Time, Speed and Distance

Formula

 $Distance = Speed \times Time$, Speed = DistanceTime Time Time = Speed **Conversion of unit**: $1 \text{km/h} \Rightarrow \frac{18}{5} \text{m/s}$

m/s = 5/18 km/h [1km = 1000m, 1h = 60min, 1min = 60s]1 mile = 1609.34 m = 1.6093 km and 1 km = 0.621 mile,1 yard = 0.9144 m

Relative Motion with Two or More Bodies

- (i). When two bodies move in the same direction: If the speeds of the two bodies A and B be S_A and S_B , then their relative speed = $S_A - S_B$ or $S_B - S_A$ i.e., in the same direction the relative speed or effective speed between two bodies is the difference of their speeds. (The difference is always considered as positive)
- (ii). When two bodies move in the opposite direction: If the speeds of the two bodies A and B be S_A and S_B then their relative speed

 $= S_A + S_B$ i. e., in the opposite direction the relative speed or effective speed between two bodies is the sum of their speeds.

Concept Based on Trains

- When two trains (or bodies) are moving in opposite 1. directions, their relative speed will be equal to the sum of their individual speeds.
- 2. When two trains are moving in the same direction their relative speed will be equal to the difference of their speeds.
- 3. Distance to be covered to cross each other is always equal to the sum of their individual lengths.
- 4. Distance to be covered such as bridge, platform etc., is always equal to the sum of the length of the train and the length of the particular object such as bridge, platform etc.
- 5. Distance to be covered such as pole, man, tree etc, is always equal to the length of the train only.
- 6. If a man is travelling in a train, then this man has to cover the distance to cross another train is equal to the length of the train which is passing or crossing him. In this case the relative speed of both the trains will be considered.

Concept Based on Boats and Rivers (or streams)

- (i). When the boat and stream (or current) of the river move in the same direction, then the relative speed of the boat is the sum of the individual speeds of boat and river. It is known as downstream speed.
- (ii). When the boat moves against the current of the river (i.e., in opposite direction), then the relative speed of the boat is the difference of the speeds of the boat and stream (of the river). It is known as upstream speed. Let the speed of boat in still water be B and speed of current of river be C then,

Downstream speed = (B+C)

Upstreamspeed = (B-C)

Speed of the boat in still water
$$=\frac{(D+U)}{2}$$

Speed of current (or stream) $=\frac{(D-U)}{2}$
where $D \rightarrow$ downstream speed of the boat
and $U \rightarrow$ upstream speed of the boat

When the distance covered by boat in downstream (i.e., with the flow of water) is same as the distance covered by boat in upstream (against the flow of the water) then,

Time taken by boat in DS	Upstream speed
Time taken by boat in US	Downstreamspeed

 $DS \rightarrow Downstream, US \rightarrow Upstream$

First Meeting on a Circular Track

- (i). Let A and B be two runners. Time taken by them to meet for the first time = Length of the circular track × Relative speed.
- (ii). When there are more than two runners, then suppose A is the fastest runner and A meets B for the first time in t_{AB} hours and A meets C for the first time in t_{AC} hours and A meets D for the first time in t_{AD} seconds/hours and so on. Then time taken by all of them to meet for the first time is the LCM of t_{AB}, t_{AC}, t_{AD} etc.



Solved Examples

- **Q 1.** A car takes half of the time taken by truck to go from Lucknow to Bombay. A truck takes 20 hours to go for the same journey. What is the speed of a truck, if the speed of a car is 120 km/h.
 - (a). 50km/h
 - (b). 60km/h
 - (c). 70km/h
 - (d). 80km/h

Solution: b

CarTruckTime \rightarrow 1:2Speed \rightarrow 2:1Therefore, the speed of the truck = 60 km/h.

- **Q 2.** A cycle covers 75 km distance in 5 hours. What is the distance covered by the cycle in 6 hours?
 - (a). 90km
 - (b). 100km
 - (c). 80km
 - (d). 70km

Solution: a

Speed = Distance

Time

Speed = $\frac{75}{5}$ = 15 km/h

Now, distance covered in 6 hours at the speed of 15 km/h

- Q 3. The distance of the college and the home of Rajeev is 80 km. One day he was late by 1 hour than the normal time to leave for the college, so he increased his speed by 4 km/h and thus he reached to college at the normal time. What is the changed (or increased) speed of Rajeev?
 - (a). 28 km/h
 - (b). 30 km/h
 - (c). 40 km/h
 - (d). 20 km/h

Solution: d

Let the normal speed be x km/h, then

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$$\frac{80}{x} - \frac{80}{(x+4)} =$$

 $\Rightarrow x^{2} + 4x - 320 = 0$ $\Rightarrow x(x+20) - 16(x+20) = 0$ (x+20)(x-16) = 0 x = 16 km/h (x+4) = 20 km/h Therefore, increased speed = 20 km/h

- Q4. Amit covers a certain distance with his speed, but when he reduces his speed by 10 km/h his time duration for the journey increases by 40 hours, while if he increases his speed by 5 km/h from his original speed he takes 10 hours less than the original time taken. Find the distance covered by him.
 - (a). 1450 km
 - (b). 1500 km
 - (c). 1600 km
 - (d). 1650 km

Solution: b



Solving eq.(i) and (ii),we get S = 25 and T = 60 :- Distance (D) = S × T=25 × 60=1500 km where D → Distance, S → Speed, T→ Time '+' means increase in value. '-' and means decrease in value.

- Q 5. The distance between two places P and Q is 700 km. Two persons A and B started towards Q and P from P and Q simultaneously. The speed of A is 30 km/h and speed of B is 40 km/h. They meet at a point M which lies on the way from P to Q.
 - (i). How long will they take to meet each other at M?
 - (ii). What is the ratio of PM: MQ?
 - (a). 10 hr and 3:4
 - (b). 12 hr and 3:4
 - (c). 10 hr and 4:3
 - (d). 12 hr and 4:3

Solution: a $A \rightarrow \qquad \leftarrow B$ P M Q

(i) Since, they are coming towards each other from opposite ends, therefore the relative speed will be the sum of their speeds = 30+40 = 70 km/h.

Thus, the required time to meet at M

= Time required to cover 700 km (combined)

$$=\frac{700}{70}=10h$$

Thus in 10 hours they will meet each other at M. (ii) The ratio of their distances covered to meet at M = Ratio of their speeds = 3 : 4 (Since, time is constant i.e., same for each) Thus PM: MQ = 3:4



- **Q 6.** The distance between two places P and Q is 700 km. Two persons A and B started towards Q from P and towards P from Q simultaneously. The speed of A is 30 km/h and speed of B is 40 km/h. They meet at a point M which lies on the way from P to Q.
 - 1. What is the distance MQ?
 - 2. What is the extra time needed by A to reach at Q than to reach at P by B?
 - (a). 300km, 70/4 hr
 - (b). 400km, 70/4 hr
 - (c). 400 km, 70 hr
 - (d). 400 km, 35 hr

Solution: b

P.....Q $A \Rightarrow 40 \text{ km/h}$ $30 \text{ km/h} \Leftrightarrow B$ 1. Meeting time \Rightarrow 700 $\overline{(12 + 22)}$

$$(40+30)$$

⇒ 10 hours Then, distance between M and Q ⇒ Speed of B × 10 ⇒ 40 × 10

 $\Rightarrow 400 \text{ km}$ 2. Time required by A to reach at Q $\Rightarrow \frac{700}{2} \Rightarrow \frac{70}{2} h$

Time required by B to reach at P = $\frac{700}{40} = \frac{70}{4}h$

- Q7. A and B are two friends. A lives at a place P and B lives at another place Q. Everyday A goes to Q to meet B at 120 km/h. Thus, he takes 3 hours. On a particular day B started to meet A so he moved towards P. On that day A took only 2 hours to meet B on the way instead at Q.
 - (i). What is the ratio of speeds of A is to B?
 - (ii). What is the speed of B?
 - (a). 2:1 and 60km/hr
 - (b). 2:1 and 50km/hr
 - (c). 3:1 and 50km/hr
 - (d). 1:2 and 60km/hr

Solution: a

Distance between P and Q = $120 \times 3 = 360$ km Let the speed of B be S_B, then Time = **Distance**

Speed

$$\Rightarrow \frac{360}{(120+SB)}$$

\Rightarrow S_B = 60 km/h

Here, A and B are moving towards each other. So, the relative speed will be the sum of the speeds of A and B both. Therefore, ratio of speeds of A: B = 2:1.

- **Q 8.** A lives at P and B lives at Q. A usually goes to meet B at Q. He covers the distance in 3 hours at 150 km/h. On a particular day B started moving away from A. While A was moving towards Q thus A took total 5 hours to meet B.
 - (i). What is the speed of B?
 - (ii). What is the ratio of speeds of A: B?

Solution

Distance = 3 × 150 = 450 km

$$Time = ----$$

$$5 = \frac{450}{(150 - S_B)}^{\text{(SB} \rightarrow \text{Speed of B)}}$$

 $S_{B} = 60 \text{ km/h}$ Ratio of speeds of A: B = $\frac{150}{60} = \frac{5}{2} = 5:2$

(i) 60 km/h

(ii) 5:2

Q 9. A train approaches a tunnel AB. Inside the tunnel a cat is located at a point which is $\frac{5}{12}$ AB measured

of the distance from the entrance A. When the train whistles, the cat runs. If the cat moves to the entrance of the tunnel A, the train catches the cat exactly at the entrance. If the cat moves to the exit B, the train catches the cat at exactly the exit. The speed of the train is greater than the speed of the cat by what order?

- (a). 6:1 (b). 5:3 (c). 8:3
- (d). 11:13



Let the speed of train be u and the speed of cat be v and train whistles at a point T, x km away from A, then

$$\frac{u}{v} = \frac{x}{5k} = \frac{x + 12k}{7k}$$

$$\Rightarrow$$
 7x = 5(x+12k)

$$\Rightarrow \frac{x}{k} = \frac{30}{1}$$



$$\frac{u}{v} = \frac{30}{5 \times 1} = \frac{6}{1}$$

Alternatively, $\frac{u}{v} = \frac{7k+5k}{7k-5k} = \frac{6}{1}$

Practice Questions

- **Q 1.** A train crosses a tree in 10 seconds. If the length of the train be 150 m, then find the speed of the train.
 - (a). 54 km/hr
 - (b). 55 km/hr
 - (c). 56 km/hr
 - (d). 57 km/hr
- Q 2. A train crosses a man coming from the opposite direction in 7.5 seconds. If the speed of man is 10 m/s and speed of train is 20 m/s, find the length of the train.
 - (a). 220m
 - (b). 225m
 - (c). 230m
 - (d). 240m
- Q 3. A train of length 250 m crosses a bridge of length 150 m in 20 seconds. What is the speed of the train?
 - (a). 70 km/hr (b). 72 km/hr
 - (c). 72 km/hr
 - (c). 65 km/hr(d). 60 km/hr
- Q 4. Two trains coming from the opposite sides crosses each other in 10 seconds if the lengths of first train and second train be 125 m and 175 m respectively, also the speed of first train be 36 km/h, find the speed of second train.
 - (a). 70km/hr
 - (b). 72km/hr
 - (c). 75km/hr
 - (d). 80km/hr
- Q 5. A fast-moving superfast express crosses another passenger train in 20 seconds. The speed of the faster train is 72 km/hr and the speed of the slower train is 27 km/h. Also, the length of the faster train is 100 m, then find the length of the slower train if they are moving in the same direction.
 - (a). 100m
 - (b). 120m
 - (c). 150m
 - (d). 175m
- Q 6. A man can row 9 km/h in still water. It takes him twice as long to row up as to row down. Find the rate of stream flow of the river.
 - (a). 3km/hr
 - (b). 4km/hr
 - (c). 5km/hr
 - (d). 6km/hr

- **Q 7.** In a one km race A gives B a start of 100 m and in a one km race B gives a start of 80 m to C. In a 1 km race who will win and by how much distance from the worst performer between two losers?
 - (a). A will win by 172m
 - (b). B will win by 100m
 - (c). C will win by 50m
 - (d). A will win by 170m
- Q 8. In a 1 km race A gives B a startup of 5 seconds and still wins over B by 15 seconds. The ratio of speeds of A and B is 2: 1. Find the time taken by A to finish 2.5 km race.
 - (a). 25 sec
 - (b). 50 sec
 - (c). 60 sec
 - (d). 75 sec
- Q 9. X can beat Y by 200 m in a race of 2000 m. Y can beat Z by 100 m in a race of 2500 m. By how many metres can X beat Z in a race of 1000 m.
 - (a). 100m
 - (b). 120m
 - (c). 130m
 - (d). 136m
- **Q 10.** Shahrukh takes 4 min to cover the same distance for which Urmila takes 6 min 30 sec. What is the ratio of distances covered by Shahrukh and Urmila in the race of 2.6 km and by what distance Shahrukh wins over Urmila?
 - (a). 800m
 - (b). 1km
 - (c). 1.2km
 - (d). 1.5km
- Q 11. Arjun and Bhishma are running on a circular track of length 600 m (i.e., circumference of the track is 600 m). Speed of Arjun is 75 m/s and that of Bhishma is 45 m/s. They start running from the same point at the same time the same direction.
 - (i). When will they meet again for the first time?
 - (ii). When will they meet again for the second time?
 - (iii). When will they meet again for the tenth time?
 - (a). 20sec, 60 sec, 100 sec
 - (b). 20 sec, 50 sec, 100 sec
 - (c). 15 sec, 20 sec, 50 sec
 - (d). 20 sec, 60 sec 200 sec

Q 12. How much time did X take to reach the destination?

- (i). The ratio between the speeds of X and Y is 3:4.
- (ii). Y takes 36 minutes to reach the same destination.
- (a). Only Statement I is necessary to answer the question
- (b). Only Statement II is necessary to answer the question
- (c). Both the Statements are necessary to answer the question
- (d). None of the Statement is sufficient to answer the question.



- **Q 13.** Shweta walked from her home to the bus stop and back again. How long did it take her to make the entire trip?
 - (i). She walked from home to the bus stop at the rate of 3 km/hr.
 - (ii). She walked back to home at 5 km/hr.
 - (a). Only Statement I is necessary to answer the question
 - (b). Only Statement II is necessary to answer the question
 - (c). Both the Statements are necessary to answer the question
 - (d). None of the Statements is sufficient to answer the question.

Q 14. What is the distance between City A and City B?

- (i). Bus starting from A reaches B at 6: 15 p.m. at an average speed of 60 kmph. noon.
- (ii). Bus at an average speed of 40 kmph reaches A at 4: 35 p.m. if it starts from B exactly at noon.
- (a). Only Statement I is necessary to answer the question
- (b). Only Statement II is necessary to answer the question
- (c). Both the Statements are necessary to answer the question
- (d). None of the Statement is sufficient to answer the question.

Q 15. Sachin jogs at a constant rate for 80 minutes along the same route everyday. How long is the route?

- (a). Yesterday, Sachin began jogging at 5:00 pm
- (b). Yesterday, Sachin had jogged 5 miles by 5: 40 p.m. and 8 miles by 6 : 04 p.m.
- (c). Only Statement I is necessary to answer the question
- (d). Only Statement II is necessary to answer the question
- (e). Both the Statements are necessary to answer the question
- (f). None of the Statement is sufficient to answer the question

Solutions

1. Solution: a

Distance = Length of train = Speed of train × Time 150 = Speed × 10 \Rightarrow Speed = 15 m/s 18 = 54 km/hSpeed = 5

NOTE: A train starts to cross a stationary thin object (of inconsiderable thickness) when the engine of the train meets the object and it completes the crossing when the last wagon (or backend) of the train just crosses the object.

2. Solution: b

Length of train = Time × Relative speed $= 7.5 \times (10+20) \Rightarrow 7.5 \times 30 \Rightarrow 225 m$

3. Solution: b

(Length of train + Length of bridge) = Speed of train × Time (250+150) = 20 × Speed

Speed = 400 = 20m/s=72 km/h 20

4. Solution: b

Speed of first train = 36 km/h =10 m/s

Now,
$$Time = Sum of length of the trains$$

Sum of their speed

$$\Rightarrow 10 = \frac{125 + 175}{(10 + x)}$$

⇒72 km/h ⇒ x = s

So,

Speed of the second train will be 72 km/hr.

5. Solution: c

$$\Rightarrow 20 = \frac{(100 + x)}{25/2} = 150 \text{ m}$$

NOTE Relative speed = $(72-27) \Rightarrow 45 \text{ km/h}$

$$\Rightarrow 45 \times \frac{5}{18}$$

$$\Rightarrow \frac{25}{2} \text{m/s}$$

6. Solution: a

Time taken in upstream Time taken in downstream Downstream speed $= \frac{2}{-}$ where

Upstream speed

 $B \rightarrow$ Speed of boat in still water $R \rightarrow$ Speed of current

$$\Rightarrow \frac{B}{R} = \frac{3}{1}$$
$$\Rightarrow \frac{9}{R} = \frac{3}{1} \Rightarrow R = 3 \text{ km/h}$$



7. Solution: a

Ratio of speeds of A: B = 1000 : 900 = 100 : 90 Ratio of speeds of B: C = 1000 : 920 = 100 : 92 Therefore, when A moves 1000 m, B moves 900 m and when B moves 900 m, C moves 828 m. Thus,



Since, C moves 8% less than B in the same time. Thus, C is the worst performer and A will win by him by 172 m.

8. Solution: b

 $\frac{\text{Speed of A}}{\text{Speed of B}} = \frac{2}{1}$ $\frac{\text{Time taken by A}}{\text{Time taken by B}} = \frac{1}{2}$ $\frac{t}{(t+20)} = \frac{1}{2}$

 \Rightarrow t = 20 s

Thus, A needs 20 seconds to cover 1 km. Thus, to cover 2.5 km race he needs 20 x 2.5=50 seconds.

9. Solution: d

Ratio of speeds of X and $Y = 10.9$	(2000: 1800)					
Ratio of speeds of Y and Z = 25:24	(2500: 2400)					
Ratio of speeds of X, Y and Z = 250: 225: 216						
Since in a race of 250 m, X beats Z by 34 m.						
So, in a race of 1000 m, X will beat Z by	/ 136 m.					

10. Solution: b

Time taken by shahrukh	_ 240 _ 8
Time taken by Urmila	390 13
Distance covered by sha	hrukh _ 13
Distance covered by U	rmila 8

Hence, Shahrukh will win the race by 1 km.

11. Solution: d

Since the two bodies are continuously and consistently running on the same circular path they will certainly meet again and again.

Under the given circumstances the two bodies will meet, after the start, when the difference in distance traversed by them is either 1 round or 2 rounds or 3 rounds and so on. That is, their first meeting occurs when the faster body covers 1 extra round. And, second meeting occurs when the faster body covers 2 extra rounds. And, third meeting occurs when the faster body covers 3 extra rounds. And so on so forth. In other words, the faster body has to have a lead of 1 round, 2 rounds, 3 rounds etc. depending on the number/order of meeting. And, thus the time

required to have a lead of 1 round = Circumference .

Relative speed

So, the time required to have a lead of n rounds

(i) In order to meet for the first time, after the start of the race, Arjun (faster man) has to have a lead of 600 m, because as soon as Arjun will cover 600 m extra than that of Bhishma, Arjun will overtake Bhishma.

And, you know that Arjun gets a lead of 30 m in every 1 second, so to have a lead of 600 m Arjun has to run for 600/30 = 20 seconds. Otherwise, Time seconds

_ Circumference _	600	600	= 20	seconds
relative speed	75 - 45	30		

That is after 20 seconds they will meet for the first time, while running in the same direction.

(ii) In order to meet for the second time, after the start of the race, Arjun (faster man) has to have a lead of 2 rounds.

Time =
$$2 \times \frac{\text{Circumference}}{\text{Relative speed}}$$

$$2 \times \frac{600}{75 - 45} = \frac{1200}{30}$$

 \Rightarrow 60 seconds

Hence, after 60 seconds they will meet for the second time, while running in the same direction.

(iii) In order to meet for the tenth time, after the start of the race, Arjun (faster man) has to have a lead of 10 rounds.

$$\text{Time} = 10 \times \frac{\text{Circumference}}{\text{Re lative speed}} = 10 \times \frac{60}{75 - 45} = \frac{6000}{30} = 200 \text{ sec onds}$$

That is after 200 seconds they will meet for the tenth time, while running in the same direction.



12. Answer: c

I. If Y takes 3 min, then X takes 4 min. II. If Y takes 36 min, then X takes (4

$$\begin{pmatrix} 4\\ -\times 36\\ 3 \end{pmatrix}$$
 min=48 min.

Thus, I and II together give the answer. -: Correct answer is (c).

13. Answer: d

Since the distance between the house and the bus stop is not given, the duration of the trip cannot be calculated. Correct answer is (d).

14. Answer: b

I. Only the reaching time is given. So, the duration of the journey and hence the distance between City A and City B cannot be calculated.

II. Required distance = $\left(40 \times \frac{35}{60}\right)$ km = $23\frac{1}{3}$ km

alone (II) can give the answer. :- Correct answer is (b).

15. Answer: b

From II, we have: Distance covered by Sachin from 5:40 p.m. to 6:04 p.m i.e., in 24 min, 3 miles.

Length of the route = Distance covered in 80 min $c_{1} = 10$ miles

$$\left(\frac{3}{24} \times 80\right)^{=10}$$

So, II alone gives the answer while I alone do not. Correct answer is (b).

