River Discharge

Create by;

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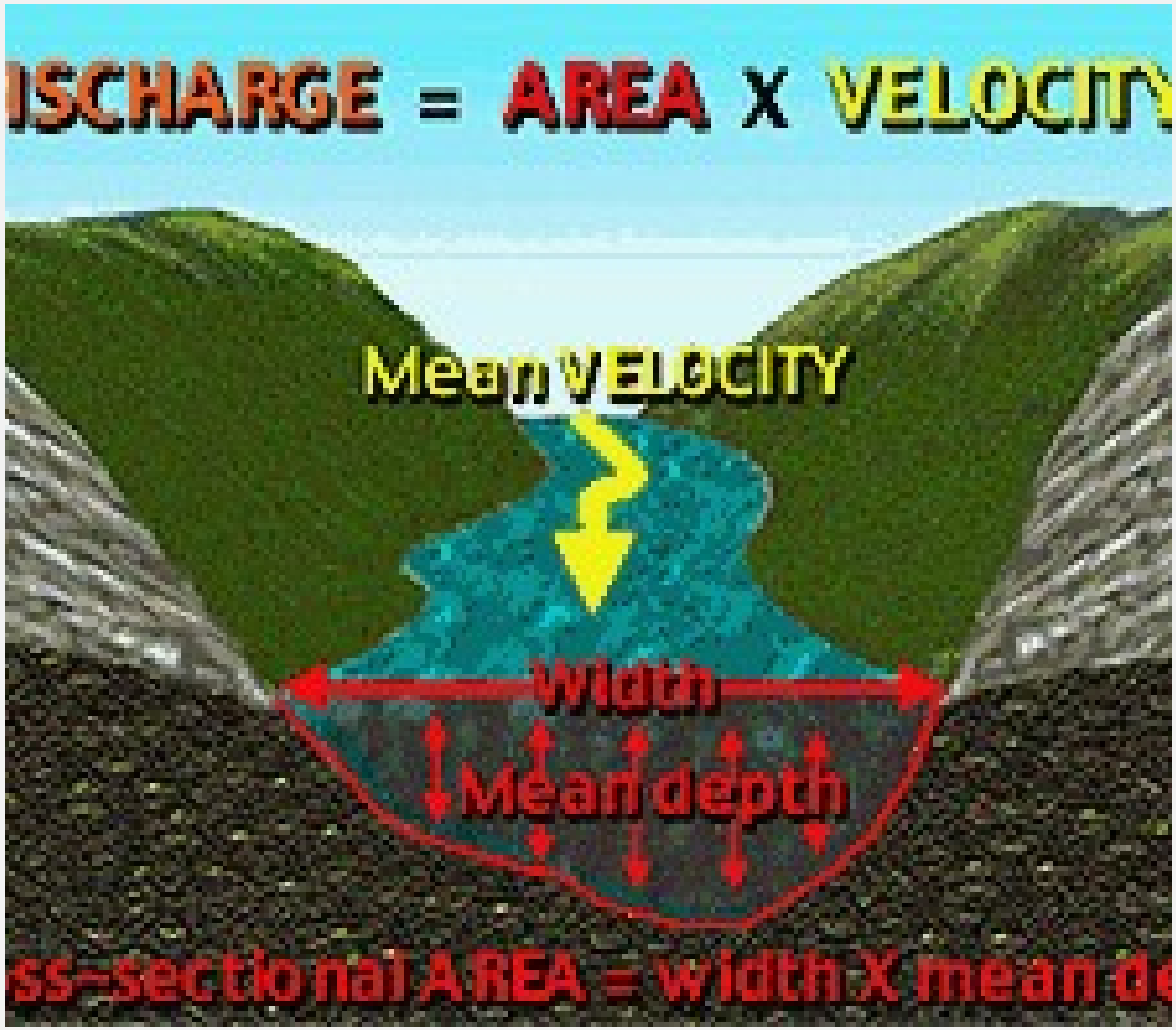
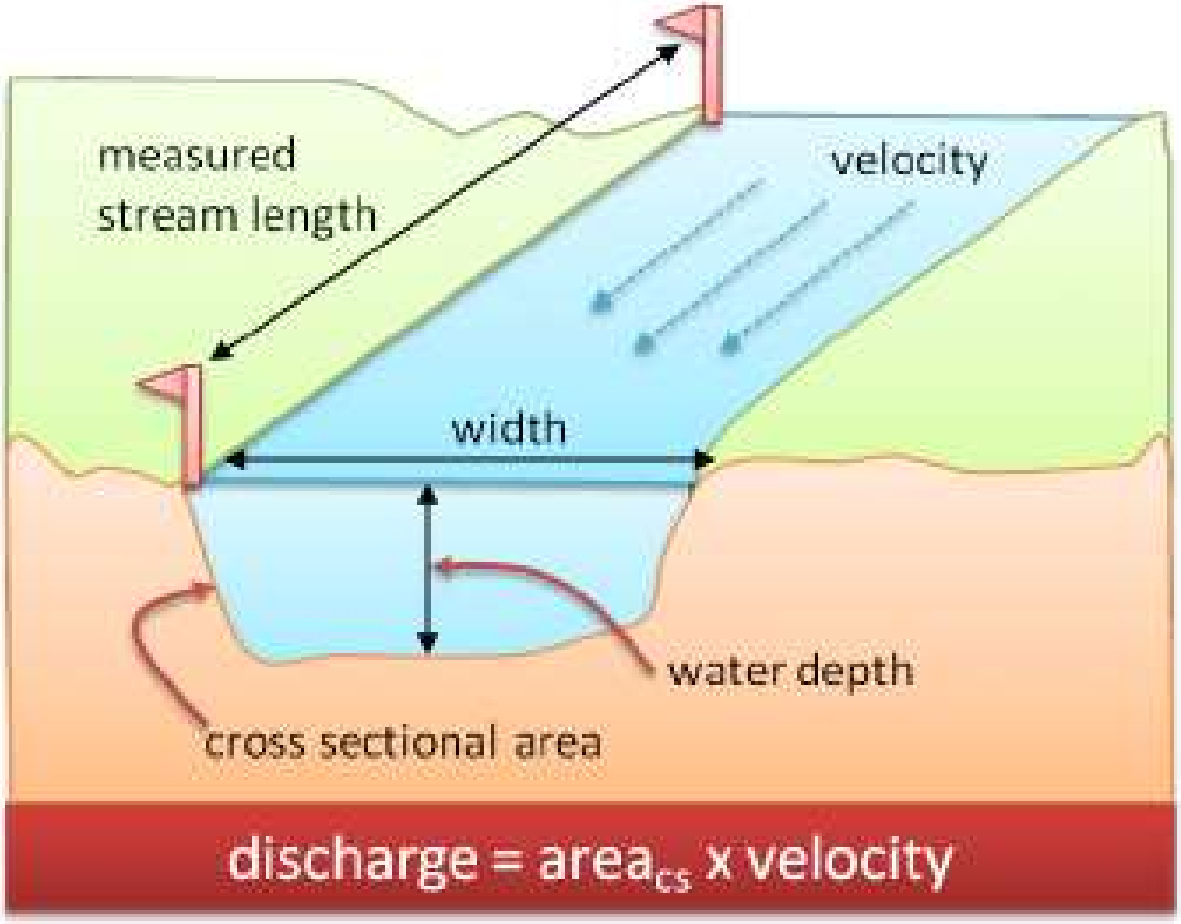


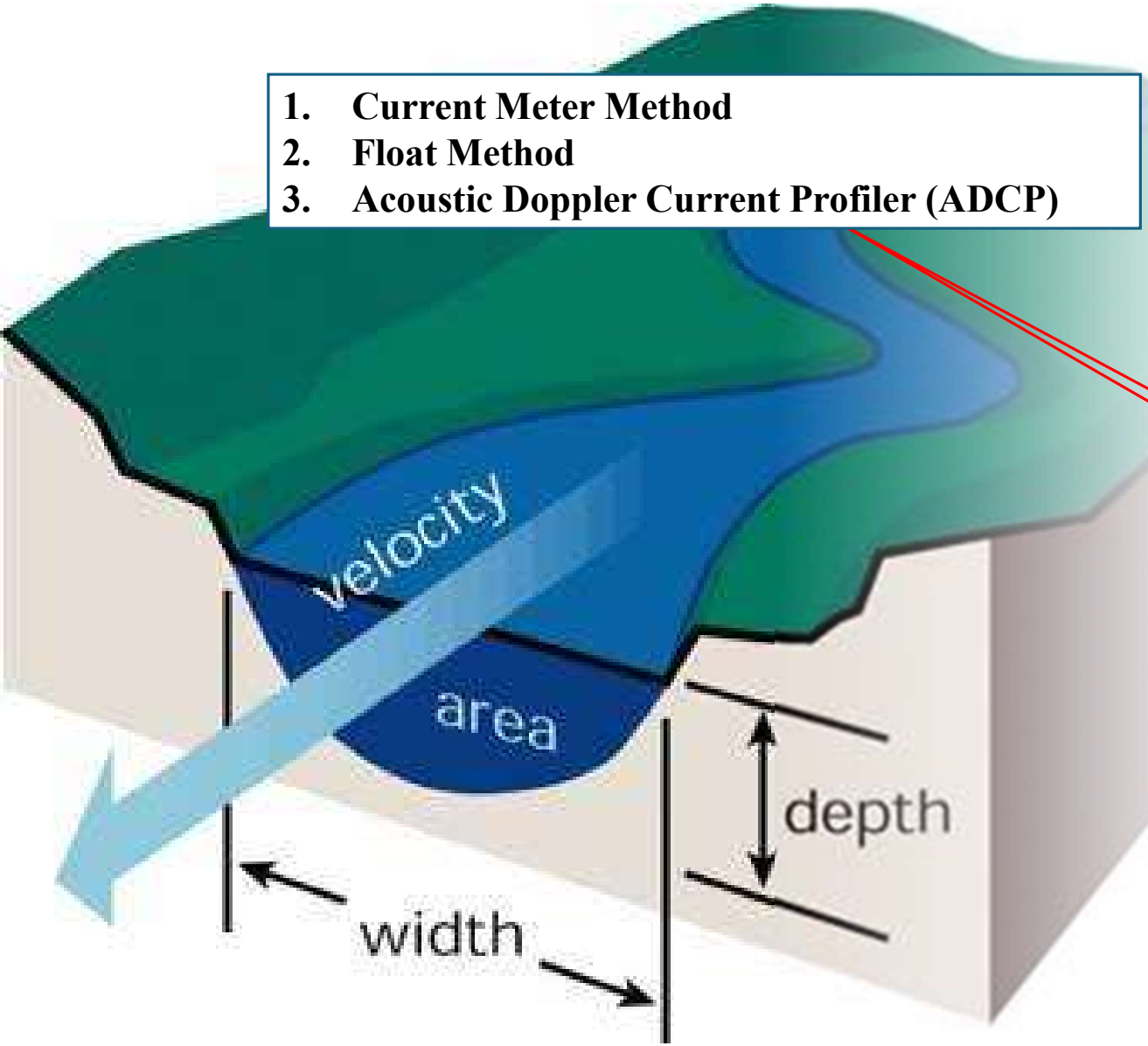
River Discharge

River discharge is the volume of water that flows past a specific point in a river channel over a given period, typically measured in cubic meters per second (m^3/s). It's calculated as the product of the river's cross-sectional area and the average water velocity ($Q = A \times V$) and is influenced by factors like precipitation, evapotranspiration, snowmelt, groundwater, and human activities such as dam construction and water extraction.



1. **Current Meter Method**
2. **Float Method**
3. **Acoustic Doppler Current Profiler (ADCP)**

Velocity – Area method



- This depends on measuring the average velocity of flow and the cross-sectional area of the channel and calculating the flow from:
  - **Q**(m^3/s) = **A**(m^2) x **V**(m/s)
- The metric unit m^3/s is referred to as the **cumec**. Because m^3/s is a large unit, smaller flows are measured in litres per second (l/s).

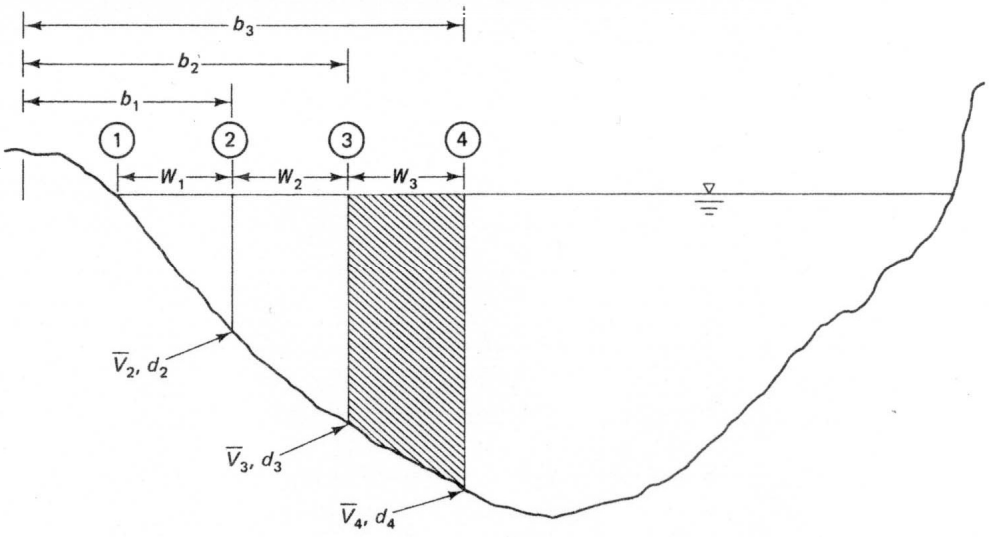
Velocity-Area Method

- Q = [Velocity x Area]
  - Need to know width of channel (*w*), Depth of channel (*d*), and Velocity of flow (V) (ft/s or m/s)
  - Area = w x d
- Because depth & velocity vary across a channel:
  i. Important to divide the channel into manageable segments (slices); Typically use 10-20 segments
  ii. For each segment measure depth, width and velocity

Measuring Streamflow Discharge

- Procedure: at each segment measure depth then velocity
  - If Depth < 0.6m, take one reading @ 60% depth
  - If Depth > 0.6m take 2 measurements and compute the average
    - One @ 20% depth
    - One @ 80% depth
    - Average the two readings
  - Two method of measurement
    - Mean section method
    - Mid section method

$$q_x = \left(\frac{\overline{V}_x + \overline{V}_{x+1}}{2}\right)\left(\frac{d_x + d_{x+1}}{2}\right)W_x$$



Exercise 1:

Given V = 0.3N + 0.05 m/ s. Determine streamflow discharge using velocity-area method (Mean-section Method).

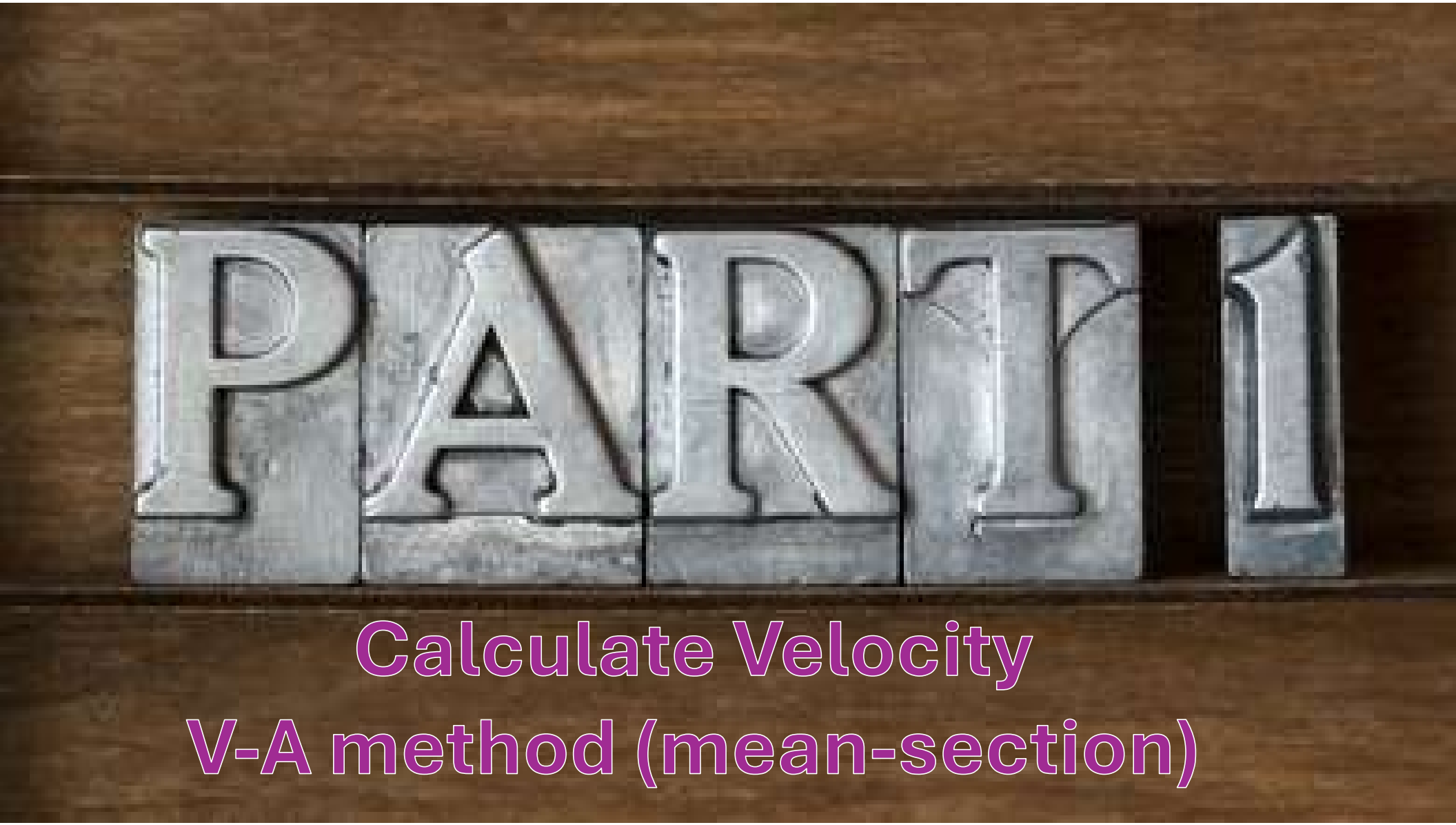
Distance from Datum (m)	Stream depth (m)	Current meter reading					
		0.2D		0.6D		0.8D	
		Rotation	Duration (s)	Rotation	Duration (s)	Rotation	Duration (s)
0	0			0	0		
1	0.5			50	95		
4	1.5	174	100			128	100
8	5.0	433	120	380	120	321	120
10	2.0	453	100			547	100
11	0			0	0		

To answer this Question, you must have;

1. Calculator
2. V-A form

Once you are ready……

Let’s do it!


PART 1
Calculate Velocity
V-A method (mean-section)

Transfer data to V-A form

Step 1

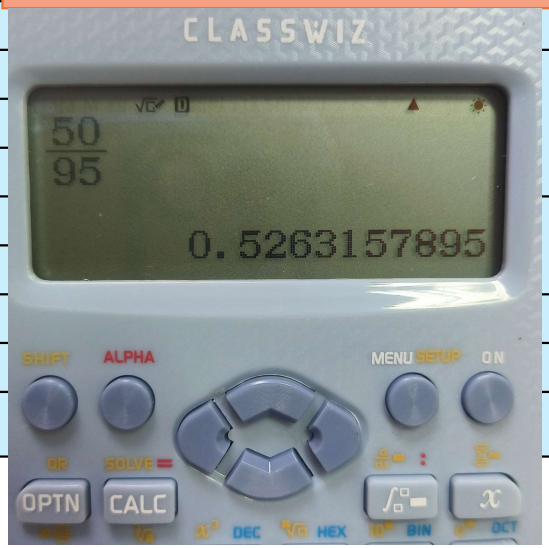
Distance From River Bank	Vertical Depth	Depth of Measurement	Time	Number Of Rotation	Number Of Rotation Per time	Velocity			Width	Vertical Depth Average	Area	Flow
						At Poi	Vertical Average	Horinzontal Average				
0	0	0.6D	0	0								
1	0.5	0.6D	95	50								
4	1.5	0.2D	100	174								
		0.8D	100	128								
8	5.0	0.2D	120	433								
		0.6D	120	380								
		0.8D	120	321								
10	2.0	0.2D	100	453								
		0.8D	100	547								
11	0	0.6D	0	0								
									TOTAL			m³/s

Distance from Datum (m)	Stream depth (m)	Current meter reading					
		0.2D		0.6D		0.8D	
		Rotation	Duration (s)	Rotation	Duration (s)	Rotation	Duration (s)
0	0			0	0		
1	0.5			50	95		
4	1.5	174	100			128	100
8	5.0	433	120	380	120	321	120
10	2.0	453	100			547	100
11	0			0	0		

Step 2

Distance From River Bank	Vertical Depth	Depth of Measurement	Time	Number Of Rotation	Number Of Rotation Per time, N	Velocity			Width	Vertical Depth Average	Area	Flow
						At Point	Vertical Average	Horinzontal Average				
0	**0**	**0.6D**	**0**	**0**	0							
1	**0.5**	**0.6D**	**95**	**50**	0.526							
4	**1.5**	**0.2D**	**100**	**174**	1.740							
		0.8D	**100**	**128**	1.280							
8	**5.0**	**0.2D**	**120**	**433**	3.608							
		0.6D	**120**	**380**	3.167							
		0.8D	**120**	**321**	2.675							
10	**2.0**	**0.2D**	**100**	**453**	4.530							
		0.8D	**100**	**547**	5.470							
11	**0**	**0.6D**	**0**	**0**	0							
											TOTAL	m³/s

Number Of Rotation Per time, N = $\frac{\text{Number Of Rotation}}{\text{Time}}$



Step 3

Equation come with the apparatus

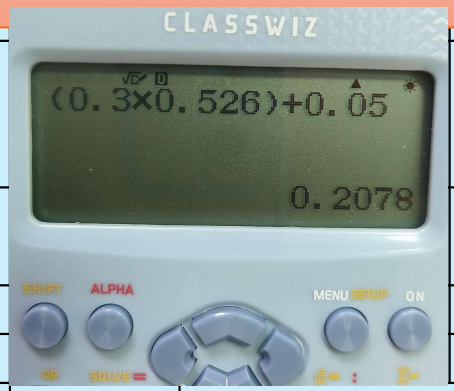
Mean-section Method

Given, **V = 0.3N + 0.05 m/ s**

Distance From River Bank	Vertical Depth	Depth of Measurement	Time	Number Of Rotation	Number Of Rotation Per time, N	Velocity			Width	Vertical Depth Average	Area	Flow
						At Point	Vertical Average	Horinzontal Average				
0	**0**	**0.6D**	**0**	**0**	0	0						
1	**0.5**	**0.6D**	**95**	**50**	0.526	0.208						
4	**1.5**	**0.2D**	**100**	**174**	1.740	0.572						
		0.8D	**100**	**128**	1.280	0.434						
8	**5.0**	**0.2D**	**120**	**433**	3.608	1.133						
		0.6D	**120**	**380**	3.167	1.000						
		0.8D	**120**	**321**	2.675	0.853						
10	**2.0**	**0.2D**	**100**	**453**	4.530	1.409						
		0.8D	**100**	**547**	5.470	1.691						
11	**0**	**0.6D**	**0**	**0**	0	0						
									TOTAL			m^3/s

Velocity At Point, **V = 0.3N + 0.05 m/ s**

Velocity At Point, **V = 0.3(0.526) + 0.05 m/ s**

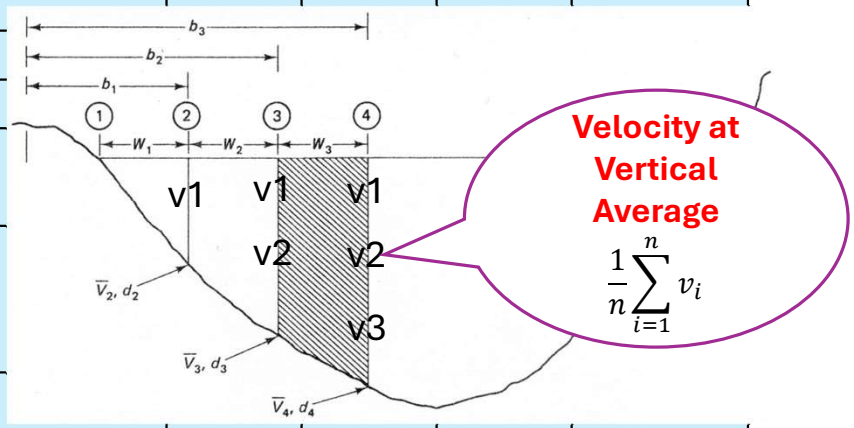


Step 4

Mean-section Method

Given, **V = 0.3N + 0.05 m/ s**

Distance From River Bank	Vertical Depth	Depth of Measurement	Time	Number Of Rotation	Number Of Rotation Per time	Velocity			Width	Vertical Depth Average	Area	Flow
						At Point	Vertical Average	Horinzontal Average				
0	**0**	**0.6D**	**0**	**0**	0	0	0					
1	**0.5**	**0.6D**	**95**	**50**	0.526	0.208	0.208					
4	**1.5**	**0.2D**	**100**	**174**	1.740	0.572	0.503					
		0.8D	**100**	**128**	1.280	0.434						
8	**5.0**	**0.2D**	**120**	**433**	3.608	1.133	0.995					
		0.6D	**120**	**380**	3.167	1.000						
		0.8D	**120**	**321**	2.675	0.853						
10	**2.0**	**0.2D**	**100**	**453**	4.530	1.409	1.55					
		0.8D	**100**	**547**	5.470	1.691						
11	**0**	**0.6D**	**0**	**0**	0	0	0					
									TOTAL			m³/s



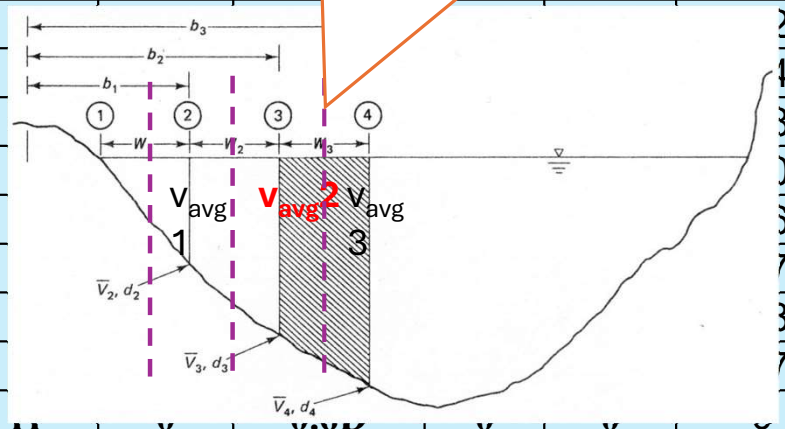
Step 5

Mean-section Method

Given, **V = 0.3N + 0.05 m/ s**

Velocity at Horinzontal Average

$$= \frac{\bar{V}_x + \bar{V}_{x+1}}{2}$$



Distance From River Bank	Vertical Depth	…er Of …n Per …e	Velocity			Width	Vertical Depth Average	Area	Flow
			At Point	Vertical Average	Horinzontal Average				
0	**0**		0	0	0				
		…26	0.208	0.208	0.104				
		…40	0.572	0.503	0.303				
		…30	0.434						
		…08	1.133	0.995	0.649				
		…67	1.000						
		…75	0.853						
		…30	1.409	1.55	1.100				
		…70	1.691						
			0	0	0.550				
						TOTAL			m³/s

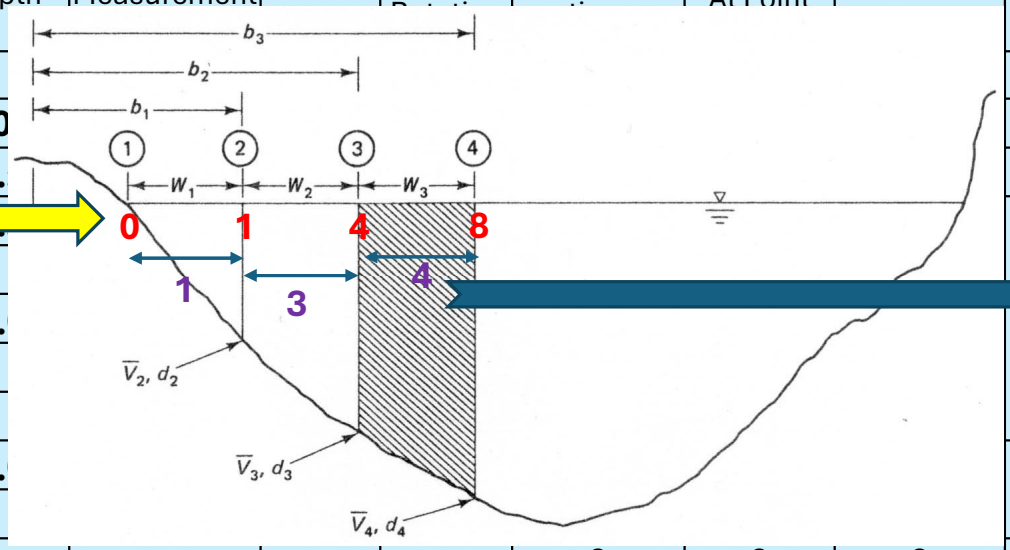
Calculate Discharge, Q
V-A method (mean-section)

Step 6

Mean-section Method

Given, **V = 0.3N + 0.05 m/ s**

Distance From River Bank	Vertical Depth	Depth of Measurement	Time	Number Of	Number Of Rotation Per	Velocity			Width	Vertical Depth Average	Area	Flow
						At Point	Vertical	Horinzontal Average				
0	**0**							0	0			
1	**0.**							0.104	1			
4	**1.**							0.303	3			
8	**5.**							0.649	4			
10	**2.**							1.100	2			
11	**0**	**0.6D**	**0**	**0**	0	0	0	0.550	1			
									TOTAL			m³/s



Step 7

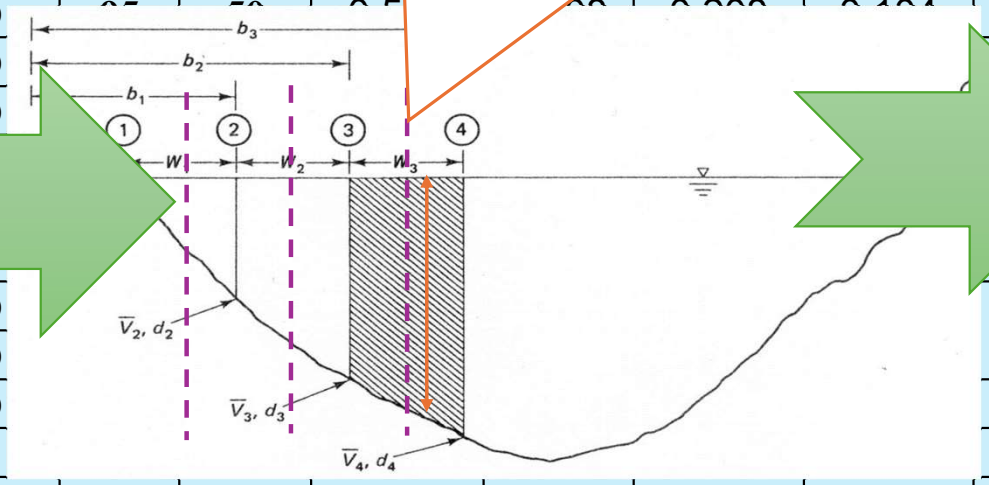
Mean-section Method

Given, **V = 0.3N + 0.05 m/ s**

Vertical Depth Average

$$= \frac{d_x + d_{x+1}}{2}$$

Distance From River Bank	Vertical Depth	Depth of Measurement	Time	Numbe Of Rotatio					Width	Vertical Depth Average	Area	Flow
0	0	0.6D	0	0					0	0		
1	0.5	0.6D							1	0.25		
4	1.5	0.2D							3	1		
		0.8D										
8	5.0									3.25		
10	2.0	0.2D							2	3.5		
		0.8D										
11	0	0.6D							1	1		
									TOTAL			m³/s



Step 8

Mean-section Method

Given, **V = 0.3N + 0.05 m/ s**

Distance From River Bank	Vertical Depth	Depth of Measurement	Time	Number Of Rotation	Number Of Rotation Per time	Velocity			Width	Vertical Depth Average	Area	
						At Point	Vertical Average	Horinzontal Average				
0	**0**	**0.6D**	**0**	**0**	0	0	0	0	0	0	0	
1	**0.5**	**0.6D**	**95**	**50**	0.526	0.208	0.208	0.104	1	0.25	0.25	
4	**1.5**	**0.2D**	**100**	**174**	1.740	0.572	0.503	0.303	3	1	3	
		0.8D	**100**	**128**	1.280	0.434						
8	**5.0**	**0.2D**	**120**	**433**	3.608	1.133	0.995	0.649	4	3.25	13	
		0.6D	**120**	**380**	3.167	1.000						
		0.8D	**120**	**321**	2.675	0.853						
10	**2.0**	**0.2D**	**100**	**453**	4.530	1.409	1.55	1.100	2	3.5	7	
		0.8D	**100**	**547**	5.470	1.691						
11	**0**	**0.6D**	**0**	**0**	0	0	0	0.550	1	1	1	
									TOTAL			m^3/s

Step 9

Mean-section Method

Given, **V = 0.3N + 0.05 m/ s**

Distance From River Bank	Vertical Depth	Depth of Measurement	Time	Number Of Rotation	Number Of Rotation Per time	Velocity			Width	Vertical Depth Average	Area	Flow
						At Point	Vertical Average	Horinzontal Average				
0	**0**	**0.6D**	**0**	**0**	0	0	0	0	0	0	0	0
1	**0.5**	**0.6D**	**95**	**50**	0.526	0.208	0.208	0.104	1	0.25	0.25	0.026
4	**1.5**	**0.2D**	**100**	**174**	1.740	0.572	0.503	0.303	3	1	3	0.910
		0.8D	**100**	**128**	1.280	0.434						
8	**5.0**	**0.2D**	**120**	**433**	3.608	1.133	0.995	0.649	4	3.25	13	8.440
		0.6D	**120**	**380**	3.167	1.000						
		0.8D	**120**	**321**	2.675	0.853						
10	**2.0**	**0.2D**	**100**	**453**	4.530	1.409	1.55	1.100	2	3.5	7	7.697
		0.8D	**100**	**547**	5.470	1.691						
11	**0**	**0.6D**	**0**	**0**	0	0	0	0.550	1	1	1	0.550
											TOTAL	**17.624** m^3/s

Finish!

Mean-section Method

Given, **V = 0.3N + 0.05 m/ s**

Distance From River Bank	Vertical Depth	Depth of Measurement	Time	Number Of Rotation	Number Of Rotation Per time	Velocity			Width	Vertical Depth Average	Area	Flow
						At Point	Vertical Average	Horinzontal Average				
0	**0**	**0.6D**	**0**	**0**	0	0	0	0	0	0	0	0
1	**0.5**	**0.6D**	**95**	**50**	0.526	0.208	0.208	0.104	1	0.25	0.25	0.026
4	**1.5**	**0.2D**	**100**	**174**	1.740	0.572	0.503	0.303	3	1	3	0.910
		0.8D	**100**	**128**	1.280	0.434						
8	**5.0**	**0.2D**	**120**	**433**	3.608	1.133	0.995	0.649	4	3.25	13	8.440
		0.6D	**120**	**380**	3.167	1.000						
		0.8D	**120**	**321**	2.675	0.853						
10	**2.0**	**0.2D**	**100**	**453**	4.530	1.409	1.55	1.100	2	3.5	7	7.697
		0.8D	**100**	**547**	5.470	1.691						
11	**0**	**0.6D**	**0**	**0**	0	0	0	0.550	1	1	1	0.550
											TOTAL	**17.624** m^3/s


Well Done!