr.

14. The speed of a boat in still water is 10 km per hr. If the boat goes 37·5 km upstream in 5 hours; find the speed of the stream.

15. The speed of a boat in still water is 9 km/hr. If the boat goes 54 km downstream in 4 hours; find the speed of the stream.

16. Two trains start at the same time from two stations and proceed towards each other with speeds 40 km per hour and 45 km per hour respectively. When they meet, it is found that one train has travelled 40 km more than the other. Find the distance between the two stations.

17. A train travelling at 60 km per hour leaves station A at 3.00 p.m. and an another train leaves the same station in the same direction at 5.00 p.m. at the speed of 75 km per hour. How many kilometres from station A will the two trains be together ?

18. Walking at $\frac{3}{5}$ of his usual speed, a man is 4 hours too late. Find his usual time.

## ANSWERS

### TEST YOURSELF

**1.** km per hour *i.e.* km $h^{-1}$ **2.** second **3.** km **4.** $\frac{5}{18}$, 10, $5{\cdot}4 \times \frac{5}{18}$, 1·5 **5.** $\frac{18}{5}$, 54, $4{\cdot}5 \times \frac{18}{5}$, 16·2 **6.** 20 $ms^{-1}$ + 30 $ms^{-1}$, 50 $ms^{-1}$, opposite, 30 $ms^{-1}$ – 20 $ms^{-1}$, 10 $ms^{-1}$, same **7.** distance, $\frac{15}{8}$ **8.** $\frac{2}{3}$, speed is the same

### EXERCISE 8(A)

**1.** (i) 90 km/hr (ii) 1·6 km/hr (iii) $3\frac{1}{3}$ m/sec **2.** (i) 35 km (ii) 1620 m = 1·620 km **3.** (i) $3\frac{1}{3}$ hrs = 3 hrs 20 min (ii) 33 sec **4.** (i) 1125 km/hr (ii) 48 minutes **5.** (i) 2·4 m/s (ii) 8·64 km/hr **6.** (i) 3 hours (ii) $66\frac{2}{3}$ km/hr **7.** (i) 295 km (ii) $65\frac{5}{9}$ km/hr **8.** 48 km/hr **9.** 60 km/hr **10.** $63\frac{1}{3}$ km/hr **11.** 30 km per hour **12.** 120 km **13.** 2 km $h^{-1}$ **14.** $12\frac{1}{2}$ hrs

### EXERCISE 8(B)

**1.** 36 min. **2.** (i) 87·5 sec = 1 min 27·5 sec (ii) 35 sec **3.** (i) 0·2 km (ii) 1 km **4.** After 7 hrs at a distance of 385 km from station P **5.** 175 m **6.** 120 km/hr **7.** (i) 15 sec (ii) 25 sec (iii) 22 sec **8.** (i) 36 km/hr (ii) 30 sec **9.** 220 m **10.** 180 m **11.** (i) 5 hrs (ii) 6 hrs (iii) 132 km **12.** (i) $4\frac{1}{2}$ hrs (ii) 11 hrs **13.** (i) 100 m (ii) 90 km/hr **14.** 2·5 km/hr **15.** 4·5 km/hr **16.** 680 km **17.** 600 km **18.** 6 hours.