18.BOATS AND STREAMS

General Rules for Solving Boats and Streams Problems

Downstream Motion

When an object is moving in their direction in which the water in the stream is flowing, then the object is said to be downstream.

Upstream Motion

When an object is moving against (opposite) direction in which the water in the stream is flowing, then the object is said to be moving upstream.

Motion in Still Water

When an object is moving in water where there is no motion in the water, then the object is said to be moving in still water.

Rule 1 Downstream and Upstream Speed

Let the speed of the boat in still water be *x* km/h and speed of the stream be *y* km/h, then

Speed of the boat with stream= downstream speed = *(x + y)* km/h

Speed of the boat against stream = upstream speed = *(x - y)* km/h

As, when the boat is moving downstream, the speed of the water aids the speed of the boat and when the boat is moving upstream, the speed of the water reduces the speed of the boat.

Rule 2 Speed of Boat in Still Water & Speed of Stream

If the downstream speed of boat is *a* km/h and the upstream speed of boat is *b* km/h, then

Speed of boat in still water = $\frac{1}{2}$ (a+ b)km/h

Speed of stream = $\frac{1}{2}$ (a - b)km/h

Example 1: The current of a stream runs at 1 km/h. A motor boat goes 35 km upstream and back again at the starting point in 12 h. What is the speed of motor boat in still water?

Solution: Let the speed of the boat in still water be *x* km/h. Then,

$$\frac{35}{x-1}+\frac{35}{x+1}=12 \Rightarrow 35(x+1+x-1)=12(x^2-1) \Rightarrow 6x^2-35x-6=0$$

$\Rightarrow (x-6)(6x+1)=0 \Rightarrow x=6$ ($\because$ x = -1/6 is not possible)

So, speed of boat in still water = 6 km/h

Example 2: A man can row 6 km/h in still water. When the river is running at 4 km/h, it takes him 2 h 15 min to row to a place and back. How far is the place?

Solution: Speed downstream = (6 + 4) km/h = 10 km/h

Speed upstream = (6 - 4) km/h = 2 km/h

Let the required distance be *x* km.

Then, $\frac{x}{10}+\frac{x}{2}=\frac{9}{4} \Rightarrow x=\left(\frac{9\times10}{4\times6}\right)$= 3.75km

EXERCISE

1. The stream runs at 1 km/hr, a motor boat goes 35km upstream and back again to the starting point after 12hours. What's the speed of the motor boat in still water?
   (a) 6km/hr (b) 7km/hr
   (c) 8km/hr (d) 10km/hr
2. If the man's rate of rowing in still water is 5km/hr and the speed of stream is 10km/hr. The distance given is 15km/hr .Find the time taken to row downstream?
   (a) 1hr (b) 2hr
   (c) 3hr (d) 4hre
3. Speed of a boat in standing water is 9 kmph and the speed of the stream is 1.5 kmph. A man rows to a place at a distance of 105 km and comes back to the starting point. The total time taken by him is:
   (a) 22 hours (b) 27 hours
   (c) 20 hours (d) 24 hours
4. A man can row 9km/hr in still water, if the river running at 4 km/hr. It takes 6 hours more to upstream than to go

downstream for the same distance. How far is the place?
(a) 48.75 km (b) 47.85km
(c) 75.48km (d) 45.78km

5. The ratio of speed of boat in still water to the speed of current is 6:1. If the upstream speed is 2 km/hr. find the speed of the boat in still water?
(a) 2.4km/hr (b) 3.6km/hr
(c) 4.4km/hr (d) 5.2km/hr

6. The speed of a boat in still water is 15 km/hr and the rate of current is 3 km/hr. The distance travelled down steam in 12 minutes is:
(a) 3.3 km (b) 2.9 km
(c) 2.4 km (d) 3.6 km

7. A person can row $\mathbf{7\frac{1}{2}}$ km/h in still water. It takes him twice as long to row up a distance as to row down the same distance. Find the speed of the stream.
(a) 2 km/h (b) 2.2 km/h
(c) 2.5 km/h (d) 2.7 km/h

8. A motorboat, whose speed is 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) 9 (b) 5
(c) 6 (d) 11

9. A man can row $9\frac{1}{3}$ kmph in still water and finds that it takes him thrice as much time to row up than as to row down the same distance in the river. The speed of the current is:
(a) $2\frac{1}{3}$ km/hr (b) $4\frac{1}{9}$ km/hr
(c) $4\frac{2}{3}$ km/hr (d) $4\frac{1}{2}$ km/hr

10. In a stream running at 2 km/h, a motor boat goes 5 km upstream and back again to the starting point in 1 h 20 min. Find the speed of the motor boat in still water.
(a) 4 km/h (b) 8 km/h
(c) 10 km/h (d) 6 km/h

ANSWER KEY									
1	a	3	d	5	a	7	c	9	c
2	a	4	a	6	d	8	b	10	b

SOLUTIONS

1. Let the speed of the motor boat be $\boldsymbol{x}$ kmph
$\frac{35}{x-1}+\frac{35}{x+1}=12 \Rightarrow \boldsymbol{x=6}$

2. $\mathbf{T_{down}=\frac{15}{5+10}=1\ Hr}$

3. Speed upstream= 7.5 kmph.
Speed downstream = 10.5 kmph.
∴ Total time taken
$=\left(\frac{105}{7.5}+\frac{105}{10.5}\right)$ hour = 24 hours.

4. Downstream speed=9+4=13 kmph
Upstream speed=9-4=5 kmph
Let the time taken to row downstream be $\boldsymbol{x\ hrs}$
Then time taken to row upstream will be $(\boldsymbol{x+6})$ hrs
Distance is same in both downstream and upstream.
Hence, $13*\boldsymbol{x=5*(x+6)}$
$\Rightarrow \boldsymbol{x=\frac{30}{8}\ hrs}$
∴distance=$13*\frac{30}{8}$=48.75 km

5. Let the speed of boat in still water be 6 $\boldsymbol{xkmph}$ and speed of stream be $\boldsymbol{x}$ kmph
Upstream speed=$6\boldsymbol{x}-\boldsymbol{x}=5\boldsymbol{x}=2$
$\Rightarrow \boldsymbol{x}=0.4$
$\Rightarrow 6\boldsymbol{x=6*0.4=2.4kmph}$

6. Speed downstream = (15 + 3) kmph
= 18 kmph.
Distance traveled $=\left(\mathbf{18\times\frac{12}{60}}\right)\boldsymbol{km}$
= 3.6 km.

7. Speed upstream + speed downstream
$=\mathbf{2\times 7\frac{1}{2}}$ = 15 km/h

Since, the times taken are in the ratio 2:1,the speeds will be in the ratio 1:2.

$\therefore$ Speed up stream = $\frac{1}{3} \times 15$ = 5 km/h

Speed downstream = $\frac{2}{3} \times 15$

= 10 km/h

Speed of the stream = $\frac{1}{2}(10 - 5)$

= 2.5 km/h

8. Let the speed of the stream be *x* km/hr. Then,

Speed downstream = (15+x) km/hr, Speed upstream =(15 - x) km/hr.

$$\therefore \frac{30}{(15+x)} + \frac{30}{(15-x)} = 4\frac{1}{2}$$

$$\Rightarrow \frac{900}{225 - x^2} = \frac{9}{2}$$

$$\Rightarrow 9x^2 = 225$$

$$\Rightarrow x^2 = 25$$

$\Rightarrow x = 5$ km/hr.

9. Let speed up stream be *x* kmph. Then, speed downstream = *3x* kmph.

Speed in still water = $\frac{1}{2}$(3.x + x) kmph

= 2x kmph.

$$\therefore 2x = \frac{28}{3} \Leftrightarrow x = \frac{14}{3}$$

So, Speed upstream = $\frac{14}{3}$ km/hr;

Speed downstream = 14 km/hr.

Hence, speed of the current

= $\frac{1}{2}\left(14 - \frac{14}{3}\right)$km/hr

= $4\frac{2}{3}$ km/hr.

10. Let the speed of the motor boat in still water be x km/h. Then,

Downstream speed = (x + 2) km/h,

Upstream speed = (x - 2) km/h

$$\therefore \frac{5}{x+2} + \frac{5}{x-2} = \frac{4}{3}$$

$$\Rightarrow \frac{1}{x+2} + \frac{1}{x-2} = \frac{4}{15}$$

$$\Rightarrow \frac{2x}{x^2-4} = \frac{4}{15} \Rightarrow 4x^2 - 16 = 30x$$

$$\Rightarrow 4x^2 - 30x - 16 = 0$$

$$\Rightarrow 2x^2 - 15x - 8 = 0$$

$$\Rightarrow 2x^2 - 16x + x - 8 = 0$$

$$\Rightarrow x = 8$$

[as x cannot be nE.g.ative]