Speed, Distance and Time

Problems on Speed, Distance and Time chapter means solving complex situations with the help of tricky solutions. The topic covers both easy and difficult aspects to the problems. The easy aspect is the formula;

$$Speed = \frac{Distance}{Time}$$

The difficult aspect is the application of the formula in a tricky way. Let's have a look at the other basic formulas of time, speed and distance problem:

Basic Conversions

Conversion Parameter	Formulas
To convert kilometer per hour (km/hr) to meter per second (m/s)	Multiply the speed in kilometer per hour by $\frac{5}{18}$ $a\ kmph = \frac{5}{18} a\ mps$
To convert meter per second to kilometer per hour	Multiply the speed in meter per second by $\frac{18}{5}$ $a\ mps = \frac{18}{5} a\ kmph$

Example 1: How long will it take for a 175 m long train running at a speed of 56 km/hr to cross a signal?

a) 12 sec
b) 11 1/4 sec
c) 13.5 sec
d) 14 sec

Answer: b)

Explanation: The train takes 1 hour (3600 sec) to cover 56 kms (56000 meters)
Therefore time taken to cover 175 meter= 3600/56000*175
= 11.25 sec

Example 2: A train travelling at the rate of 72 km/hr crosses a pole in 8 seconds. What is its length?

a) 125 m
b) 145 m
c) 160 m
d) None of these

Answer: c)

Explanation: Time $= 8\ secs$
Speed $= 72\ kmph = 72 \times \frac{5}{18}\ m/s = 20\ m/s$
Length $= speed \times time = 8 \times 20 = 160\ m$

Average Speed

The basic formula for average speed is

$$Average\ speed = \frac{Total\ distance}{Total\ time}$$

That is,

$$Average\ speed = (d_1 + d_2 + \cdots . + d_n)/(t_1 + t_2 + \cdots \ldots + t_n)$$

- *When distance is constant:*
  The average speed is given by the formula,

$$Average\ speed = \frac{n}{\left(\frac{1}{s_1}\right) + \left(\frac{1}{s_2}\right) + \cdots .. + (1/s_n)}$$

  Where n – s_1, s_2, s_n are the different speeds.
  For two speeds,

$$Average\ speed = \frac{2s_1 s_2}{s_1 + s_2}$$

  Where are s_1 and s_2 are the two different speeds.
  For e.g., if a car travels d distance at a speed of x kmph and returns at y kmph then the above formula can be used to calculate the average speed.

- *When time is constant:*
  The average speed is given by the formula,

$$Average\ speed = \frac{s_1 + s_2 + \cdots + s_n}{n}$$

  For two speeds,

$$Average\ speed = \frac{s_1 + s_2}{2}$$

Example (3-4): Answer the questions based on the information given below:
Cities A and B are in different time zones. A is located 3000 km east of B. The table below describes the schedule of an airline operating non-stop flights between A and B. All the times indicated are local and on the same day.
Assume that planes cruise at the same speed in both directions. However, the effective speed is influenced by a steady wind blowing from east to west at 50 km per hour. *(CAT 2007 Exam)*

Departure		Arrival	
City	Time	City	Time
B	8:00 a.m.	A	3:00 p.m.
A	4:00 p.m.	B	8:00 p.m.

What is the time difference between A and B?
a) 1 hour and 30 minutes
b) 2 hours
c) 2 hours and 30 minutes
d) 1 hour
e) Cannot be determined
Answer: d)
Explanation: Let the speed of the plane be x kmph.
Then the speed from B to A will be (x — 50) kmph and from A to B will be (x + 50) kmph.
It can be deduced that the plane travels from B to A, halts for 1 hour and travels back to B, total in 12 hrs.

$\frac{3000}{x-50} + 1 + \frac{3000}{x+50} = 12$

The above expression can be satisfied with the value of $x = 550$.

Therefore, the Speed of plane = 550 kmph

Now, the plane takes $\frac{3000}{500} = 6$ hrs to travel from B to A.

It reaches A when the time at B is 8:00 am + 6 hrs = 2:00 p.m.

The time difference between A and B is 1 hour.

What is the plane's cruising speed in km per hour?

a) 700
b) 550
c) 600
d) 500
e) Cannot be determined

Answer: b)

Explanation: The cruising speed of the plane is 550 km/hr which already has been calculated in the previous question.

Example 5: A man rides a motor cycle for 11 km at 20 km/hr and for 20 km at 11 km/hr. What is the average speed of both his trips?

a) 75 km/hr
b) 74.31 km/hr
c) 71.43 km/hr
d) 73.41 km/hr

Answer: d)

Explanation: Time to cover 11 km= 11/20 hrs

Time to cover 20 km= 20/11 hrs

Total time= $\frac{11}{20} + \frac{20}{11} = \frac{521}{220}\ hrs$

Speed = $31 * \frac{521}{220}$ = 73.41 km/hr

Example 6: Four cars are hired at the rate of Rs. 6 per km plus the cost of diesel at Rs. 40 a litre. In this context, consider the details given in the following table:

Car	Mileage (km/l)	Hours	Total Payment (Rs.)
A	8	20	2120
B	10	25	1950
C	9	24	2064
D	11	22	1812

Which car maintained the maximum average speed? *(CSAT 2014 Exam)*

a) Car A
b) Car B
c) Car C
d) Car D

Answer: a)

Explanation: Let the distances travelled by cars A, B, C and D be a, b, c and d, respectively.

Then, total payment for car A = $6a + 40\left(\frac{a}{8}\right) = 11a$

$=> 11a = 2120 => a = \frac{2120}{11}$

It is mentioned that car A travels for 20 hrs

Then, the average speed of A = $\frac{2120}{11 \times 20} = 9.64$ ..... 1)

Equation for B: $6b + 40\left(\frac{b}{10}\right) = 1950 \Rightarrow b = 195$

The average speed of B = $\frac{195}{25} = 7.80$ ..... 2)

Equation for C: $6c + 40\left(\frac{c}{9}\right) = 2064 \Rightarrow c = \frac{9288}{47}$

The average speed of C = $\frac{9288}{47 \times 24} = 8.23$ ..... 3)

Equation for D: $6d + 40\left(\frac{d}{11}\right) = 1812 \Rightarrow d = \frac{9966}{53}$

The average speed of D = $\frac{9966}{53 \times 22} = 8.55$ ..... 4)

Hence, car A has the maximum average speed of 9.64 km/hr.

Problems on Trains

- *Opposite Direction*

  Running in opposite direction, time taken by two trains of length a km and b km and speeds x mph and y kmph respectively to cross each other is given by,

$$\frac{a+b}{x+y}\ hours$$

Example 7: Two trains start towards each other, from two places A and B which are at a distance of 160 km. They start at the same time 08: 10 AM. If the speeds of the trains are 50 km and 30 km per hour respectively, they will meet each other at: *(CSAT 2013 Exam)*

a) 10 : 10 AM
b) 10 : 30 AM
c) 11 : 10 AM
d) 11 : 20 AM

Answer: a)

Explanation: Relative speed= Sum of speeds of two trains = $50 + 30 = 80\ km/hr$

Time= $\frac{Distance}{Speed}$ => $\frac{160}{80}$ = 2 hours

Required time = $8{:}10 + 2{:}00 = 10{:}10\ hours$

- *Same Direction*

  Running in same direction, time taken by two trains of length a km and b km and speeds x mph and y kmph respectively to cross each other is given by,

$$\frac{a+b}{x-y}\ hours$$

Example 8: Two train travel in same direction one at 30 kmph and the other at 102 kmph. A man sitting in the slower train passes the faster train in 6 s. what is the length of the faster train?

a) 120m
b) 145 m
c) 130
d) None of these

Answer: a)

Explanation: Since the train are running in same direction,
The length of the faster train

$= (102 - 30) \times \frac{5}{18}$Error! Bookmark not defined. $\times 6\ secs = 72 \times \frac{5}{18} \times$ 6Error! Bookmark not defined. $= 120\ m$

Example 9: The speed of train A and train B are in ratio 4:5. If A takes 40 min more than B to cover the same distance then how much time does A take to cover this distance?

a) 200 m
b) 220 m
c) 250 m
d) None of these

Answer: a)

Explanation: Since the ratio of speed is 4 : 5 , so the ratio of time will be 5 : 4 .
If it takes 40 min more, then $5x - 4x = 40 \Longrightarrow x = 40\ min$
A takes 5 x min or 5 × 40 = 200 min

- If two trains X and Y starting from A and B and run towards each other and take a and b hours to reach B and A respectively after crossing each other then,

$$Speed\ of\ X : Speed\ of\ Y = \sqrt{b} : \sqrt{a}$$

Example 10: A train starts moving from A to B, and at the same time another train starts from B to walk to A. After passing each other they complete their journeys in $3\frac{1}{3}$ and $4\frac{4}{5}$ hours respectively. At what rates does the second train moves if the first moving at 8 km per hour?

a) $6\frac{2}{3}$
b) $5\frac{2}{3}$
c) $4\frac{1}{3}$
d) None of these

Answer: a)

Explanation: If two trains X and Y start at the same time in opposite directions from two points and arrive at the point p and q hrs respectively after having met, then

X's speed: Y's speed = $\sqrt{q} : \sqrt{p}$

$$= \frac{\sqrt{4\frac{4}{5}}}{\sqrt{3\frac{1}{3}}} = \frac{6}{5}$$

2nd train's speed $= \frac{5}{6} \times 8 = 6\frac{2}{3}$

Example 11: A train travels at a certain average speed for a distance of 63 km and then travels a distance of 72 km at an average speed of 6 km/hr more than its original speed. If it takes 3 hours to complete the total journey, what is the original speed of the train in km/hr? *(CSAT 2013 Exam)*

a) 24
b) 33
c) 42
d) 66

Answer: c)

Explanation: $t_1 = \frac{63}{x}$

$t_2 = \frac{72}{x+6}$

$t_1 + t_2 = \frac{63}{x} + \frac{72}{x+6}$

$3 = \frac{63}{x} + \frac{72}{x+6}$

$3x(x+6) = 63(x+6) + 72x$

$3x^2 + 18x = 63x + 378 + 72x$

$3x^2 - 117x - 378 = 0$

$3x^2 + 9x - 126x - 378 = 0$

$3x(x+3) - 126(x+3) = 0$

$(3x - 126)(x+3) = 0$

Since speed can never be in negative figure,

So, $x = \frac{126}{3} = 42\ km/hr$

Example 12: In covering a certain distance, the speeds of train A and train B are in the ratio of 3 : 4. Train A take 30 minutes more than train B to reach the destination. The time taken by train A to reach the destination is: *(SSC CGL 1999 Exam)*

a) 1 hour

b) $1\frac{1}{2}$ hours

c) 2 hours

d) $2\frac{1}{2}$ hours

Answer: c)

Explanation: Let the distance of destination = D km

Let the speed of train A = 3x km/hr

Then speed of train B = 4x km/hr

∴ According to question,

$$\frac{D}{3x} - \frac{D}{4x} = \frac{1}{2}\text{hr} = 30 \text{ minutes}$$

$$\therefore \frac{D}{12x} = \frac{1}{2}\text{hr}$$

$$\therefore \frac{D}{3x} = \frac{4}{2} = 2 \text{ hours}$$

∴ Time taken by train A to reach destination = 2 hours

Boats and Streams

If the speed of boat in still water is x kmph and the speed of the stream is y kmph then,

Boat will travel with the stream *or Upstream speed* $= (x - y)kmph$

Boat will travel against the stream *or Downstream speed* $= (x + y)kmph$

If the downstream speed is a kmph and upstream speed is b kmph then,

$$Speed\ of\ boat\ in\ still\ water = \frac{a+b}{2}\ kmph$$

$$Speed\ of\ stream = \frac{a-b}{2} kmph$$

Note: If in the question the speed of boat is given then it normally means speed of boat in still water.

Example 13: A boat goes 20 km downstream in one hour and the same distance upstream in two hours. The speed of the boat in still water is: *(SSC CPO 2003 Exam)*

a) 15 km/hr
b) 10 km/hr
c) 5 km/hr
d) 6.5 km/hr

Answer: a)

Explanation: Let the speed of boat in still water = x kmph and the rate of stream = y kmph.

$\therefore$ Downstream rate

$= (x + y)$ kmph and upstream rate $= (x - y)$ kmph.

Now,

$$\frac{20}{x = y} = 1$$

$$\Rightarrow x + y = 20 \ldots..(i)$$

$$\text{and } \frac{20}{x - y} = 2$$

$$\Rightarrow x - y = 10....(ii)$$

From (i) and (ii) we have $x = 15\ km/hr$.

Example 14: Two boats, travelling at 5 and 10 kms per hour, head directly towards each other. They begin at a distance of 20 kms from each other. How far apart are they (in kms) one minute before they collide? *(CAT 2004 Exam)*

a) $\frac{1}{12}$
b) $\frac{1}{6}$
c) $\frac{1}{4}$
d) $\frac{1}{3}$

Answer: c)

Explanation: Relative speed of two boats = 5 + 10 = 15 km/hr

i.e. in 60 min they cover (together) = 15 km

$\therefore$ in 1 min they will cover (together) $\frac{15}{60} = \frac{1}{4}$ km

Some Shortcut Methods

- A person can row certain distance downstream in t_1 hours and returns the same distance upstream in t_2 hours. If the speed of stream is y km/h, then the speed of man in still water is given by

$$= y\left(\frac{t_2 + t_1}{t_2 - t_1}\right) km/h$$

Example 15: A person travels some distance against the current of the stream in 2 hour and returns with the stream in 20 minutes. If the speed of stream is 4 km/hr then how long will it take for the man to go 4 km in still water?

a) 40 mins (approx.)

b) 30 mins (approx.)
c) 20 mins (approx.)
d) 10 mins (approx.)
Answer: b)
Explanation: Let's say t_1 = 20 minutes = 0.33 hours and t_2 = 1 hours
Y = 4, then man's speed in still water

$$= \frac{y\left(\frac{t_2+t_1}{t_2-t_1}\right)km}{h} = 4\left(\frac{1+0.33}{1-0.33}\right) = \frac{4\times1.33}{0.67} = 7.94\ km/hr$$

So man's speed is 7.94 km/h in still water.
Now, time taken by the man to row 4 km in still water

$$= \frac{4\times1}{7.94} = 0.504\ hrs = 30.23\ mins$$

- A person can row in still water at x km/h. In a stream flowing at y km/h, if it takes him t hours to row to a place and come back, then the distance between two places is given by

$$= \frac{t(x^2-y^2)}{2x}$$

Example 16: A person can row 4 km/hr in still water. When the water is running at 2 km/hr, it takes him 2 hours to go to a place and come back. What is the distance between that place and person's initial position?
a) 3 km
b) 4 km
c) 5 km
d) 6 km
Answer: a)
Explanation: Let's say x = 4 km/hr = man's speed in still water.
y = 2 km/hr = water's speed.
t = 2, so

$$\text{Distance} = \frac{t(x^2-y^2)}{2x} = \frac{2(4^2-2^2)}{2\times4} = 3\ km$$

- A person can row in still water at x km/hr. In a stream flowing at y km/hr, if it takes t hours more in upstream than to go downstream for the same distance, then the distance is given by

$$= \frac{t(x^2-y^2)}{2y}$$

Example 17: A person can row 4 km/hr in still water. The water is running at 2 km/hr. He travels to a certain distance and comes back. It takes him 2 hours more while travelling against the stream than travelling with the stream. What is the distance?
a) 5 Km
b) 6 Km
c) 7 Km
d) 8 Km
Answer: b)
Explanation: Let's say x = 4 km/h = man's speed in still water.
y = 2 km/h = water's speed.
t = 2, so

$$\text{Distance} = \frac{t(x^2-y^2)}{2y} = \frac{2(4^2-2^2)}{2\times2} = 6\ km$$

- A person can row in still water at x km/hr. In a stream flowing at y km/hr, if he rows the same distance up and down the stream, then his average speed is given by

$$= \frac{Upstream \times Downstream}{Man's\ speed\ in\ still\ water}$$

$$= \frac{(x-y)\times(x+y)}{x} = \frac{(x^2-y^2)}{x} km/h$$

Example 18: Speed of an ark in still water is 9 km/hr and speed of stream is 2 km/hr. The ark rows to a place which is 47 km away and comes back in the same path. Find the average speed of ark during whole journey.

a) 6.55 km/hr
b) 7.55 km/hr
c) 8.55 km/hr
d) 9.55 km/hr

Answer: c)

Explanation: Let's say x = 9 km/h = speed in still water

$y = 2\ km/hr$ = speed of stream

Average Speed $= \frac{(x^2-y^2)}{x} = \frac{(9^2-2^2)}{9} = 8.55\ km/hr$

Races and Chases

The questions relating to races & chases involves contest of speed in running, riding, driving, sailing or rowing. This topic also comes under the umbrella of Speed, Distance and Time.

Linear Race

- Winners' distance = Total length of the race track
- Time taken by winner = Time taken by loser- (beat time + start time)
- Loser's distance = Winner's distance-(beat distance+ start distance)
- $\frac{Winner's\ time}{Loser's\ distance} = \frac{Loser's\ time}{Winner's\ distance} = \frac{beat\ time + start\ time}{beat\ distance + start\ distance}$
- A race ends in dead lock when beat time=beta distance = 0

Example 19: A thief running at 8 km/hr is chased by a policeman whose speed is 10 km/hr. If the thief is 100 m ahead of the policeman, then the time required for the policeman to catch the thief will be

(CSAT 2013 Exam)

a) 2 min
b) 3 min
c) 4 min
d) 6 min

Answer: b)

Explanation: If we consider the difference of speeds, the policeman is at 2 km/hr leading speed and hence he can catch the thief at 100m ahead by:

$$\frac{100m}{2kmp\ h} = \frac{100}{2000} \times 60 = 3\ minutes$$

Example 20: In a 500 meters race, B starts 45 meters ahead of A, but A wins the race while B is still 35 meters behind. What is the ratio of the speeds of A to B assuming that both start at the same time?

(CSAT 2015 Exam)

a) 25:21
b) 25:20
c) 5:3
d) 5:7
Answer: a)
Explanation: Both A and B started at the same time. -------- (1)
B starts 45 m ahead of A but A wins the race while B is still 35 m behind.
∴ When A finishes, B would have run 80 m less than A. -------- (2)
A runs the entire race length, i.e., 500 m. -------- (3)
From (1), (2), (3), B would have run 420 m in the same time that Aruns 500 m.
∴ Ratio of the speeds of A and B = 500 : 420 = 25:21

Circular Race

When two people run in a circular track of length '*L*' at speeds '*a*' and '*b*' respectively in the same direction, then,

- Time at which they meet first= $\frac{L}{a-b}$

When two people run in a circular track of length '*L*' at speeds '*a*' and '*b*' respectively in the opposite direction, then,

- Time at which they meet first= $\frac{L}{a+b}$

When three people run in a circular track of length '*L*' at speeds '*a*' , '*b*' *and* 'c' respectively in the same direction, then,

- Time at which they meet first= $\frac{L}{a-b}, \frac{L}{a-c}$

Example 21: In a circular race of 1800 m length, A and B start with speeds of 36kmph and 54 km/hr starting at the same time from the same point. When will they meet for the first time at the starting point when running in the same direction and opposite direction?

a) 240, 160
b) 360, 360
c) 240, 240
d) 160, 480
Answer: b)
Explanation: Length of the track L = 1800 m

Speed of A = $36 \times \frac{5}{18} = 10\ m/s$

Speed of B = $54 \times \frac{5}{18} = 15\ m/s$

Time taken by A to complete one round = $\frac{1800}{10} = 180\ sec$

Time take by B to complete one round = $\frac{1800}{15} = 120\ sec$

(i) Same direction:
They will meet at the starting point at a time which is the LCM of the timings taken by each of them to complete one full round, i.e., the LCM of 120s and 180s which is 360 Seconds.
(ii) Opposite Direction:
They will meet at the starting point at a time which is the LCM of the timings taken by each of them to complete one full round, i.e., the LCM of 160s and 240s which is 360 Seconds.

Circular Motion

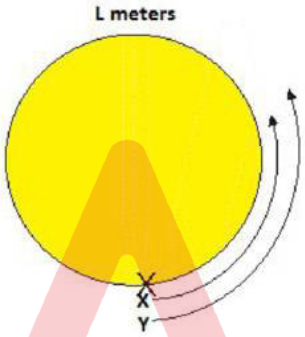
Circular motion should be seen as a logical extension of Races where runners are running on a circular track. Since it an enclosed track (by virtue of it being circular), runners are bound to meet at some point or the other.

- Same Direction

  Relative speed of two bodies moving in a circular path in the same direction at x and y kmph respectively is given by

  $$(x-y)kmph$$

  When two persons X, and Y are running around a circular track of length L meters with speeds of $x\ and\ y$ m/s in the same direction.



  They meet each other at any point on the track is $\frac{L}{x-y}$ seconds

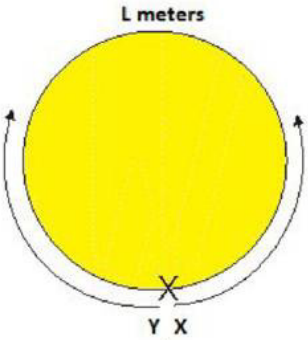
  They meet each other at exactly at the starting point $= (\frac{L}{x}, \frac{L}{y})$ seconds

- Opposite Direction

  Relative speed of two bodies moving in a circular path in the opposite direction at x and y kmph respectively is given by

  $$(x+y)kmph$$

  When two persons X, and Y are running around a circular track of length L meters with speeds of $x\ and\ y\ m/s$ in opposite direction,



  They meet each other at any point on the track is $\frac{L}{x+y}$ seconds

  They meet each other at exactly at the starting point $= (\frac{L}{x}, \frac{L}{y})$ seconds

- When three persons A, B and C are running around a circular track of length L meters with speeds of $x, y \text{ and } z\ m/s$ in the same direction, then
  They meet each other at any point on the track is $\frac{L}{x-y}, \frac{L}{y-z}$ seconds

Example 22: P and Q are travelling in the opposite directions on a circular track and they meet each other after some time. What will be the ratio of their speeds, if the time taken by P and Q to meet is $1/4^{th}$ of the time taken if they both travel in the same direction?

a) 5: 3
b) 6 : 5
c) 4 : 3
d) 3 : 2

Answer: a)

Explanation: Let speed of P = x kmph
& speed of Q = y kmph (Note: $x > y$)
When they are travelling in same direction, time taken be t

$\frac{1}{x-y} = t$ ..... (i)

When they are travelling in opposite direction

$\frac{1}{x+y} = \frac{t}{4}$ ..... (ii)

From Equation (i) & (ii)

$\frac{x+y}{x-y} = 4$

$x + y = 4x - 4y \Rightarrow 5y = 3x$

$\Rightarrow \frac{x}{y} = \frac{5}{3}$

$x : y = 5 : 3$

Practice Exercise

LEVEL – I

1. How much time does one running at a speed of 10 km/he takes to cover a distance of 600 meters?
   a) 3 minutes 12 seconds
   b) 3 minutes
   c) 3 minutes 36 seconds
   d) 3 minutes 45 seconds

2. A train crosses a 100 meter platform and a person standing on it in 20 seconds and 15 seconds respectively. What is the speed of the train?
   a) 70 kmph
   b) 72 kmph
   c) 68 kmph
   d) Cannot be determined

3. Find out the average speed of the car if a person covers the first 60 km of its journey in 15 minutes and the remaining 65 km in 35 minutes?
   a) 42 km/hr
   b) 50 km/hr

c) 125 km/hr
d) 120 km/hr

4. Ramit covered a distance of 450 km as follows. He covered the first 30 km at 45 km/hr, the next 240 km at 60 km/hr and the remaining journey at 75 km/hr. Find his average speed for the journey of 450 km.
   a) 65 km/hr
   b) 67.5 km/hr
   c) 70 km/hr
   d) 73.5 km/hr

5. Two trains of length 123 m and 124 m are running in opposite direction at a speed of 125 kmph and 122 kmph respectively. How much time do they take to cross each other?
   a) 1 min
   b) 1×10^{-3} hrs
   c) 0.01 hrs
   d) Cannot be determined

6. Two trains from A and B cross each other and reach B and A after 3 and a half hours and 3 hours 20 minutes respectively. What is the speed of train B if the speed of A is 80 km/hr?
   a) 78.16 km/hr
   b) 78.99 km/hr
   c) 78.85 km/hr
   d) 79.25 km/hr

7. 70 men took a dip in a water tank 14 m long and 20 m broad on a religious day. If the average displacement of water by a man is 3 m^3, then the rise in the water level in the tank will be:
   a) 70 cm
   b) 75 cm
   c) 60 cm
   d) 65 cm

8. If a boy walks from his house at 5 kmph, he reaches school 5 min early, and if he walks at 4 kmph he reaches 5 min late. How far does he walk for his school?
   a) 5 Km
   b) 10 Km
   c) 6.67 Km
   d) 3.33 Km

9. The speed of the boat in still water is 20 m/s and the speed of the stream is 12 m/s. if the boat is moving upstream and again downstream, then what is the ratio of the time taken to cover a particular distance in each direction?
   a) 4:1
   b) 3:1
   c) 2:1
   d) 1:1

10. A boat takes a total of 8 hours to travel 12 kms downstream and to return back to the starting point. If speed of the boat is 4 kmph, then for how much time was the boat moving downstream and for how much time upstream?
    a) 6.82 hours
    b) 7.82 hours
    c) 8.82 hours
    d) 9.82 hours

11. A boat travel 3 hours downstream and then 3 hours upstream and covers a total distance of 12 kms, if the speed of stream is 1 kmph, how much time will he have to travel upstream to reach the starting point?
    a) 12
    b) 6
    c) 9
    d) 15

12. The speeds of two athletes are in the ratio 2:3 and the first athlete reaches the destination 15 minutes after the second athlete. What is the distance covered?
    a) 1 km
    b) 2 km
    c) 0.75 km
    d) 1.5 km

13. A, B, C run around a circular track 1800 m long with speed of 36, 54, 72 km/hr. If they start at the same point and at the same time in the same direction, when will they meet again at the starting point?
    a) 360 sec
    b) 480 sec
    c) 240 sec
    d) None of the above

14. Karan and Arjun are jogging on a circular track. Arjun is a better athlete and jogs at 18 km/hr, while Karan jogs at 9 km/hr. The circumference of the track is 500 m. They start from the same point and in the same direction. When will they be together again for the first time?
    a) 500 sec
    b) 250 sec
    c) 200 sec
    d) 180 sec

15. A can run one full round of a circular track in 12 min and B in 30 min. If both A and B start simultaneously from the same starting point then how many times would they met in the time B has completed 20 rounds when running in same direction, and in opposite direction?
    a) 50, 40
    b) 50, 70
    c) 30, 40
    d) 30, 70

LEVEL – II

16. Ram and Shyam leave cities A and B at 8 am and travel towards B and A respectively. Speed of Ram is 60 km/h and speed of Shyam is 120 km/h. Mohan leaves A for B sometime later and travels at a speed of 90 km/h. If the distance between A and B is 1080 km and all three meet at the same point on the way, at same time, then at what time did Mohan leave A?
    a) 7:00 am
    b) 10:00 am
    c) 7:30 am
    d) 10:00 am

17. A lady while walking diametrically across a semicircular playground takes 3 minutes less than if she had kept walking round the circular path from A to B. If she walks 60 metres a minute, what is the diameter of the play ground:
    a) 600 m
    b) 720 m
    c) 840 m
    d) 480 m

18. The speed of a train during the second hour of its journey is thrice that in the first hour. Also its third hours speed is the average speed of the first two hours. Had the car travelled at the second hours speed during all the first three hours, and then it would have travelled 300 km more. Find the percentage reduction in time in the second case for the first three hours:
    a) $33\frac{1}{3}\%$
    b) 40%
    c) 25%
    d) 50%

19. A man can cross a downstream river by steamer in 60 minutes and same by boat in 80 minutes. If the time of crossing the river in upstream direction by steamer is 70% more than downstream time by the steamer and the time required by boat to cross the same river by boat in upstream is 70% more than the time required in downstream by boat. What is the time taken for the man to cross the river downstream by steamer and then return to same place by boat half the way and by steamer the rest of the way?
    a) 85 min
    b) 172.5 min
    c) 150 min
    d) 125 min

20. A person fired two shots from a building at an interval of 152 seconds. A bear separating too fast hears the two shots at an interval of 166 seconds. If the velocity of the sounds is 1195.2 km/h, then find the speed of bear?
    a) 112.8 km/h
    b) 100.8 km/h
    c) 80.16 km/h
    d) None of these

21. There were a rabbit and a dog walking in the two different rings of same radii. There is a person observed that when rabbit moved 3 steps, dog moved 5 steps in the same time, but the distance traversed by rabbit in 5 steps is equal to be distance traversed by dog in 4 steps. What is the number of rounds that a rabbit made when dog completed 200 rounds?
    a) 120
    b) 96
    c) 75
    d) None of these

22. A candle of 12 cm long burns at the rate of 10 cm in 10 h and another candle of 16 cm long burns at the rate of 12 cm in 8 h. What is the time required by each candle to remain of equal lengths after burning for some hours, when they start to burn simultaneously with uniform rate of burning?
    a) 1 h
    b) 1.5 h
    c) 2 h
    d) None of these

23. Two boats start at the same instant to cross a river X metre wide. The faster boat reaches the other bank and returns back immediately. What are the distances travelled by them when they meet, where the speeds of these boats are S_1 & S_2?
    (a) $\frac{2X}{(S_1+S_2)}, \frac{2X}{(S_1-S_2)}$
    (b) $\frac{2X}{(S_1+S_2)}S_1$ and $\frac{2X}{(S_1+S_2)}S_2$
    (c) $\frac{X}{(S_1+S_2)}S_1, \frac{X}{(S_1+S_2)}S_2$
    (d) Data insufficient

24. A bee flew from point X, the starting point of a subterranean passage and a train is entering from Y, the other end of passage. At moment when train starts from Y towards X, fly starts moving towards the engine , and then comes back to the end X. It repeats until train until train engine reaches point X of the passage. Find the total distance covered by the bee if the speed of the bee is 40 km/hour, the speed of the train is 80 Km/hour and the passage length is 20 km?
    a) 20 km
    b) 30km
    c) 10km
    d) Cannot be determined

25. A criminal escaped from the jail and run at the speed of 45 km /hr. The police start chasing him in the same direction at the speed of 60 km/hr. The police had a dog, which could run at 70 km/hr. The dog would run to the thief and then return back to the police and then back to thief. It kept on doing so till the police caught the thief. Find the total distance travelled by the dog in the direction of the thief?
    a) 650 km
    b) 720 km

c) 700 km
d) Data insufficient

26. Without stoppage, a train travels a distance of 120 km in 2 hours. and with stoppage it covers the same distance with an average speed of 40Km/hr. On an average, how many minutes per hour does the train stop during the journey?
a) 12 minutes
b) 15 minutes
c) 18 minutes
d) 20 minutes

27. A journey of 384 km takes 2 hours less by a fast train than by a slow train. If the average speed of the slow train is 32 kmph less than that of a fast train, what is average speed of the fast train?
a) 80 km/h
b) 98 km/h
c) 96 km/h
d) None of these

28. Three boats B_1, B_2 and B_3 working together carry 60 people in one trip. One day an early morning B_1 carried 50 people in few trips alone. When it stopped carrying the passengers B_2 and B_3 started carrying the people together. It took a total of 10 trips to carry 300 people by B_1, B_2 and B_3. How many trips it would take to B_1 to carry 150 passengers alone? (Book)
a) 10
b) 15
c) 20
d) 25

29. Two athletes left Gurgaon for Agra simultaneously. The first athlete stopped 42 min later when he was 1 km short of Agra and the other one stopped 52 min later when he was 2 km short of Agra. If the first athlete jogged as many kilometres as the second and the second as many kilometres as the first, the first one would need 17 min less than the second. Find the distance between Gurgaon and Agra.
a) 5 km
b) 17 km
c) 25 km
d) 35 km

30. The Shatabadi Express without its rake can go 48km an hour, and the speed is diminished by a quantity that varies as the square root of the number of wagons attached. If it is known that with four wagons its speed is 40km/h, the greatest number of wagons with which the engine can just move is
a) 144
b) 140
c) 143
d) 124

Answer Keys	
Level - I	Level - II

Question Number	Answer	Question Number	Answer
1	c)	16	b)
2	b)	17	d)
3	c)	18	a)
4	b)	19	b)
5	b)	20	b)
6	a)	21	b)
7	b)	22	d)
8	d)	23	b)
9	a)	24	c)
10	c)	25	d)
11	b)	26	d)
12	d)	27	c)
13	a)	28	b)
14	c)	29	b)
15	d)	30	c)

Solutions

LEVEL – I

1. **Solution:** Formula to convert km/hr to meter/sec= $\left(Speed\ \left(in\ \frac{km}{hr}\right) * \frac{5}{18}\right)$
Thus, 10 km/hr is $10 * \frac{5}{18} = \left(\frac{50}{18}\right) meter/sec$
$Time = \frac{Distance}{Speed}$
$= 600 \times \frac{18}{50}$
$= 216\ seconds = 3\ \text{min}\ 36\ sec$

2. **Solution:** Let the speed and length of the train be '*S*' and '*l*' respectively.
Train crossing the platform in 20 seconds➔$\frac{100+l}{S} = 20$
Train crossing the person➔$\frac{l}{S} = 15$➔$l = 15s$
Substituting the value of l in the previous equation:
$S = 20\ mps$
To convert mps to kmph,
$20 \times \frac{18}{5} = 72\ kmp$

3. **Solution:** Average speed = $\frac{\text{total distance}}{\text{total time}}$
Required average speed = $\frac{(60+65)}{\frac{15}{60}+\frac{45}{60}} = 125$ km/hr.

4. **Solution:** Average speed = Total distance / Total time
$= \frac{450}{\frac{30}{45}+\frac{240}{60}+\frac{150}{75}} = 67.5\ km/h$

5. **Solution:** Time taken to cross each other when running in opposite direction= $\frac{Length\ 1+Length\ 2}{Speed\ 1+Speed\ 2}$

Note: Length should be in Kms.

$= \frac{0.123+0.124}{125+122}$

$= \frac{0.247}{247}$

$= 1 \times 10^{-3}$ Hrs

6. **Solution:** Formula:

Speed of A: Speed of B = $\sqrt{Time\ taken\ by\ Train\ B}$: $\sqrt{Time taken\ by\ Train\ A}$

$\frac{80}{Speed\ of\ B} = \sqrt{(22/21)}$

$Speed\ of\ B = 78.16\ kmph$

7. **Solution:** Total volume of water displaced $= (3 \times 70)m^3 = 210m^3$

Rise in water level $= \left(\frac{210}{14\times20}\right)m = 75\ cm$

8. **Solution:** Let his normal speed be x kmph.

Let his normal time t hr.

Distance = Speed × Time

$\Rightarrow 5\left(t - \frac{5}{60}\right) = 4\left(t + \frac{5}{60}\right)$

$\Rightarrow 5t - \frac{5}{12} = 4t + \frac{4}{12}$

$\Rightarrow t = \frac{3}{4}hr$

Distance = $5\left(\frac{3}{4} - \frac{1}{12}\right)$ = 3.33 km

9. **Solution:** Let the distance travelled in one direction be x.

Time taken for covering the distance upstream $= \left(\frac{x}{20-12}\right) = \frac{x}{8}$

Time taken for covering the same distance downstream $= \left(\frac{x}{20+12}\right) = \frac{x}{32}$

Hence, the ratio of the times $= \frac{x}{8} : \frac{x}{32} = 4:1$

10. **Solution:** Let the speed of the stream be x,

Then,

$\frac{12}{4+x} + \frac{12}{4-x} = 8$

$\Rightarrow \frac{36-12x+36+12x}{16-x^2} = 8$

$\Rightarrow 72 = 128 - 8x^2$

$\Rightarrow 8x^2 = 56$

$\Rightarrow x = \sqrt{7}kmph = 2.64\ kmph$

Thus, time taken downstream $= \frac{12}{4+2.64} = \frac{12}{6.64} = 1.80\ hours$

Time taken upstream $= \frac{12}{4-2.64} = \frac{12}{1.36} = 8.82\ hours$

11. **Solution:** Let the speed of the boat be x

And the speed of the stream be $y = 1\ kmph$

Then upstream speed = x-y and downstream speed = $x + y$

Time taken = 3 hours, then

$3(x+y)+3(x-y)=12$
$\Rightarrow 3(x+1)+3(x-1)=12$
$\Rightarrow 6x=12$
$\Rightarrow x=2\ kmph$
The distance left to be covered to reach starting point $=3(x+1)-3(x-1)=6km$
Thus, time taken to reach the top $=\frac{6}{x-1}=6\ hours$

12. **Solution:** Let the distance to be covered be x kms
Let the speeds of the athletes be 2 km/hr: 3 km/hr respectively.
Equating time taken by both athletes, we get,
$\frac{x}{2}=\frac{x}{3}+\frac{1}{4}$
$x=1.5\ km$

13. **Solution:** L = 1800 m
Speed of $A(a)=36\times\frac{5}{18}=10\ m/sec$
Speed of $B(b)=54\times\frac{5}{18}=15\ m/sec$
Speed of $C(c)\ =72\times\frac{5}{18}=20\ m/sec$
They will meet for the first time at a time which is the LCM of $L/a, L/b, L/c$
$\frac{L}{a}=\frac{1800}{10}=180$
$\frac{L}{b}=\frac{1800}{15}=120$
$\frac{L}{c}=\frac{1800}{20}=\ 90$
LCM of 180, 120 and 90 is 360 Sec. So they meet after 6 min.

14. **Solution:** For every round that Karan makes,
Arjun would have made 2 rounds because the ratio of their speeds is 1 : 2.
Hence, when Karan has made one full round, Arjun would have taken a lead of one round.
Karan's speed $=9\times\frac{5}{18}=2.5m/s$
Therefore, they would meet after
$\left[\frac{1\ round}{Karan's\ Speed}=\frac{500}{2.5}s\right]=200s$

15. **Solution:** When B has completed 20 rounds, A would have completed $20\times\frac{30}{12}=50$ rounds.
When running in same direction, this would mean A having run 30 rounds more than B and would thus have met 30 times (For every one round that A runs more than B, A meets B)
When running in Opposite direction, this would mean A and B together having run 70 rounds and thus would have met 70 times.

LEVEL – II

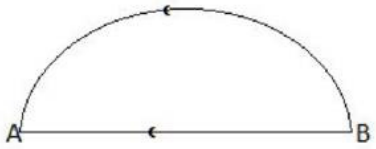
16. **Solution:** Time taken to meet Ram and Shyam = $\frac{1080}{(60+120)}=6$ h

So, in 6 hours Ram covers 360 km and this 360 km distance Mohan covers in $\frac{360}{90} = 4\text{h}.$

Hence, Mohan Leaves A 2 hours later than Ram i.e., at 10 am. Mohan leaves A.

Note: The distance of 360 km covered by Ram to meet Shyam can also be calculated by their speeds.

17. **Solution:** Let the radius be r, then difference in the distance



$= (\pi r - 3r) = r(\pi - 2)$

$$= r\left(\frac{22}{7} - 2\right) = 60 \times 4$$

$$\Rightarrow 2r = 480 \text{ m}$$

18. **Solution:**

	First hour	Second hour	Third hour	Total
Initial Speed	x	3x	2x	6x
New Speed	3x	3x	3x	9x

Time, Speed and Distance

$\therefore$ Percentage increase in speed = $\frac{3x}{6x} \times 100 = 50\%$

Since speed is increased by 50%

Therefore, time will reduce by 33.33%

19. **Solution:** Downstream (Streamer) = 60 min
Downstream (Boat) = 80 min
Upstream (steamer) = 105 min
Upstream (Boat) = 120 min
Required time = 60 + 60 + 52.5 = 172.5 min

20. **Solution:** In case of increasing gap between two objects.

$$\frac{\text{Speed of sound}}{\text{Speed of bear}} = \frac{\text{Time utilised}}{\text{Difference in time}}$$

$$\frac{1195.2}{x} = \frac{166}{14}$$

$$\Rightarrow \quad x = 100.8 \text{ km/h}$$

21. **Solution:** The ratio of speeds
= The ratio of distances, when time is constant
$\therefore$ The ratio of distances covered by rabbit to the dog =12:25
Again, ratio of rounds made by rabbit to the dog = 12:25

Hence, rabbit makes 96 rounds, when dog makes 200 rounds.

22. **Solution:** $(12 - x) = (16 - 1.5x)$
⇒ x = 4 cm
So, it will take 4 hours to burn in such a way that they remain equal in length.

23. **Solution:** Total distance covered by them when they meet = 2X
And Total time = $\frac{2X}{S_1 + S_2}$

$$\therefore \quad d_1 = \frac{2X}{(S_1 + S_2)} S_1 \text{ and } d_2 = \frac{2X}{(S_1 + S_2)} S_2$$

24. **Solution:** Time required for engine to move from one end to the other end,
Speed = $\frac{Distance}{Time}$, $80 = \frac{20}{time}$, Time = 15 minutes.
Distance travelled by the bee in 15 minutes = 40 km× $\frac{15}{60}$ = 10 km

25. **Solution:** Since dog is once running in the direction as thief,
then return back and continue till the criminal caught.
So we cannot calculate the distance covered by the dog.

26. **Solution:** Without stoppage,
Average speed of the train = 60 km/hr means it speed per minute = 1 km.
With stoppage it covers the same distance with an average speed of 40Km/hr means it travel only for 40 minutes.
The train stops for 20 minutes per hour during the journey.

27. **Solution:** Let the speed of faster train be X km/hour and
speed of slower train be (X – 32) km/hour.
According to question, $\frac{384}{X-32} - \frac{384}{X}$ = 2
X = 96

28. **Solution:** Combined efficiency of all the three boats = 60 passengers/trip
$b_1 + b_2 + b_3 = 60 \ldots (i)$
Let x be the trips made by b_1
$xb_1 = 50 \quad \ldots (ii)$
$(10 - x)(b_2 + b_3) = 250$
$=> (10 - x)(60 - b_1) = 250$
$=> 600 - 60x - 10b_1 + xb_1 = 250$
$=> 600 - 60x - 10b_1 + 50 = 250$
$6x + b_1 = 40 \quad \ldots (iii)$
$Solving\ (ii) and\ , b_1 = 10\ or\ 30\ but\ b_1 \neq 30,$
as then, x becomes a fraction which is not possible.
$Thus\ b_1 = 10$
To carry 150 passengers, b_1 will take 15 trips

29. **Solution:** Athlete would run at 4 min per km.
In the new condition, the first athlete would jog for 13 km while the second athlete would jog for 14 km and their respective times would be 39 mins and 56 minutes.
This is consistent with the condition in the question which talks about a difference of 17 minutes in their respective times.

30. **Solution:** Speed = 48- $k\sqrt{N}$.
Putting value of N = 4 we get:
40 = 48 – 2k
Hence k = 4
Thus the equation is: S =48– $4\sqrt{N}$
This means that when N = 144, the speed will become zero.
Hence, the train can just move when 143 wagons are attached.