

SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

Approved by AICTE, New Delhi, Affiliated to Anna University, Chennai

Accredited by NAAC-UGC with 'A++' Grade (Cycle III) &

Accredited by NBA (B.E - CSE, EEE, ECE, Mech & B.Tech.IT)

COIMBATORE-641 035, TAMIL NADU



Boats and Streams

Boats and streams is an application of concepts of speed, time and distance. Speed of river flowing either aids a swimmer (boat), while travelling with the direction of river or it opposes when travelling against the direction of river.

Still water: If the speed of water of a river is zero, then water is considered to be still water.

Stream water: If the water of a river is moving at a certain speed, then it is called as stream water.

Speed of Boat: Speed of boat means speed of boat (swimmer) in still water. In other words, if the speed of a boat (swimmer) is given, then that particular speed is the speed in still water.

Downstream Motion: If the motion of a boat (swimmer) is along the direction of stream, then such motion is called downstream motion.

Upstream Motion: If the motion of a boat (swimmer) is against the direction of stream, then such motion is called upstream motion.

Basic Formulae Related to Boats and Streams

If the speed of a boat in still water is x km/h and speed of the stream is y km/h, then

1. Speed downstream = $(x + y)$ km/h
2. Speed upstream = $(x - y)$ km/h
3. Speed of a boat in still water (x) = $\frac{1}{2}$ (Speed downstream + Speed upstream)
4. Speed of a stream (y) = $\frac{1}{2}$ (Speed downstream - Speed upstream)

Example : 1 A man can row with a speed of 6 km/h in still water. What will be his speed with the stream, if the speed of stream is 2 km/h?

Solution: Given, speed of man in still water = $x = 6$ km/h and speed of stream = $y = 2$ km/h

Speed downstream = $x + y = 6 + 2 = 8$ km/h.

Example : 2 If the speed of a boat in still water is 8 km/h and the rate of stream is 4 km/h, then find upstream speed of the boat.

Solution: Given, speed of a boat = $x = 8$ km/h

Speed of stream = $y = 4$ km/h

Speed upstream = $x - y = 8 - 4 = 4$ km/h

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Example : 3 Shantanu can row upstream at 10 km/h and downstream at 18 km/h. Find the man's rate in still water and the rate of the current.

Solution: Speed upstream = 10 km/h and Speed downstream = 18 km/h

According to the formula,

Man's rate in still water = $\frac{1}{2}(\text{Speed downstream} + \text{Speed upstream})$

$$= \frac{1}{2}(18 + 10) = \frac{28}{2} = 14 \text{ km/h}$$

Speed of current = $\frac{1}{2}(\text{Speed downstream} - \text{Speed upstream})$

$$= \frac{1}{2}(18 - 10) = \frac{8}{2} = 4 \text{ km/h}$$

Example : 4 What time will be taken by a boat to cover a distance of 64 km along the stream, if speed of boat in still water is 12 km/h and speed of stream is 4 km/h?

Solution: Given that, distance = 64 km, speed of boat in still water = $x = 12 \text{ km/h}$ and speed of stream = $y = 4 \text{ km/h}$

Downstream speed of boat = $x + y = 12 + 4 = 16 \text{ km/h}$

Required time = $\frac{\text{Distance}}{\text{Speed(downstream)}} = \frac{64}{16} = 4 \text{ h.}$

Example : 5 A boat takes 8 h to row 48 km downstream and 12 h to row the same distance upstream. Find the boat's rate in still water and rate of current.

Solution: Speed downstream = $\frac{\text{Distance}}{\text{Time}} = \frac{48}{8} = 6 \text{ km/h}$

Speed upstream = $\frac{48}{12} = 4 \text{ km/h}$

Now, rate of boat in still water = $\frac{(\text{Speed downstream} + \text{Speed upstream})}{2} = \frac{6+4}{2} = 5 \text{ km/h}$

and rate of current = $\frac{(\text{Speed downstream} - \text{Speed upstream})}{2} = \frac{6-4}{2} = 1 \text{ km/h.}$

Fast Track Techniques to solve the questions:

Technique :1

If speed of stream is a and a boat (swimmer) takes n times as long to row up as to row down the river, then

Speed of boat (Swimmer) in still water = $\frac{a(n+1)}{(n-1)}$



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Note : This formula is applicable for equal distances.

Example : 6 Rajnish can row 12 km/h in still water. It takes him twice as long to row up as to row down the river. Find the rate of stream.

Solution: Here speed of Rajnish in still water = 12 km/h

$n = 2$, Speed of stream (a) = ?

According to the formula, Speed in still water = $\frac{a(n+1)}{(n-1)}$

$$12 = \frac{a(2 + 1)}{(2 - 1)}$$

$$3a = 12 \Rightarrow a = 4 \text{ km/h}$$

Technique : 2

A person can row at a speed of x in still water. If stream is flowing at a speed of y , it takes time T to row to a place and back, then

Distance between two places = $\frac{T(x^2 - y^2)}{2x}$

Example : 7 A man can row 12 km/h in still water. When the river is running at 2.4 km/h, it takes him 1 h to row to a place and to come back. How far is the place?

Solution: Here, Speed of man in still water = $x = 12 \text{ km/h}$

Speed of river = 2.4 km/h ; $T = 1 \text{ h}$

According to the formula,

$$\text{Required distance} = \frac{T(x^2 - y^2)}{2x} = \frac{1 \times [(12)^2 - (2.4)^2]}{2 \times 12} = \frac{138.24}{24} = 5.76 \text{ km}$$

Technique : 3

A man rows a certain distance downstream in x h and returns the same distance in y h. when the stream flows at the rate of a km/h, then

Speed of the man in still water = $\frac{a(x+y)}{(y-x)}$

Example : 8 Kamal can row a certain distance downstream in 12 h and can return the same distance in 18 h. If the stream flows at the rate of 6 km/h, then find the speed of Kamal in still water.

Solution: Here, $x = 12 \text{ h}$, $y = 18 \text{ h}$

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Rate of stream (a) = 6 km/h

According to the formula,

$$\text{Speed of kamal in still water} = \frac{a(x+y)}{(y-x)} = \frac{6 \times (12+18)}{(18-12)} = \frac{6 \times 30}{6} = 30 \text{ km/h}$$

Note: If in case of technique 3, man's speed in still water is b km/h and we are asked to find the speed of stream, then technique 3 takes the form as

$$\text{Speed of the stream} = \frac{b(y-x)}{(x+y)}$$

Example : 9 If in the above example, the speed of Kamal in still water is 12 km/h, then find the speed of the stream.

Solution: Here, b=12, y=18 and x=12

According to the formula,

$$\text{Speed of stream} = \frac{b(y-x)}{(x+y)} = \frac{12(18-12)}{18+12} = \frac{12 \times 6}{30} = \frac{12}{5} = 2.4 \text{ km/h}$$

Technique : 4

If boat's (swimmer's) speed in still water is a km/h and river is flowing with a speed of b km/h, then average speed in going to a certain place and coming back to starting point is given by $\frac{(a+b)(a-b)}{a}$ km/h.

Example : 10 Ramesh rows in still water with a speed of 4.5 km/h to go to a certain place and to come back. Find his average speed for the whole journey, if the river is flowing with a speed of 1.5 km/h.

Solution: Here a= 4.5 km/h , b= 1.5 km/h

$$\text{Average speed} = \frac{(a+b)(a-b)}{a} = \frac{(4.5+1.5)(4.5-1.5)}{4.5} = \frac{6 \times 3}{4.5} = \frac{18}{4.5} = 4 \text{ km/h}$$

Technique : 5

When boat's speed (swimmer's speed) in still water is a km/h and river is flowing with a speed of b km/h and time taken to cover a certain distance upstream is T more than the time taken to cover the same distance downstream, then Distance = $\frac{(a^2-b^2)T}{2b}$



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Example : 11 A boat's speed in still water is 10km/h, while river is flowing with a speed of 2 km/h and time taken to cover a certain distance upstream is 4 h more than time taken to cover the same distance downstream. Find the distance.

Solution: Here, $a = 10 \text{ km/h}$, $b = 2 \text{ km/h}$ and $T = 4 \text{ h}$

According to the formula,

$$\text{Required distance} = \frac{(a^2 - b^2)}{2b} \times T = \frac{(10^2 - 2^2)}{2 \times 2} \times 4 = \frac{100 - 4}{4} \times 4 = 100 - 4 = 96 \text{ km}$$

Technique : 6

If a man covers l km distance in t_1 h along the direction of river and he covers same distance in t_2 h against the direction of river, then

$$\text{Speed of man} = \frac{1}{2} \left(\frac{l}{t_1} + \frac{l}{t_2} \right) = \frac{l}{2} \left(\frac{1}{t_1} + \frac{1}{t_2} \right)$$

$$\text{Speed of the stream} = \frac{1}{2} \left(\frac{l}{t_1} - \frac{l}{t_2} \right) = \frac{l}{2} \left(\frac{1}{t_1} - \frac{1}{t_2} \right)$$

Example : 12 A boat covers 20 km in an hour with downstream and covers the same distance in 2 h with upstream. Then, find the speed of boat in still water and speed of stream.

Solution: Here, $l = 20 \text{ km}$, $t_1 = 1 \text{ h}$, $t_2 = 2 \text{ h}$

$$\text{Speed of boat in still water} = \frac{l}{2} \left(\frac{1}{t_1} + \frac{1}{t_2} \right) = \frac{20}{2} \left(\frac{1}{1} + \frac{1}{2} \right) = 10 \times \frac{3}{2} = 15 \text{ km/h}$$

$$\text{Speed of stream} = \frac{l}{2} \left(\frac{1}{t_1} - \frac{1}{t_2} \right) = \frac{20}{2} \left(\frac{1}{1} - \frac{1}{2} \right) = 10 \times \frac{1}{2} = 5 \text{ km/h}$$