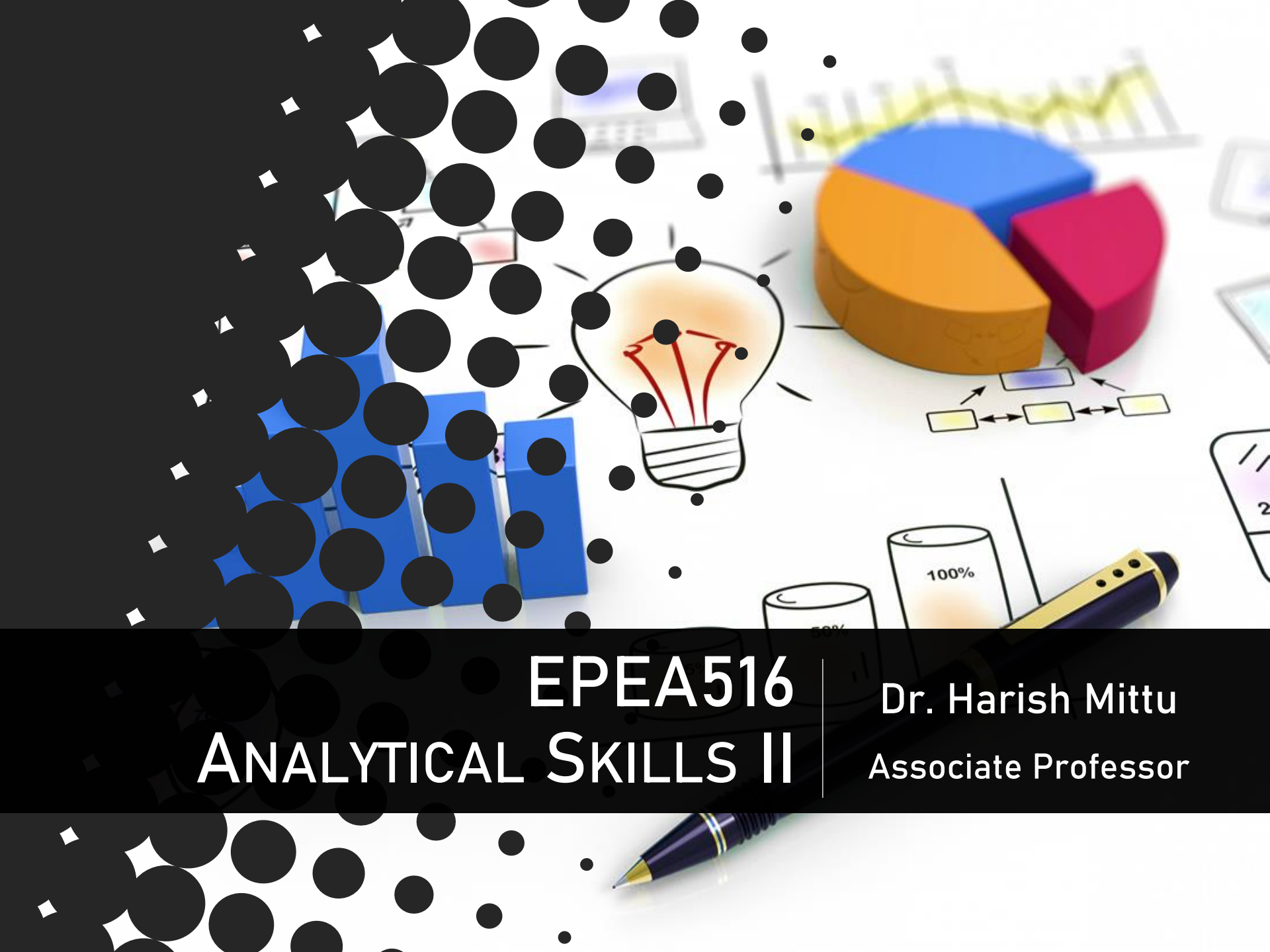

EPEA516
Analytical Skills II

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Learning Outcomes

After this lecture, you will be able to

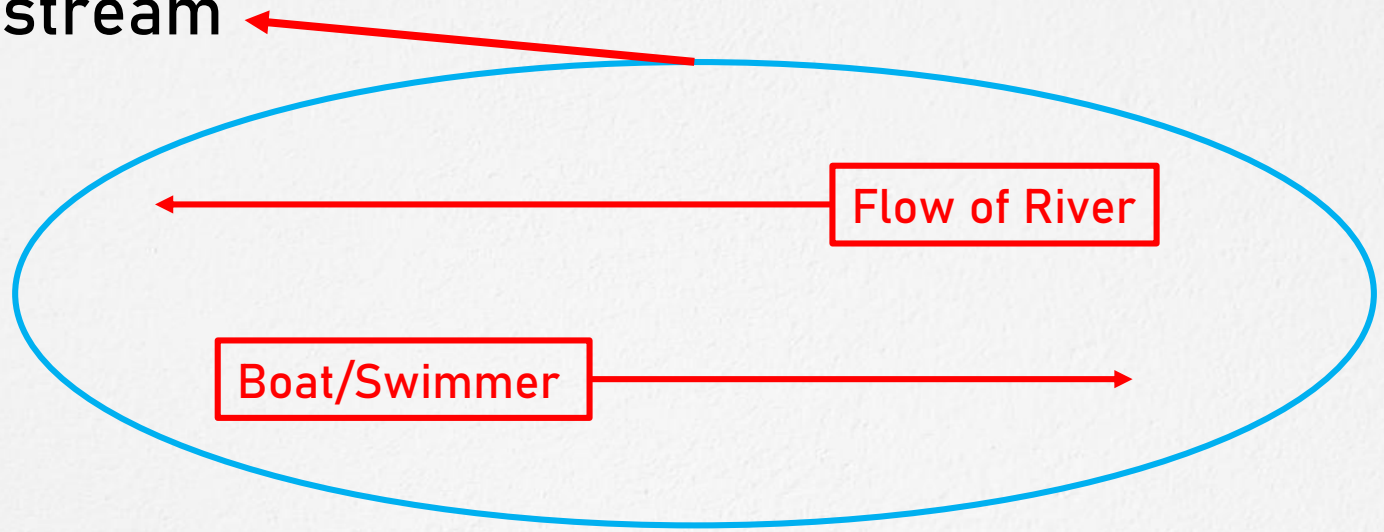
- develop understanding about basics of stream, upstream and downstream,
- derive important facts and formulae relating to various problems on boats and streams,

Basics, Important Facts & Formulae

- Still Water
  - Speed of Water (River) - Zero
- Stream
  - Moving Water – River
- Given Speed of a Boat/Swimmer - Speed in Still Water

Basics, Important Facts & Formulae

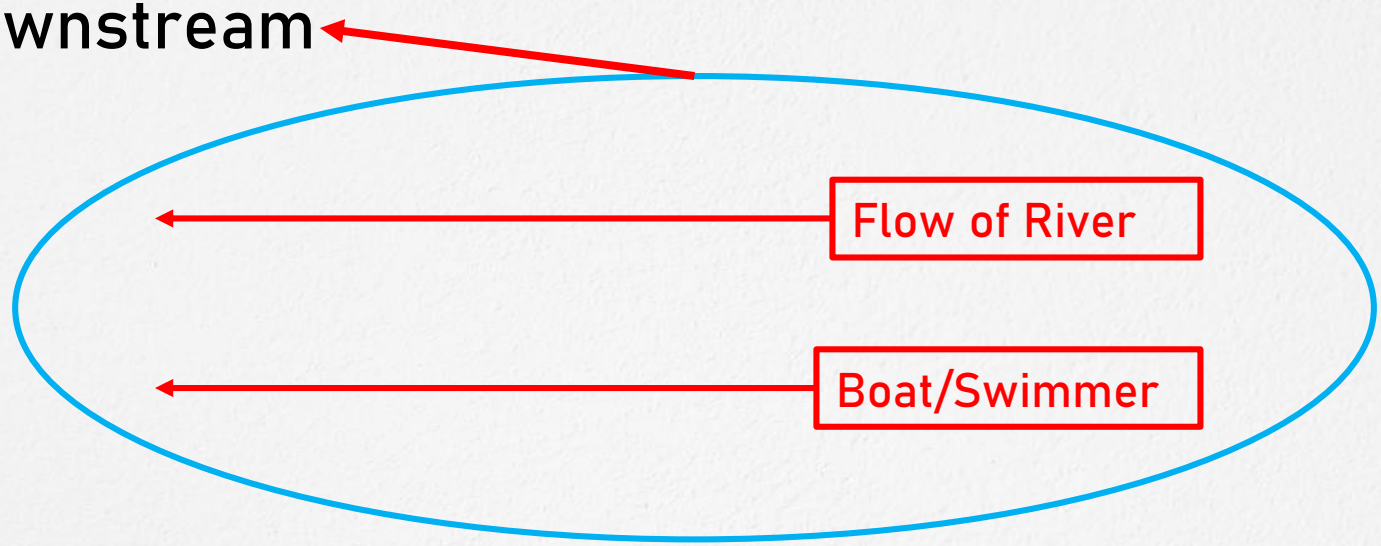
- Upstream



  - Boat/Swimmer - Against Stream (Flow of River)
  - Direction - Opposite to Direction of Stream

Basics, Important Facts & Formulae

- Downstream



  - Boat/Swimmer – With Stream (Flow of River)
  - Direction - Along Direction of Stream

Important Facts & Formulae

- If the speed of a boat/swimmer be ‘a’ Km/h and the speed of a stream/current be ‘b’ Km/h, then
- Downstream Speed of Boat/Swimmer,

$$x = (a + b) \text{ Km/h}$$

- Upstream Speed of Boat/Swimmer,

$$y = (a - b) \text{ Km/h}$$

Important Facts & Formulae

- Suppose a man can swim in still water at the rate of ‘a’ Km/h, the speed of current/stream is ‘b’ Km/h, and the man wishes to cross the stream (of width ‘d’ m) straight along its width, then time taken to cross the river is the same as time taken to swim ‘d’ m at ‘a’ km/hr.

Important Facts & Formulae

- If downstream speed of boat be ‘x’ Km/h and upstream speed of boat be ‘y’ Km/h, then

- Speed of Boat = $\frac{\text{Downstream Speed + Upstream Speed}}{2}$

$$= \frac{x + y}{2} \text{ Km/h}$$

Important Facts & Formulae

- If downstream speed of boat be ‘x’ Km/h and upstream speed of boat be ‘y’ Km/h, then

- Speed of Stream

$$= \frac{\text{Downstream Speed} - \text{Upstream Speed}}{2}$$

$$= \left(\frac{x - y}{2}\right) \text{Km/h}$$

Important Facts & Formulae

- If speed of a boat be ‘a’ Km/h, speed of a stream be ‘b’ Km/h, downstream speed of boat be ‘x’ Km/h, and upstream speed of boat be ‘y’ Km/h, then
- Downstream Speed of Boat,

$$x = (a + b) \text{ Km/h} \ldots\ldots (1)$$

- Upstream Speed of Boat

$$y = (a - b) \text{ Km/h} \ldots\ldots (2)$$

- Downstream Speed + Upstream Speed = $(a + b) + (a - b)$

Important Facts & Formulae

- Downstream Speed + Upstream Speed = $(a + b) + (a - b)$
- Downstream Speed + Upstream Speed = $2a$
- $2a$ = Downstream Speed + Upstream Speed
- $a = \frac{\text{Downstream Speed + Upstream Speed}}{2}$
- Speed of Boat (a) = $(\frac{x + y}{2})$ Km/h

Important Facts & Formulae

- If speed of a boat be ‘a’ Km/h, speed of a stream be ‘b’ Km/h, downstream speed of boat be ‘x’ Km/h, and upstream speed of boat be ‘y’ Km/h, then
- Downstream Speed of Boat, x = (a + b) Km/h ….. (1)
- Upstream Speed of Boat, y = (a – b) Km/h …… (2)
- Downstream Speed – Upstream Speed = (a + b)–(a – b)

Important Facts & Formulae

- Downstream Speed - Upstream Speed = ~~(a +~~ b)-~~(a -~~ b)
- Downstream Speed - Upstream Speed = 2b
- 2b = Downstream Speed - Upstream Speed
- $b = \frac{\text{Downstream Speed} - \text{Upstream Speed}}{2}$
- Speed of Stream (b) = $(\frac{x - y}{2})$ Km/h

Important Facts & Formulae

- If a man capable of rowing at the speed of ‘a’ Km/h in still water, rows the same distance up and down a stream which flows at a rate of ‘b’ Km/h.
- Downstream Speed of Man, x =(a + b) Km/h
- Uptream Speed of Man, y = (a – b) Km/h
- Average Speed of Man throughout Journey

$$= \frac{(\text{Downstream Speed of Man})(\text{Uptream Speed of Man})}{\text{Speed of Man in Still Water}}$$

Important Facts & Formulae

- Average Speed of Man throughout Journey

$$= \frac{\text{(Downstream Speed of Man)(Uptream Speed of Man)}}{\text{Speed of Man in Still Water}}$$

$$= \frac{(x)(y)}{a}$$

$$\text{or} \quad = \frac{(a + b)\,(a - b)}{a} \text{ Km/h}$$

$$\text{or} \quad = \frac{(a^2 - b^2)}{a} \text{ Km/h}$$

Important Facts & Formulae

- A man can row a boat in still water at ‘a’ Km/h. In a stream flowing at ‘b’ Km/h, if it takes ‘T’ hours more in upstream than to go downstream for the same distance. Find distance.
- Let, distance between two places = d
- Downstream Speed of Man, x = (a + b) Km/h
- Uptream Speed of Man, y = (a – b) Km/h
- Time = $\frac{\text{Distance}}{\text{Speed}}$

Important Facts & Formulae

- Upstream Time - T = Downstream Time
- T = Upstream Time - Downstream Time

$$T = \frac{d}{a-b} - \frac{d}{a+b}$$

$$T = d\left\{\frac{a+b-(a-b)}{a^2-b^2}\right\}$$

$$T = d\left\{\frac{2b}{a^2-b^2}\right\}$$

- Distance between the two places $= \frac{(a^2-b^2)(T)}{2b}$ Km

Important Facts & Formulae

- If a man can row a certain distance downstream in t_1 hours and returns the same distance upstream in t_2 hours. If the speed of the stream be 'b' Km/h, then find speed of man in still water.
- Let, Speed of man in still water = 'a 'Km/h
- Speed of the stream = 'b' Km/h
- Downstream Speed of Man, x = (a + b) Km/h
- Uptream Speed of Man, y = (a – b) Km/h
- Downstream Time = t_1 h & Upstream Time = t_2 h

Important Facts & Formulae

- Distance = Speed x Time
- Downstream Distance = Upstream Distance

$$(a + b)\, t_1 = (a - b)\, t_2$$

$$at_1 + bt_1 = at_2 - bt_2$$

$$bt_2 + bt_1 = at_2 - at_1$$

$$b(t_2 + t_1) = a(t_2 - t_1)$$

- Speed of the man in still water i.e., $a = \frac{(b)(t_2 + t_1)}{(t_2 - t_1)}$

Important Facts & Formulae

- A man can row a boat in still water at ‘a’ Km/h. In a stream flowing at ‘b’ Km/h if it takes him ‘T’ hours to row to a place and come back, then find distance between the two places.
- Let, distance between two places = d
- Downstream Speed of Man, x = (a + b) Km/h
- Uptream Speed of Man, y = (a – b) Km/h
- Total Time = T hours
- Time = $\frac{\text{Distance}}{\text{Speed}}$

Important Facts & Formulae

- Total Time = Downstream Time + Upstream Time

$$T = \frac{d}{a+b} + \frac{d}{a-b}$$

$$T = d\left\{\frac{a-b+a+b}{a^2-b^2}\right\}$$

$$T = d\left\{\frac{2a}{a^2-b^2}\right\}$$

- Distance between the two places $= \frac{(a^2-b^2)(T)}{2a}$ Km

Important Facts & Formulae

- A boat takes n times as long to row upstream as to row downstream the river. If the speed of boat be ‘a’ Km/h and the speed of stream be ‘b’ Km/h, compute speed of boat and stream.
- Let, distance between two places = d
- Speed of Boat = ‘a’ Km/h & Speed of Stream = ‘b’ Km/h
- Downstream Speed of boat, x = (a + b) Km/h
- Uptream Speed of Man, y = (a – b) Km/h

Important Facts & Formulae

- Let, distance between two places = d
- Speed of Boat = ‘a’ Km/h & Speed of Stream = ‘b’ Km/h
- Downstream Speed of boat, x = (a + b) Km/h
- Uptream Speed ofboat, y = (a – b) Km/h
- Time = $\frac{\text{Distance}}{\text{Speed}}$
- Upstream Time = n (Downstream Time)
- $\frac{d}{a-b} = n\left(\frac{d}{a+b}\right)$

Important Facts & Formulae

- $\frac{d}{a - b} = n\left(\frac{d}{a + b}\right)$
- $a + b = n(a - b)$
- $a + b = na - nb$
- $nb + b = na - a$
- $b(n + 1) = a(n - 1)$
- Speed of Boat i.e., $a = \frac{b(n + 1)}{(n - 1)}$

Important Facts & Formulae

- $\frac{d}{a-b} = n\left(\frac{d}{a+b}\right)$
- $a + b = n(a - b)$
- $a + b = na - nb$
- $nb + b = na - a$
- $b(n + 1) = a(n - 1)$
- Speed of Stream i.e., $b = \frac{a(n-1)}{(n+1)}$

Important Facts & Formulae

- A man can swim directly across a stream of width 'd' Km in 't_1' hours when there is no current and in 't_2' hours when there is a current, then,

- Rate of Current = $\sqrt{\frac{1}{(t_1)^2} - \frac{1}{(t_2)^2}}$ Km/h

Important Facts & Formulae

- If a man can row a distance of 'd_1' Km upstream and 'd_2' Km downstream in 't_1' hours. Also, he can row a distance of 'd_3' Km upstream and 'd_4' Km downstream in 't_2' hours.

- Upstream Speed of man = $\frac{(d_1 d_4 - d_2 d_3)}{(d_4 t_2 - d_2 t_1)}$

- Downstream Speed of man = $\frac{(d_1 d_4 - d_2 d_3)}{(d_1 t_2 - d_3 t_1)}$

Conclusion

- Stream
- Upstream
- Downstream
- Downstream Speed of Boat = (a + b) Km/h
- Upstream Speed of Boat = (a - b) Km/h
- Speed of Boat = $\frac{\text{Downstream Speed + Upstream Speed}}{2}$
- Speed of Stream = $\frac{\text{Downstream Speed – Upstream Speed}}{2}$

Conclusion

- If a man capable of rowing at the speed of ‘a’ Km/h in still water, rows the same distance up and down a stream which flows at a rate of ‘b’ Km/h then average Speed of Man throughout Journey is

$$\frac{(\text{Downstream Speed of Man})(\text{Uptream Speed of Man})}{\text{Speed of Man in Still Water}}$$

- A man can row a boat in still water at ‘a’ Km/h. In a stream flowing at ‘b’ Km/h, if it takes ‘T’ hours more in upstream than to go downstream for the same distance, then distance between the two places $= \frac{(a^2 - b^2)(T)}{2b}$ Km

Conclusion

If a man can row a certain distance downstream in t_1 hours and returns the same distance upstream in t_2 hours. If the speed of the stream be 'b' Km/h, then speed of the man in still water i.e., $a = \frac{(b)(t_2 + t_1)}{(t_2 - t_1)}$

A man can row a boat in still water at 'a' Km/h. In a stream flowing at 'b' Km/h if it takes him 'T' hours to row to a place and come back, then distance between the two places is

$$\frac{(a^2 - b^2)(T)}{2a} \text{ Km}$$

Conclusion

- A boat takes n times as long to row upstream as to row downstream the river. If the speed of boat be 'a' Km/h and the speed of stream be 'b' Km/h, then speed of boat & speed of stream are $a = \frac{b(n+1)}{(n-1)}$ & $b = \frac{a(n-1)}{(n+1)}$ respectively.
- A man can swim directly across a stream of width 'd' Km in 't_1' hours when there is no current and in 't_2' hours when there is a current, then, Rate of Current = $\sqrt{\frac{1}{(t_1)^2} - \frac{1}{(t_2)^2}}$ Km/h

Conclusion

- If a man can row a distance of 'd_1' Km upstream and 'd_2' Km downstream in 't_1' hours. Also, he can row a distance of 'd_3' Km upstream and 'd_4' Km downstream in 't_2' hours.

- Upstream Speed of man $= \dfrac{(d_1 d_4 - d_2 d_3)}{(d_4 t_2 - d_2 t_1)}$

- Downstream Speed of man $= \dfrac{(d_1 d_4 - d_2 d_3)}{(d_1 t_2 - d_3 t_1)}$

Summary

- Basics
  - Stream, Upstream & Downstream
- Important Facts & Formulae
  - Boats & Streams

That’s all for now…