Time Speed And Distance

BASIC RELATIONS :

Let's foremost learn the definition of distance and time.

Distance: The numerical description of **"How far two objects"** is called distance. It may also refer to the length between two points that may be present or may get created.

Time: It is a component to compare the **"durations of events"** and the **"intervals"** between them and to quantify the motions of objects.

So, what is speed?

Suppose a man walks a distance of 10 kilometres and he takes 2 hours to walk the distance, the speed of the man is defined as the distance travelled by him in unit time. Here, we can say that the man travels 5 kilometres for every hour thereby completing the journey of 10 kilometres in 2 hours. The speed of the man is the rate at which he travels the specified distance.

The 3 formulas for Speed, Time & Distance:
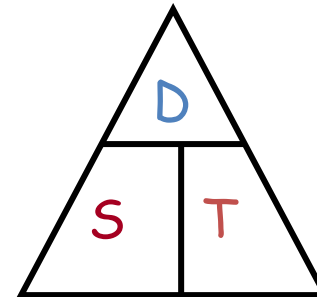
$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

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

$$\text{Distance} = \text{Speed} \times \text{Time}$$

Solving for Speed   Solving for Time   Solving for Distance

Remember them from

this triangle:

Ex.1 A windsurfer travelled 28 km in 1 hour 45 mins.

Calculate his speed.

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Calculate his speed.

Speed $= \dfrac{\text{Distance}}{\text{Time}}$

$= \dfrac{28}{1 \cdot 75}$ ⟶ 1 hour 45 mins
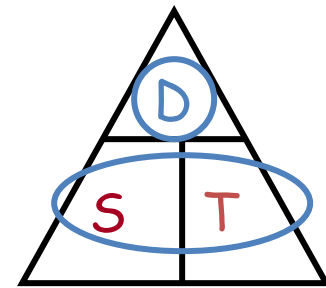
$= 16$ km/h

Answer: His speed was 16 km / hour

Example 2: A salesman travelled at an average speed of 50 km/h for 2 hours 30 mins. How far did he travel?

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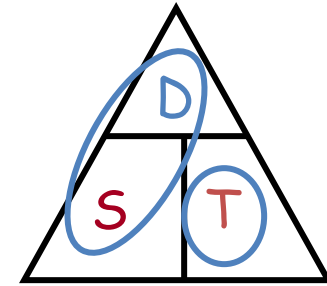
Distance = Speed x Time

= 50 x 2·5 ⟶ 2 hour 30 mins

= 125 km

Answer: He travelled 125 km

Example 3: A train travelled 555 miles at an average speed of 60 mph. How long did the journey take?

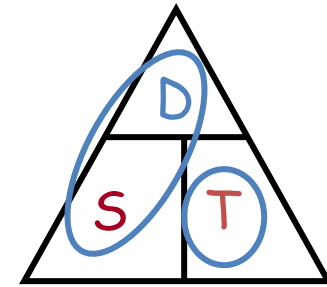A train travelled 555 miles at an average speed of 60 mph. How long did the journey take?

Time $= \dfrac{\text{Distance}}{\text{Speed}}$

$= \dfrac{555}{60}$

$=$ 9·25 hours $=$ 9 hours 15 mins

Answer: It took 9 hours 15 minutes

UNITS OF SPEED AND THEIR CONVERSION

Standard Units

The standard units of speed are as follows.

Unit	Symbols
metres per second	m/s
kilometres per hour	km/h
miles per hour	m/h

1 kilometre = 1000 metres

1 mile = 1.60934 kilometres or 1.6 kilometres

1 hour = 3600 seconds

Conversion of units from km/h to m/s and vice versa

1 km/h = 1000m / 3600s = 5m / 18s

So,

1 km/h = 5/18 m/s and 1 m/s = 18/5 km/h

1 km/h = 50/3 m/min and 1 m/min = 3/50 km/h

Example 4: 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

PROPORTIONALITY :

(i)   Distance is constant, Speed and Time are inversely proportional

$$S = \frac{D}{T} \quad ; \quad as \quad D = Const$$

$$S \propto \frac{1}{T}$$

As Speed is inversely proportional to Time
Therefore If Speed increases Time of the journey decreases
Or
If Speed decreases then Time of the journey increases

Example 5: A car travelling with 5/7 of its actual speed covers 42 km in 1 hr 40 min 48 sec. Find the actual speed of the car.

A car travelling with 5/7 of its actual speed covers 42 km in 1 hr 40 min 48 sec. Find the actual speed of the car

Time taken = 1 hr 40 min 48 sec = 1 hr 40 4/5 min
= 126/75 hrs

Let the actual speed be *A* km/hr.
S=D/T $\implies$ S*T=D

Then (5/7) * A*(126/75) = 42

A= 35km/hr

As D = Const $\implies$ $S \propto \frac{1}{T}$

$$\frac{S_1}{S_2} = \frac{T_2}{T_1} = \frac{7}{5}$$

7 parts $= \frac{126}{75}$; 5 parts $= \frac{126}{75} \times \frac{5}{7}$

$Speed = \frac{D}{T}$; D = 42

$T = \frac{126 \times 5}{7 \times 75}$

$$S = \frac{42 \times 7 \times 75}{126 \times 5}$$

$S = 35 \text{ km/hr}$

Example 6: Ajay takes 3 hours to travel from City A to City B at his normal speed. However, he can travel the same distance in 2 hours by travelling at '*x*' km/h. Find the normal speed of Ajay if the difference between the speeds is 20 km/h.

(ii) Time is constant, Speed and Distance are directly proportional

$$S = \frac{D}{T} \quad ; \quad As \quad T = Const.$$

$$S \propto D$$

Therefor, Faster the speed more will be the distance travelled
OR
Slower the speed less will be the distance travelled

Example 7: 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:

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:

Let the actual distance travelled be x km.

Then, x/10 = (x+20) / 14

$\Rightarrow$14x=10x+200

$\Rightarrow$4x=200

$\Rightarrow$x=50km

As T= Const

$S \propto D$

$\dfrac{S_1}{S_2} = \dfrac{14}{10} \cdot \dfrac{7}{5} = \dfrac{D_1}{D_2} = \dfrac{14}{5} \Big) = 2$

2 parts = 20 Km

$D_2 = 5 \times \dfrac{20}{2} = 50\,km$

Example 8: Two cars start from A and B travel towards each other at speeds of 50 km/h and 60 km/h respectively. At the time of their meeting, the second car has travelled 12 kms more than the first. Find the distance between A and B.

(iii) Speed is constant, Time and Distance are directly proportional

$$S = \frac{D}{T} \; ; \; As \; S_1 = Const.$$

$$D \propto T$$

Like Distance is directly proportional to Time
Therefore, if the distance travelled increases time also increases
OR
if the distance travelled decreases time also decreases

AVERAGE SPEED

What is the Average Speed Formula?

The average speed of a body is equal to the total distance covered, divided by the total time taken. The average speed formula is expressed as follows:

Average Speed Formula

$$\text{Average Speed} = \frac{\text{Total Distance Covered}}{\text{Total Time Taken}}$$

- **Average Speed Formula with Two Speeds**

The average speed formula with two speeds can be calculated after adding the total distance and dividing it by the total time taken to cover that distance.

Now, if two speeds are given along with the time taken by them, we will have to find the two distances.

We find the distance covered by using the formula, Distance = Speed × Time.

After this, we add the two distances and divide it by the total time.

Let us understand this with the help of an example.

Example: During a journey, a train moves at a speed of 50 kilometers per hour for the first 2 hours and 70 kilometers per hour for the next 3 hours. Find the average speed of the train using the average speed formula.

Solution:

We know that the train moves at a speed of 50 kilometers per hour for the first 2 hours. So, $speed_1 = 50$, $time_1 = 2$

And the train moves at a speed of 70 kilometers per hour for the next 3 hours. So, $speed_2 = 70$, $time_2 = 3$

- We will use the following steps to solve the question.

First, we will the $Distance_1$ and $Distance_2$ separately using the formula, Distance = Speed × Time.

We know that total distance = ($Distance_1$ + $Distance_2$)

We know that total time = ($Time_1$ + $Time_2$)

Average Speed Formula = Total Distance/Total Time

Average Speed = ($Distance_1$ + $Distance_2$) ÷ ($Time_1$ + $Time_2$)

Applying all these steps together we get,

Average Speed = (50 × 2 + 70 × 3) ÷ (2 + 3)

= (310) ÷ (5) = 62 kilometer/hour

Therefore, the average speed of the train is 62 kmph.

Q9. A train is moving with a speed of 80 miles per hour for the first 4 hours and 110 miles per hour for the next 3 hours. Find the average speed of the train with the help of the average speed formula.

- **Case 1 –** When the distance is constant:
- ➢ Two speeds S_1 and S_2 are given

Average speed = $\dfrac{2 S_1 S_2}{S_1 + S_2}$

- ➢ Two speeds S_1, S_2 and S_3 are given

Average speed = $\dfrac{3 S_1 S_2 S_3}{S_1 S_2 + S_2 S_3 + S_1 S_3}$

- **Case 2** – When the time taken is constant:

Average speed = (x + y)/2;

$$x = S_1$$
$$y = S_2$$

Q10. If the car had gone from A to B at 50 kmph and returned from B to A at 60 kmph, what would be the average speed?

Q11. A boy goes to school at a speed of 3 km/hr and returns to village at 2 km/hr. If he takes 5 hours, what is the distance between the school and the village?

Q12. A man covers a certain distance between his house and office on bike. Having an average speed of 30 km/hr, he is late by 10 minutes. However, with a speed of 40 km/hr, he reaches his office 5 minutes earlier. Find the distance between his house and office?

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METHOD 1

Difference in time;

10+5 = 15 minutes

=>   *15/60 hours*

=>   *0.25 hours*

The required distance

= (30×40)x0.25/(40-30)

= 30 km

METHOD 2

$$S = \frac{D}{T}$$

$$T = \frac{D}{S}$$

$$T_s - T_f = 5 - (-10)$$
$$= 15 \text{ min}$$

$$\frac{D}{S_s} - \frac{D}{S_f} = \frac{15}{60} \text{ hrs}$$

$$D\left[\frac{S_f - S_s}{S_f \cdot S_s}\right] = \frac{15}{60}$$

$$D\left[\frac{40-30}{\underset{20}{40 \cdot 30}}\right] = \frac{15}{60}$$

$$D = 30 \text{ km}$$

METHOD 3

Speed Ratio = 3 : 4

Time Ratio = 4 : 3

diff = 1 part

= 15 min

Hence time taken

= 60 min & 40 min

Distance = S*T

=> 30*1 = 30 km

Finding Speed or Time Required after Crossing Each Other:

Application:

If two persons or trains A and B start their journey at the same time from two points P and Q towards each other and after crossing each other they take a and b hours in reaching Q and P respectively, then

$$\frac{A' \, Speed}{B' \, Speed} = \frac{\sqrt{b}}{\sqrt{a}}$$

Note: Using this relationship you can find out the missing variables which can be either speed or time. Once these are known you can easily find the distance.

Q13. Two, trains, one from Howrah to Patna and the other from Patna to Howrah, start simultaneously. After they meet, the trains reach their destinations after 9 hours and 16 hours respectively. The ratio of their speeds is:

Solution:

ANSWER KEY

1 – 16km/hr   2 – 125 km/hr   3 – 9hr 15m

4 – 7.2km/hr   5 –35kph   6 – 40km/h

7– 50km   8 – 132km

9 – 92.85km/h   10 – 54.54km/h

11 – 6km   12 – 30km   13– 4:3

Practice Questions:

1. A man covers a certain distance by car driving at 30kmph and he returns back to the starting point with a speed 40kmph. Find his average speed for the whole journey.

a)   35 km/hr

b)   34.3 km/hr

c)   36 km/hr

d)   None

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

a) 85km/hr
b) 87.5 km/hr
c) 90 km/hr
d) None

3. A truck covers a distance of 550 meters in 1 minute whereas a train covers a distance of 33 kms in 45 minutes. What is the ratio of their speed?

a) 4:3

b) 3:4

c) 5:4

d) None

4. A person has to cover a distance of 6 km in 45 minutes. If he covers one-half of the distance in two-thirds of the total time; to cover the remaining distance in the remaining time, what should be his speed in km/hr?

a)   10 km/hr

b)   12 km/hr

c)   15 km/hr

d)   None

5. A man travels the first part of his journey at 30 kmph and the remaining part at 90 kmph, and he covers the entire journey at an average speed of 50 kmph. What is the ratio of the distance he covered at 30 kmph to that he covered at 90 kmph?

a)   1 : 2

b)   1 : 3

c)   2 : 3

d)   3 : 4

6. Ram starts from Ludhiana at 6 a.m. at a constant speed of 40 kmph. He halts at Jalandhar for half an hour and then drives at 70 kmph. He reaches Amritsar at 9.30 a.m. which is 180 km away from Ludhiana. What is the distance between Jalandhar and Amritsar?

a)   120 km

b)   140 km

c)   100 km

d)   130 km

7. While driving from Chennai to Bangalore, I covered half of the journey at an average speed of 80 kmph, half of the 2nd half of the journey at an average speed of 40 kmph and the rest at 60kmph. It took 5 hours and 30 minutes to reach Bangalore. How far is Bangalore from Chennai?

a)   310 km

b)   350 km

c)   330 km

d)   360 km

8. Anil and Jagjeet want to go from Coimbatore to Ooty. There are two ways to do this. First way is to hire a two wheeler, second is to go by bus. Jagjeet started immediately to Ooty in a non stop bus. After sometime Anil hired a Yamaha bike and started towards Ooty. Anil overtook Jagjeet at 10.00 a.m. Anil reached Ooty at 12.30 p.m. and spent an hour. While returning from Ooty, he met the bus at 2.00 p.m. When will the bus reach Ooty?

a)   2.30 p.m.

b)   3.00 p.m.

c)   3.30 p.m.

d)   4.00 p.m.

9. There are 20 windmills with a constant distance between each pole. A car takes 22 seconds to reach the 12th pole. How much time will it take to reach the last pole?

a)   36 seconds

b)   38 seconds

c)   40 seconds

d)   42 seconds

10. A was travelling in a bus. After going 2/3rd of the total distance, the bus broke down. So he hired an auto and completed the rest of the journey. He found that the auto took twice the time the bus took. Find the ratio of the speed of the bus to that of the auto.

a)   1 : 2

b)   2 : 1

c)   3 : 1

d)   4 : 1

11. By walking at 3/7th of his usual speed, a man reaches office 20 minutes later than usual time. What is his usual travel time?

a)   10 min

b)   15 min

c)   20 min

d)   25 min

12. City B is located between the cities A and C, dividing the distance in the ratio 2:3. Raju travels from A to B at 20 km/h and B to C at 30 km/h. When he comes back from C, he reaches B at an average speed of 20 km/h and then A at 30 km/h. Then the average speed of his journey is (all in km/h)

a)   24

b)   25

c)   27

d)   22.5

13. Two buses travel to a place at 45 km/h and 60 km/h respectively. If the second bus takes 5 1/2 hours less than the first for the journey, the length (all in km) of the journey is

a)   900

b)   945

c)   990

d)   1350

14. If I walk at 30 miles/hr I reach 1 hour before the reporting time and if I walk at 20 miles/hr I reach 1 hour late. Find the distance between 2 points and the exact time of reaching destination is 11 am then find the speed with which I have to walk to reach on time.

a)   100miles and 24 miles/hr

b)   120miles and 24 miles/hr

c)   120miles and 16 miles/hr

d)   100miles and 16 miles/hr

15. A ship went on a voyage. After 180 miles a plane started with 10 times speed that of the ship. Find the distance when they meet from starting point.
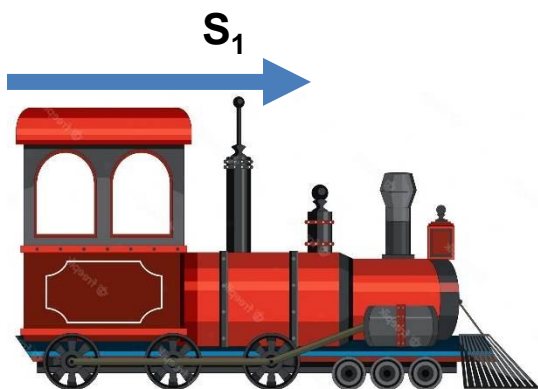
a)   185 miles

b)   190 miles

c)   200 miles

d)   220 miles

- ANSWER KEY (practice questions)
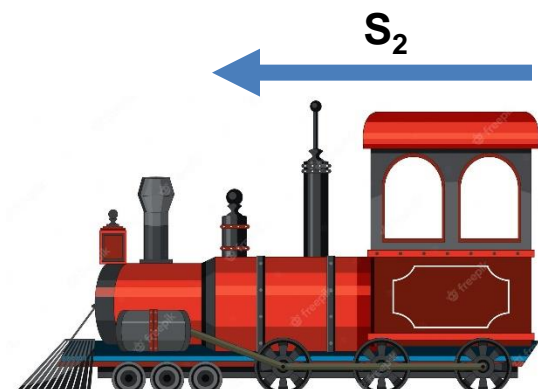
1 B   2 B   3 B   4 B   5 C   6 B   7 C   8 B   9 B   10 D
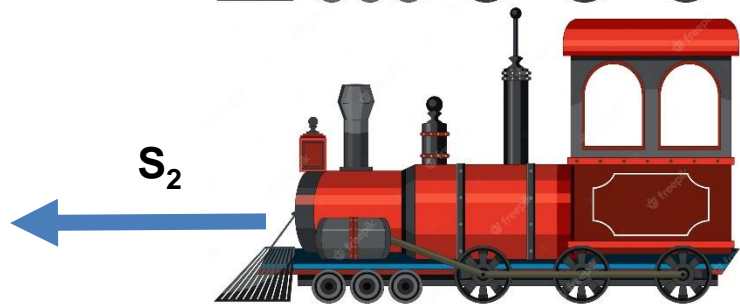
11 B   12 A   13 C   14 B   15 C

RELATIVE SPEED

S_1

S_2

RELATIVE SPEED

$S_R = S_1 + S_2$

(CROSSING)

RELATIVE SPEED

$S_R = S_1 - S_2$

S_1

S_2
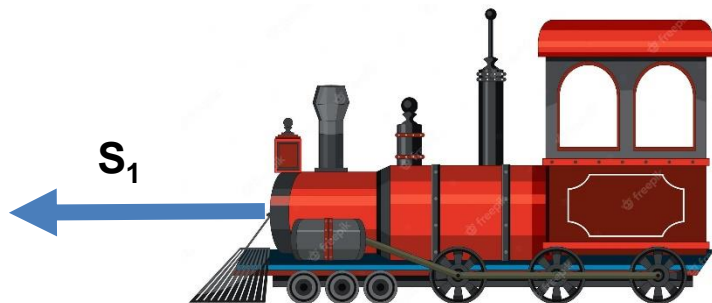
- Length object:

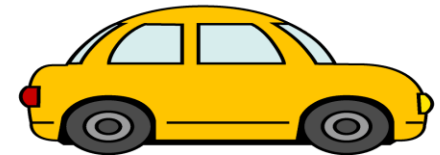Train   Tunnel   Bridge   Platform

- Point object:

Traffic signal   Man   Electric Pole   Car

TRAIN PROBLEMS

Train problems broadly centre around the following three types.

L_t= Length of the train

S = Speed of the train

T = Time taken

1. Length object crossing the point object

Distance Travelled = Length of the train

Time taken(T) = L_t / S

2. Length object crossing the length object

Distance Travelled = Length of train + length of object

$$\text{Time Taken} = (L_t + SL)/S$$

3. Length object crossing movable length object

Distance Travelled = Length of train + length of object Speed by which trains are moving = Relative Speed(S_R)

$$\text{Time Taken} = (L_{t1} + L_{t2})/S_R$$

1. 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, then what is the length of the platform?

a)   200 m

b)   240 m

c)   300 m

d)   864 m

2. Two trains are running In opposite direction with the same speed. If the length of each train is 135 meters and they cross each other in 18 seconds, the speed of each train is

a)   29 km/hr

b)   35 km/hr

c)   27 km/hr

d)   54 km/hr

3. A policeman starts chasing a thief who is 250 metres ahead of the policeman. If the policeman was able to catch the thief in 15 minutes and the speed of the thief is 8 km/h, find the distance travelled (in kilometres) by the policeman in 15 minutes.

a)   1.5 km

b)   2 km

c)   2.25 km

d)   2.5 km

4. Two men start travelling in the opposite direction up to a point where the other started. If they take 13 minutes and 52 minutes respectively to reach the other end, after how much time (all in minutes) would they have met?

a)   39

b)   10.4

c)   26

d)   Cannot say

5 . A train travelling at 42 km/h passes a runner in 9 seconds running in same direction and took 5 seconds in the opposite direction. Find the length of the train.

a)   75 m

b)   100 m

c)   84 m

d)   90 m

6. The distance between two stations is 425 km. Two trains start simultaneously from the stations on parallel tracks to cross each other. The speed of one of them is greater than that of the other by 5 km/h. If the distance between the two trains after 3 hours of their start is 20 km, find the speed of each train (all in km/h).

a)   80, 85

b)   70, 75

c)   60, 65

d)   65, 70

7. A man standing on a railway platform notices that a train going in one direction takes 10 seconds to pass him and other train of the same length takes 15 seconds to pass him. Find the time taken by the two trains to cross each other when they are running in the opposite direction (all in seconds).

a)   12

b)   14

c)   13.5

d)   15

8. Two guns were fired from the same place at an interval of 13 minutes but a person in a train approaching the place hears the second report 12 minutes 30 seconds after the first. Find the speed of the train in m/s, supposing that sound travels 330 metres per second?

a) 12 m/s

b) 13 m/s

c) 14 m/s

d) 13.2 m/s

9. A man travels from A to B at a speed of x km/h. Then he rests at B for x hours. He then travels from B to C at a speed of $2x$ km/h and rests for $2x$ hrs. He moves further to D at a speed twice as that between B and C. He then reaches D in 16 hours. If distance A to B, B to C and C to D are equal to 12 km each, the time taken for which he rested at B could be (all in hours)

a)   3

b)   4

c)   5

d)   6

10. A car travelling in fog passed a man walking at 3 km/h in the same direction. He could see the car for 4 minutes and up to a distance of 100 m. What is the speed of the car (all in km/h)?

a)   40.5

b)   4.5

c)   1.5

d)   5.5

11. A car travelled a distance of 600 km in 6 hours. The first part of the journey is covered with a speed of 70 km/h and the rest of the journey is covered with the speed of 120 km/h. The distance covered in the first part of the journey is

a) 240 km

b) 120 km

c) 168 km

d) None of these

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

a)   24 hrs

b)   16 hrs

c)   56/3 hrs

d)   58/3 hrs

13. Two trains of length 115 m and 110 m respectively run on parallel rails. When running in the same direction, the faster train passes the slower one in 25 seconds, but when they are running in opposite directions with the same speeds as earlier, they pass each other in 5 seconds. Find the speed of the faster train.

a)   27 m/s
b)   18 m/s
c)   36 m/s
d)   None of these

- ANSWER KEY (practice questions)

1 B   2 C   3 C

4 B   5 A   6 D   7 A   8 D   9 A   10 B   11 C
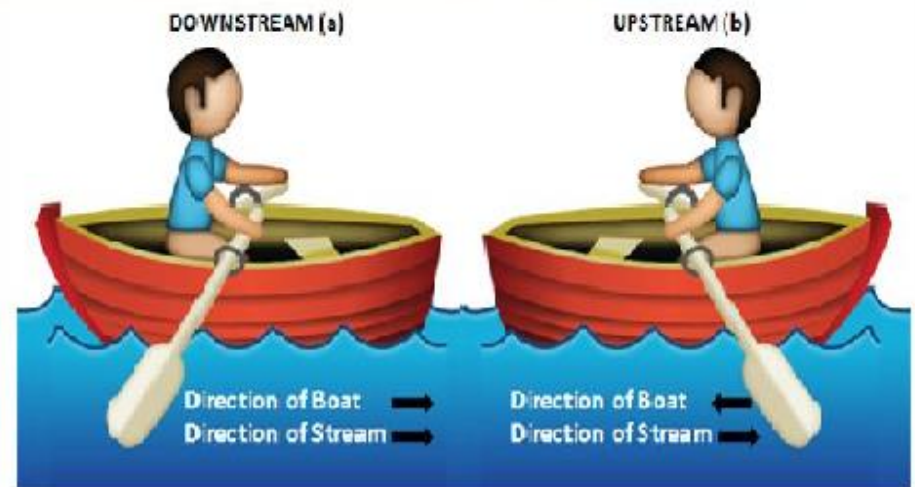
12 D   13 A

Boats and Streams

Upstream: if a boat or man moves in the opposite direction of the stream then it is called upstream.

Downstream: if a boat or man moves in the same direction of the stream then it is called downstream.

Formulas:

Speed of boat/man   =   x
Speed of stream   =   y
Downstream speed   =   x+y
Upstream speed   =   x-y

Speed of boat/man   =   (D+U)/2
Speed of stream   =   (D-U)/2

DOWNSTREAM (a)   UPSTREAM (b)

Direction of Boat ➡   Direction of Boat ⬅
Direction of Stream ➡   Direction of Stream ➡

1. A boat can travel with a speed of 13 km/hr in still water. If the speed of the stream is 4 km/hr, find the time taken by the boat to go 68 km downstream.

a)   2 hours

b)   3 hours

c)   4 hours

d)   5 hours

2. A motorboat, whose speed in 15 km/hr in still water goes 30 km downstream and comes back in a total of 4 hours 30 minutes. The speed of the stream (in km/hr) is:

a)   4

b)   5

c)   6

d)   10

3. A boat running downstream covers a distance of 16 km in 2 hours while for covering the same distance upstream, it takes 4 hours. What is the speed of the boat in still water?

a)   4 km/hr

b)   6 km/hr

c)   8 km/hr

d)   Data inadequate

4. A boat takes 19 hours for travelling downstream from point A to Point B and coming back to a Point C midway between A and B. If the velocity of the stream is 4 kmph and the speed of the boat in still water is 12 kmph, what is the distance between A and B?

a) 60 km

b) 152 km

c) 200 km

d) 220 km

5. A boat takes 90 minutes less to travel 36 miles downstream than to travel the same distance upstream. If the speed of the boat in still water is 10 mph, the speed of the stream is:

2 mph

2.5 mph

3 mph

4 mph

- ANSWER KEY (practice questions)

1 C   2 B   3 B   4 B   5 A