Time, Speed and Distance

In this lesson we learn to solve problems on speed, distance, time, relative speed and boats and streams etc

Key Concepts

1. Distance = Speed × Time
2. 1 km/hr = $\frac{5}{18}$ m/s
3. If the ratios of speed is a : b : c, then the ratios of time taken is : $\frac{1}{a} : \frac{1}{b} : \frac{1}{c}$

Relation between variables:

To distance, Speed and Time both are directly proportional and To speed, Time is inversely proportional.
$S \propto D$ and $T \propto D$ i.e. if speed is doubled, distance covered in a given time also gets doubled and ,$S \propto \frac{1}{T}$ i.e. if speed is doubled, time taken to cover a distance will be half.

Average speed is defined as =. $\frac{\text{Total distance travelled}}{\text{Total time taken}}$

Relative speed

If two bodies are moving (in the same direction or in the opposite direction), then the speed of one body with respect to the other is called its relative speed.

Relative speed is a phenomenon that we observe everyday. Suppose you are travelling in college bus and there is a second bus coming in the opposite direction, then it seems that the second Bus is moving much faster than actual. If both the Buses were moving in the same direction at same speeds, they seem to be stationary if seen from one of these Busses, even though they might actually be at a speed of 100 km/hr each. So what you actually observe is your speed relative to the other.

Concepts

1. If two objects are moving in opposite directions towards each other at speeds u and v, then relative speed = Speed of first + Speed of second = u + v.
This is also the speed at which they are moving towards each other or the speed at which they may be moving away from each other.

2. If the two objects move in the same direction with speeds u and v, then

relative speed = difference of their speeds = u – v.

This is also the speed at which the faster object is either drawing closer to the slower object or moving away from the slower object as the case may be.

3. If the two objects start from A and B with speeds u and v respectively, and after crossing each other take a and b hours to reach B and A respectively, then u : v = $\sqrt{\frac{b}{a}}$

Note: In case of Trains moving in the opposite directions or in the same direction, the total distance required to be traveled before they cross each other completely is equal to the sum of the lengths of the two trains. This distance is covered at the relative speeds of the trains.

Solved Examples

1. A scooterist covers a certain distance at 36 km/hr. How much distance does he cover in 3 min?

Speed = 36 km/hr = 36 × $\frac{5}{18}$ × m/s = 10 m/s

Thus, the distance covered in 3 min = (10 x 3 x 60) = 1800 m.

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

Let usual time be t hours. We know that S X T = D, But now his speed is 3/4 (S). So time to cover the same distance becomes 4/3 (T).

$\frac{4}{3}$ × t = t + $\frac{3}{2}$

t = 4.5 hr.

Alternative method:

We know that when his speed got reduced his time went up by 1 1/2 hr.

st = $\frac{3s}{4}(t+\frac{3}{2})$

⇒ 4st = 3st + 4.5 s

⇒ t = 4.5 hr.

3. A man starts from L to M, another from M to L at the same time. After passing each other they complete their journey in 3 1/3 hours and 4 4/5 hours respectively. Find the speed of the second man if the speed of the first is 24 km/hr?

Speed of first man : Speed of second man = $\sqrt{\frac{b}{a}}$ where a and b are the time taken by 1st and 2nd man

respectively.

Speed of first man : Speed of second man = $\frac{\sqrt{\frac{24}{5}}}{\frac{10}{3}} = \sqrt{\frac{24}{5} \times \frac{3}{10}} = \sqrt{\frac{36}{25}} = \frac{6}{5}$

Thus second man's speed = $\frac{5}{6}$ × 24 = 20 km/hr.

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4. Two cyclists cover the same distance in 15 km/hr and 16 km/hr, respectively. Find the distance travelled by each, if one takes 16 min longer than the other does.

Let the required distance be x km.

$\frac{x}{15} - \frac{x}{16} = \frac{16}{60}$ or 16x – 15x = 64 or x = 64

Hence, the required distance = 64 km

Alternative Method:

If the speeds are in the ratio 15 : 16 then the ratio of the times to cover the same distance would be in the ratio 16 : 15 or 16x and 15x respectively. But we know that difference in the times is 16 min or 16x - 15x = 16 min so x = 16 min

From the above derivation, second person takes 15 × 16 min = 4 hours to cover the distance at the speed of 16 km/hr. So distance = 4 × 16 = 64 km

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5. A thief is spotted by a policeman at a distance of 400 m. If the speed of the thief be 10 km/hr and that of the policeman be 12 km/hr, at what distance will the policeman catch the thief?

Relative speed of the policeman = 2 km/hr. This means, every hour the distance between police man and thief get reduces by 2000 meters. To cover 400 meters, Police needs 400/2000 Hrs or 1/5th hour. But in 1/5th hour police covers 12/5 km = 2.4 km

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6. What is the average speed if a person travels from A to B and back at the speeds of 10 km/hr and 20 km/hr, respectively

a. for equal intervals of time,

b. for equal distance,

a. the concept of weighted average can be used here.

The average speed = $\frac{(10+20)}{2} = 15\text{km/hr}$

Note:

For equal intervals of time, the average speed is given as $\frac{S_1+S_2+S_3+\ldots+S_n}{n}$

, where S1, S2, S3, ... , Sn are the speeds and n is the number of observations.

b. The weighted average concept cannot be applied here, because we do not know the fractions of time spent travelling the two distances. It would be a mistake to calculate the average speed as $\frac{(10+20)}{2} = 15\text{Km/hr}$

Total time taken = $(\frac{D}{10}) + (\frac{D}{20}) = T$

Total distance travelled = 2D.

So, average speed = $\frac{2D}{T}=\frac{2D}{(\frac{D}{10}+\frac{D}{20})}=\frac{2D}{D(\frac{1}{10}+\frac{1}{20})}=13\frac{1}{3}$ km/hr

Note:

The physical interpretation of average speed of km/hr is that if the person had moved from A to B and back at a constant speed of km/hr, he would have taken the same total time as in that case when he traveled with two different speeds of 10 km/hr and 20 km/hr (may be he was travelling with the car or a bullock cart!)

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7. A hare makes 9 leaps in the same time as a dog makes 5. But the dog's leap is 2m while hare's is only 1 m. How many leaps will the dog have to make before catching up with the hare if the hare has a head start of 16 m?

Distance covered by dog in 5 leaps = 5 × 2 = 10 m

Distance covered by hare in 9 leaps = 9 × 1 = 9 m

Distance gained by the dog in 5 leaps = 1 m. Hence, for 1 m gain he has to make 5 leaps.

Number of leaps required by the dog to gain 16 m = 5 × 16 = 80 leaps.

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8. Two men A and B walk from P to Q, a distance of 21 km at 3 km/h and 4 km/h respectively. B reaches at point Q and returns immediately and he meets A at point R. Find the distance from P to R.

Both of them together have walked twice the distance from P to Q i.e. 42 km.

Ratio of speeds of A and B = 3 : 4.

Therefore, Distance travelled by A = PR = $\frac{3}{7}$ x 42 = 18 km.

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9. Buses take 12 hr to cover the distance of 120 km between A and B. A bus starts from point A at 8.00 a.m. and another bus starts from point B at 10.00 a.m. on the same day.

When do the two buses meet?

The distance between A and B is 120 km.

Speed of the buses = $\frac{120}{12}$ = 10 km/hr

By 10.00 a.m., the bus from A would have covered 20 km.

Hence, the distance between the buses at 10.00 a.m. = 120 – 20 = 100 km

Relative speed of the buses = 20 km/hr. Time taken to meet = $\frac{100}{20}$ = 5 hr after B starts, i.e.the buses will meet at 3 p.m.

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10. Train A took 35 minute to cover a distance of 50 km. If the speed of train B is 25% faster than train A, it will cover the same distance in:

Let, speed of train A = 100 km/h

Then, speed of train B = 125 km/h

Ratio of speeds of trains A and B = 100 : 125 = 4 : 5

Therefore, Ratio of time taken by them to cover equal distance = 5 : 4

Given, time taken by train A = 35 minute

Time take by train B = $\frac{4}{5}$ x 35 minute = 28 minute.

Alternative Method:

Speed of train B is faster by 25% = $\frac{1}{4}$

Therefore, Decrease in time taken by train B = $\frac{1}{5}$ x 35 minute = 7 minute.

Therefore, Time taken by train B = 35 - 7 = 28 minute.

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11. Two persons start walking in opposite directions at 5 km/h and 4 km/h respectively. After how many hours will they be 45 km apart?

Relative speed of two persons = 5 + 4 = 9 km/h

Therefore, Time taken = $\frac{45}{9}$ = 5 hours

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12. A man is walking at a speed of 10 km/h. After every km, he takes rest for 4 minutes. How much time will he take to cover a distance of 10 km?

He covers 10 km in 1 hour (i.e. in 60 minutes)

Therefore He will take 6 minutes in covering 1 km.

He rests for 4 minutes after every km.

Time taken = (6 + 4) minutes = 10 minutes for every km.

Therefore, Time taken (for first 9 km) = 9 x 10 = 90 minutes.

Time taken to cover 10th km = 6 minutes

Therefore, Total time taken = 90 + 6 = 96 minute.

Hint: Rest time after 10th km is not added as he has reached his destination.

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13. A theft is reported to a policeman. The thief starts running and the policeman chases him. When the policeman starts chasing, the thief was at a distance of 250 metre. The thief and the policeman run at the speed of 8 km/h and 9 km/h respectively. Find the time the policeman will take to catch the thief.

Policeman gains = (9 - 8) km.h = 1 km/h

Therefore, He will gain 250 metre in 15 minutes.

He will catch the thief in 15 minutes.

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14. A train left station A for station B at a certain speed. After travelling for 100 km, the train meets with an accident and could travel at $\frac{4}{5}$ th of the original speed and reaches 45 minutes late at station B. Had the accident taken place 50 km further on, it would have reached 30 minutes late at station B. What is the distance between station A and B?

Let, initial speed of the train = 5 km/h

Then, speed after the accident = $\frac{4}{5}$ x 5 = 4 km/h

Time taken to cover 50 km @ 5 km/h = 10 hours

Time taken to cover 50 km @ 4 km/h = $12\frac{1}{2}$ hours

Difference between times taken = $12\frac{1}{2}$ - 10 = $2\frac{1}{2}$ hours = 150 minutes

But, actual difference = (45 - 30) minutes = 15 minutes

= $\frac{1}{10}$ of 150 minutes

Therefore, Speed is 10 times of assumed speed.

Therefore, Speed before accident = 10 x 5 = 50 km/h

And, Speed after accident = 10 x 4 = 40 km/h

Distance after accident is covered @ 40 km/h instead of 50 km/h

And, time difference = 45 minutes = $\frac{3}{4}$ hour

Therefore, Distance between place of accident and B = $\frac{50 \times 40}{50-40} \times \frac{3}{4}$ = 150 km

Therefore, Distance between A and B = 100 + 150 = 250 km.

MCQ's:

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1. The distance between two stations A and B is 220 km. A train leaves A towards B at an average speed of 80 km/hr. After half a hour, another train leaves B towards A at an average speed of 100 km/hr. The distance of the point where the two trains meet, from A is :

a. 120 km

b. 130 km

c. 140 km

d. 150 km

Correct Option: A

Explanation:

Let required distance be x km. Then,

$\frac{x}{80} - \frac{220-x}{100} = \frac{1}{2} \Rightarrow 5x - 4(220-x) = 200$

$\Rightarrow 9x = 1080 \Rightarrow x = 120\text{km}$

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2. A cart has to cover a distance of 80 km in 10 hours. If it covers half of the journey in (3/5)th time, what should be its speed to cover the remaining distance in the time left ?

a. 8 km/hr

b. 20 km/hr

c. 6.4 km/hr

d. 10 km/hr.

Correct Option: D

Explanation:

Distance left = $(\frac{1}{2} \times 80)$ km=40 km

Time left = $[(1 - \frac{3}{5}) \times 10] = \frac{2}{5} \times 10 = 4$ hrs

Speed required = (40÷ 4) km/hr= 10 km/hr.

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3. Ravi started cycling along the boundaries of a square field from corner point A. After half an hour, he reached the corner point C, diagonally opposite to A. If his speed was 8 km/hr. what is the area of the field in square km ?

a. 64

b. 8

c. 4

d. Cannot be determined

Correct Option: B

Explanation:

As his speed is 8kmph, in half an hour he covers 4 kmph. But 4 km is equal to two sides of the square. So side of the square = 2 km

Area of the field = 2 km x 2 km = 4 km

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4. A man goes uphill with an average speed of 35 km/hr and comes down with an average speed of 45 km/hr. The distance travelled in both the cases being the same, the average speed for the entire journey is :

a. $38\frac{3}{8}$ km/hr

b. $39\frac{3}{8}$ km/hr

c. 40 km/hr

d. None of these

Correct Option: B

Explanation:

Average speed = $(\frac{2 \times 35 \times 45}{35+45})$ km/hr = $39\frac{3}{8}$ km/hr.

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5. A man walking at 3 km/hr crosses a square field diagonally in 2 min. The area of the field is :

a. 2500 m^2

b. 3000 m^2

c. 5000 m^2

d. 6000 m^2

Correct Option: C

Explanation:

Speed = $(3 \times \frac{5}{8})$ m/sec = $(\frac{5}{6})$ m/sec.

Distance covered in $(2 \times 60)\,sec.$ = $(\frac{5}{6} \times 2 \times 60)$ m=100m

Length of diagonal = 100 m

So, area = $\frac{1}{2} \times (diagonal)^2$ = $(\frac{1}{2} \times 100 \times 100)\,m^2$ = 5000m^2

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6. A certain distance is covered at a certain speed. If half of this distance is covered in double the time, the ratio of the two speeds is :

a. 4 : 1

b. 1 : 4

c. 2 : 1

d. 1 : 2

Correct Option: A

Explanation:

Let x km be covered in y hrs. Then,

Ist speed = $(\frac{x}{y})$ km/hr.

2nd speed = $(\frac{x}{2} \div 2y)$ km/hr = $(\frac{x}{4y})$ km/hr

Ratio of speed = $\frac{x}{y} : \frac{x}{4y} = 1 : \frac{1}{4} = 4 : 1$

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7. If a boy takes as much time in running 10 m as a car takes in covering 25 m, the distance covered by the boy during the time the car covers 1 km. is :

a. 400 m

b. 40 m

c. 250 m

d. 650 m

Correct Option: A

Explanation:

25 : 10 :: 1000 : x or x = $\frac{10 \times 1000}{25}$ = 400 m

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8. The ratio between the rates of walking of P and Q is 2 : 3. If the time taken by Q to cover a certain distance is 36 minutes, the time taken by P to cover that much distance is :

a. 24 min

b. 54 min

c. 48 min

d. 21.6 min

Correct Option: B

Explanation:

Ratio of times taken = $\frac{1}{2} : \frac{1}{3}$

$\frac{1}{2} : \frac{1}{3}$ = x : 36 or $\frac{1}{2} \times 36 : \frac{1}{3} \times x \Rightarrow 18 = \frac{1}{3} \times x$ or x = 54 min.

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9. A man, on tour, travels first 160 km at 64 km/hr and the next 160 km at 80 km/hr. the average speed for the first 320 km of the tour, is :

a. 35.55 km/hr

b. 71.11 km/hr

c. 36 km/hr

d. 72 km/hr

Correct Option: B

Explanation:

Average speed = $(\frac{2 \times 64 \times 80}{64 + 80})$ km/hr = $(\frac{2 \times 64 \times 80}{144})$ km/hr.

=71.11 km/hr.

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10. A man travels 35 km partly at 4 km/hr and at 5 km/hr. If he covers former distance at 5 km/hr and later distance at 4 km/hr, he could cover 2 km more in the same time. The time taken to cover the whole distance at original rate

is

a. 9 hours

b. 7 hours

c. $4\frac{1}{2}$ hours

d. 8 hours

Correct Option: D

Explanation:

Suppose the man covers first distance in x hrs.and second distance in y hrs. Then,

4x+5y=35 and 5x+4y = 37

Solving the equations,

we get x = 5 and y = 3

Total time taken = (5+3)hrs = 8 hrs

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11. By walking at $\frac{3}{4}$ of his usual speed, a man reaches his office 20 minutes later than usual . His usual time is :

a. 30 min.

b. 60 min.

c. 75 min.

d. 1 hr.30 min.

Correct Option: B

Explanation:

At a speed of $\frac{3}{4}$ of the usual speed, the time taken is (4/3)rd of the usual time.

$(\frac{4}{3}$ of usual time) - (usual time) = 20 min.

$\frac{4}{3}x - x = 20 \Rightarrow \frac{1}{3}x = 20$ or x = 60 min.

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12. Rama travels a certain distance at 3 km/hr and reaches 15 min.late. If he travels at 4 km/hr he reaches 15 min.earlier. The distance he has to travel is :

a. 4.5 km

b. 6 km

c. 7.2 km

d. 12 km

Correct Option: B

Explanation:

Let the distance be x km.

Then, $\frac{x}{3} - \frac{x}{4} = \frac{30}{60}$ or $\frac{4x-3x}{12}$

or $\frac{4x-3x}{12} = \frac{1}{2}$ or x = 6 km.

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13. A train leaves Vijayawada at 6 a.m and reaches Rajahmundry at 10 a.m. Another train leaves Rajahmundry at 8 a.m and reaches Vijayawada at 11.30 a.m. At what time do the two trains cross one another ?

a. 9.26 a.m

b. 9 a.m

c. 8.36 a.m

d. 8.56 a.m

Correct Option: D

Explanation:

Let the distance between Vijayawada and Rajahmundry be y km.

Average speed of the train leaving Vijayawada = $(\frac{y}{4})$ km/hr

Average speed of the train leaving Rajahmundry = $(\frac{2y}{7})$ km/hr

Suppose they meet x hours after 6 a.m

Then, $\frac{xy}{4} + \frac{2y(x-2)}{7} = y$

or $\frac{x}{4} + \frac{2x-4)}{7} = 1$

15x = 44 or x = $\frac{44}{15}$ = 2 hrs 56 min

So, the trains meet at 8.56 a.m.

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14. Two trains start at the same time from Vijayawada and Madras and proceed towards each other at 16 km/hr and 21 km/hr respectively. When they meet, it is found that one train has travelled 60 km more than the other. The distance between the two stations is :

a. 445 km

b. 444 km

c. 440 km

d. 450 km

Correct Option: B

Explanation:

Suppose they meet after x hours. Then

21x-16x= 60 or x = 12

Required distance = $(16 \times 12 + 21 \times 12)$ km=444 km

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15. Raghuveer has to cover a distance of 6 km in 45 minutes. If he covers one half of the distance in $\frac{2}{3}$rd time, what should be his speed to cover the remaining distance in the remaining time ?

a. 12 km/hr

b. 16 km/hr

c. 3 km/hr

d. 8 km/hr

Correct Option: A

Explanation:

Time left = $(\frac{1}{3} \times \frac{45}{60})$ hr = $\frac{1}{4}$ hr

Distance left = 3 km

Speed required = $(3 + \frac{1}{4})$ km/hr = 12 kmph

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16. A train covers a distance in 50 minutes. If it runs at a speed of 48 km per hour on an average, the speed at which the train must run to reduce the time of journey to 40 minutes will be :

a. 50 km/hr

b. 55 km/hr

c. 60 km/hr

d. 70 km/hr

Correct Option: C

Explanation:

Distance = $(48 \times \frac{50}{60})$ km = 40 km

Required Speed = $(\frac{40}{40/60})$ km/hr = $(\frac{40 \times 60}{40})$ km/hr=60 km/hr

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17. A car covers four successive three km stretches at speeds of 10 km/hr, 30 km/hr and 60 km/hr respectively. Its average speed over this distance :

a. 10 km/hr

b. 20 km/hr

c. 30 km/hr

d. 25 km/hr

Correct Option: B

Explanation:

Total time taken = $(\frac{3}{10} + \frac{3}{20} + \frac{3}{30} + \frac{3}{60})$ hrs = $\frac{3}{5}$ hrs

Average speed = $\{\frac{12}{3/5}\}$ km/hr = $(\frac{12 \times 5}{3})$ km/hr = 20 km/hr.

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18. P and Q are two stations. A atrain goes from P to Q at 64 km/hr and returns to P at a slower speed. If its average speed for the whole journey is 56 km/hr.at what speed did it return?

a. 48 km/hr

b. 49.77 km/hr

c. 52 km/hr

d. 47 km/hr

Correct Option: B

Explanation:

Let the required speed be x km/hr.

Then, $\frac{2 \times 64 \times x}{64 + x} = 56$

$\Rightarrow 128x = 64 \times 56 + 56x$

x = $\frac{64 \times 56}{72} = 49.77$ km/pr

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19. A car completes a certain journey in 8 hours. It covers half the distance at 40 km/hr. and the rest at 60 km/hr. The length of the journey is :

a. 350 km

b. 420 km

c. 384 km

d. 400 km

Correct Option: C

Explanation:

Let the total journey be x km.

$\frac{x}{2}\cdot\frac{1}{40}+\frac{x}{2}\cdot\frac{1}{60}=8$

$\Rightarrow \frac{x}{8}+\frac{x}{120}=8$

3x + 2x=1920$\Rightarrow$5x = 1920 $\Rightarrow$ x = 384

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20. Ravi travelled 1200 km by air which formed $(\frac{2}{5})$ of his trip. One third of the whole trip, he travelled by car and the rest of the journey he performed by train. The distance travelled by train was :

a. 1600 km

b. 800 km

c. 1800 km

d. 480 km

Correct Option: B

Explanation :

Let the total distance be x km.

Then, $\frac{2}{5}x=1200\Rightarrow x=\frac{1200\times 5}{2}=3000$

Distance travelled by car = $(\frac{1}{3}\times 3000)$ = 1000 km

Distance travelled by train = [(3000-(1200+1000)] km = 800 km.

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21. A boy goes to school with a speed of 3 km/hr and returns to the village with a speed of 2 km/hr. If he takes 5 hours in all, the distance between the village and the school is:

a. 6 km

b. 7 km

c. 8 km

d. 9 km

Correct Option: A

Explanation:

Let the required distance be x km. Then.

$\frac{x}{3}+\frac{x}{2}=5\Rightarrow 2x+3x=30\Rightarrow x=6$

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22. A train is moving with a speed of 92.4 km/hr. How many metres will it cover in 10 minutes ?

a. 1540 m

b. 15 km

c. 16 km

d. 17 km

Correct Option: B

Explanation:

92.4 km/hr = $(92.4 \times \frac{5}{18})$ m/sec.

Distance covered in (10×60) sec = $(92.4 \times \frac{5}{18} \times 10 \times 60)$ m = 15400 m

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23. If a man covers 10.2 km. in 3 hours, the distance covered by him in 5 hours is :

a. 18 km

b. 15 km

c. 16 km

d. 17 km

Correct Option: D

Explanation:

Speed = $(\frac{10.2}{3})$ km/hr=3.4 km/hr

Distance covered in 5 hours = (3.4×5) km=17 km

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24. A man crosses a street 600m long in 5 minutes. His speed in km.per hour is :

a. 7.2

b. 3.6

c. 10

d. 8.4

Correct Option: A

Explanation:

Speed =