Time and Distance

Time

The duration(or interval) spent to cover a certain distance is called time.

Distance

The length of path travelled by any object ehoeen two places is called distance.

Speed

The distance moved by an object in a specific time is known as speed.

i.e. $$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

Conversion of Unit

$$a \text{ km/h} = \frac{a \times 1000 \text{ m}}{3600 \text{ s}} = \frac{5a}{18} \text{ m/s}$$

$$a \text{ m/s} = \frac{a \times 3600 \text{ km}}{1000 \text{ s}} = \frac{18a}{5} \text{ km/h}$$

Average Speed

The average speed of an object over a given time interval is the total distance travlled by an object divided by the total time taken.

i.e. Average speed

$$= \frac{\text{Total distance travelled by an object}}{\text{Total time taken}}$$

If an object covers a distance at x km/h and the same distance at y km/h, then average speed by an object is $\frac{2xy}{x+y}$ km/h.

Example 1 A certain distance is covered in 3 h 48 min at 5 km/h. How much time will be taken to cover it at 28.5 km/h^2?

(a) 30 min (b) 40 min (c) 45 min (d) 50 min

Sol. (b) Distance = Speed × time

$$= 5 \times \frac{19}{5} \text{ km} = 19 \text{ km}$$

Now, distance = 19 km and speed = 28.5 km/h

$$\therefore \text{ Time taken} = \frac{\text{Distance}}{\text{Speed}} = \frac{19}{28.5} = \frac{19}{28.5} \times 60$$

$$= 40 \text{ min}$$

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

(a) $6\frac{4}{11}$ km/h (b) $7\frac{1}{2}$ km/h

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

Sol. (c) Here, total distance = (30 + 40) km = 70 km

and total time $= \left(\frac{30}{6} + 5\right)$ h = 10 h

$$\therefore \text{ Average speed} = \frac{\text{Total distance}}{\text{Total time}} = \frac{70}{10} = 7 \text{ km/h}$$

Important Formulae

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

(ii) The distance covered by train in passing a pole or a standing man is equal to the length of the train.

(iii) If a train of length l_1 m passes through a bridge or a platform or another train of length l_2 m, the running train travels a distance (l_1+l_2) m.

(iv) Let the speed of a boat (or a body) in still water be x km/h and that of stream be y km/h, then
- speed of boat downstream $= (x+y)$ km/h
- speed of boat upstream $= (x-y)$ km/h

(v) Let the speed of boat in downstream and upstream be u km/h and v km/h, then
- Speed of boat in still water $= \frac{1}{2}(u+v)$ km/h
- Speed of current $= \frac{1}{2}(u-v)$ km/h

Example 3 A 100 m long train is moving at a speed of 60 km/h. In what time will it cross a sign pole?

(a) 6 s (b) 5 s

(c) 8 s (d) 9 s

Sol. (a) Here, speed of train $= 60$ km/h

$$= 60 \times \frac{5}{18} = \frac{50}{3} \text{ m/s}$$

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

Example 4 The distance between two stations, Delhi and Amritsar is 450 km. A train starts at 4 pm from Delhi and moves towards Amritsar at an average speed of 60 km/h. Another train starts from Amritsar at 3 : 20 pm and moves towards Delhi at an average speed of 80 km/h. How far from Delhi will the two trains meet and at what time?

(a) 180 km, 6 : 30 pm (b) 170 km, 6 : 50 pm

(c) 180 km, 7 : 00 pm (d) None of these

Sol. (b) Suppose the two trains meet a distance of x km from Delhi. Let the trains from Delhi and Amritsar be A and B respectively. Then,

Time taken by B to cover $(450-x)$ km

$$= \frac{450-x}{80}$$

Time taken by A to cover x km $= \frac{x}{60}$

$\therefore$ $\frac{450-x}{80} - \frac{x}{60} = \frac{40}{60}$

$\Rightarrow$ $3(450-x) - 4x = 160$

$\Rightarrow$ $7x = 1190$

$\Rightarrow$ $x = 170$ km

Thus, the trains meet at a distance of 170 km from Delhi.

Time taken by A to cover 170 km $= \frac{170}{60}$

$= 2$ h 50 min

Hence, the train meet at 6 : 50 pm.

Example 5 The speed of a boat in still water is 10 km/h. If it can travel 26 km downstream and 14 km upstream in the same time, find the speed of the stream.

(a) 8 km/h (b) 4 km/h

(c) 5 km/h (d) 3 km/h

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

Since, speed of boat in still water $= 10$ km/h

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

and speed of boat in upstream $= (10-x)$ km/h

$\therefore$ Time taken to travel 26 km in downstream

$$= \frac{26}{10+x} \text{ h}$$

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

According to the given condition,

$\frac{26}{10+x} = \frac{14}{10-x}$

$\Rightarrow$ $26(10-x) = 14(10+x)$

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

$\Rightarrow$ $40x = 120$

$\Rightarrow$ $x = 3$ km/h

Practice Exercise

1. If a person travels $10\frac{1}{5}$ km in 3 h, then the distance covered by him in 5 h will be
   (a) 17 km (b) 20 km
   (c) 22 km (d) None of these

2. A car travels a distance of 840 km at a uniform speed. If the speed of the car is 10 km/h more then it takes 2 h less to cover the same distance. The original speed of the car was
   (a) 45 km/h (b) 50 km/h
   (c) 60 km/h (d) 75 km/h

3. The ratio between the rates of walking of A and B is 2 : 3 and therefore A takes 10 min more than the time taken by B to reach the destination. If A had walked at doubled the speed, he would have covered the distance in
   (a) 30 min (b) 20 min (c) 15 min (d) 17 min

4. Two boys start together to walk a certain distance, one at 3.75 km/hour and another at 3 km/hour. The former arrives half an hour before the latter. The distance (in km) is
   (a) 9.5 (b) 7.5 (c) 6 (d) 8

5. A can go round a circular path 8 times in 40 min. If the diameter of the circle is increased to 10 times the original diameter, the time required by A to go round the new path once, travelling at the same speed as before is
   (a) 25 min (b) 20 min
   (c) 50 min (c) 100 min

6. A man goes uphill with an average speed of 24 km/h and comes down with an average speed of 36 km/h. The distance travelled in both the cases being the same, the average speed for the entire journey is
   (a) 30 km/h (b) 28.8 km/h
   (c) 32 km/h (d) None of these

7. If a person travels $\frac{2}{5}$th of a distance at 20 km/h, $\frac{1}{5}$th of the distance 30 km/h and rest of the journey at 40 km/h, then what is his average speed for the entire journey?
   (a) 27.77 km/h (b) 27.27 km/h
   (c) 37.77 km/h (d) None of these

8. Two cyclists start from the same place in opposite directions. One goes towards north at 18 km/h and the other goes towards south at 20 km/h. What time will they take to be 47.5 km apart?
   (a) $1\frac{1}{4}$ h (b) 2 h
   (c) 3 h (d) None of these

9. Two trains of length of 120 m and 80 m are running in the same direction with velocities of 40 km/h and 50 km/h respectively. The time taken by them to cross each other is
   (a) 60 s (b) 75 s (c) 72 s (d) 80 s

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

11. A car daiver, driving in a fog passes a pedestrian who was walking at the rate of 2 km/h in the same direction. The pedestrian could see the car for 6 min and it was visible to him up to a distance of 0.6 km. What was the speed of the car?
    (a) 30 km/h (b) 15 km/h
    (c) 20 km/h (d) 8 km/h

12. 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

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

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

15. A man standing on a railway platform observes that a train going in one direction takes 4 s to pass him. Another train of same length going in the opposite direction takes 5 s to pass him. The time taken (in seconds) by the two trains to cross each other will be
(a) $\frac{49}{9}$ (b) $\frac{40}{9}$ (c) $\frac{50}{9}$ (d) $\frac{31}{9}$

16. A boat goes 40 km upstream in 8 h and a distance of 36 km downstream in 6 h. The speed of the boat in standing water (in km/h) is
(a) 5 (b) 6
(c) 5.5 (d) 7

17. A motor boat takes 2 h to travel a distance of 9 km down the current and it takes 6 h to travel the same distance against the current. The speed of the boat in still water and that of the current (in km/h) respectively are
(a) 3, 2 (b) 3.5, 2.5
(c) 3, 1.5 (d) 3, 1

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

Answers

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

Hints and Solutions

1. (a) $\text{Speed} = \frac{\text{Distance}}{\text{Time}} = \frac{51}{5} \times \frac{1}{3} = \frac{17}{5}$ km/h

$\therefore$ Distance = Speed × Time $= \frac{17}{5} \times 5 = 17$ km

2. (c) Let the original speed be x km/h.
According to the given condition,

$$\frac{840}{x} - \frac{840}{x+10} = 2$$

$\Rightarrow \quad 840(x+10) - 840x = 2x(x+10)$

$\Rightarrow \quad x^2 + 10x - 4200 = 0$

$\Rightarrow \quad (x + 70)(x - 60) = 0$

$\Rightarrow \quad x = 60$ km/h

3. (c) Ratio of time taken $= \frac{1}{2} : \frac{1}{3} = 3 : 2$

$\left[\because \text{speed} \propto \frac{1}{\text{time}}\right]$

Suppose B takes x min. Then, A takes (x + 10) min.

$\therefore \frac{x+10}{x} = \frac{3}{2} \Rightarrow 2(x+10) = 3x \Rightarrow x = 20$

Thus, A takes 30 min.
As A double the speed, it will take 15 min.

4. (b) Let the distance be x km.

Then, $\frac{x}{3} - \frac{x}{3.75} = \frac{1}{2}$

$\Rightarrow \quad 0.75x = \frac{3 \times 3.75}{2} \Rightarrow x = \frac{3 \times 3.75}{2 \times 0.75}$

$\Rightarrow \quad x = 7.5$ km

5. (c) Time taken in completing 1 round = 5 min
As the diameter becomes 10 times, so the circumference also becomes 10 times.
$\therefore$ Time take in completing 1 round
$= 5 \times 10 = 50$ min

6. (b) Average speed $= \frac{2xy}{x+y} = \frac{2\times 24\times 36}{24+36}$

$= 28.8$ km/h

7. (b) Let the total distance be d km/h.

$\therefore$ Average speed $= \frac{1}{\frac{2d}{5}\times\frac{1}{20}+\frac{d}{5}\times\frac{1}{30}+\frac{2d}{5}+\frac{1}{40}}$

$= \frac{600}{2\times 6+4+2\times 3}$

$= \frac{300}{11} = 27.27$ km/h

8. (a) Since, they are in opposite direction.
So, relative speed $= 18 + 20 = 38$ km/h

For 47.5 km apart, time taken $= \frac{1}{38}\times 47.5$

$= 1\frac{1}{4}$ h

9. (c) Since, the trains are running in same direction, therefore

Relative speed $= (50 - 40)$ km/h

$= 10\times\frac{5}{18} = \frac{25}{9}$ m/s

$\therefore$ Required time = Time taken to cover (120 + 80) at $\frac{25}{9}$ m/s $= 200\times\frac{9}{25} = 72$ s

10. (b) Since, police car and other car are moving in same direction, so

speed $= 100 - 80 = 20$ km/h.

Now, police car has to travel 5 km to overtake other car.

$\therefore$ Required time $= \frac{5}{20}\times 60$ min $= 15$ min

11. (d) Let the speed of the car be x km/h.

Then, the relative speed $= (x - 2)$ km/h

$\therefore \quad x - 2 = \frac{0.6}{6/60}$

$\Rightarrow \quad x - 2 = 6 \Rightarrow x = 8$ km/h

12. (b) Speed $= 72\times\frac{5}{18} = 20$ m/s

Let the length of tunnel be x m.

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

13. (b) Since, the trains are running in opposite direction, therefore

Relative speed $= (40 + 50)$ km/h $= 90\times\frac{5}{18}$ m/s

$= 25$ m/s

$\therefore$ Required time = Time taken to cover (180 + 220) at 25 m/s $= \frac{400}{25} = 16$ s

14. (d) Let their respective speeds be x km/h and y km/h respectively. Then, the time taken by Ist train to cover 110 km = Time taken by IInd train to cover 100 km

Thus, $\frac{110}{x} = \frac{100}{y} \Rightarrow \frac{x}{y} = \frac{11}{10}$

15. (b) Let the length of each train be x m.

Then, speed of first train $= \frac{x}{4}$ m/s

and speed of second train $= \frac{x}{5}$ m/s

Relative speed $= \left(\frac{x}{4}+\frac{x}{5}\right)$ m/s $= \frac{9x}{20}$ m/s

$\therefore$ Time taken to cross each other

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

$= 2x\times\frac{20}{9x} = \frac{40}{9}$ s

16. (c) Rate of upstream $= \frac{40}{8} = 5$ km/h

Rate of downstream $= \frac{36}{6} = 6$ km/h

$\therefore$ Rate in still water $= \frac{1}{2}(5 + 6) = 5.5$ km/h

17. (c) Rate downstream $= \frac{9}{2} = 4.5$ km/h

Rate upstream $= \frac{9}{6} = 1.5$ km/h

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

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

18. (a) Let the speed of the boat in still water be x km/h and that of the stream be y km/h.

Then, speed downstream $= (x + y)$ km/h

and speed upstream $= (x - y)$ km/h

Let k be the distance travelled.

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

$\Rightarrow \quad 2x - 2y = x + y \Rightarrow x = 3y$

$\therefore \quad x : y = 3 : 1$