

Time and Distance- Key Notes

Distance= Speed*time

For a non-uniform motion Average speed= Total distance travelled/Total time taken

When the body travels at 'u' m/s for t₁ seconds and 'v' m/s for t₂ seconds, then

Average speed= $(ut_1+vt_2)/(t_1+t_2)$

When the body travels l distance at 'u' m/s and 'm' distance at 'v' m/s; Average speed = $(mu+lv)/(l+m)$

Relative Speed: Speed of a moving body w.r.t. another moving body is called relative speed.

Speed of A w.r.t. B

(i) When they are moving in same direction; Relative speed of A= A-B

(ii) When they are moving in opposite direction; Relative speed of A= A+B

Key points on Trains

When a train is crossing a pole distance travelled by the train= length of train

When a train of length l is crossing a bridge of length b; the distance travelled by train=l+b

When a train of length l is crossing a platform of length p; then distance travelled by train=l+p

When a train of length l₁ is crossing/ overtaking another train l₂; then distance travelled = l₁+l₂

Exercise questions

1. Train A traveling at 60 km/hr leaves Mumbai for Delhi at 6 P.M. Train B traveling at 90 km/hr also leaves Mumbai for Delhi at 9 P.M. Train C leaves Delhi for Mumbai at 9 P.M. If all three trains meet at the same time between Mumbai and Delhi, what is the speed of Train C if the distance between Delhi and Mumbai is 1260 kms?

- A) 60 km/hr
- B) 90 km/hr
- C) 120 km/hr
- D) 135 km/hr

2. Two trains A and B start simultaneously from stations X and Y towards each other respectively. After meeting at a point between X and Y, train A reaches station Y in 9 hours and train B reaches station X in 4 hours from the time they have met each other. If the speed of train A is 36 km/hr, what is the speed of train B?

- A) 24 km/hr
- B) 54 km/hr

- C) 81 km/hr
- D) 16 km/hr

3. A man moves from A to B at the rate of 4 km/hr. Had he moved at the rate of 3.67 km/hr, he would have taken 3 hours more to reach the destination. What is the distance between A and B?

- A) 33 kms
- B) 132 kms
- C) 36 kms
- D) 144 kms

4. A man driving his bike at 24 kmph reaches his office 5 minutes late. Had he driven 25% faster on an average he would have reached 4 minutes earlier than the scheduled time. How far is his office?

- A) 24 km
- B) 72 km
- C) 18 km
- D) Data Insufficient

5. A man and a woman 81 miles apart from each other, start traveling towards each other at the same time. If the man covers 5 miles per hour to the women's 4 miles per hour, how far will the woman have travelled when they meet?

- A) 27
- B) 36
- C) 45
- D) None of these.

6. The speed of a motorboat itself is 20 km/h and the rate of flow of the river is 4 km/h. Moving with the stream the boat went 120 km. What distance will the boat cover during the same time going against the stream?

- A) 80 km
- B) 180 km
- C) 60 km
- D) 100 km

7. I travel the first part of my journey at 40 kmph and the second part at 60 kmph and cover the total distance of 240 km to my destination in 5 hours. How long did the first part of my journey last?

- A) 4 hours B) 2 hours C) 3 hours D) 2 hours 24 minutes

8. By walking at $\frac{3}{4}$ th of his usual speed, a man reaches office 20 minutes later than usual. What is his usual time?

- A) 30 min
- B) 60 min
- C) 70 min

D) 50 min

9. A passenger train covers the distance between stations X and Y, 50 minutes faster than a goods train. Find this distance if the average speed of the passenger train is 60 kmph and that of goods train is 20 kmph.

A) 20 kms

B) 25 kms

C) 45 kms

D) 40 kms

10. Ram covers a part of the journey at 20 kmph and the balance at 70 kmph taking total of 8 hours to cover the distance of 400 km. How many hours has been driving at 20 kmph?

A) 2 hours

B) 3 hours 20 minutes

C) hours 40 minutes

D) 3 hours 12 minutes

Answer Key

1.C; 2.B; 3.B; 4.C; 5.B; 6.A; 7.C; 8.B; 9.B; 10.D

Concepts and Theory

Important Formula and Equations

1. Speed, Time and Distance:

Speed = Distance / time

Time = distance / speed

Distance = speed * time

2. km/hr to m/sec conversion:

$x \text{ km/hr} = [x * 5/18] \text{ m/sec}$

3. m/sec to km/hr conversion:

$x \text{ m/sec} = [x * 18/5] \text{ km/h}$

4. If the ratio of the speeds of A and B is $a : b$, then the ratio of the times taken by them to cover the same distance is $1/a : 1/b$ or $b : a$

5. Suppose a man covers a certain distance at x km/hr and an equal distance at y km/hr. Then, the average speed during the whole journey is $[xy/(x+y)]$ km/hr

Key Note:

Caution average speed should not be calculated as average of different speeds, i.e., Ave. speed $\neq$ (Sum of speed / No. of different Speed)

There are two different cases when average speed is required.

Case I

When time remains constant and speed varies :

If a man travels at the rate of x km/h for t hours and again at the rate of y km/h for another t hours, then for the whole journey, his average speed is given by

$$\begin{aligned}\text{Average speed} &= \text{Total distance} / \text{Total time taken} = (xt + yt) / (t + t) \\ &= (x + y) / 2 \text{ kmph}\end{aligned}$$

Case II

When the distance covered remains same and the speeds vary :

When a man covers a certain distance with a speed of x km/h and another equal distance at the rate of y km/h. then for the whole journey, the average speed is given by Average speed $= 2xy / (x + y)$ km/h.

Velocity : The speed of a moving body is called as its velocity. If the direction of motion is also taken into consideration

$$\text{Velocity} = (\text{Net displacement of the body}) / (\text{Time taken})$$

Relative speed:

a) Bodies moving in same direction

When two bodies move in the same direction, then the difference of their speeds is called the relative speed of one with respect to the other.

When two bodies move in the same direction, the distance between them increases (or decreases) at the rate of difference of their speeds.

b) Bodies moving in opposite direction

The distance between two bodies moving towards each other will get reduced at the rate of their relative speed (i.e., sum of their speeds).

Relative speed of one body with respect to other body is sum of their speeds.

Increase or decrease in distance between them is the product of their relative speed and time.

Key notes to solve problems

When a moving body covers a certain distance at x km/h and another same distance at the speed of y km/h, then average speed of moving body during its entire journey will be $[2xy / (x + y)]$ km/h

A man covers a certain distance at x km/h by car and the same distance at y km/h by bicycle. If the time taken by him for the whole journey by t hours, then Total distance covered by him is equal to $2txy / (x + y)$ km.

A boy walks from his house at x km/h and reaches the school ' t_1 ' minutes late. If he walks at y km/h he

reaches 't₂' minutes earlier. Then, distance between the school and the house

$$= \frac{(xy)}{(y-x)} * (t_1+t_2)/60 \text{ km}$$

If a man walks with (x/y) of his usual speed he takes t hours more to cover a certain distance, then the time to cover the same distance when he walks with his usual speed, $(xt)/(y-x)$ hours.

If two persons A and B start at the same time in opposite directions from the points and after passing each other they complete the journeys in 'x' and 'y' hrs. respectively, then A's speed: B's speed=speed=
 $\sqrt{y} : \sqrt{x}$

If the speed is (a/b) of the original speed, then the change in time taken to cover the same distance is given by Change in time = $((b/a)-1)*\text{original time}$

Key notes to solve problems on Trains

The time taken by a train in passing a signal post or a telegraph pole or a man standing near a railway line = (Length of the train)/ (speed of the train)

The time taken by a train passing a railway bridge or a platform or a tunnel or a train at rest=
 $(x+y)/\text{Speed}$ where, x = length of the train, y = length of the bridge or platform or standing train or tunnel

Time taken by faster train to pass the slower train in the same direction= $(x+y)/(u-v)$; where, x = length of the first train ; y = length of the second train ; u = speed of the first train ; v = speed of the second train and $u > v$

Time taken by the trains in passing each other while moving in opposite direction = $(x+y)/(u+v)$

Time taken by the train to cross a man = $x/(u-v)$ where, both are moving in the same direction and x = length of the train; u = speed of the train and v = speed of the man.

Time taken by the train to across a man running in the opposite direction= $x/ (u+v)$

If two trains start at the same time from two points A and B towards each other and after crossing, they take a and b hours in reaching B and A respectively. Then, A's speed: B's speed= $b : a$

A train starts from a place at u km/h and another fast train starts from the same place after t hours at v km/h in the same direction. Find at what distance from the starting place both the trains will meet and also find the time of their meeting.

Distance= $uvt/(v-u)$ km

Time= $ut/(v-u)$ hours

The distance between two places A and B is x km. A train starts from A to B at u km/h. One another train after t hours starts from B to A at v km/h. At what distance from A will both the train meet and also find the time of their meeting

Time = $(x - ut) / (u + v) + t$ hours

Distance from A = $u((x - ut) / (u + v) + t)$ km

Two trains start simultaneously from the stations A and B towards each other at the rates of u and v km/h respectively. When they meet it is found that the second train had traveled x km more than the first. Then the distance between the two stations (i.e., between A and B) is $x(u + v) / (v - u)$ km

Exercise Questions

1. A boy runs 200 metres in 24 seconds. What is his speed ?

- a) 20 km/hr b) 24 km/hr c) 28.5 km/hr d) 30 km/hr

2. If the speed of a man is 45 km per hour, then what is the distance traveled by him in 30 seconds ?

- a) 275m b) 360m c) 375 m d) 420 m

3. An escalator moves towards the top level at the rate of 11 ft/sec and its length is 140 feet. If a person walks on the moving escalator at the rate of 3 feet per second towards the top level, how much time does he take to cover the entire length.

- a) 14 sec b) 10 sec c) 12 sec d) 8 sec

4. Two trains, 250 metres and 150 metres long respectively, are running on parallel lines. If they are running in the same directions, the faster train crosses the slower train in 40 seconds. If they are moving in the opposite direction they pass each other in eight seconds. What is the speed of the slower train?

- a) 108 kmph b) 82 kmph c) 92 kmph d) 72 kmph

5. Two persons , Ram & Lakshman , who are at a distance of 100 km from each other, move towards each other from two places P and Q at speeds of 20 kmph and 25 kmph respectively. Lakshman reaches P, returns immediately and meets Ram at R, who started on the return journey to P immediately after reaching Q. What is the distance between Q and R?

- a) $33 \frac{1}{3}$ km b) 25 km c) 30 km d) $27 \frac{1}{3}$ km

6. With out any halt a train travels a certain distance with an average speed of 75 km ph , and with halts it covers the same distance at an average speed of 60 kmph. When it is traveling with halts, how many minutes/per hour does the train halt on an average ?

- a) 48 min. b) 12 min. c) 15 min. d) 18 min.

7. A lady starts from P towards Q and realizes that at a point R, if he walks 50 km further he will be at a point S, which is as far away from R as it is from Q. What is the distance between P and Q if the distance between P and R is half the distance from R to Q? (Assume that P, Q, R and S are all on the same straight line)

- a) 150 km b) 200 km c) 250 km d) 125 km

8. In a 1000 m race Usha beats Shiny by 50 m. In the same race, by what time margin Shiny beat Mercy who runs at 4 m/s ?

- a) 100 sec. B) 50 sec c) 25 sec d) Data not sufficient

9. A and B participate in a 5000 m bicycle race which is being run on a circular track of 500 m. If the speed of A and B are 20 m/s and 10 m/s respectively, what is the distance covered by A when he passes B for the seventh time ?

- a) 2500 b) 2800 c) 4000 m 4) situation is not possible

10. Two buses A and B leave the same bus depot, A towards the North and B towards the East. The bus A travels at a speed of 5 km/hr more than that of the bus B. If after four hours the distance between the two buses is 100 km, find the speed of the bus A.

- a) 60 kmph b) 40 kmph c) 20 kmph d) 15 kmph

11. A person traveled from his house to office at 30 kmph; then he was late to his office by 5 minutes. If he increases his speed by 10 kmph he would be early by 15 minutes to his office. What should be his speed so that he reaches his office on time?

- a) 36 kmph b) 32 kmph c) 34 kmph d) 35 kmph

12. A train 575 m long crosses a tunnel of length 325 in 90 sec. What is the speed of the train in kmph.

- a) 28 b) 32 c) 36 d) 24

13. A train which has 390 m long, is running 45 kmph. In what time will it cross a person moving at 9 kmph in same direction?

- a) 26 sec b) 39 sec c) 36 sec d) 29 sec.

14. Two persons start running simultaneously around a circular track of length 400 m from the same point at speeds of 15 kmph and 25 kmph. When will they meet for the first time anywhere on the track if they are moving in the opposite direction?

- a) 144 b) 36 c) 124 d) 32

15. Two persons C & D started traveling from A and B which are 300 km apart, towards B and A respectively at 1.00 p.m. C travels at a constant speed of 30 kmph whereas D doubles his speed every hour. If D reaches A in $4\frac{5}{8}$ hours, at what time did C and D meet each other?

- a) 4:30 p.m. b) 4:40 p.m. c) 5:00 p.m. d) 5:10 p.m.

16. Two trains T1 and T2 start simultaneously from two stations X and Y respectively towards each other. If they are 70 km apart both 3 and 6 hours after start, then find the distance between the two stations.

- a) 210 km b) 240 km c) 220 km d) 180 km

17. Ajith and Rana walk around a circular course 115 km in circumference, starting together from the same point. If they walk at speed of 4 and 5 kmph respectively, in the same direction, when will they meet?

a) after 20 hours b) after 115 hours c) after 115 minutes d) after 20 minutes

18. There are 4 people who has to cross a stretch of 300 km. They normally run at a speed of 10 kmph. One of them has a bike that travels at 50 kmph. The bike first takes one person alone and crosses the stretch while the other two keep running. Then he comes back without wasting time and picks up another person from the way, drives him across the stretch, and does the same for the last person. How long does this whole process take?

a) 24 hrs b) 16 hrs c) $56/3$ hrs d) $58/3$ hrs

19. Ragav took a bus from home to market, that travels at 40 kmph. While walking back at 4 kmph, halfway through, he suddenly realized he was getting late and he cycled back the remaining distance in 30 kmph. Find the average speed.

a) 6.5 kmph b) 12.0 kmph c) 28.5 kmph d) none of these

20. Two trains of equal length 120 metres move in the same direction. The faster train completely overtakes the slower one in 15 seconds. If the slower train were to move at half its speed, the overtaking would take in 10 seconds. At what speeds are the 2 trains moving (faster and slower respectively in m/s)

a) 24, 22 b) 32, 16 c) 30, 18 d) 28, 14

Answers & Explanations

1. Expl : $200/24 * 18/5 = 30$ km/hr

2. Expl : The distance traveled in 30 sec = $45 * (5/18) * 30 = 375$ m

3. Time taken to cover the entire length = tot.dist/resultant speed = $140 / (11+3) = 10$ sec

4. Expl : Let the speed of faster train be f and slower train be y .

Time taken to cross each other traveling in the same direction = $250 + 150 / (x-y) = 40$(1)

Time taken to cross each other traveling in the opposite direction = $250 + 150 / (x+y) = 8$ (2)

From (1) and (2) $f = 30$ m/s and $s = 20$ m/s

Speed of slower train = $20 * 18/5 = 72$ kmph

5. Expl : Ram takes $100/20 = 5$ hours to cover the distance from P to Q. By that time Lakshman covers $5 * 25 = 125$ km

Lakshman covers 25 km more than the distance PQ . Now the distance between them = 75 km

Time taken by them to meet = Distance/ Relative speed = $75/(20+25) = 75/45 = 5/3$ hrs.

Distance between Q and R is nothing but the distance covered by Ram in $5/3$ hours = $20 * 5/3 = 100/3$ km or $33 \frac{1}{3}$ km

6. Expl :

With halt in 1 hour the train travels 60km

With out halt for traveling same distance it take $60/75 = 4/5 = 48$ minutes

$\therefore$ 12 minutes is the halting time per hour

7. Expl : P 50 R 50 S 50 Q

The above figure gives the locations of P, R, S & Q in relation to each other.

- 8.Expl: Speed of Shiny = $50/ 10 = 5$ m/s

Time taken by shiny to complete the race is B = $1000/5 = 200$ sec.

Time taken by Baley to complete the race is D = $1000/4 = 250$ sec.

Hence, D-B = 50 sec

9. Track length = 500 m

Speed of A and B are 20m/s and 10 m/s respectively

Time taken by them to meet = length/ relative speed = $500/(20-10) = 50$ sec.

Time taken to meet for the 7th time = $7 * 50 = 350$ sec(1)

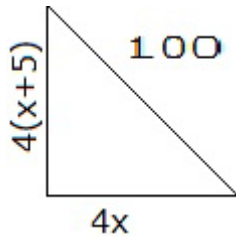
Total duration of race = total length of race/ speed

$$= 500/20 = 250 \text{ sec(2)}$$

From (1) and (2) we can find out that 7th time meeting is not possible.

10. Let the speed of the bus B be x km/hr. Then the speed of the bus A will be $(x + 5)$ kmph

Distance traveled in 4 hours is $4x$ and $4(x + 5)$ for the two buses respectively (refer the figure)



$$(4x)^2 + \{4(x + 5)\}^2 = (100)^2$$

$$16x^2 + 16x^2 + 160x + 400 = 1000$$

$$32x^2 + 160x - 9600 = 0$$

$$x^2 + 5x - 300 = 0 \quad (x-15)(x+20) = 0$$

$$x = 15$$

$$\therefore \text{Speed of the bus A} = 15 + 5 = 20 \text{ kmph}$$

11. Expl : Let the distance between house and office be x km

$$(x/30) - (x/40) = 20/40; \quad x/120 = 1/3 \quad x = 40 \text{ km}$$

Travelling at 40 kmph, he reaches office in 1 hour i.e. 15 minutes early

$$\text{So required speed} = 40 / (5/4) = 40 * 4/5 = 160/5 = 32 \text{ kmph}$$

12. Total distance traveled = Length of train + Length of tunnel = $575 + 325 = 900$

Time taken to cross the tunnel = 90 sec.

$$\text{Speed in kmph} = \text{distance/time} * 18/5 = 900/90 * 18/5 = 180/5 = 36 \text{ kmph}$$

13. Time taken to cross a moving person = length of train/ relative speed

$$\text{Time taken} = 390 / ((45-9) (5/18)) = 390 / 36 * (5/18) = 390/10 = 39 \text{ sec}$$

14. Time taken to meet the first time = length of track/relative speed

$$= 400 / (15 + 25) (5/18)$$

$$= 400/40 * (18/5) = 36 \text{ sec.}$$

15. Let speed of D in first hour = x

$$D's \text{ speed} = x + 2x + 4x + 8x + 16x * (5/8) = 25x$$

$$\text{Given } 25x = 300 \therefore X = 12$$

At the end of four hours C traveled 120 (30 * 4) kmph and D traveled 12 + 24 + 48 + 96 = 180 kmph

$\therefore$ They meet each other after 4 hours ie at 5: p.m.

16. In first 3 hours T1 travels R km and T2 travels S km.

After 6 hours they traveled R+S+70 = 700

$$2(R+S) = R+S + 140$$

$$R+S = 140$$

Hence distance between XY is R+S+ 70 = 140 + 70 = 210

17. Expl : Rana is the faster person. He gains 1 km in 1 hour. So Rana will gain one complete round over Ajith in 115 hours. i.e. they will meet after 115 hours.

18. Expl : Time taken to carry 2nd person = 300/50 = 6 hrs.

$$\text{Time taken to meet 3rd person} = (300 - 6 * 10) / (50 + 10) = 4 \text{ hrs}$$

$$\text{Time taken to carry 3rd person} = 4 \text{ hours}$$

$$\text{Time taken to meet 4th person} = (300 - 140) / 60 = 8/3$$

$$\text{Total time} = 6 + 4 + 4 + 8/3 + 8/3 = 58/3 \text{ hours}$$

19. Let the distance be 2x(one way)

Time taken by bus = 2x/40, by walking = x/4, by cycling = x/30 hours

$$\therefore \text{Average speed} = \frac{\text{Total Distance}}{\text{Total time}} = \frac{4x}{x/20 + x/4 + x/30} = \frac{4 * 60}{3 + 15 + 2} = 12.0$$

$$\text{Total time} \quad x/20 + x/4 + x/30 \quad 3 + 15 + 2$$

20. The total distance covered for over taking = length of the two trains = 120 + 120 = 240

Speed of faster train be x m/s and slower train be y m/s

In the first case Relative speed = $x - y$

$$\text{Relative Speed} = \text{Distance} / \text{Time taken} = x - y = 240/15 = 16 \text{ m/s} \dots\dots\dots(1)$$

In the second case, the slower train moves at half its speed

$$\text{Relative Speed} = x - 0.5y = 240/10 = 24 \text{ m/s} \dots\dots\dots(2)$$

Solving equation 1 & 2 we get $x = 32$ and $y = 16$.

$\therefore$ The speed of the faster and slower trains are 32 m/s and 16 m/s respectively

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