BOATS & STREAMS

EFFECTIVE SPEED

Effective speed is defined as the final speed of a body influenced by an external force/speed.

Let's take the instance of riding a bi-cycle against the wind. Though you pedal harder you will not be able to travel at the speed of your pedaling because of the resistance offered by the wind. Here, the effective speed is the difference between the speed of the bi-cycle and that of the wind.

However, when you ride in the direction of the wind, you benefit from the speed of the wind. Here, you travel at a speed more than the speed of your pedaling. Thus the effective speed becomes the sum of the speeds of the bi-cycle and the wind.

The concept of effective speed is solely applied in the topics Boats and Streams and Escalators.

BOATS AND STREAMS

These problems are governed by the following results.

- Downstream (along the current) speed (D)

  = boat speed (B) + current (stream) speed (C)
- Upstream (against the current) speed (U)

  = boat speed – current (stream) speed
- Speed of the boat = average of downstream and upstream speeds
- Speed of the current = half the difference of downstream and upstream speeds

Or as formulae,

$$D = B + C$$

$$U = B - C$$

$$B = (D + U)/2$$

$$C = (D - U)/2$$

Example:

A boatman goes 2 km against the current of the stream in 1 hour and goes 1 km along the current in 10 minutes. How long will it take to go 5 km in stationary water?

Solution:

Rate downstream = 1/10 × 60 km/h = 6 km/h

Rate upstream = 2 km/h

Speed in still water = 1/2(6 + 2) km/h = 4 km/h

Therefore, the required time for 5 km = 5/4hrs = 1 ¼ hrs = 75 min.

Practice Questions:

1. A boat takes a circular route to travel a total distance of 24 km to reach its initial position. The speed of the boat in still water is 5 km/hr and the speed of the stream is 3 km/h. How much time (in hrs) does the boat travel upstream and downstream respectively?

a) 12, 3

b) 3, 12

c) 5, 3

d) 3, 5

Ans: A

2. Boat goes downstream from P to Q in 2hrs, upstream in 6hrs and if speed of stream is 6kmph, then find the distance PQ

a) 6 km

b) 4 km

c) 10 km

d) 36 km

Ans: D

3. A river runs at 4 km/hr. if the time taken by a man to row is boat upstream is thrice as the time taken by him to row it downstream then find the speed of the boat in still water.

a) 16 km/hr

b) 8 km/hr

c) 6 km/hr

d) 12 km/hr

Ans: B

4. A motorboat whose speed is 15 kmph in still water goes 30 km downstream and comes back in a total of 4hrs 30min. What is the speed of the stream?

a) 5 km

b) 6 km

c) 10 km

d) 12 km

Ans: A

5. A boat sails 15 km of a river towards upstream in 5 hours. How long will it take to cover the same distance downstream, if the speed of current is one-fourth the speed of the boat in still water:

a) 1.8 h

b) 3 h

c) 4 h

d) 5 h

Ans: B

6. A man can row a certain distance against the stream in six hours. However, he would take two hours less to cover the same distance with the current. If the speed of the current is 2 Kmph, then what is the speed of the man in still water.

a) 10 kmph

b) 12 kmph

c) 16 kmph

d) 8 kmph

Ans: A

7. A man can row downstream at 12 Kmph and upstream at 8 Kmph. Find the ratio of the speed of the current to the speed of the man in still water?

a) 1 : 5

b) 5 : 4

c) 25 : 16

d) 16 : 25

Ans: A

8. In a stream running at 2 km/h, a motor boat goes 10 km upstream and returns to the starting point in 55 minutes. Find the speed (all in km/h) of the motor boat in still water.

a) 2

b) 11

c) 22

d) None of these

Ans: C

9. On a river, B is between A and C and is equidistant from A and C. A boat goes from A to B and back in 5 hours 15 minutes and from A to C in 7 hours. How long will it take to go from C to A, if the river flows from C to A (all in hours)?

a) 2

b) 2 ¼

c) 3 ¼

d) 3 ½

Ans: D

10. The ratio of the speed of the boat in still water to the speed of the current is 4:1. What is the ratio of the downstream speed of the boat to the upstream speed?

a) 2:1

b) 1:1

c) 5:3

d) None of these

Ans: C

11. A boatman rows to a place at a distance 45 km and comes back in 20 hours. He finds that he can row 12 km with the stream in the same time as 4 km against the stream. Find the speed of the stream.

a) 3 km/h

b) 2.5 km/h

c) 4 km/h

d) 3.5 km/h

Ans: A

12. Two boats, travelling at 5 km/h and 10 km/h respectively, head directly towards each other. They begin at a distance of 20 km from each other. How far apart are they (in km) one minute before they collide?

a) 1/12

b) 1/6

c) 1/4

d) 1/3

Ans: C

13. A man takes twice as long to row a distance against the stream as to row the same distance along the stream. The ratio of the speed of the boat (in still water) and the stream is

a) 2:1

b) 3:1

c) 3:2

d) 4:3

Ans: B

14. The speed of a boat when it travels downstream is 5 times the speed when it travels upstream. The speed of the current is what percent of the speed of the boat in still water?

a) 33 1/4%

b) 50 %

c) 66 2/3%

d) Cannot be determined

Ans: C

15. Two boats go downstream from A to B. The faster one covers the distance 1.5 times as fast as the slower one. The slower one lags 8 km for every hour. However, if they go upstream, then the faster boat covers the distance from B to A in half the time of the slower one. Find the speed of the faster boat in still water.

a) 12 km/h

b) 20 km/h

c) 24 km/h

d) 25 km/h

Ans: B

ESCALATORS

- An escalator is a moving stairway where people can walk up/ down the stairs themselves along with the moving stairs.
- Here, the speed of the escalator is perceived as the rate at which the escalator moves the steps i.e. the number of steps moved by the escalator in unit time because the entire escalator setup does not move at a certain speed.
- The number of steps in an escalator is considered as the distance say 50 steps, 60 steps, etc.

So, we can say that the total number of steps in an escalator is covered by

- The moving stairs alone when a person remains stationary on a step
- A person walking along with the moving stairs either in the same or in the opposite direction of the movement of the stairs

Thus we can infer that the movement of stairways influences the rate at which a person covers steps in an escalator.

Hence, by applying the concept of effective speed we learn that

(i) When a person walks up/down opposite to the movement of stairs

The actual rate at which a person covers the steps = Difference of the rates at which the person and the escalator cover the steps.

(Here, it is assumed that the rate at which a person covers the steps is always greater than the rate at which an escalator moves the steps)

(ii) When a person walks up/down in the direction of the movement of stairs

The actual rate at which a person covers the steps = Sum of the rates at which the person and the escalator moves the steps

(Here, the rate at which a person covers the steps is either lesser or greater than the rate at which an escalator covers the steps)

Generally,

No. of steps in an escalator = sum of the steps covered by the person and the moving stairs

(when the person moves in the direction of the moving stairs)

or

No. of steps in an escalator = difference of the steps covered by the person and the moving stairs

(when the person moves opposite to the moving stairs)

Here,

No. of steps moved by the escalator = product of the rate at which the escalator moves the steps and the time taken for it

No. of steps covered by the person = product of the rate at which the person covers the steps and the time taken for it

Practice Questions:

1. Jagjeet can walk up an escalator in 9 seconds when he takes 25 steps. If he takes only 7 steps then he will reach in 15 seconds. What is the total number of steps in the escalator?

a) 62

b) 50

c) 52

d) 54

Ans: C

2. Anil and his son step into 2 different escalators which are moving at the same speed. The father reaches down in 30 seconds taking 26 steps whereas the son reaches in 18 seconds taking 34 steps. Find the total number of steps in the escalators assuming both have equal number of steps.

a) 60

b) 20

c) 46

d) 12

Ans: C

3. Abhrajit gets down a moving escalator in 4 seconds during which the escalator moves 44 steps. If the total number of steps in the escalator is 72, then how many steps does the man move down the escalator per second?

a) 4

b) 11

c) 7

d) 9

Ans: C

4. Lovedeep keeps on walking at constant speed in the moving escalator. It takes him 30 seconds to reach the top and 90 seconds to come back. If his walking speed is constant in both the direction, find out the time taken by the man to walk up when the escalator is stationary.

a) 40

b) 45

c) 54

d) 60

Ans: B

5. Jay walks down to the bottom of an escalator that is moving up and he counts 300 steps. Aakash walks up to the top of the same escalator and counts 150 steps. If Jay's speed of walking (in steps per unit time) is three times Aakash's walking speed, how many steps are visible on the escalator at a given time?

a) 240

b) 120

c) 150

d) 225

Ans: A

6. Vikrant is climbing on a moving escalator that is going up and takes 30 steps to reach the top. Farhaz on the other hand is coming down on the same escalator. For every 5 steps that Farhaz takes, Vikrant takes only 3 steps. Both of them take the same amount of time to reach the other end. What is the total number of steps in the escalator?

a) 40

b) 60

c) 30

d) 80

Ans: A

7. Ashish takes 60 seconds to reach the bottom on an escalator which is moving down when he walks down but takes 40 seconds when he runs down. He takes 20 steps when he is walking whereas he takes 30 steps when he is running. Find the total number of steps in the escalator?

a) 40

b) 50

c) 60

d) None of these

Ans: B

8. Pooja and Nisha walk up an escalator (moving stairway). The escalator moves at a constant speed, Pooja takes three steps for every two of Nisha's steps. Pooja gets to the top of the escalator after having taken 25 steps. While Nisha (because her slower pace lets the escalator do a little more of the work) takes only 20 steps to reach the top. If the escalator were turned off, how many steps would they have to take to walk up?

a) 40

b) 50

c) 60

d) 80

Ans: B

9. Ravi and Rakesh are climbing on a moving escalator that is going up. Ravi takes 10 seconds to reach the top but Rakesh takes 8 seconds to reach the top. This happens because Rakesh is faster than Ravi. Rakesh takes 4 steps whereas Ravi can take only 3 steps in one second. What is the total number of steps in the escalator?

a) 30

b) 40

c) 50

d) 60

Ans:B

10. A person is walking up an ascending escalator. He covers 50 steps and reaches the top in 25 seconds. If the total number of steps on the escalator is 200. Find the ratio of the speed of the person of the speed of the escalator.

a) 2 : 3

b) 1 : 3

c) 3 : 1

d) 3 : 2

Ans: B