Parul University Faculty of Engineering and Technology Department of Applied Science & Humanities
Academic Year 2025-26
Subject: Quant and Reasoning (203105371)
Branch: CSE

Unit – 5 : Time & work , pipes and Cisterns, Time speed and distance , Problems on train crossings, Boats & streams

Time & work

Time and Work Formula

Given below are a few such important time and work formulas for your reference:

1. Work = time taken × Rate of work.
2. Rate of work = 1/time taken.
3. Time taken to finish a task = 1/rate of work.
4. work done in 1 day = 1/n, where n = total number of days required to do the work.
5. Efficiency = work/time.
6. Total work = efficiency x number of days.
7. Efficiency and Time are inversely proportional to each other
8. X:Y is the ratio of the number of men which are required to complete a piece of work, then the ratio of the time taken by them to complete the work will be Y:X
9. If x number of people can do W1 work, in D1 days, working T1 hours each day and the number of people can do W2 work, in D2 days, working T2 hours each day, then the relation between them will be

$$\frac{M1 \times D1 \times T1}{W1} = \frac{M2 \times D2 \times T2}{W2}$$

10.

Time and work deals with the time taken by an individual or a group of individuals to complete a piece of work and the efficiency of the work done by each of them.

..... **Work from Days:**

If a " person A" can do a piece of work in *n* days, then A's 1 day's work = $\frac{1}{n}$

Ex. If A can do a work in 10 days ,then A's 1 day work =$\frac{1}{10}$

Days from Work:

If A's 1 day's work(RATE) = $\frac{1}{n}$ then A can finish the work in *n* days

Ex if A's one day work(RATE) = $\frac{1}{12}$ then A can finish the work in 12 days

For Example: If A does a work in 10 days and B does the same work individually in 12 days, in how many days will the work be completed if they work simultaneously?

Approach 1: Per day's work:

If A can complete the work in 'x' days and B can complete the same work in 'y' days, when they work together, the time taken to complete the work is given below.

A can complete the work in 'x' days. So in one day, he will do 1/x of the work.

B can complete the work in 'y' days. So in one day, he will do 1/y of the work.

Total work done by both in one day = (1/x) + (1/y). = $\frac{X+Y}{XY}$

Hence, the total time required to do the work = $\frac{XY}{(X+Y)}$ days.

EXAMPLE :

Since A completes the entire work in 10 days, A does 1/10th of the work in 1 day.

Since B completes the entire work in 12 days, B does 1/12th of the work in 1 day.

Working simultaneously, they do 1/10 + 1/12 = 11/60 = 6/60+5/60=11/60

of the work in 1 day. Thus total days taken by both working simultaneously = 60/11 days

- **Individual efficiency problems with people**
  - **1. Fraction Method or Unitary Work Method**
  - In this method we will assume the total work to be 1 unit and calculate the individual efficiency in terms of fractions and solve the problem. Let's solve the above example problem by using the fraction method to understand it better.
  - **Example Problem**
  - Person A and B can do a piece of work in20 and 30 days respectively. If both of them work together, in how many days will the work be completed?
  - **Step 1:** Assume the total work to be 1.
  - **Step 2:** Calculate the individual efficiencies of the given people
  - Here,Person A will complete the work in 20 days, So in 1 day he will do 1/20th of the total work.
  - Person B will complete the work in 30 days, So in 1 day he will do 1/30th of the total work.
  - **Step 3:** Calculate the combined efficiency of both these people in a day
  - Here, Combined work done in 1 day = ((1/20) + (1/30))
  - After solving we get,Combined work done in 1 day = 1/12

- **Step 4:** Taking the inverse of work done in 1 day will give us the total time taken to complete the task.
- So, If both of them work together, work will be completed in **12 days.**

2. LCM Method

In this method we will assume the total work to be the LCM of the given numbers and calculate the individual efficiency in terms of integers and solve the problem. This will help us to solve the problem faster. Let's solve the above example problem by using the fraction method to understand it better.

Example Problem

Person A and B can do a piece of work in20 and 30 days respectively. If both of them work together, in how many days the work will be completed?

Step 1: Assume the total work to be LCM of 20 and 30, Here LCM = 60.

Step 2: Calculate the individual efficiencies of the given pipes with LCM as total work.

Here,

- **Person A will do the entire work (60 work) in 20 days , So in 1 day it will fill 60/20 of the tank= 3 work/day.**
- **Person B will do the entire work (60 work) in 30 days , So in 1 day it will fill 60/30 of the tank= 2 work/day.**

Step 3: Calculate the combined efficiency of both the persons in a day

- **Combined work done in 1 day = 3+2 Solving these we get ,**
- **Combined work done in 1 day = 5 work / day**

Step 4: Divide the total work by the work done in 1 day ⇒ 60/5 ⇒ 12 days.

So, If both of them work together, work will be completed in **12 days.**

There can be several types of questions asked in Time and Work, and essentially all of them can be addressed by utilizing the aforementioned methods.

Q 1. A builder appoints three construction workers Akash, Sunil and Rakesh on one of his sites. They take 20, 30 and 60 days respectively to do a piece of work. How many days will it take Akash to complete the entire work if he is assisted by Sunil and Rakesh every third day?

1. 10 days
2. 15 days
3. 25 days

4. 30 days
5. 45 days

Answer: (2) 15 days

Solution:

Total work done by Akash, Sunil and Rakesh in 1 day = {(1/20) + (1/30) + (1/60)} = 1/10

Work done along by Akash in 2 days = (1/20) × 2 = 1/10

Work Done in 3 days (1 day of all three together + 2 days of Akash's work) = (1/10) + (1/10) = 1/5

So, work done in 3 days = 1/5

Time taken to complete the work = 5×3 = 15 days

Q 2. To complete a piece of work, Samir takes 6 days and Tanvir takes 8 days alone respectively. Samir and Tanvir took Rs.2400 to do this work. When Amir joined them, the work was done in 3 days. What amount was paid to Amir?

1. Rs. 300
2. Rs. 400
3. Rs. 800
4. Rs. 500
5. Rs. 100

Answer: (1) Rs.300

Solution:

Total work done by Samir and Tanvir = {(1/6) + (1/8)} = 7/24

Work done by Amir in 1 day = (1/3) – (7/24) = 1/24

Amount distributed between each of them = (1/6) : (1/8) : (1/24) = 4:3:1

Amount paid to Amir = (1/24) × 3 × 2400 = Rs.300

Q 3. Dev completed the school project in 20 days. How many days will Arun take to complete the same work if he is 25% more efficient than Dev?

1. 10 days
2. 12 days
3. 16 days

4. 15 days
5. 5 days

Answer: (3) 16 days

Solution:

Let the days taken by Arun to complete the work be x

The ratio of time taken by Arun and Dev = 125:100 = 5:4

5:4 :: 20:x

⇒ x = {(4×20) / 5}

⇒ x = 16

Q 4. Time taken by A to finish a piece of work is twice the time taken B and thrice the time taken by C. If all three of them work together, it takes them 2 days to complete the entire work. How much work was done by B alone?

1. 2 days
2. 6 days
3. 3 days
4. 5 days
5. Cannot be determined

Answer: (2) 6 days

Solution:

Time taken by A = x days

Time taken by B = x/2 days

Time Taken by C = x/3 days

⇒ {(1/x) + (2/x) + (3/x) = 1/2

⇒ 6/x = 1/2

⇒ x = 12

Time taken by B = x/2 = 12/2 = 6 days

Q 5. Sonal and Preeti started working on a project and they can complete the project in 30 days. Sonal worked for 16 days and Preeti completed the remaining work in 44 days. How many days would Preeti have taken to complete the entire project all by herself?

1. 20 days
2. 25 days
3. 55 days
4. 46 days
5. 60 days

Answer: (5) 60 days

Solution:

Let the work done by Sonal in 1 day be x

Let the work done by Preeti in 1 day be y

Then, $x+y = 1/30$ ——— (1)

$\Rightarrow 16x + 44y = 1$ ——— (2)

Solving equation (1) and (2),

$x = 1/60$

$y = 1/60$

Thus, Preeti can complete the entire work in 60 days

Example 2: A can do a job in 10 days. B can do a job in 5 days. In how many days they can complete the job if they work together?

Answer: Since A can do the job in 10 days, we can write the efficiency of A is equal to (100/10)% = 10%. Thus, A's efficiency = 10%. Similarly, we can say that B's efficiency is equal to 20%. Now we nee to find their combined efficiency as follows:

(A+ B) efficiency = (10 + 20)% = 30%. This means in one day A and B together can do 30% of the work. Therefore, Number of days A and B together take to do 100% of work = (100/3) days = 3.33 days.

Example 3: A can do a certain work in 12 days. B is 60% more efficient than A. How many days does B alone take to do the same job?

Answer: Ratio of time taken by A & B = 160:100 = 8:5. Suppose B alone takes x days to do the job. Then, 8:5::12:x. In other words, we may write: 8x = 5×12 and thus we have x = 15/2 days.

Example 4: If eight men and 12 boys can complete a piece of work in twelve days, in what time will 40 men and 45 boys complete another piece of work three times as great, supposing sixteen men can do as much work in 8 hours as 12 boys can do in 24 hours?

A) 4 days B) 16 days C) 8 days D) 32 days

Answer: We are given that sixteen men can do a certain work in 8 hours. The same amount of work can be done by 12 boys in 24 hours.

We can write 16 = 1/8 and 12 = 1/24

Therefore we can write the two equations as (16 men)×(8 hours) = 1 [1 means the complete 100% of work].

Similarly, we can say that (12 boys)×(24 hours) = 1. Comparing the two equations, we can write (16 men)×(8 hours) = (12 boys)×(24 hours).

On the left-hand side, we have the men and on the right-hand side, we have the boys. So we can write (16 × 8 hours) men = (12 × 24) boys. In other words, we may write, 4 men = 9 boys which means that the amount of work that 4 men can do could be done by 9 boys.

Therefore, moving on to the question, we have: 8 men + 12 boys can do some work in 12 days. Converting the equation to boys only, we have:

8 men + 12 boys = 9 × 2 boys + 12 boys = 30 boys.

Similalry, from the second condition in the question, we have: 40 men + 45 boys = 10 × 9 boys + 45 boys = 135 boys.

Now, 30 boys can complete the work in 12 days. This means that one boy can complete the work in 30×12 days. Therefore, 135 boys will complete the work in (30×12)/135 days.

Also, the number of boys that will complete the work three times bigger = (30×12×3)/135 = 8 days. Therefore the answer is C) 8 days.

20 men can do a piece of work in 50 days. Find the amount of work done by 70 men in 5 days.
a) 25%

b) 35%
c) 45%
d) 55%

Answer: b
Explanation: The total work to be done = 20 * 50 = 1000
The amount of work done = 70 * 5 = 350
The percentage of work done = 350 / 1000 * 100 = 35%

2. 54 men can do a work in 12 days. Find the amount of work done by 5 men in 12 days.
a) 9%
b) 10%
c) 11%
d) 12%

Answer: a
Explanation: The total work done by 54 men in 12 days = 54 * 12 = 648 units
The work done by 5 men in 12 days = 60 units
The percentage of the work done = 60 / 648 * 100 = 9.25%

3. 43 men can do a work in 89 days. Find the amount of work done by 90 men in 55 days.
a) 129%
b) 130%
c) 131%
d) 132%

Answer: a
Explanation: The total work to be done = 43 * 89 = 3827 units
The work done = 90 * 55 = 4950 units
The percentage done = 4950 / 3827 * 100 = 129.34%

1. 10 men can do a work in 12 days. Find the time required to do 20% of the work working twice as fast as before.
a) 1 day
b) 2 days
c) 3 days
d) 2.5 days

Answer: a
Explanation: The speed is doubled, and the work is made 20% as before.
Th efficiency of the men = 12 / 10 = 1.2 part of the work daily
The new work = 20% of 12 = 2.4 of the work
The new efficiency = twice as before = 1.2 * 2 = 2.4
The time taken = 2.4 / 2.4 = 1 day

2. 25 men can do a work in 5 days. Find the amount of work done by 5 men in 10 days.
a) 25%
b) 30%
c) 35%
d) 40%

Answer: d
Explanation: The total work done by 25 men in 5 days = 25 * 5 = 125 units
The work done by 5 men in 10 days = 50 units
The percentage of the work done = 50 / 125 * 100 = 40%

3. 67 men can do a work in 50 days. Find the amount of work done by 60 men in 42 days.
a) 57.22%
b) 75.22%
c) 56.22%
d) 65.22%

Answer: b
Explanation: The total work to be done = 67 * 50 = 3350 units
The work done = 60 * 42 = 2520 units
The percentage done = 2520 / 3350*100 = 75.22%

Q 1: A and B together can do a job in 4 days. If A can do a job in 12 days if he works alone, then how many days B alone take to complete the job?

A) 6 days B) 8 days C) 10 days D) 10 days

Ans: 6 days.

Q 2: Twenty women can do a work in sixteen days. Sixteen men can complete the same work in fifteen days. What is the ratio between the capacity of a man and a woman?

A) 4: 7 B) 7: 3 C) 4: 3 D) 3: 7

Ans: C) 4: 3

Q 1: Khan and Samip can do a certain task in 8 days. Samip and Yawer can do the same job in 12 days. Khan, Samip, and Yawer if working together can do the job in 6 days. In how many days can Khan and Yawer complete the job?

A) 8 days B) 16 days C) 32 days D) 6 days

Ans: A) 8 days

Q 2: Two persons A and B together can do a piece of work in 8 days. A alone does the same work in 12 days. Then if B alone works, he can do the same work in?
A) 100 days B) 33.33 days C) 24 days D) 80 days

Ans: C) 24 days.

Q 3: Three people A, B, and C can do a piece of work in 20, 30 and 60 days respectively. In how many days can A do the work if he is assisted by B and C on every third day?

A) 10 days B) 15 days C) 20 days D) 25 days

Ans: .

Q 4 A, B and C can do a piece of work in 24 days, 30 days and 40 days respectively. They began the work together but C left 4 days before the completion of the work. In how many days was the work completed?

A) 11 days B) 12 days C) 13 days D) 14 days

Q 5A is thrice as good as workman as B and therefore is able to finish a job in 60 days less than B. Working together, they can do it in:

A) 20 days B) 22.5 days C) 25 days D) 30 days

Q 6A alone can do a piece of work in 6 days and B alone in 8 days. A and B undertook to do it for Rs. 3200. With the help of C, they completed the work in 3 days. How much is to be paid to C?

A) Rs.375 B) Rs.400 C) Rs.600 D) Rs.800

Q 7 A is twice as fast as B. If B alone can do a piece of work in 30 days, in what time can A and B together complete the work?

A) 10 days B) 12 days C) 15 days D) 8 days

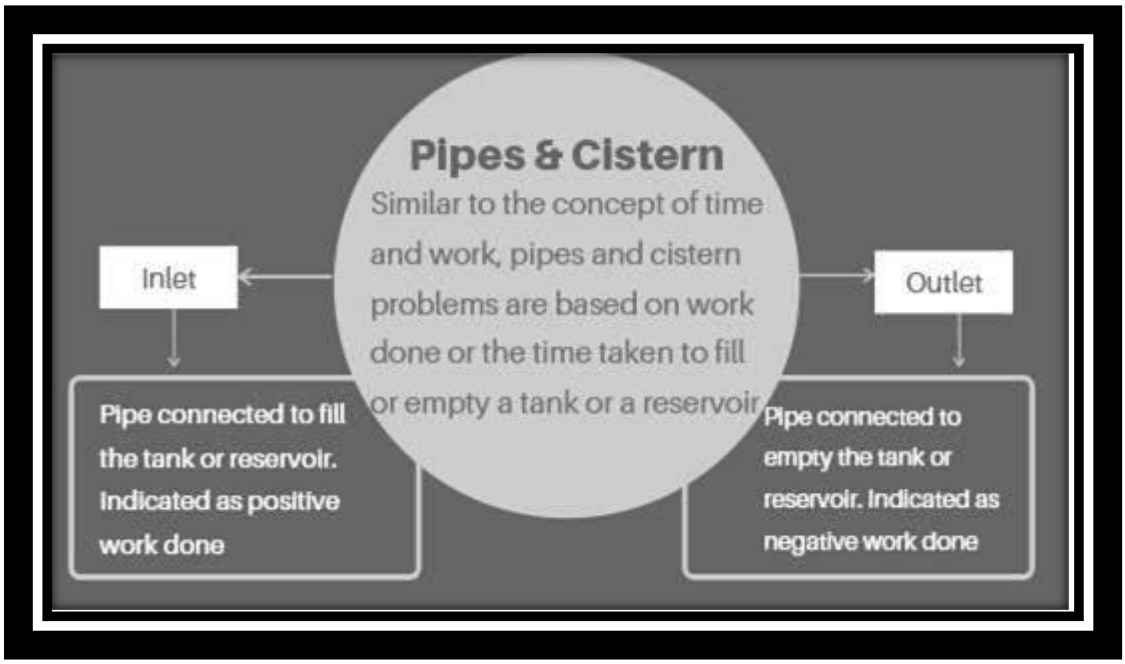
Q 8 10 women can complete a work in 7 days and 10 children take 14 days to complete the work. How many days will 5 women and 10 children take to complete the work?

A) 3 days B) 5 days C) 7 days D) 10 days

Q 9 If 12 men and 16 boys can do a piece of work in 5 days; 13 men and 24 boys can do it in 4 days, then the ratio of the daily work done by a man to that of a boy is?

A) 2:1 B) 3:1 C) 3:2 D) 5:4

Pipes and Cisterns



Pipes and cistern is another format of time and work-based questions. Questions like the time taken to fill or empty a tank, the amount of work done for the same and similar type of questions may be asked. There are two major things which a candidate needs to know about such questions:

- **Inlet:** An inlet is a pipe which is connected to fill a tank with water. This is the positive type of work done
- **Outlet:** An outlet is a pipe which is connected to empty the tank of water. This indicates a negative type of work done. It may also be referred to as 'leak' in the question

Important Formula on Pipes and Cistern

Given below are a few important formulas which shall help you solve the pipes and cistern based questions quicker and more efficiently:

- If x hours are required to fill up a tank, then part filled in 1 hr =1/x
- If y hours are required to empty the tank, then part emptied in 1 hour = 1/y
- If a pipe can fill a tank in x hours and can empty the same tank in y hours. When both the pipes are opened at the same time, then the net part of the tank filled in 1 hr = {(xy) / (y-x)}, provided y>x
- If a pipe can fill a tank in x hours and can empty the same tank in y hours. When both the pipes are opened at the same time, then the net part of the tank filled in 1 hr = {(xy) / (x-y)}, provided x>y
- Net work done = (Sum of work done by Inlets) – (Sum of work done by Outlets)

- One inlet can fill the tank in x hr and the other inlet can fill the same tank in y hrs, if both the inlets are opened at the same time, the time taken to fill the whole tank = {(xy) / (y+x)}
- If two pipes take x and y hours respectively to fill a tank of water and a third pipe is opened which takes z hours to empty the tank, then the time taken to fill the tank = {1 / (1/x)+(1/y)+(1/z)} and the net part of the tank filled in 1 hr = (1/x)+(1/y)-(1/z)

- One must be familiar with terms like inlet, outlet, leak, filling a tank, emptying a tank and the formulas related to the same. Only then can a candidate answer these questions without getting confused
- If you are unable to crack the question, then ensure that you do not spend too much time on a single question
- Memorize the formulas and practise as much as possible to understand the concept better

Q 1. It takes 6 hours for three pipes, X, Y and Z to fill a tank. When the three worked together for 2 hours, Z was closed and, X and Y filled the remaining tank in 7 hours. How many hours would it take Z alone to fill the tank?

1. 15 hours
2. 23 hours
3. 12 hours
4. 14 hours
5. 21 hours

Answer: (4) 14 hours

Solution:

Part of the tank which was filled in 2 hours = 2/6 = ⅓

The part of the tank remaining to be filled = 1 – ⅓ = ⅔

Work done by X and Y together in 7 hours = ⅔

Work done by X and Y together in 1 hour = [(⅔) / 7] = 2/21

Work done by Z in 1 hour = [{(X+Y+X)'s 1 hour's work } – {(X+Y)'s 1 hour's work}]

= (⅙) – (2/21) = 1/14

Therefore, it would take Z alone 14 hours to fill in the tank

Q 2. It takes two pipes A and B, running together, to fill a tank in 6 minutes. It takes A 5 minutes less than B to fill the tank, then what will be the time taken by B alone to fill the tank?

1. 10 minutes
2. 15 minutes
3. 20 minutes
4. 25 minutes
5. 8 minutes

Answer: (2) 15 minutes

Solution:

Let the time taken by pipe A to fill the tank be x minutes

Time is taken by pipe B to fill the tank = x+5 minutes

So, $1/x + 1/(x+5) = 1/6$

$\Rightarrow x = 10$

Thus, time taken by B alone to fill the tank is 10+5, i.e., 15 minutes

Q 3. If two pipes can fill a tank in 24 and 20 minutes respectively and another pipe can empty 3 gallons of water per minute from that tank. When all the three pipes are working together, it takes 15 minutes to fill the tank. What is the capacity of the tank?

1. 100 gallons
2. 150 gallons
3. 125 gallons
4. 130 gallons
5. 120 gallons

Answer: (5) 120 gallons

Solution:

Work done by the outlet pipe in 1 minute = $\{1/15 – (1/24)+(1/20)\} = 1/15 – 11/120 = -(1/40)$

Here, the negative sign indicates the negative work done, that is the loss of water from the outlet

The capacity of 1/40 part = 3 gallons

So, Capacity of whole tank = $40 \times 3 = 120$ gallons

Q 4. It takes 20 minutes for pipe A to fill the tank completely and it takes 30 minutes for pipe B to fill the tank completely. If both the inlets are opened together, then how much time will be taken to fill the tank completely?

1. 15 minutes
2. 12 minutes
3. 11 minutes
4. 10 minutes
5. 22 minutes

Answer: (2) 12 minutes

Solution:

A portion of the tank filled by pipe A in 1 minute = 1/20

A portion of the tank filled by pipe B in 1 minute = 1/30

Total portion filled by both pipe A and B in 1 minute = (1/20 + 1/30) = 1/12

Thus it will take 12 minutes to fill the tank completely if both the inlets are opened together.

Q 5. Pipe A can fill the tank 3 times faster in comparison to pipe B. It takes 36 minutes for pipe A and B to fill the tank together. How much time will pipe B alone take to fill the tank?

1. 100 minutes
2. 124 minutes
3. 134 minutes
4. 144 minutes
5. 154 minutes

Answer: (4) 144 minutes

Solution:

Let the time taken by pipe B be x minutes

So, the time taken by pipe A = x/3 minutes

Thus, 1/3 + 3/x = 1/36

$\Rightarrow 4/x = 1/36$

$\Rightarrow x = 4 \times 36$

⇒ x = 144 minutes

Time speed and distance , Problems on train crossings

Relationship Between Speed, Time & Distance

1. **Speed = Distance/Time –** This tells us how slow or fast an object moves. It describes the distance travelled divided by the time taken to cover the distance.
2. Speed is directly Proportional to Distance and Inversely proportional to Time. Hence,
3. **Distance = Speed X Time**, and
4. **Time = Distance / Speed**, as the speed increases the time taken will decrease and vice versa.

Using these formulas any basic problems can be solved. However, the correct usage of units is also an important thing to consider while using formulas.

Units of Speed Time & Distance

Each Speed, Distance and Time can be expressed in different units:

Time: seconds(s), minutes (min), hours (hr)

Distance: (meters (m), kilometers (km), miles, feet

Speed: m/s, km/hr

So if Distance = km and Time = hr, then as Speed = Distance/ Time; the units of Speed will be km/ hr.

Now that the units of Speed, Time and Distance is clear, let us understand the conversions related to these.

Speed, Time & Distance Conversions

- To convert from km / hour to m / sec, we multiply by 5 / 18. So, 1 km / hour = 5 / 18 m / sec
- To convert from m / sec to km / hour, we multiply by 18 / 5. So, 1 m / sec = 18 / 5 km / hour = 3.6 km / hour
- Similarly, 1 km/hr = 5/8 miles/hour
- 1 yard = 3 feet
- 1 kilometer= 1000 meters = 0.6214 mile
- 1 mile= 1.609 kilometer
- 1 hour= 60 minutes= 60*60 seconds= 3600 seconds
- 1 mile = 1760 yards

- 1 yard = 3 feet
- 1 mile = 5280 feet
- 1 mph = (1 x 1760) / (1 x 3600) = 22/45 yards/sec
- 1 mph = (1 x 5280) / (1 x 3600) = 22/15 ft/sec
- For a certain distance, if the ratio of speeds is a : b, then the ratio of times taken to cover the distance would be b : a and vice versa.

Application of Speed, Time & Distance

Given below are a few subheads under the Speed, Time and Distance topics that tell us the basis of the variety of questions asked in the examination.

1. Average Speed

Average Speed = (Total distance traveled)/(Total time taken)

Case 1 – When the distance is constant: **Average speed = 2xy/x+y**; Where, x and y are the two speeds at which the same distance has been covered.

Case 2 – When the time taken is constant: **Average speed = (x + y)/2**; Where, x and y are the two speeds at which we traveled for the same time.

Examples:

Q1. A person travels from one place to another at 30 km/hr and returns at 120 km/hr. If the total time taken is 5 hours, then find the Distance.

Solutions:

Here the Distance is constant, so the Time taken will be inversely proportional to the Speed. Ratio of Speed is given as 30:120, i.e. 1:4

So the ratio of Time taken will be 4:1.

Total Time taken = 5 hours; Time taken while going is 4 hours and returning is 1 hour.

Hence, Distance = 30x 4 = 120 km

Q.2. Traveling at 3/4th of the original Speed a train is 10 minutes late. Find the usual Time taken by the train to complete the journey?

Solutions:

Let the usual Speed be S1 and usual Time be T1. As the Distance to be covered in both the cases is same, the ratio of usual Time to the Time taken when he is late will be the inverse of the usual Speed and the Speed when he is late

If the Speed is S2 = ¾S1 then the Time taken T2 = 4/3 T1 Given T2 – T1 = 10 =>4/3 T1 – T1 = 10 => T1 = 30 minutes.

2. Inverse Proportionality of Speed & Time

Speed is inversely proportional to Time when the Distance is constant. S is inversely proportional to 1/T when D is constant. If the Speeds are in the ratio m:n then the Time taken will be in the ratio n:m.

There are two methods to solve questions:

- Using Inverse Proportionality
- Using Constant Product Rule

Example:

Q1. After traveling 50km, a train meets with an accident and travels at (3/4)th of the usual Speed and reaches 45 min late. Had the accident happened 10km further on it would have reached 35 min late. Find the usual Speed?

Solutions:

Using Inverse Proportionality Method

Here there are 2 cases

Case 1: accident happens at 50 km

Case 2: accident happens at 60 km

Difference between two cases is only for the 10 kms between 50 and 60. The time difference of 10 minutes is only due to these 10 kms.

In case 1, 10 kms between 50 and 60 is covered at (3/4)^th Speed.

In case 2 , 10 kms between 50 and 60 is covered at usual Speed.

So the usual Time “t” taken to cover 10 kms , can be found out as below. 4/3 t – t = 10 mins = > t = 30 mins, d = 10 kms

so usual Speed = 10/30min = 10/0.5 = 20 km/hr

Using Constant Product Rule Method

Let the actual Time taken be T

There is a (1/4)th decrease in Speed, this will result in a (1/3)rd increase in Time taken as Speed and Time are inversely proportional

(A 1/x increase in one of the parameters will result in a 1/(x+1) decrease in the other parameter if the parameters are inversely proportional) The delay due to this decrease is 10 minutes

Thus 1/3 T= 10 and T=30 minutes or ½ hour

Also, Distance = 10 km

3. Meeting Point Questions

If two people travel from two points A and B towards each other, and they meet at point P. The total Distance covered by them on the meeting will be AB. The Time taken by both of them to meet will be the same. As the Time is constant, Distances AP and BP will be in the ratio of their Speed. Say that the Distance between A and B is d.

If two people are walking towards each other from A and B, When they meet for the first Time, they together cover a Distance "d" When they meet for the second Time, they together cover a Distance "3d" When they meet for the third Time, they together cover a Distance of "5d"……

Example:

Q1. Amit and Aman have to travel from Delhi to Jaipur in their respective cars. Amit is driving at 60 kmph while Aman is driving at 90 kmph. Find the Time taken by Aman to reach Jaipur if Amit takes 9 hrs.

Solutions:

As the Distance covered is constant in both cases, the Time taken will be inversely proportional to the Speed. In the problem, Speed of Amit and Aman is in ratio 60: 90 or 2:3.

So the ratio of the Time taken by Amit to that taken by Aman will be in the ratio 3:2. So if Amit takes 9 hrs, Aman will take 6 hrs.

Q.1. A man travels from his home to office at 4km/hr and reaches his office 20 min late. If the Speed had been 6 km/hr he would have reached 10 min early. Find the distance from his home to office.

1. 8 km
2. 12 km
3. 6 km
4. 9 km

Answer (3) 6 km

Solutions:

Let the Distance between home and office =d. Suppose he reaches the office on Time, the Time taken = x minutes

Case 1: When he reaches office 20 minutes late,

Time taken = x+20

Case 2: when he reaches office 10 minutes early,

Time taken = x-10 As the Distance traveled is the same, the ratio of Speed in case 1 to the Speed in case 2 will be the inverse of the Time taken in both cases Ratio of Speed in both cases = 4:6 = 2:3 Ratio of Time in both cases = 3:2 Therefore (x+20)/(x-10)=3/2 2x+40 = 3x -30 x= 70 minutes Taking case 1, 4= d/(90/60)=> d= 360/60 = 6 km

Q.2. Ram can row a boat in still water at 10 kmph. He decides to go boating in a river. To row upstream he takes 2 hours and to row downstream he takes 1 ½ hours. Find the Speed of the river.

1. 10/7 kmph
2. 11/5 kmph
3. 9/7 kmph
4. 13/5 kmph

Answer (1) 10/7 kmph

Solutions:

Suppose the Speed of the river is ‘y’ kmph.

While rowing upstream he takes 2 hrs and while rowing downstream he takes 1 ½ hours.

As the Distance covered is constant the ratio of the net Speeds of the boat while going upstream and downstream will be the inverse of the ratio of the Time taken.

Ratio of Time taken (downstream: upstream) = 1.5/2 =3/4

So the ratio of Speed of boat (downstream: upstream) = 4/3

Speed downstream: 10 + y Speed upstream : 10 – y

(10+y)/((10-y)) = 4/3

30+3y=40-4y. Thus, 7y=10 & Y=10/7

Speed of river = 10/7 kmph

Q.3. Ram and Shyam are standing at two ends of a room with a width of 30 m. They start walking towards each other along the width of the room with a Speed of 2 m/s and 1 m/s, respectively. Find the total distance travelled by Ram when he meets Shyam for the third time.

1. 110 m
2. 112 m
3. 120 m
4. 100 m

Answer (4) 100 m

Solution:

When Ram meets Shyam for the third time, they together would have covered a Distance of 5d, i.e 5x30m = 150 m.

The ratio of Speed of Ram and Shyam = 2:1, so the total distance travelled by them will also be in the ratio 2:1 as the Time taken is constant.

So the Distance travelled by Ram will be 2/3 x 150= 100 m

Q.4. A man decided to cover a distance of 6 km in 84 minutes. He decided to cover two thirds of the distance at 4 km / hr and the remaining at some different speed. Find the speed after the two third distance has been covered.

1. 5 kmph
2. 7 kmph
3. 9 kmph

4. 3 kmph

Answer (1) 5 kmph

Solution:

We are given that two thirds of the 6 km was covered at 4 km / hr i.e. 4 km distance was covered at 4 km / hr. Time taken to cover 4 km = 4 km / 4 km / hr = 1 hr = 60 minutes

Time left = 84 – 60 = 24 minutes

Now, the man has to cover remaining 2 km in 24 minutes or 24 / 60 = 0.4 hours

Speed required for remaining 2 km = 2 km / 0.4 hr = 5 km / hr

Q.5. While going to office, Ramesh travels at a speed of 30 kmph and on his way back, he travels at a speed of 45 kmph. What is his average speed of the whole journey?

1. 45 kmph
2. 36 kmph
3. 32 kmph
4. 42 kmph

Answer (2) 36 kmph

Solution:

When distance travelled is same, then average speed = 2ab / (a+b); (where a and b are two different speeds) therefore,

The Average Speed = Therefore, Average Speed = 2 x 45 x 30 / 45 + 30, solving this we get 36 kmph.

Q1 A person crosses a 600 m long street in 5 minutes. What is his speed in km per hour?

A) 3.6 B) 7.2 C) 8.4 D) 10

An aeroplane covers a certain distance at a speed of 240 kmph in 5 hours. To cover the same distance in $1\frac{2}{3}$ hours, it must travel at a speed of:

A) 300 kmph B) 300 kmph C) 600 kmph D) 720 kmph

If a person walks at 14 km/hr instead of 10 km/hr, he would have walked 20 km more. The actual distance travelled by him is:

A) 50 km B) 56 km C) 70 km D) 80 km

A train can travel 50% faster than a car. Both start from point A at the same time and reach point B 75 kms away from A at the same time. On the way, however, the train lost about 12.5 minutes while stopping at the stations. The speed of the car is:

A) 100 kmph B) 110 kmph C) 120 kmph D) 130 kmph

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In a flight of 600 km, an aircraft was slowed down due to bad weather. Its average speed for the trip was reduced by 200 km/hr and the time of flight increased by 30 minutes. The duration of the flight is:

A) 1 hour B) 2 hour C) 3 hour D) 4 hour

A man complete a journey in 10 hours. He travels first half of the journey at the rate of 21 km/hr and second half at the rate of 24 km/hr. Find the total journey in km.

A) 220 km B) 224 km C) 230 km D) 234 km

The ratio between the speeds of two trains is 7 : 8. If the second train runs 400 km in 4 hours, then the speed of the first train is:

A) 70 kmph B) 75 kmph C) 84 kmph D) 87.5 kmph

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 kmph B) 36 kmph C) 71.11 kmph D) 71kmph

A car travelling with $\frac{5}{7}$ of its actual speed covers 42 km in 1 hr 40 min 48 sec. Find the actual speed of the car.

A) $17\frac{6}{7}$ kmph B) 25 kmph C) 30 kmph D) 35kmph

In covering a distance of 30 km, Abhay takes 2 hours more than Sameer. If Abhay doubles his speed, then he would take 1 hour less than Sameer. Abhay's speed is:

A) 5kmph B) 6 kmph C) 6.25 kmph D) 7.5kmph

Robert is travelling on his cycle and has calculated to reach point A at 2 P.M. if he travels at 10 kmph, he will reach there at 12 noon if he travels at 15 kmph. At what speed must he travel to reach A at 1 P.M.?

A) 8kmph B) 11 kmph C) 12 kmph D) 14kmph

It takes eight hours for a 600 km journey, if 120 km is done by train and the rest by car. It takes 20 minutes more, if 200 km is done by train and the rest by car. The ratio of the speed of the train to that of the cars is:

A) 2:3 B) 3: 2 C) 3: 4 D) 4: 3

A farmer travelled a distance of 61 km in 9 hours. He travelled partly on foot @ 4 km/hr and partly on bicycle @ 9 km/hr. The distance travelled on foot is:

A) 14 km B) 15 km C) 16 km D) 17 km

A man covered a certain distance at some speed. Had he moved 3 kmph faster, he would have taken 40 minutes less. If he had moved 2 kmph slower, he would have taken 40 minutes more. The distance (in km) is:

A) 35 km B) $36\frac{2}{3}$ km C) $37\frac{1}{2}$ km D) 40 km

What is Relative Speed?

We can define relative speed as the speed of a moving body with respect to another. When two bodies move in the same direction, their relative speed is computed by their difference. But when two bodies are moving in the opposite direction, the relative speed is calculated by adding the speed of both the bodies.

The difference between relative speed and relative velocity is that relative speed is the scalar quantity whereas relative velocity is the vector quantity.

How to calculate relative speed?

Suppose two bodies are moving at a different speed in the same direction.

Let the speed of 1st body be x km/hr
And the speed of the 2nd body is y km/hr.

So, their relative speed is = **(x – y) km/hr** [x > y]

Then,

The time after which both the bodies meet = distance travelled / relative speed

= d km/ (x – y) km/hr

We already know that relative speed is the speed of one object with respect to another.

So, when the time after which both the bodies meet is given,

Suppose time = t hrs.

Then, the distance covered in 't' hours = relative speed * time.

= (x – y) km/hr * t hrs.

Relative Speed Examples

Example 1:

The thief Bhagu Ram is spotted by the policeman Pakad Singh from a distance of 200m. Once they see each other, they start running. What is the Distance Bhagu Ram, who is running at five kmph would have covered before being caught by Pakad Singh running at seven kmph?

Solution:

Here are two bodies moving at different Speeds. So assume Bhagu Ram to be stationary and take the Speed of Pakad Singh relative to Bhagu Ram. So, once the concept of relative Speed is applied, it can be deduced that Bhagu Ram is standing and Pakad Singh who is at a distance of 200 m is running at 7 – 5 = 2 kmph. To catch Bhagu Ram he needs to travel a distance of 200 m or 0.2 km. So Time taken = 0.2/2 = 0.1 hours or 6 minutes. Thus the distance that is covered by Bhagu Ram before being caught is 0.5 km.

Example 2:

A bird is sitting on a train A moving at a speed of 40 kmph. It sees another train B at a distance of 200 m with speed of 60 kmph coming from the opposite direction on the same rail track. It flies with an average speed of 10 kmph and sits on another train. Again immediately it flies back to the first train and again to the second train and so on. It does so before the two trains crash. What is the total distance travelled by the bird?

Solution:

Two trains are moving in opposite directions with speed 40 kmph and 60 kmph. Make train B stationary and then take the speed of train A relative to the train B. So relative speed of train A = 40 + 60 = 100 kmph. Before it crashes into the stationary train B it has to travel a

distance of 200 m which it will do in (0.2/100) hours. During this duration, the average speed of bird has been 10 kmph i.e. before the crash total distance covered by the bird = 0.2 * 10/100 km = 20 metres.

Some Specific Cases of Relative Speed

CASE 1 : Boats & Streams

Let the Speed of boat in still water = x

Speed of stream = y

As it is previously discussed that in questions where two bodies with different speeds are concerned, the concept of relative speed should be used. Here the stream can be assumed to be the stationary body and the speed of boat relative to the speed of the stream can be taken. Using the concept of relative speed, one can now have the situation where the stream is stationary and only the boat is moving at a speed determined by the direction of the boat relative to the stream.

Therefore, along the stream, or the "Downstream" Speed of the boat, $a = x + y$
And against the stream, or "Upstream" Speed of the boat $b = x - y$
If downstream Speed, a and upstream Speed, b are given, then

Speed of boat X' = $\frac{a + b}{2}$ speed of stream 'y'= $\frac{a - b}{2}$

Example 3:

Gita rows a boat at a speed of 15 kmph upstream and 20 kmph downstream. Find the Speed with which Gita rows the boat in still water and also find the speed of the stream.

Solution:

Given that upstream speed = 15 kmph

Downstream speed = 20 kmph

Speed of Gita in still water = x = ((a + b))/2= (20+15)/2 = 35/2

Speed of stream = y = ((a – b))/2= (20-15)/2 = 5/2.

Example 4:

The Speed of Narmada river is 5 kmph. A stationary body is placed in the river. Find the time taken by the floating body to reach a stone which is 10 km downstream from the point where it is now?

Solution:

Speed of stone = Speed of river (as Speed of stone is 0) = 5 kmph

Speed=Distance/Time.

So, time taken to reach 10 km = 10/5 = 2 hours.

Example 5:

A man rows 135 km upstream in 2.7 hours. He rows the same distance downstream in 2.5 hours. However, for downstream, he reduces his speed by 9%, while speed of the current gets reduced by 20%. Find the speed of the man.

(a) 52

(b) 55

(c) 50

(d) none of these

Solution:

Let us use a different approach for this question

x= The speed of boat and

y= The speed of stream

Given that x-y= 135/2.7= 50 ——(1) & Given that 10/11 x + 4/5 y = 135/2.5 = 54 ———(2)

(reduction of 9% = 100- 9 = 0.91x. 0.91 in terms of a fraction can be written as 10/11 since 1/11= 0.0909). (Similarly, reduction of 20% => 0.8 y. 0.8 in terms of a fraction can be written as 4/5.

Option (c)The Speed of the man cannot be 50, as the speed of the stream cannot be zero (on substituting in equation (1))

option (b) substitute x= 52 and x=55 in the second equation and see for which value you are getting an integral value for y. This happens only for x=55, where you will get y=5. Hence answer is the option (b) Here the Reverse Gear approach is used i.e. working from answer options. It should be remembered that longer the question, the easier it is to eliminate the wrong answer options.

Relative Speed of 2 bodies = Sum of their speeds if they are moving in the opposite direction = Difference of their speeds if they are moving in the same direction.

Consider A and B starting simultaneously, travelling in the opposite direction with a speed of 20 kmph and 30 kmph, and they have to travel a distance of 200 km. The concept of relative speed can be used to find the time of their meeting.

Two bodies moving toward each other are A and B, with speeds of 20 kmph and 30 kmph. Now make body A stationary and take the speed of B in reference to A, so the relative Speed of B = sum of their respective speeds = 20 + 30 = 50 kmph (as they are travelling in opposite directions).

Now A can be assumed to be stationary, and the total distance has to be travelled by B, which he will do with a Speed = of 50 kmph. So he will meet A after 200/50 = 4 hrs.

1.	1.A train running at the speed of 60 km/hr crosses a pole in 9 seconds. What is the length of the train?
	A. 120 metres **B.** 180 metres **C.** 324 metres **D.** 150 metres
	2.A train 125 m long passes a man, running at 5 km/hr in the same direction in which the train is going, in 10 seconds. The speed of the train is:
	A. 45 km/hr **B.** 50 km/hr **C.** 54 km/hr **D.** 55 km/hr
	3.Find the length of the bridge, which a train 130 metres long travelling at the speed of45 km/hr cross in 30 seconds, :
	A. 200 m **B.** 225 m **C.** 245 m **D.** 250 m
	4.Two trains running in opposite directions cross a man standing on the platform in 27 seconds and 17 seconds respectively and they cross each other in 23 seconds. The ratio of their speeds is:

A. 1 : 3

B. 3 : 2

C. 3 : 4

D. None of these

5.A train passes a station platform in 36 seconds and a man standing on the platform in 20 seconds. If the speed of the train is 54 km/hr, what is the length of the platform?

A. 120 m

B. 240 m

C. 300 m

D. None of these

6.A train 240 m long passes a pole in 24 seconds. How long will it take to pass a platform 650 m long?

A. 65 sec

B. 89 sec

C. 100 sec

D. 150 sec

7 A 270 metres long train running at the speed of 120 kmph crosses another train running in opposite direction at the speed of 80 kmph in 9 seconds. What is the length of the other train?

A. 230 m

B. 240 m

C. 260 m

D. 320 m

E. None of these

8.Two stations A and B are 110 km apart on a straight line. One train starts from A at 7 a.m. and travels towards B at 20 kmph. Another train starts from B at 8 a.m. and travels towards A at a speed of 25 kmph. At what time will they meet?

A. 9 a.m.

B. 10 a.m.

C. 10.30 a.m.

D. 11 a.m.

Boat and

- **Upstream = (u−v) km/hr**, where "u" is the speed of the boat in still water and "v" is the speed of the stream
- **Downstream = (u+v)Km/hr**, where "u" is the speed of the boat in still water and "v" is the speed of the stream
- **Speed of Boat in Still Water = ½ (Downstream Speed + Upstream Speed)**
- **Speed of Stream = ½ (Downstream Speed – Upstream Speed)**
- **Average Speed of Boat = {(Upstream Speed × Downstream Speed) / Boat's Speed in Stii Water}**
- If it takes "t" hours for a boat to reach a point in still water and comes back to the same point then, the distance between the two points can be calculated by **Distance = {(u^2-v^2) × t} / 2u**, where "u" is the speed of the boat in still water and "v" is the speed of the stream
- If it takes "t" hours more to go to a point upstream than downstream for the same distance, the formula for distance will be: **Distance = {(u^2-v^2) × t} / 2v**, where "u" is the speed of the boat in still water and "v" is the speed of the stream
- If a boat travels a distance downstream in "t1" hours and returns the same distance upstream in "t2" hours, then the speed of the man in still water will be: **Speed of Man in Still Water = [v × {(t2+t1) / (t2-t1)}] km/hr**, where"v" is the speed of the stream

Types of Questions

The questions from this topic may usually be asked in four different formats. These include:

- **Time Based Questions –** The time taken by a boat to travel upstream or downstream may be asked with the speed of a boat in still water and speed of the stream given in the question
- **Speed Based Questions –** Questions to find the speed of the stream or the speed of the boat in still water may be asked
- **Questions on Average Speed –** With the speed of the boat upstream and downstream given in the question, the average speed of the boat may be asked
- **Questions Based on Distance –** The distance travelled by boat upstream or downstream may be asked
- The first and most important tip is that a candidate must memorise the important formulas to answer the questions correctly. Memorising the formulas will help candidates answer straight forward questions without making any errors
- Do not confuse yourselves between the concept of upstream and downstream as the question may not specifically mention the two terms and instead mention " in the direction of flow" or "against the direction of flow"
- Reading the questions carefully will help candidates avoid making silly mistakes, so do not be in a rush while reading the instructions mentioned in the article

- Ensure that you do not panic reading the length of the question or the terms used in the questions as boat and stream questions asked in the Government exams are mostly direct and not too complex. It is just the formation of the question that makes it sound complicated

– Boat and Stream

Given below are a few sample boat and stream questions with solutions that may help you understand the concept better.

Q 1. A person can swim in water with a speed of 13 km/hr in still water. If the speed of the stream is 4 km/hr, what will be the time taken by the person to go 68 km downstream?

1. 2.5 hours
2. 3 hours
3. 4 hours
4. 3.5 hours
5. 4.5 hours

Answer: (3) 4 hours

Solution:

Downstream Speed = (13+4) km/hr = 17 km/hr

To travel 68 km downstream.

Time taken = 68/17 = 4 hours

Q 2. In one hour, a boat goes 13 km/hr in the direction of the stream and 7 km/hr against the direction of the stream. What will be the speed of the boat in still water?

1. 8 km/hr
2. 10 km/hr
3. 14 km/hr
4. 6 km/hr
5. Cannot Be Determined

Answer: (2) 10 km/hr

Solution:

According to the formula,

Speed of a boat in still water = ½ (DownstreamSpeed + UpstreamSpeed)

Speed of boat in still water = ½ (13+7) = ½ × 20 = 10 km/hr

Q 3. A woman can row upstream at 16 km/hr and downstream at 26 km/hr. What is the speed of the stream?

1. 5 km/hr
2. 2 km/hr
3. 4.5 km/hr
4. 21 km/hr
5. 12 km/hr

Answer: (1) 5km/hr

Solution:

According to the formula,

Speed of the stream = ½ (Downstream Speed – Upstream Speed)

Speed of the stream = ½ (26-16) = ½ × 10 = 5 km/hr

Q 4. A speedboat, whose speed in 15 km/hr in still water goes 30 km downstream and comes back in a total of 4 hours 30 minutes. What is the speed of the stream in km/hr?

1. 2.5 km/hr
2. 3.5 km/hr
3. 4 km/hr
4. 5 km/hr
5. 3.25 km/hr

Answer: (4) 5 km/hr

Solution:

Let the speed of the stream be x km/hr

Upstream Speed = 15 + x

Downstream Speed = 15 – x

So, {30 / (15+x)} + {30 / (15-x)} = 4 ½ (4 hours 30 minutes)

⇒ {900 / (225-x2)} = 9/2

⇒ $9x^2 = 225$

$\Rightarrow x^2 = 25$

$\Rightarrow x = 5$

Q 5. A boat is moving 2 km against the current of the stream in 1 hour and moves 1 km in the direction of the current in 10 minutes. How long will it take the boat to go 5 km in stationary water?

1. 1 hr 20 minutes
2. 1 hr 30 minutes
3. 1 hr 15 minutes
4. 30 minutes
5. 45 minutes

Answer: (3) 1 hr 15 minutes

Solution:

Downstream = (1/10 × 60) = 6 km/hr

Upstream = 2 km/hr

Speed in still water = ½ (6+2) = 4 km/hr

So, the time is taken by the boat to go 5km in stationary water = 5/4 hrs = 1 ¼ hrs = 1 hr 15 minutes