SPEED, TIME AND DISTANCE

In this chapter, we study speed of a person/object /train to cover a distance from a point to another point in certain time.

Speed

The rate at which a body or an object travels to cover a certain distance is called speed of body. The unit of speed is km/h and m/s.

Time

The duration in hours, minutes or seconds spent to cover a certain distance is called the time. The unit of time is hours, minute and seconds.

Distance

The length of the path travelled by any object or any person between two places is known as distance. The unit of distance is m, km, etc.

Relationship between Time, Speed and Distance

Relationship between time, distance and speed is expressed by

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

This expression shown that

1. Speed is directly proportional to distance.
2. Distance and time are directly proportional.
3. Time is inversely proportional to speed.

Average Speed

When a certain distance is covered at speed A and the same distance is covered at speed B, then the average speed during the whole journey is given by $\dfrac{2AB}{A + B}$.

Note If a body covers a distance D_1 at S_1 km/h, D_2 at S_2 km/h, D_3 at S_3 km/h and so on upto D_n at S, km/h then

Average speed

$$= \dfrac{D_1 + D_2 + D_3 + D_4 + \ldots + D_n}{\dfrac{D_1}{S_1} + \dfrac{D_2}{S_1} + \dfrac{D_3}{S_3} + \dfrac{D_4}{S_4} + \ldots + \dfrac{D_n}{S_n}}$$

Average speed $\neq \dfrac{S_1 + S_2 + S_3 + S_4 \ldots S_n}{n}$

Example 1 A person goes to Delhi from Mumbai at the speed of 60 km/h and comes back at the speed of 50 km/h. Calculate the average speed of the person for the entire trip.
(a) 54.75 km/h   (b) 54.54 km/h
(c) 57.57 km/h   (d) 75.57 km/h

Sol. *(b)* Average Speed $= \dfrac{2 \times 60 \times 50}{60 + 50}$

$$[\because A = 60 \text{ km/h}, B = 50 \text{ km/h}]$$

$$= \dfrac{6000}{110} = 54.54 \text{ km/h}$$

Example 2 A teacher reaches the school in 30 min with average speed of 15km/h. If they want to reach school in 10 minute earlier, their speed should be
(a) 80 km/h   (b) 90 km/h
(c) 50 km/h   (d) 75 km/h

Sol. *(b)* Let the distance covered by the teacher to reach to the school in d km with time t.

$$\because \quad \text{Speed} = \dfrac{\text{Distance}}{\text{Time}}$$

$$15 = \dfrac{d}{\dfrac{30}{60}} \Rightarrow d = \dfrac{15 \times 60}{30} = 30 \text{km}$$

Again using formula,

$$S = \dfrac{30}{\dfrac{(30 - 10)}{60}} = \dfrac{30 \times 60}{20} = 90 \text{ km/h}$$

Some Another Formulae

1. To convert a m/s into km/h, multiply by $\dfrac{18}{5}$,

   i.e. $a \times \dfrac{18}{5}$ km/h. e.g. Convert 25 m/s to km/h.

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

2. To convert a km/h into m/sec, multiply by $\dfrac{5}{18}$,

   i.e. $a \times \dfrac{5}{18}$ m/s. e.g. Convert 72 km/h into m/s

   $$\therefore 72 \text{ km/h} = \left(72 \times \dfrac{5}{18}\right) \text{ m/s} = 4 \times 5 = 20 \text{ m/s}$$

3. When two bodies A and B are moving with speed a km/h and b km/h respectively, then the relative speed of two bodies is
   (i) $(a + b)$ km/h (if they are moving in opposite direction)
   (ii) $(a - b)$ km/h (if they are moving in same direction)

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

5. The distance covered by train in passing a pole or a standing man or a signal post or any other object (of negligible length) is equal to the length of the train.

6. If a train passes a stationary object (bridge, platform etc) having some length, then the distance covered by train is equal to the sum of the lengths of train and that particular stationary object which it is passing.

7. (i) If two trains of lengths x and y km are moving in opposite directions with speeds of u and v respectively, then time taken by the trains to cross each other
   $$= \dfrac{\text{Sum of lengths}}{\text{Sum of speeds}} = \dfrac{(x + y)}{(u + v)}$$

   (ii) If trains are moving in same directions, then time taken by faster train to cross slower train
   $$= \dfrac{\text{Sum of lengths}}{\text{Difference of speed}} = \dfrac{x + y}{u - v}$$

   Here, $u > v$.

Example 3 The speed of a bus is 72 km/h. The distance covered by the bus in 5 s is
(a) 50 m   (b) 74.5 m   (c) 100 m   (d) 60 m

Sol. *(c)* Speed of bus in m/s $= 72 \times \dfrac{5}{18} = 20$ m/s

∴ Distance travelled in 5 s $= 20 \times 5$ (Speed × Time)
$$= 100 \text{ m}$$

Example 4 Two trains are running in the same direction. The speeds of two trains are 5 km/h and 15 km/h, respectively. What will be the relative speed of second train with respect to first?
(a) 10 km/h (b) 15 km/h (c) 20 km/h (d) 5 km/h

Sol. *(a)* We know that, if two trains are running in same direction, then difference in speeds is the required relative speed.

∴   Required relative speed $= 15 - 5 = 10$ km/h

Example 5 Two trains of lengths 75 m and 95 m are moving in the same direction at 9 m/s and 8 m/s, respectively. Find the time taken by the faster train to cross the slower train.
(a) 120 s   (b) 170 s
(c) 140 s   (d) 190 s

Sol. *(b)* According to the formula,

$$\text{Required time} = \frac{x + y}{u - v}$$

where, $x = 75$ m,
                $y = 95$ m,
                $u = 9$ m/s
and $v = 8$ m/s

∴ Required time $= \dfrac{75 + 95}{9 - 8}$
$$= 170 \text{ s}$$

PRACTICE EXERCISE

1. A train runs at the rate of 120 km/s. The speed is m/s is
(a) $66\dfrac{2}{3}$ (b) 25   (c) 30   (d) $33\dfrac{1}{3}$

2. An Athlete runs 200 m race in 24 s his speed (in km/h) is
(a) 20   (b) 24   (c) 30   (d) 28.5

3. A person crosses a 600 m long street in 5 min. What is his speed in km per hour?
(a) 3.6   (b) 7.2
(c) 8.4   (d) 10

4. A train is 125 m long. If the train takes 30 s to cross a tree by the railway line, then the speed of the train is
(a) 14 km/h   (b) 15 km/h
(c) 16 km/h   (d) 12 km/h

5. A man riding on a bicycle at a speed of 15 km/h crosses a bridge in 5 min. Find the length of the bridge.
(a) 1 km   (b) 2 km
(c) $2\dfrac{1}{2}$ km   (d) $1\dfrac{1}{4}$ km

6. A train 110 m long is running at the speed of 72 km/h to pass a 132 m long platform in how many times?
(a) 9.8 s   (b) 12.1 s   (c) 12.42 s   (d) 14.3 s

7. If a man covers $10\dfrac{1}{5}$ km in 3 h, the distance covered by him in 5 h is
(a) 16 km   (b) 15 km   (c) 18 km   (d) 17 km

8. A train 700 m long is running at the speed of 72 km/h. If it crosses a tunnel in 1 min, then the length of the tunnel is
(a) 650 m   (b) 500 m   (c) 550 m   (d) 700 m

9. A car does a journey in 10 h, the first half at 21 km per hour, and the rest at 24 km per hour. The distance travelled by the car is
(a) 264 km (b) 244 km (c) 254 km (d) 224 km

10. Sunita reaches the coaching in 25 min with an average speed of 14 km/h. She want to reach school 5 min later, then her speed should be
(a) 11.67 km/h   (b) 12 km/h
(c) 13 km/h   (d) 13.5 kn/h

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

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

13. A train passes two bridges of lengths 800 m and 400 m in 100 s and 60 s respectively. The length of the train is
(a) 80 m   (b) 90 m
(c) 200 m   (d) 150 m

14. Two runners cover the same distance at the rate of 15 km and 16 km per hour respectively. The distance travelled when one takes 16 min longer than the other is
(a) 64 km   (b) 60 km
(c) 52 km   (d) 58 km

15. Excluding stoppages, the speed of a bus is 54 km/h and including stoppages, it is 45 km/h. For how many minutes does the bus stop per hour?
(a) 9   (b) 10
(c) 12   (d) 20

16. Two persons are moving in the directions opposite to each other. The speeds of the both persons are 5 km/h and 3 km/h, respectively. Find the relative speed of the two persons in respect of each other
(a) 7 km/h   (b) 3 km/h   (c) 8 km/h   (d) 5 km/h

17. A train 240 m long passes a pole in 24 s. How long will it take to pass a platform 650 m long?
(a) 65 sec   (b) 89 sec   (c) 100 sec   (d) 150 sec

18. Distance between two towns P and Q is 240 km. A motor cycle rider starts from P towards Q at 8 pm at a speed of 40 km/h. At the same time another motor cycle rider starts from Q towards P at 50 km/h. At what time will they meet?
(a) 9 : 45 pm   (b) 10 : 40 pm
(c) 11 pm   (d) 10 : 30 pm

19. A car travels 25 km an hour faster than a bus a takes 10 hours less journey of 500 kms. The speed of the car and bus are given by respectively.
(a) 60 and 35   (b) 45 and 70
(c) 80 and 55   (d) 50 and 55

20. Two trains running in opposite directions cross a man standing on the platform in 54s and 34s respectively and they cross each other in 46 s. Find the ratio of their speeds.
(a) 3 : 2   (b) 2 : 3   (c) 5 : 3   (d) 3 : 5

Answers

1	(d)	2	(c)	3	(b)	4	(b)	5	(d)	6	(b)	7	(d)	8	(b)	9	(d)	10	(a)
11	(b)	12	(a)	13	(c)	14	(a)	15	(b)	16	(c)	17	(b)	18	(b)	19	(b)	20	(a)

Hints and Solutions

1. 120 km/h $= 120 \times \dfrac{5}{18} = 33\dfrac{1}{3}$ m/s

2. Distance $= 200$ m, Time $= 24$ s

Speed $= \dfrac{200}{24} \times \dfrac{18}{5}$ km/h $= 30$ km/h

3. Speed $= \dfrac{\text{Distance}}{\text{Time}} = \dfrac{600}{5 \times 60}$ m/s $= 2$ m/sec

$= 2 \times \dfrac{18}{5}$ km/hr $= 7.2$ km/hr

4. Speed of train $= \dfrac{\text{Distance}}{\text{Time}} = \dfrac{125}{30} \times \dfrac{18}{5}$

$= 15$ km/h

5. Length of bridge

$=$ Speed $\times$ time taken to cross the bridge

$= \dfrac{15 \times 5}{60} = 1\dfrac{1}{4}$ km

6. Speed of the train $= 72$ km/h

$= 72 \times \dfrac{5}{18}$ m/s $= 20$ m/s

$\therefore$ Required time $= \dfrac{110 + 132}{20}$

$= \dfrac{242}{20} = 12.1$ s

7. Distance covered by man in 3h

$= 10\dfrac{1}{5}$ km

Distance covered by man in 1 h

$= \dfrac{51}{5 \times 3} = \dfrac{17}{5}$ km

Distance covered by man in 5 h will be

$= \dfrac{17}{5} \times 5 = 17$ km

8. Speed $= 72 \times \dfrac{5}{18} = 20$ m/s

Let the length of tunnel be x m.

Then, $\dfrac{700 + x}{20} = 60$

$\Rightarrow \qquad\qquad x = 500$ m

9. Average speed

$= \dfrac{2 \times 21 \times 24}{21 + 24} = \dfrac{2 \times 21 \times 24}{45}$

$= \dfrac{2 \times 21 \times 24}{45} \times \dfrac{112}{5}$ km/hr

$\therefore$ Distance $= \dfrac{112}{5} \times 10 = 224$ km

10. Let the distanve covered by Sunita to reach the school in d km withe time t. Then

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

$14 = \dfrac{d}{\dfrac{25}{60}}$

$\Rightarrow \qquad d = \dfrac{14 \times 25}{60} = \dfrac{350}{60} = \dfrac{35}{6}$

Again using formula,

require speed $= \dfrac{\dfrac{35}{6}}{\dfrac{(25 + 5)}{60}} = \dfrac{35 \times 10}{30}$

$= \dfrac{35}{3} = 11.67$ km/h

11. Total distance covered

$= 50 + 40 + 90 = 180$ km

Total time taken $= \dfrac{50}{25} + \dfrac{40}{20} + \dfrac{90}{15} = 10$ h

$\therefore$ Average speed for the whole journey

$= \dfrac{180}{10} = 18 = 18 \times \dfrac{5}{18} = 5$ m / s

12. Distance between car and scooter $= 30$ km

Difference of velocity

$= 60 - 50 = 10$ km/h

So, time taken by scooter to travel 30 km extra than a car when its speed 10 km/h more

$= \dfrac{30}{10} = 3$ h

13. Let train is x m long.

According to the question,

$$\frac{800 + x}{100} = \frac{400 + x}{60}$$

$$4800 + 6x = 4000 + 10x \Rightarrow 4x = 800$$

$$\therefore \qquad x = 200 \, \text{m}$$

14. Let distance covered by runners $= x$ km

Then, according to the question,
difference time in both runner $= 6$ min

$$\Rightarrow \qquad \frac{x}{15} - \frac{x}{16} = \frac{6}{60} \qquad [\because 1 \, \text{hour} = 60 \, \text{min}]$$

$$\Rightarrow \qquad \frac{x}{15 \times 16} = \frac{6}{60}$$

$$\Rightarrow \qquad x = \frac{15 \times 16}{10} = 64 \, \text{km}$$

Hennce, distance covered by runners $= 64$ km

15. $\qquad$ Speed $= 54$ km/hr

After stopage $= 45$ km/hr

$$\Rightarrow \quad \text{Difference} = 54 - 45 = 9 \, \text{km/hr}$$

$$\therefore \quad \text{Required time } = \frac{9}{54} \times 60 = 10 \, \text{min}$$

16. We know that, the two speeds will be added, if the motions of two objects are in opposite directions.

$\therefore$ Required relative speed

$$= 5 + 3 = 8 \, \text{km/h}$$

17. Speed of train $= \dfrac{240}{24}$ m/s $= 10$ m/s

$$\text{Time} = \frac{650 + 240}{10} = 89 \, \text{s}$$

18. Suppose, they meet x h after 8 pm. Then, sum of distance covered by them in hours $= 240$ km.

$$\therefore \quad 40x + 50x = 240$$

$$\Rightarrow \qquad x = \frac{240}{90} = 2 \, \text{h} \, 40 \, \text{min}$$

$$= 8 \, \text{pm} + 2 \, \text{h} \, 40 \, \text{min}$$

Hence, they will meet $= 10{:}40$ pm

19. Let speed of bus $= x$ km/hr

Speed of car $= (x + 25)$ km/hr

According to the question,

$$\frac{500}{x} - \frac{500}{x + 25} = 10$$

$$\therefore \quad \text{Car } x = 45 \, \text{km/hr.}$$

$$\text{Bus} = 45 + 25 = 70 \, \text{km/hr.}$$

20. Let the speed of two trains be x and y, respectively.

$\therefore$ Length of 1st train $= 54x$
Length of the 2nd train $= 34y$
According to the question,

$$\frac{54x + 34y}{x + y} = 46$$

$$\Rightarrow \; 54x + 34y = 46x + 46y$$

$$\Rightarrow \; 27x + 17y = 23x + 23y$$

$$\Rightarrow \quad 4x = 6y \Rightarrow 2x = 3y$$

$$\Rightarrow \quad \frac{x}{y} = \frac{3}{2}$$

$$\therefore \quad x : y = 3 : 2$$