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Expt No.	Name of Experiment	Page No.	Date of Experiment	Date of Submission	Remarks
04 →	To chart the flow projectile for an orifice/nozzle with a Hook's gauge.		10/01/23	17/01/23	9.5/10
05 →	Pipeline viscometer		17/01/23	24/01/23	9/10
06(a) →	Calliberation of Venturimeter		24/01/23	31/01/2023	8.5/10
(b)	Calibration of rotameter				
07 →	pitot tube		31/01/23	07/02/2023	9/10
08 →	Flow through triangular Notch weirs		07/01/23	14/02/2023	9.5/10

P.T.O.

Objective :→ To chart the flow projectile for an orifice/nozzle with Hook's gauge and hence to Calculate:

(a) Coefficient of Velocity C_v

(b) coefficient of discharge C_d

(c) Coefficient of Contraction C_c

Theory:

A jet of liquid flowing through an orifice/nozzle under pressure will assume a parabolic path for a free fall Condition.

$$X = V \times t$$

$$Y = \frac{1}{2} g t^2$$

Actual velocity of the jet using equation (1) & (2)

$$V = \sqrt{\frac{g x^2}{2y}}$$

Since the constant head is maintained in liquid tank, theoretical velocity can be given as:

$V_{Th} = \sqrt{2g\Delta H}$

Hence $C_v = \frac{\text{Actual Velocity } V}{\text{Theoretical velocity } V_{Th}} = \sqrt{\frac{gx^2/2y}{2g\Delta H}}$

Since there is contraction of the jet, coefficient of contraction, (C_c) is the ratio between the jet areas at vena contracta and at the orifice.

$C_d = \frac{\text{Actual disharge}}{\text{Theoretical discharge}} = \frac{Q}{Q_{th}}$

Apparatus

Hook's gauge, stop watch, buket, weighing balance.

Procedure

Maintain constant head of liquid with the help of bypass valve and measure the actual flow rate. Measure the actual flow rate. Measure the ~~actual~~ co-ordinates of various point of the jet and repeat the same for two liquid ~~hed~~ heads.

Calculation procedure

Actual velocity (v) = $\sqrt{\frac{gx^2}{2y}}$

$d = 1.0998\,cm$

for $Q = 14\,L/min$

$= 233.33\,cm^3/s$

Head = 4.4 cm

① $x = 5\,cm$ $y = 3\,cm$

$V = \sqrt{\frac{gx^2}{2y}} = 63.93\,cm/s$

$V_{th} = 92.91\,cm/s$

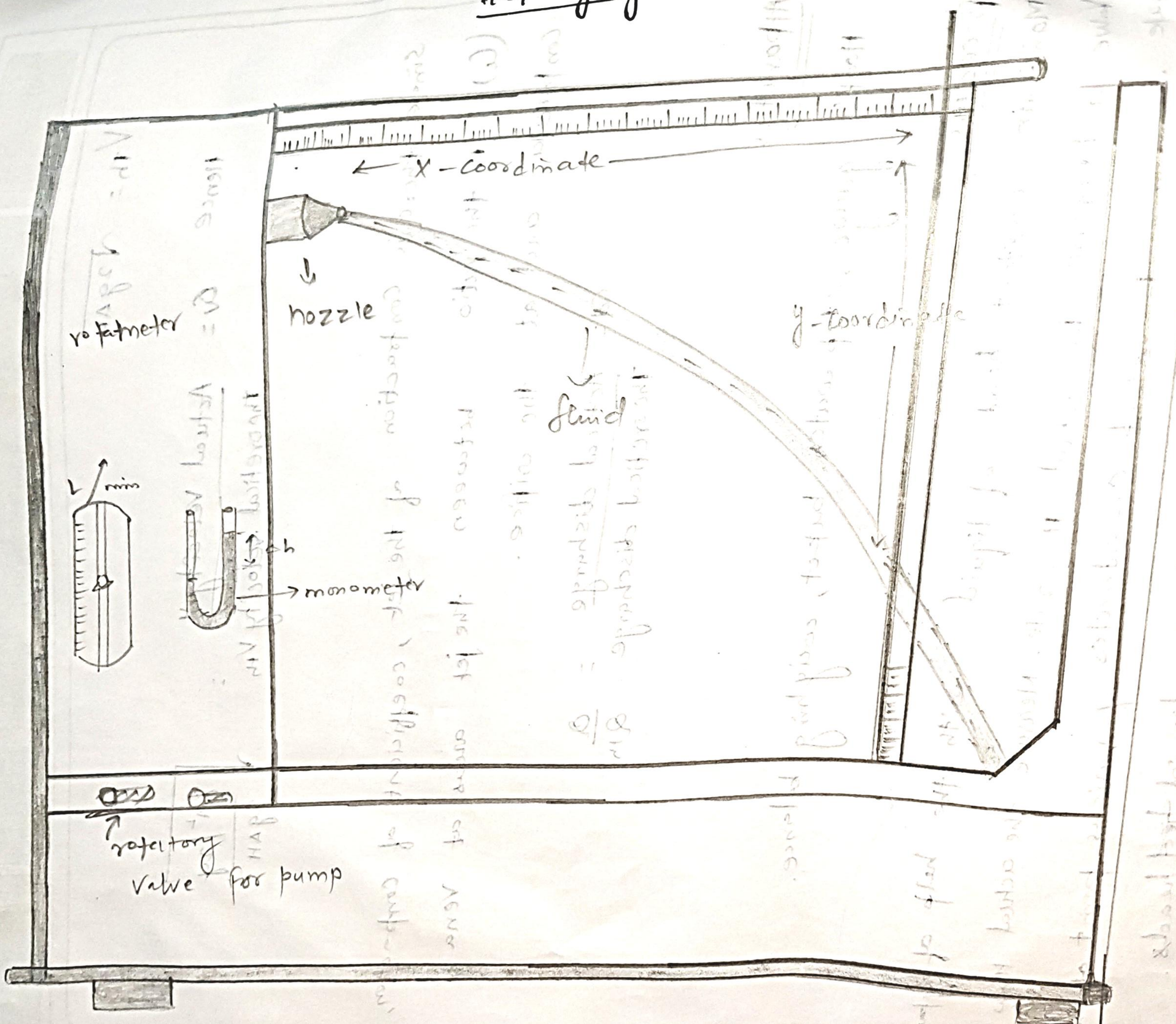
$C_v = \frac{x}{\sqrt{4y\Delta H}} = 0.688$

$Q = \frac{\pi}{4} d^2 V = \frac{242.93}{4}\,cm^3/s = 60.73$

$Q_{th} = 233.33\,cm^3/s$

$C_d = \frac{Q}{Q_{th}} = 0.26027$, $C_c = \frac{C_d}{C_v} = 0.377$

Hook's gauge:



X-coordinate
nozzle
y-coordinate
fluid
rotameter
L/min
h
monometer
rotatory
valve for pump

Observation

Table No. 1

Q = 8 L/min , Head = 3.6 cm

RUN NO	X (cm)	y (cm)	Cv	Cd	Ce
1	5	3.5	0.704	0.421	0.59
2	10	5	1.417	0.705	0.602
3	15	7	1.494	0.894	0.598
4	20	10.5	1.626	0.9739	0.598
5	25	14	1.76	1.0545	0.598

Q = 10 L/min

Head = 4 cm.

RUN NO.	X (cm)	y (cm)	Cv	Cd	Ce
1	5	4	0.629	0.318	0.804
2	10	4.5	1.178	0.626	0.531
3	15	5.5	1.599	0.849	0.530
4	20	7	1.889	1.004	0.531
5	25	9.5	2.027	1.023	0.504

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flow rate = 12 L/min

Head = 4.2 cm

Run no.	x (cm)	y (cm)	Cv	Cd	Cc
1	5	3.5	0.652	0.28	0.43
2	10	4	1.22	0.526	0.43
3	15	4.8	1.64	0.7202	0.43
4	10	5.7	2.04	0.8812	0.43
5	15	7.3	2.25	0.97	0.43

flow rate = 14 L/min

Head = 4.4 cm

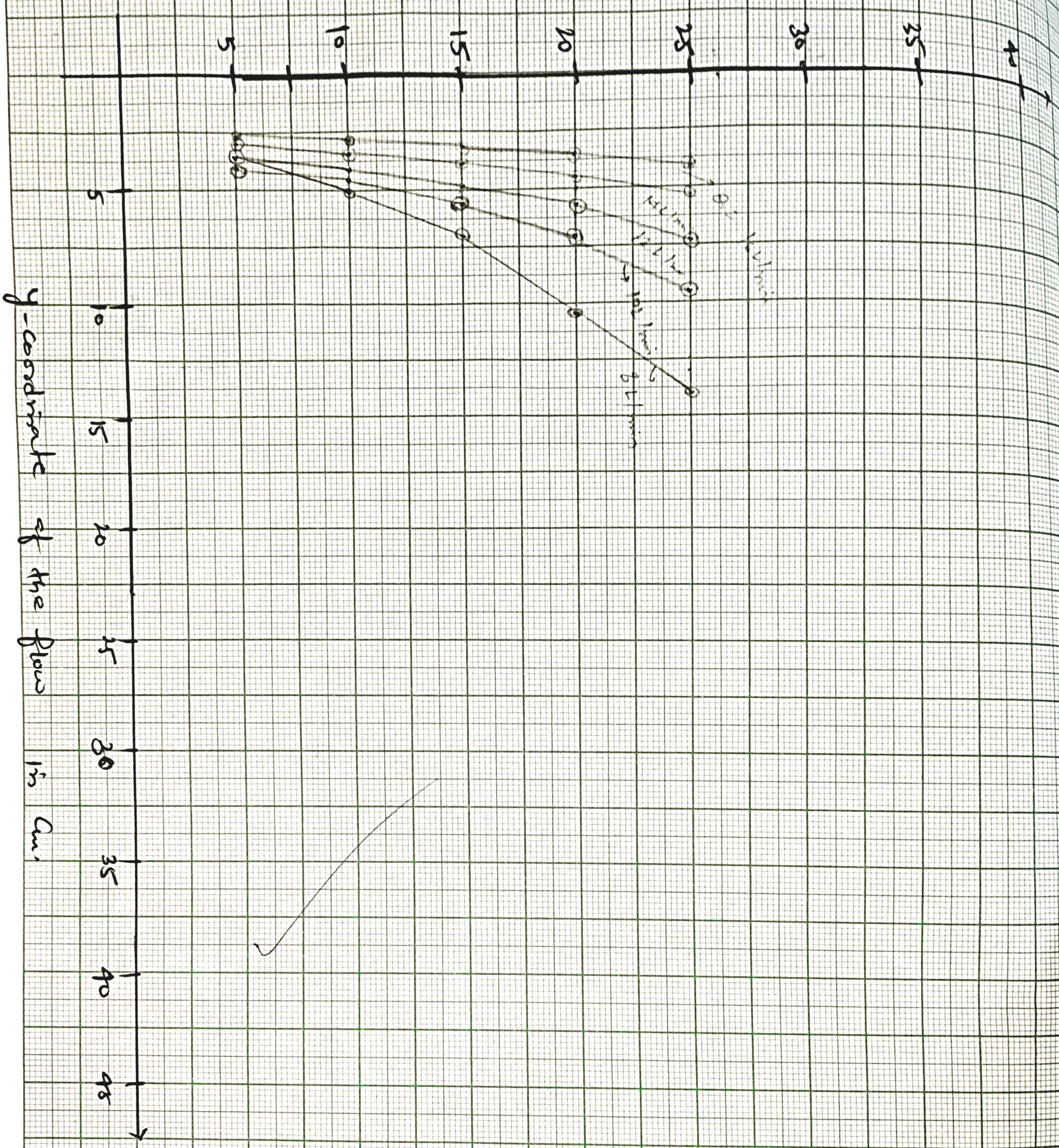
Run no.	x (cm)	y (cm)	Cv	Cd	Cc
1	5	3	0.68	0.2607	0.377
2	10	3.5	1.27	0.4814	0.377
3	15	3.9	1.810	0.684	0.377
4	20	4.5	2.247	0.849	0.377
5	25	5.3	2.5884	0.978	0.377

flow rate = 16 L/min

Head = 4.7 cm

RUN NO	x (cm)	y (cm)	Cv	Cd	Cc
1.	5	2.7	0.701	0.240	0.342
2.	10	2.8	1.378	0.471	0.342
3.	18	3.1	1.964	0.6772	0.342
4.	20	3.5	2.465	0.843	0.342
5.	25	4.5	2.813	0.962	0.342

Plot of projectile path of the fluid path.



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- Discussion

Measurement of the venacontracta is useful in echo cardiography, where it describes the smallest ~~ech~~ area of the blood flow jet as it exists a least value. This corresponds to effective orifice area calculator ~~lea~~ ~~least~~ Least valves using the continuity equation.

The effect is also observed in flow from a tank into pipe or sudden contraction in pipe diameter. streamline will ~~convey~~ converge just down stream of the diameter change, & a region of seperated flow occurs from the diameter change and extends past the vena contracta. The formation of vena contracta can be seen in venturimeter meter. The reason for this phenomena is that fluid streamline cannot abruptly change direction.

- Due to scale error, the value of Cv goes over 1. also ~~ie~~ error in cd and Cc

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Precautions

1→ Take the reading of discharge accurately.

2→ Take value of h without any parallax error.

3→ Take reading from ~~look~~. hook gauge carefully.

4→ water flow should be steady and uniform.

17/Jan/2023

~~10~~

P → Explain the plot = ? ?

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Pipeline Viscometer

→ **Aim** → To prepare the shear diagram for the fluid under study & to calculate its viscocity.

→ **Theory** → when a fluid flows through a pipe, it experiences drag because of stationary boundary wall of pipe. The fluid being viscous there sets in a Velocity gradient. If Δp is the pressure drop due to drag over a length of pipe L. at diameter D, at the Viscometer flow rate of fluid Q, then the shear stress at wall & average rate of shear are given by

$$\tau_w = \frac{\Delta p * D}{4L}$$

$$\left(\frac{du}{dr}\right)_{avg} = \frac{32Q}{\pi D^3}$$

τ_w → Shear stress, kgf/m^2
Δp → pressure drop
D → Diameter of pipe, m
Q

Procedure

1) → Open pipe valve wait for 1-2 seconds so that there is steady flow is maintained inside pipe.

2) Set a timer & collect water at other end & measure the pressure drop Manometric system.

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3) Change Valve opening & take different readings.

4) Repeat the experiment for different pipe dimensions & note down the required readings.

→ Observation & Calculation

Inside diameter:

Pipe → 1 = 1.3 Cm Manometric fluid ⇒ CCl_4 | $\rho_{CCl_4} = 1.6 g/cm^3$

Pipe → 2 = 6 mm Manometric fluid ⇒ CCl_4

Pipe → 3 = 5 mm Manometric fluid ⇒ CCl_4

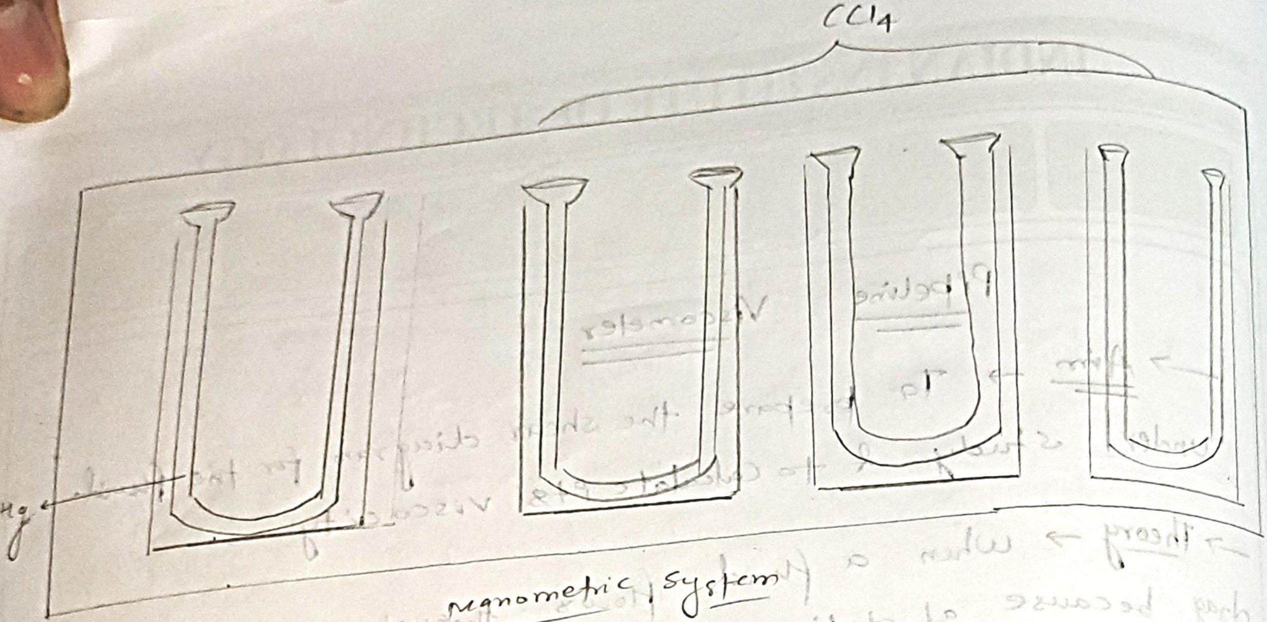
Pipe → 4 = 3 mm Manometric fluid ⇒ mercury.

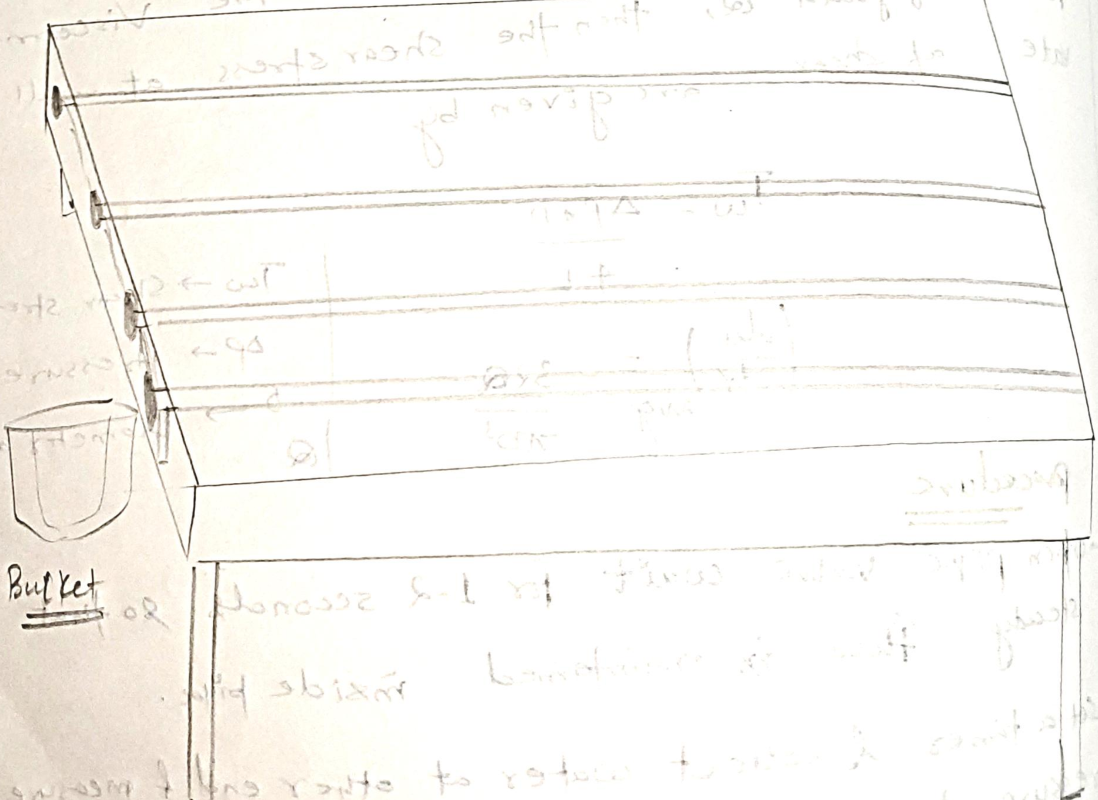
Thickness = 1.5 cm

length of pipes, L = 186 cm.

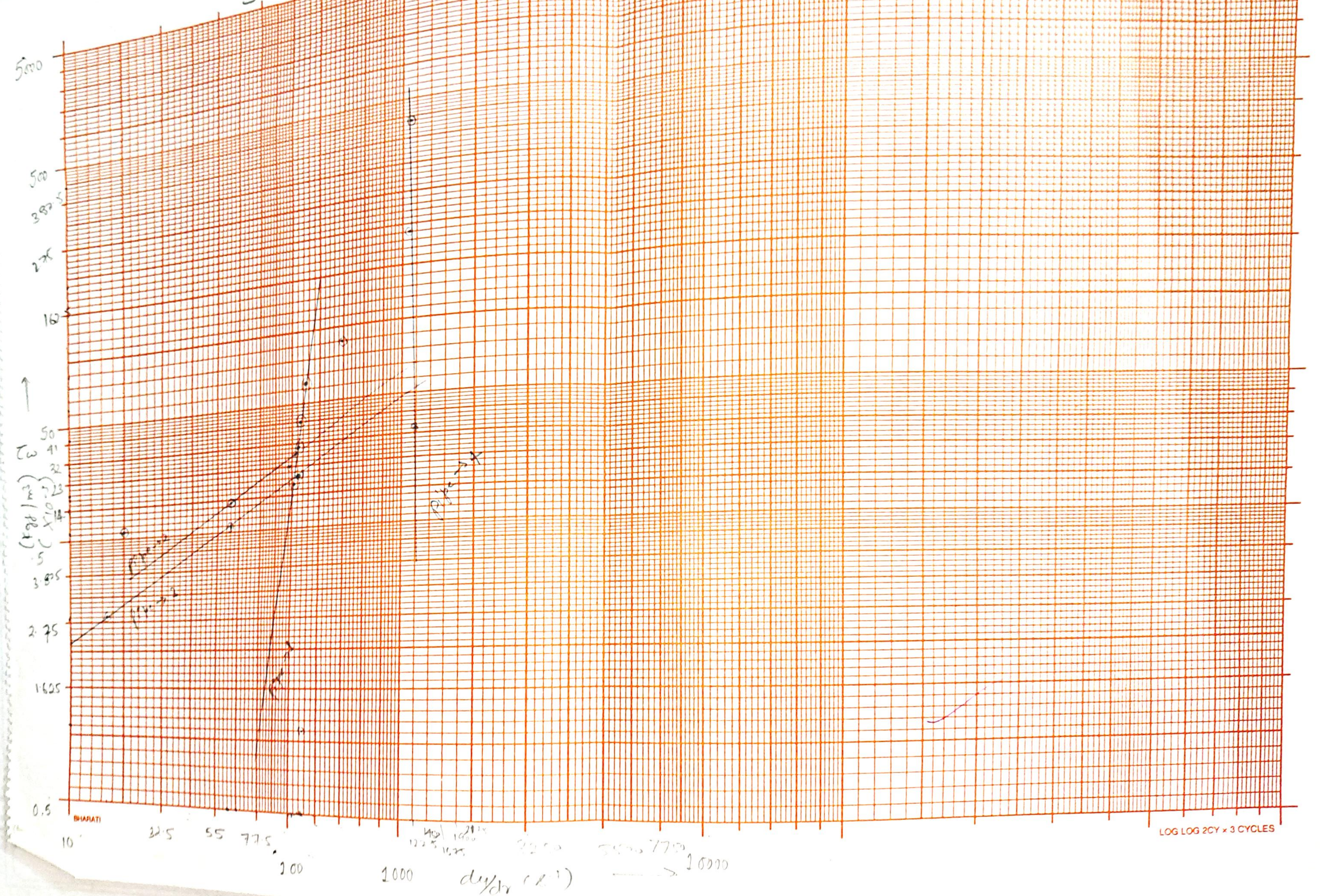
→ Pipe 1 d = 1.3 cm

SLNO	Mass of fluid collected (kg)	time (s)	Volumetric flow rate (m^3/s)	Manometer height		Δh	ΔP
				left	right		
1	400×10^{-3}	10	4×10^{-5}	5.7	11.7	6	36
2	362×10^{-3}	10	3.62×10^{-5}	6.7	10.8	4.1	24.6
3	305×10^{-3}	10	3.05×10^{-5}	7.4	10.3	2.9	17.4
4	225×10^{-3}	10	2.25×10^{-5}	7.9	9.6	1.7	10.2


CCl_4
Hg
manometric system


Bucket

Sakib Khan 2141100[illegible]



Pipe 2 $d = 6$ mm

Sl.No	Mass of fluid collected (kg)	time (s)	Volumetric flow rate (m^3/s)	Manometer height Left	right	difference Δh (cm)	Δp
1	80×10^{-3}	1 min	1.33×10^{-6}	6.8	4	2.8	16.8
2	150×10^{-3}	1 min	2.5×10^{-6}	8.1	2.5	5.6	33.6
3	34×10^{-3}	1 min	0.567×10^{-6}	6.1	4.7	1.4	8.4
4	125×10^{-3}	1 min	2.08×10^{-6}	7.8	3	4.8	28.8

Pipe → 3 $d = 5$ mm

Sl.No	Mass of fluid collected (kg)	time (s)	Volumetric flowrate m^3/s	Manometric height left	right	difference Δh	Δp
1	135×10^{-3}	1 min	2.25×10^{-6}	8.7	9	0.3	1.8
2	70×10^{-3}	1 min	1.67×10^{-6}	7.7	2.9	4.8	28.8
3	45×10^{-3}	1 min	0.75×10^{-6}	5.8	4.1	1.7	10.2
4	13×10^{-3}	1 min	0.21×10^{-6}	5.4	4.7	0.7	4.2

Pipe → 4 $d = 3$ mm

Sl.No	Mass of fluid collected	time (s)	Volumetric flow rate (m^3/s)	Manometric height left	right	difference Δh	Δp
1	30×10^{-3}	10 s	0.3×10^{-5}	13.7	5.1	8.6 cm	1083.6
2	32×10^{-3}	10 s	0.32×10^{-5}	12.7	6.1	6.6 cm	831.6
3	28×10^{-3}	10 s	0.28×10^{-5}	11.4	7.4	4 cm	504
4	12.5×10^{-3}	10 s	0.125×10^{-5}	10.3	8.64	1.8	226.8

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Result :-

Pipe → 1

SL. No	Q = Volumetric flow rate (m^3/s)	τ_w = Shear stress (kgf/m^2)	du/dr
1	4×10^{-5}	62.9×10^{-3}	185.481
2	3.62×10^{-5}	42.93×10^{-3}	167.833
3	3.05×10^{-5}	30.40×10^{-3}	141.4066
4	2.25×10^{-5}	17.82×10^{-3}	104.31

$\mu_1 = 1.13 \times 10^{-3}$

Pipe → 2

$d = 0.6 cm$

SL. NO	Q = Volumetric flowrate (m^3/s)	τ_w = shear stress (kgf/m^2)	du/dr (unit) ?
1	1.33×10^{-6}	13.54×10^{-3}	62.71
2	2.5×10^{-6}	27.09×10^{-3}	117.89255
3	5.66×10^{-7}	6.77×10^{-3}	23.9688
4	2.08×10^{-6}	23.22×10^{-3}	98.088

$\mu_2 = 0.244 \times 10^{-3}$

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Pipe-3

$D = 5\,mm$

SL.NO	Q (m^3/s)	τ_w	du/dr
1	2.25×10^{-6}	11.20×10^{-3}	183.34
2	1.67×10^{-6}	19.35×10^{-3}	136.083
3	0.75×10^{-6}	6.855×10^{-3}	61.11
4	0.21×10^{-6}	2.82×10^{-3}	17.111

Pipe → 4

$\mu_3 = 0.38\times10^{-3}$

$d = 3\,mm$

SL.NO	Q (m^3/s)	τ_w (kgf/m^2)	du/dr
1	0.3×10^{-5}	436.93×10^{-3}	1131.76
2	0.32×10^{-5}	33.709×10^{-3}	1207.2197
3	0.28×10^{-5}	203.22×10^{-3}	1056.371
4	0.125×10^{-5}	91.45×10^{-3}	471.5702

$\mu_4 = 5.3\times10^{-3}$

$$\mu = (\mu_1+\mu_2+\mu_3+\mu_4)/4 = \cancel{0.9025\times10^{-3}}\ Pa\text{-}s$$

$$= 1.77\times10^{-3}$$

→ Precautions:→

(1) for the experiment to work, flow should be laminar. Re < 2100

(2) we need to fluctuate the flow of water very carefully

→ Discussion :-

(1) The results are presented here as well shear stress against the apparent shear rate. It is seen that flow curve depends on both the tube length & diameter reduction in measured viscosity with a decreases in the tube diameter is manifestation of the wall effect.

(2) Wall effect can be corrected if experimental data are taken with at least three tube diameters.

(3) To obtain the true shear-stress rate curve from viscometry allowances must be made for the influence of wall effects & end effect in the observed results.

(4) Take sufficiently large L/D ratio for pipes so that entrance effect can be neglected.

Caliberation of a Venturimeter

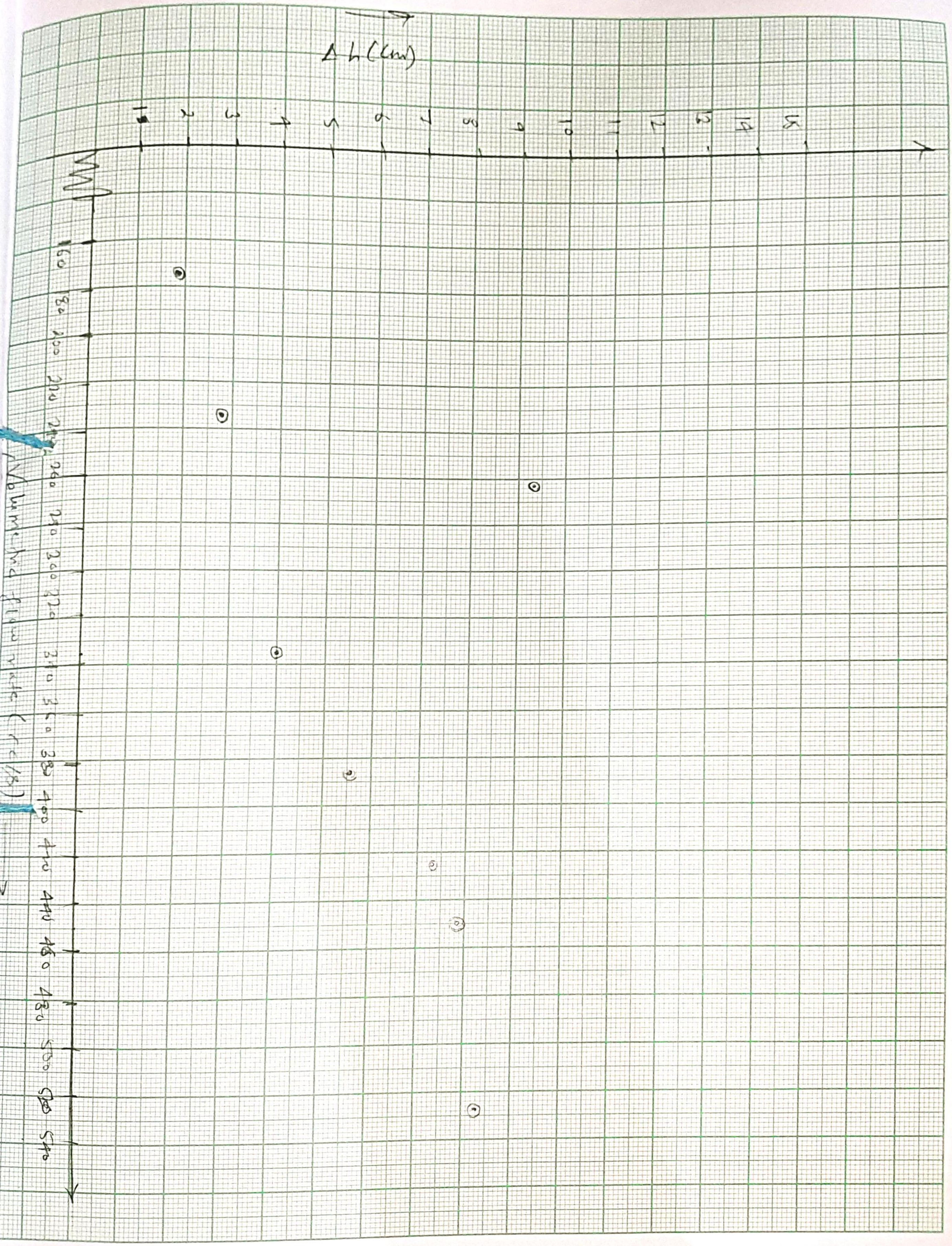
Aim → 1 → To prepare a ~~venturimeter~~ caliberation chart for the venturimeter (Q Vs Δh).

2 → To make a plot showing variation of cofficient of discharge of the venturimeter & Reynolds number (C_v Vs N_{Re}) based on Venturi-throat.

→ **Theory** :- A Venturimeter Consists of a Coverging & diverging section connected to the main pipeline. As the Velocity increases gradually the upstream convergent section, the pressure of ~~the~~ the fluid keeps decreasing. The Velocity the gradually decreases in the divergent section & the original pressure is largely recovered. Venturimeter works on the principle of Bernoullis principle.

$$q = C_v \times a \sqrt{\frac{2g(P_1 - P_2)}{\phi\,(1-\beta^4)}}$$

$$C_v = \frac{q}{a} \times \sqrt{\frac{(1-\beta^4)\,\phi}{2g(P_1-P_2)}} = \frac{qk}{\sqrt{\Delta p}}$$


Δh (cm)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480 500 520 540
Volume flow rate (cc/s)

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Where

K = Constant

a = area of throat (cm^2)

→ $\beta = \dfrac{\text{diameter of throat}}{\text{diameter of pipe}}$

→ C_v = coff of discharge

→ P = pressure g/cm^2

→ h = manometer liquid head difference (cm)

→ q = Volumetric flow rate of fluid (cc/s)

→ d & d_m = density of flowing fluid & manometric fluid (g/cc)

→ W = mass flow rate of the liquid.

→ Apparatus required :-

1 → Venturimeter
2 → Stop watch
3 → Bucket
4 → weighing Balance
5 → Manometer

→ procedure :- Measure the flowrate & write down the manometer readings.

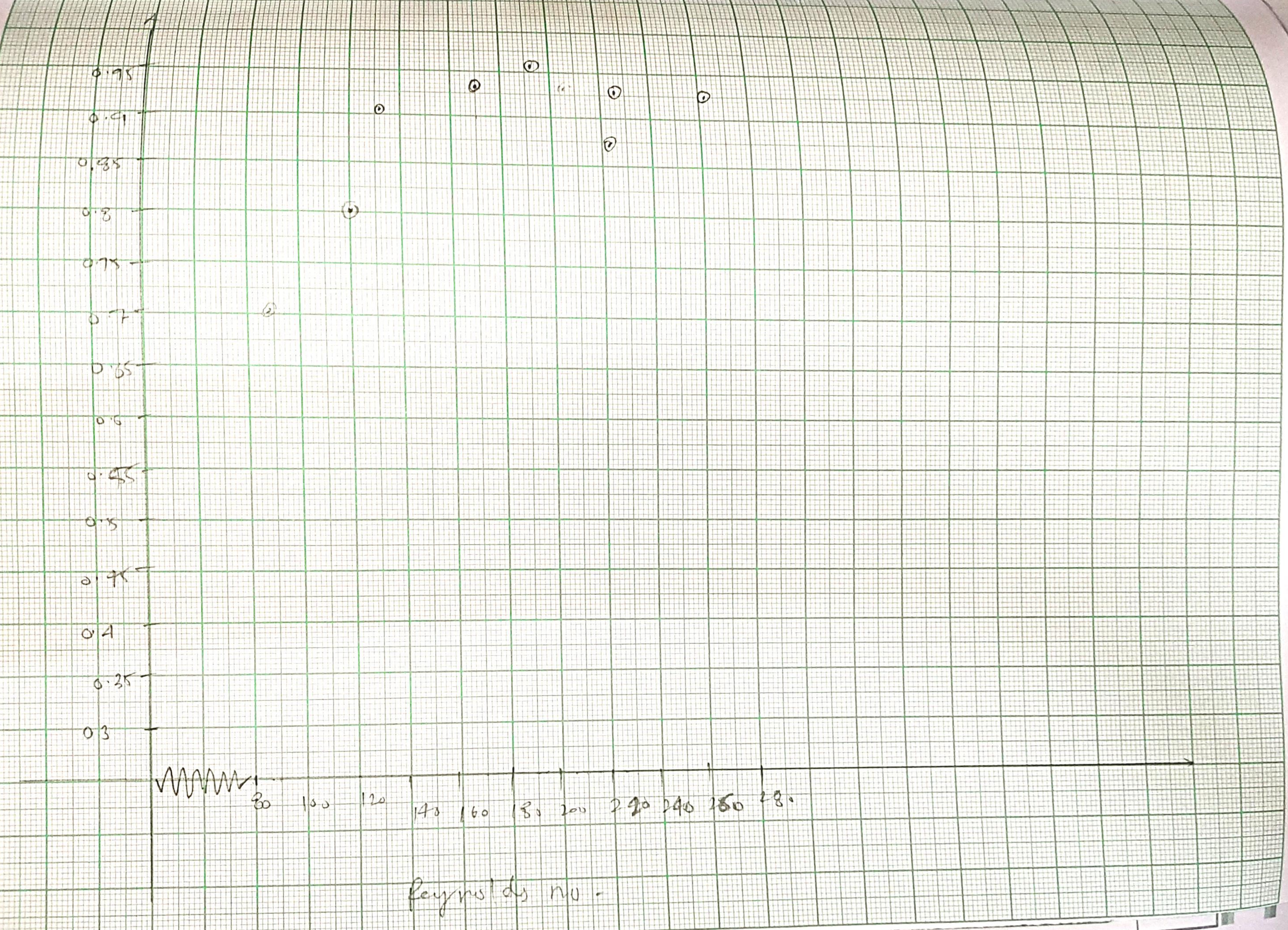
→ observation & results :-

Pipe size = 2 inch

Diameter of throat = 1 inch = 2.54 cm

Area of throat = 5.06 cm^2

Mass of empty bucket = 2750 g


0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
80
100
120
140
160
180
200
220
240
260
280
Reynolds no.

RUN NO	Amount of liquid (g)	Time(s)	Manometer readings			q (cc/s)	N_{Re}	C_v
			LHS	RHS	Δh			
1	1750	10	18.3	16.4	1.9	175	87.72	0.707
2	2375	10	18.8	16.1	2.7	237.5	119.05	0.804
3	3375	10	19.4	15.4	4	337.5	169.18	0.934
4	3875	10	20.1	14.6	5.5	387.5	194.244	0.958
5	2625	10	22.2	12.9	9.3	262.5	131.584	0.920
6	2250	5	21.4	13.5	7.9	450	225.57	0.935
7	2125	5	20.7	14.3	6.4	425	213.04	0.891
8	2625	5	~~20.7~~ 21.6	13.3	8.3	525	263.169	0.932
9	2750	5	22.8	12	10.8	550	275.70	
10	3250	5	23.9	11.3	12.6	650	[illegible]	

Calculation :-

$$q = V/t = \frac{m/d}{t}$$

$$\beta = \frac{d_{throat}}{d_{pipe}} = 1/2$$

$$q = C_v \times a \sqrt{\frac{2g(P_1 - P_2)}{d(1-\beta^4)}}$$

$$\Delta P = P_1 - P_2 = \Delta h (d_m - d) g$$

d_m (d_{CCl_4}) = 1.6 g/cc

d = 1 g/cc

d_{throat} = 1 inch

area of throat = 5.067 cm^2

$d_{throat} = 1$ inch

$d_{pipe} = 2$ inch

Area of throat $= \frac{\pi}{4}(2.54)^2 = 5.067\ cm^2$

$$C_d = \frac{q}{a}\sqrt{\frac{(1-\beta^4)d}{2g(P_1-P_2)}} = qK/\sqrt{\Delta P}$$

$$\cancel{P_1}\ \ P_1 - P_2 = \Delta h\,(d_m - d) \times g$$

$$= 1.9 \times (0.6) \times 9.8$$

$$C_d = \frac{175}{5.067}\sqrt{\frac{(1-\frac{1}{16})\times 1}{2\times 981\times 1.9\times 0.6}} = 34.537 \times (\ ) = 0.707$$

$$Re = \frac{\rho v d}{\mu} = \frac{\rho q}{a\times\mu} d = \frac{\rho q d}{\frac{\pi d^2}{4}\mu} \rightarrow (1) = \frac{q\times 4}{\pi d}$$

$$= \frac{175\times 4}{3.14\times 2.54} = 87.72$$

Discussion:

→ A Venturimeter is a device used to measure the flow rate of fluid in pipe. In a Calibration experiment, the Venturimeter in first installed in the pipe, and the fluid flow rate is measured using a calibrated flow meter.

→ Calibration process should be repeated regularly to ensure that the Venturimeter remain accurated over time. Additionally the callibration should be done with the same fluid and at similar temperature and pressure as in the operating condition.

→ The experiment calibration of Venturimeter aims to ensure the accuracy of the flow measurement the process involves measuring and fluid flow rate using a calibrated flow meter and comparing it to the reading obtained from the Venturimeter at various flow rate.

P. Anusya
ankesh
31/01/23

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Caliberation of Rotameter

1 → **Objective** (i) To know the different part of Rotameter
(ii) To caliberate the rotameter by plotting Rotameter reading Vs actual flow rate of liquid.
(iii) To plot rotameter v/s percentage error.

→ **Theory** :-

Rotameter is a variable area meter in which pressure drop is nearly constant. The annular area between the float & tapered tube changes with flow rate of liquid for a given flow rate the flow attains an equillibrium position which the weight of float is Balanced by byobuoyant & dry face.

$$F_D g_c = g\left(m_{float} - m_{float}\left(d_{liq}/d_{float}\right)\right] = m_{float}\, g\left(1 - d_{liq}/d_{float}\right)$$

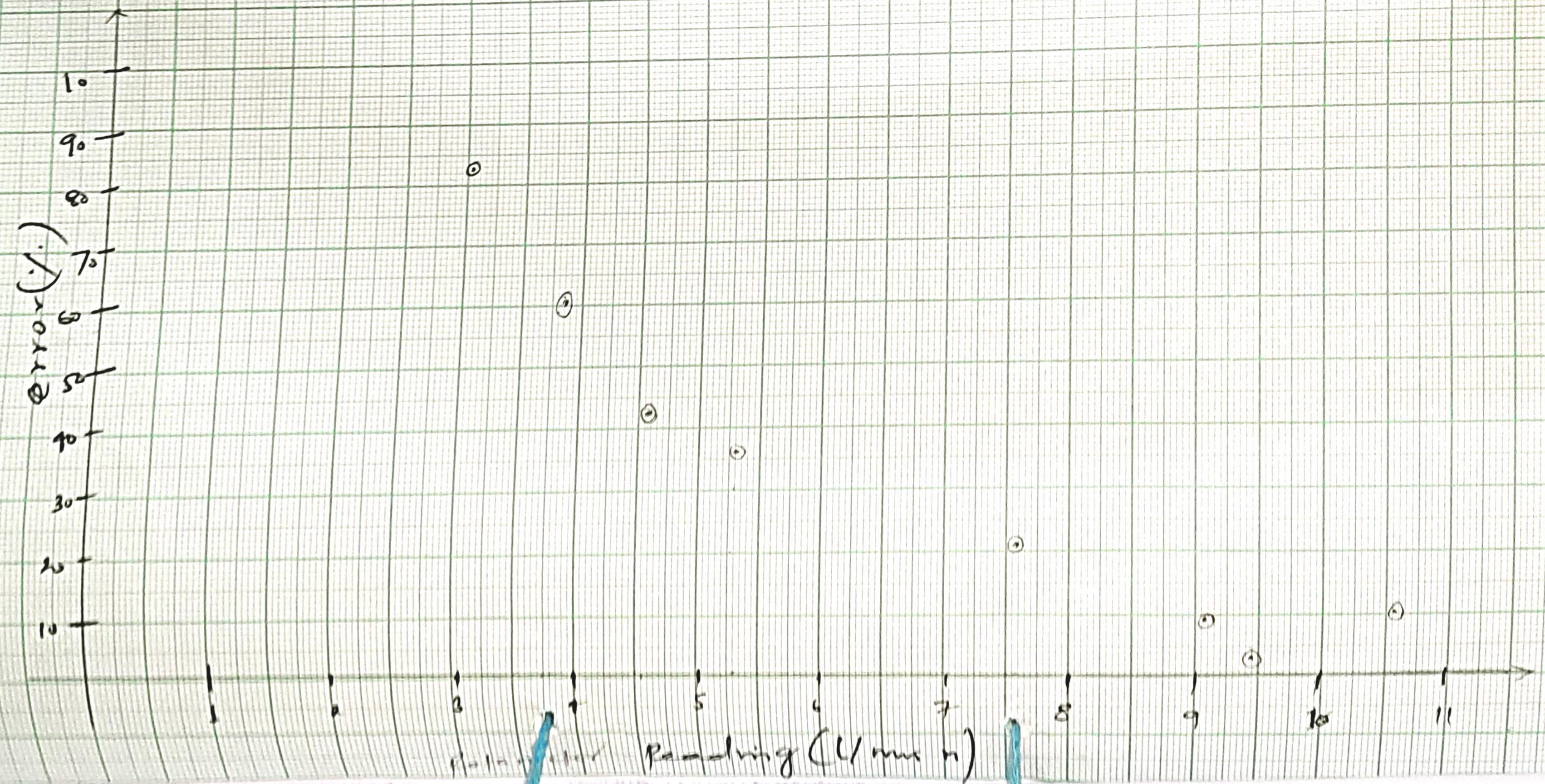
where,

F_D = drag force

m_{float} = mass of the float

d_{liq} = density of liquid

d_{float} = density of flow


error (%)
10
90
80
70
60
50
40
30
20
10
1
2
3
4
5
6
7
8
9
10
11
Reading

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→ Procedure:—

1→ Measure the flow rate of ~~liqu~~ liquid & note the rotameter reading.

2→ Vary flowrate to cover entire range of rotameter.

→ observation & results :—

Density of the liquid =

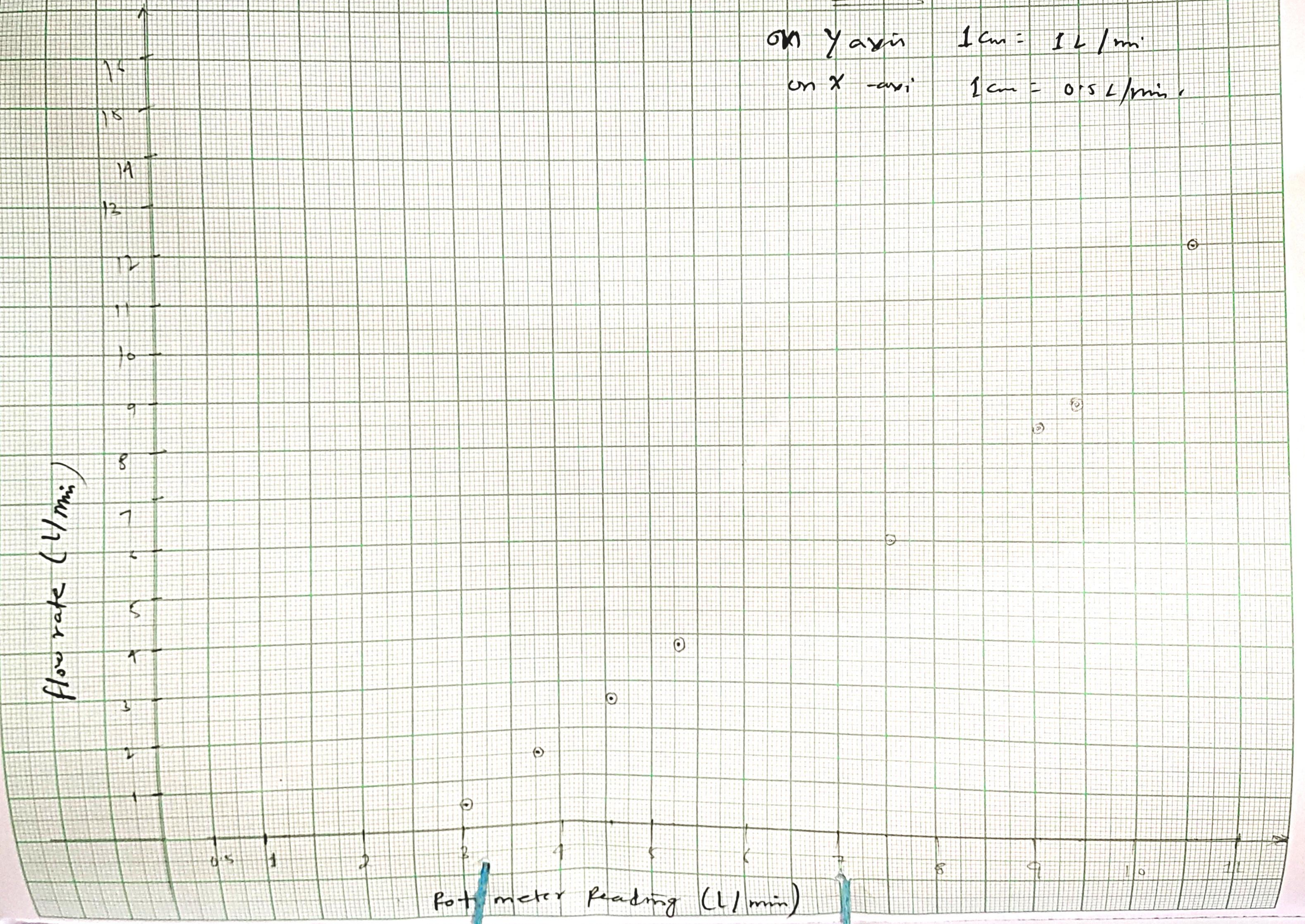
Mass of empty bucket =

RUN.NO	weight of liquid (g)	Time (s)	flow rate (l/min)	Rotameter reading (cm	% dev ~~eff~~
1	250	30 s	0.5	0.8 = 3.02	82.62%
2	750	30	1.5	1 = 3.782	60.36%
3	875	20	2.625	1.2 = 4.342	42.2%
4	1125	20	3.375	1.4 = ~~7.57~~ 5.299	36.3%
5	1000	10	6	2 = ~~9.08~~ 7.57	20.7%
6	1375	10	8.25	2.4 = 9.084	9.25%
7	1375	10		2.5	
8	1625	10	9.75	2.8 = 9.46	2.9%
9	2000	10	12	3 = 10.596	11.16%
10	1625	20		1.8	

Calculation → Run 1

$Q = \frac{0.25}{30s} = 0.5\ L/min$

1 gallon = 3.785 L



Scale

on Y axis 1cm = 1 L/min

on X axis 1cm = 0.5 L/min.

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(b) 0.8 gallon = 3.02 L , Rotameter reading = 3.02 L/min

Percentage deviation = $\frac{3.02 - 0.5}{3.02} \times 100$

$= 82.62\%$

Discussions :→

→ A Rotameter has 3 basic Components
(I) A tapering tube
(II) A float inside the tapering tube
(III) Measurement making on the tapering tube.

→ water or any other liquid in inlet at bottom of the rotameter which then flows through the tube and outlet from the top which is collected in a bucket and measured.

→ Rotameter has less friction, low cost and easy to install and use. Hence, has a great industrial importance.

→ It is designed in accordance with the basic eqn basic eqn for Volumetric flow rate.

$$Q = KA\sqrt{gh}$$

→ There are Certain factor that affect the measurement of a flow rate → fluid temperature, pressure, Specific gravity.

Precautions :→

→ Converts the unit before Calculations.

→ wait for the float to settle ~~before~~ taking the reading.

P. Ganesh
31/01/23

P.R.E.

Pitot tube

→ Aim → Caliberation of pitot tube & measurement of fluid Velocity.

→ Theory → A pitot tube is a sample device meant for measuring the velocity of a fluid at any point. In its simple form, the pitot tube consists of a tube. whose lower end is bent at right angles. The device is placed in a moving fluid with lower opening directed in the upstream direction. The liquid level in the pitot tube will depend on the velocity of the stream. The point will depend on the velocity of stream. The pitot tube is meant for measuring the velocity at any point in a stream of liquid flowing in a pipeline. Consider the two points A & B. The point B is just at the inlet to the pitot tube while the point A is at the same level as that of B but at some distance from B & outside the pitot tube.

let u be the velocity of A,

pressure head at A, $\frac{P_a}{\rho g} = H$

at B, there is no velocity & the pressure head at B.

$$= \frac{P_b}{\rho g} = H + \Delta h$$

Sr. No.	Flow rate (lpm)	Position, y(cm)	Manometric reading		Δh	Velocity (cm/s)	Vavg	√Δh
			h(left)	h(right)				
							0	0
		2.2	26.3	28.8	2.5	88.59120865		
		3	26	29.4	3.4	103.3142152		
1	20	3.5	25.8	29.5	3.7	107.7758569	29.2372	1.702938637
		4.5	26.6	28.6	2	79.2383859		
		2.2	25.5	29.8	4.3	116.1862809		
		3	25	30.5	5.5	131.4019975		
2	25	3.5	25.5	30	4.5	118.8575788	36.5465	2
		4.5	26.8	28.5	1.7	73.05418215		
		2.2	25	30.5	5.5	131.4019975		
		3	24.5	31	6.5	142.8490317		
3	30	3.5	25.3	30.3	5	125.2868888	43.8558	2.252776065
		4.5	26	29.3	3.3	101.7835496		
		2.2	25	30.5	5.5	131.4019975		
		3	22	33.5	11.5	190.0069745		
4	35	3.5	23.5	32	8.5	163.3541173	51.1651	2.692582404
		4.5	26	29.5	3.5	104.8225317		

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Where, Δh = difference in the two legs of the manometer
The point B where the velocity has reached zero is called stagnation pressure.

Applying Bernoulli's theorem to the point A & B

$$\frac{1}{2}\rho_w V^2 + \rho g H = 0 + \rho g (H + \Delta h)$$

$$\frac{1}{2}\rho_w V^2 = \rho g \Delta h$$

$$V = \sqrt{\frac{2\rho g \Delta h}{\rho_w}}$$

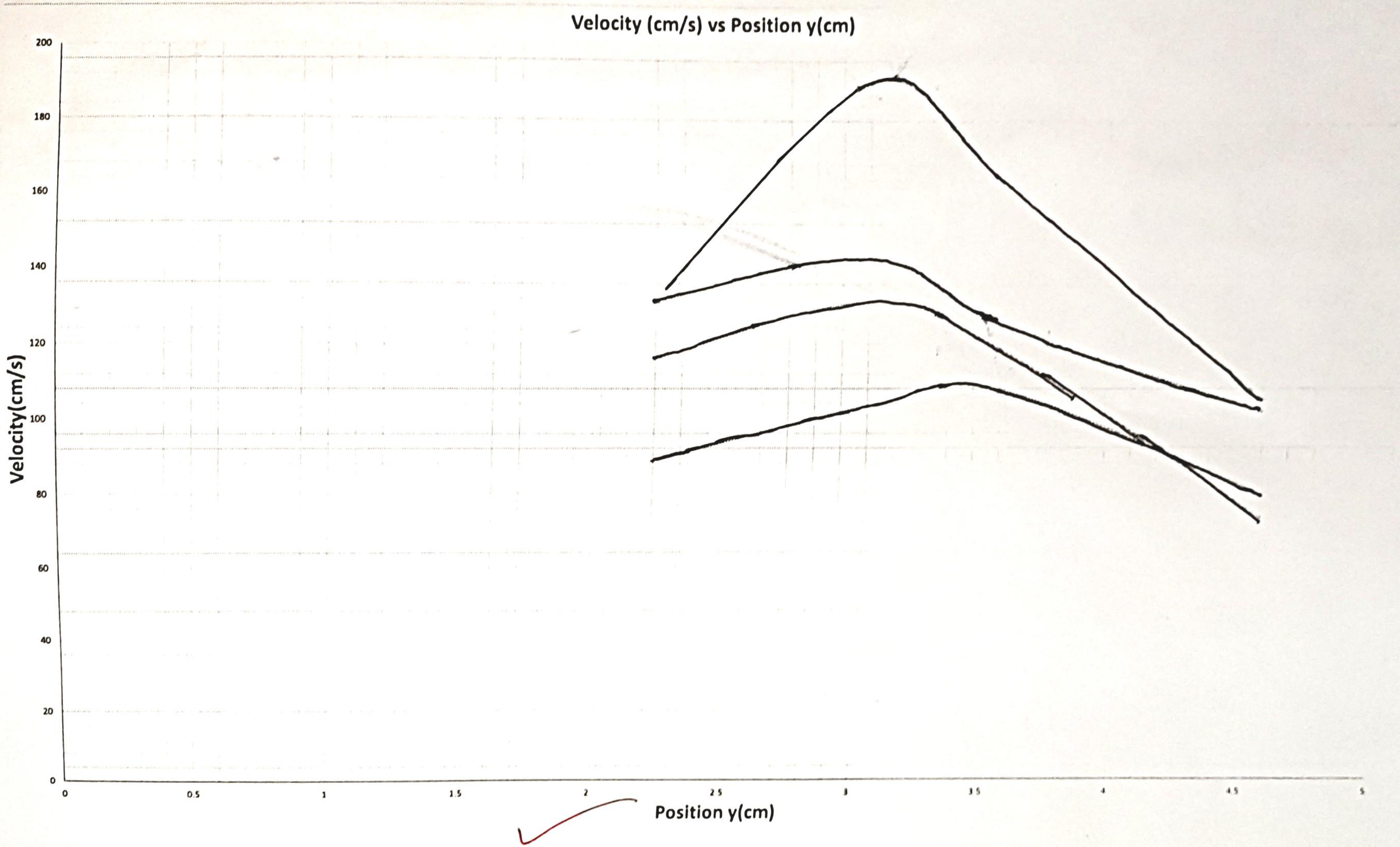
To take into account of losses in the actual cases the velocity is given by.

$$V = C_v \sqrt{\frac{\cancel{2g}\ 2\rho g \Delta h}{\rho_w}}$$

where, C_v = pitot tube coefficient.

The pitot tube is used to measure the velocity of a liquid in a pipe then we must adopt some method to know the static pressure head. H, for instance, we may use a pitot tube & a vertical piezometer tube & measure the difference of the liquid level in the two tubes.
In another arrangement the point tube & vertical tube connected to the pipe may be connected to the U-tube containing a heavy liquid in the U-tube is y.

Then, $h = (\rho - 1) y$


Velocity (cm/s) vs Position y(cm)
Velocity(cm/s)
200
180
160
140
120
100
80
60
40
20
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Position y(cm)

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where,

$$S = \frac{\text{specific gravity of the heavy liquid in U-tube}}{\text{specific gravity of the liquid flowing in the pipe}}$$

→ procedure :—

1 → filled the water in the circulating tank through a water inlet to 3/4 level.

2 → Connected manometer & released air through stopcocks.

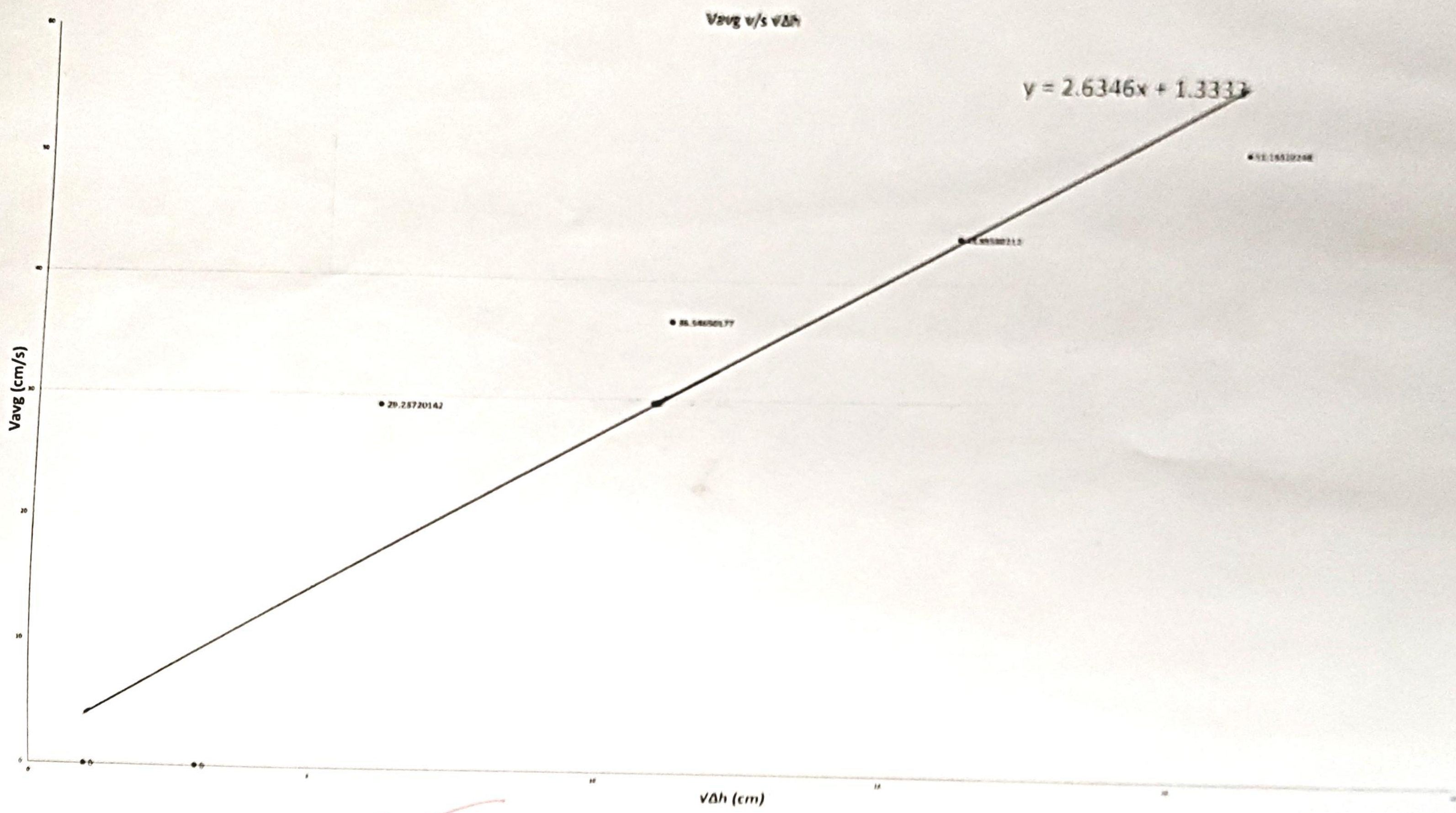
3 → Start the water pump.

4 → Adjust flow rate through Valve (V_1), & closed Valve (V_2) a little to set a water flow rate in pitot tube.

5 → Took the ~~flow~~ flow rate reading in rotameter & pressure drop in manometer.

6 → Repeat the step 3 & 4 for Various flow rates & record the reading in tube below be draw the liquid in pitot tube & water.

7 → Above procedure may also be repeated for different depth of pitot tube.


Vavg v/s √Δh
y = 2.6346x + 1.3333
29.23720142
Vavg (cm/s)
√Δh (cm)

Sample Calculations:

$d = 3.81 cm$ $\quad$ $area = \frac{\pi}{4} d^2 = 11.4 cm^2$

$V_{avg} = \frac{Flow\ rate}{Area}$ $\quad$ $V = \sqrt{\frac{2 \rho_{CCl_4} g (h_2 - h_1)}{\rho_{water}}}$

$\frac{\rho_{CCl_4}}{\rho_{water}} = 1.6$ and $g = 981 cm^2/s$

when flow rate = 20 LPM and $\Delta H = 2.5$

$V = \sqrt{\frac{2 \times 1.6 \times 981 \times 2.5}{1}} = 88.58 cm/s$

$V_{avg} = \frac{\frac{20 \times 10^{-3}}{60}}{11.4 \times 10^{-4}} = 0.2924 m/s$

Plotted a graph V_{avg} and $\sqrt{\Delta h}$ and determined the ~~time cof~~ and coefficient of Velocity of pitot tube.

$C_V = \frac{Slope}{\sqrt{2g}} = \frac{2.6346}{\sqrt{2 \times 981 \times 1.6}} = 0.047$

→ Discussion:

The errors in the values are because:

(i) The fluid flow is viscous, which is not taken into consideration in our computations.

(ii) Instrument like pitot tube could get blocked because it is not in ~~use~~ use for long time which gives error in readings.

(iii) Capillary rise due to surface tension in manometer tube gives error in readings.

(iv) frictional losses are also not taken into account.

(v) The flow was ~~turbulent~~ - which was expected to be laminar may be due to operating at low flow rate.

→ Precautions:-

(i) Don't fill the tank above full level.

(ii) Drain the water after using the instrument to avoid caking of algae.

(iii) Maintain laminar flow.

(iv) Use only mild detergents to ~~close~~ clean the instruments, do never use any organic solvent in strong acid or alkalies.

(v) Ground the instruments properly to avoid electric shock density ~~—~~.

7.01.23

Flow through tringular notch ~~weirs~~ weirs

→ objective :-

(a) To make a Caliberation plot (q vs h)

(b) To plot C_d Vs q

→ Theory

Weirs are the area meters to measure flow rate of liquid in open channels. for a sharp ~~a~~ crested wire, the ~~fol~~ following equation gives the fluid flow rate.

$$q_{ac} = \frac{8}{15} C_d \sqrt{2g} \left(\tan \theta/_2\right) h^{5/2}$$

Where,

C_d = Coefficient of discharge

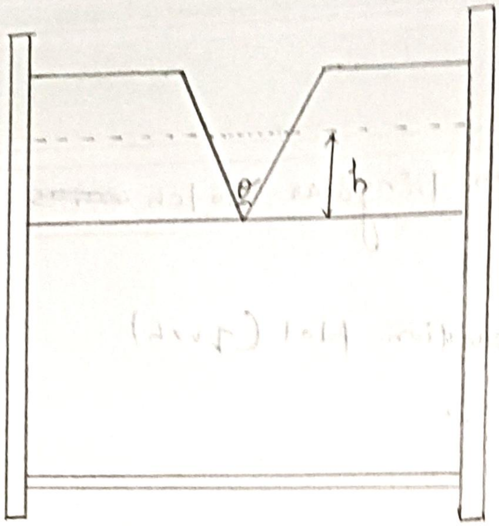
h = height of the liquid level above the wire crest (cm)

q_{ac} = actual Volumetric flow rate of liquid (cc/s)

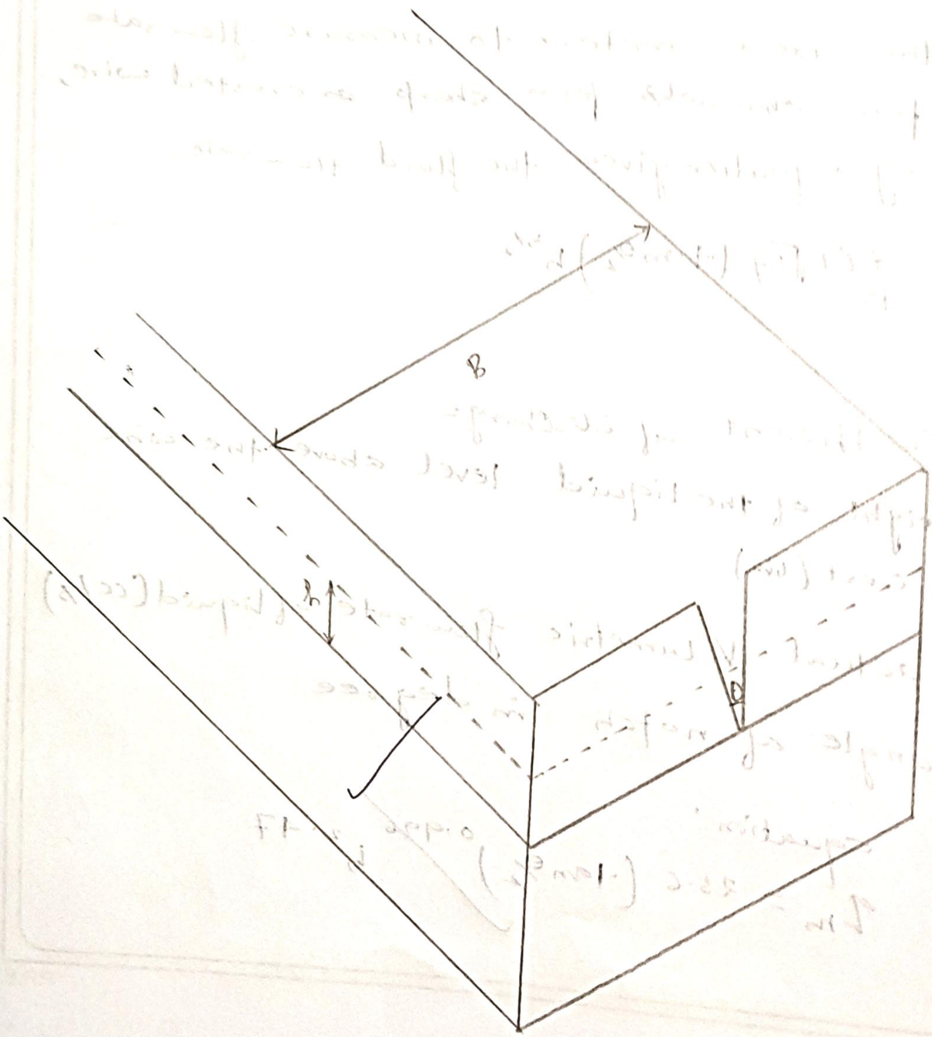
θ = angle of notch in degree

francis equation :

$$q_m = 23.6 \left(\tan \theta/_2\right)^{0.996} h^{2.47}$$



V-notch or triangular notch



Apparatus required:—

open channel with V-notch, stopwatch, bucket, weighing balance.

→ procedure :-

1→ find out angle by measuring height & breath of the notch.

2→ Adjusted the pointer for zero flow rate & note down the readings.

3→ Adjust the level of the liquid & measure h & found the actual discharge rate.

4→ Repeat it a few times.

→ observation :→

Height of V-notch = 15.132 cm,

Breath of V-notch = 15.494 cm.

∴ Angle of notch in degrees = 54.22°.

Also weight of bucket = 2.3 kg.

Run No.	Water Collected (Kg)	Time (s)	h (cm)	q (cc/s)	Cd	qth (cc/s)	% Variation
1	0.5	30	19.1	16.66666667	0.8752386874	18.97041787	0.1214391383
2	2	30	18.4	66.66666667	1.109827828	59.02290949	-0.1295049201
3	3	20	17.7	150	1.139957764	128.0806105	-0.1711374531
4	3.5	10	16.4	350	0.9652446394	348.6814143	-0.003781634479
5	4.5	10	16.1	450	1.031145995	418.7212163	-0.07470073754
6	5	10	15.7	500	0.9126542841	524.2169555	0.04619643684
7	6	10	15.3	600	0.889113309	644.1027157	0.06847155688
8	7.5	10	15	750	0.9607324527	743.8076102	-0.008325257396
9	4	5	14.7	800	0.8929986269	852.1649084	0.06121456998
10	4.5	5	14.5	900	0.9202448532	929.3223109	0.03155235866

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Sample Calculation

Dead height = 20.3cm

water collected = 3.5 Kg

time = 10 s

$h = 16.4$

$\Delta h = 3.9$

$q = V/t = \frac{m/\rho}{t} = .3500/1 = 350 cc/s$

Notch angle $(\theta) = 54.22°$

$q^{th} = 23.6 \left(\tan \theta/2\right)^{0.996} h^{2.47}$

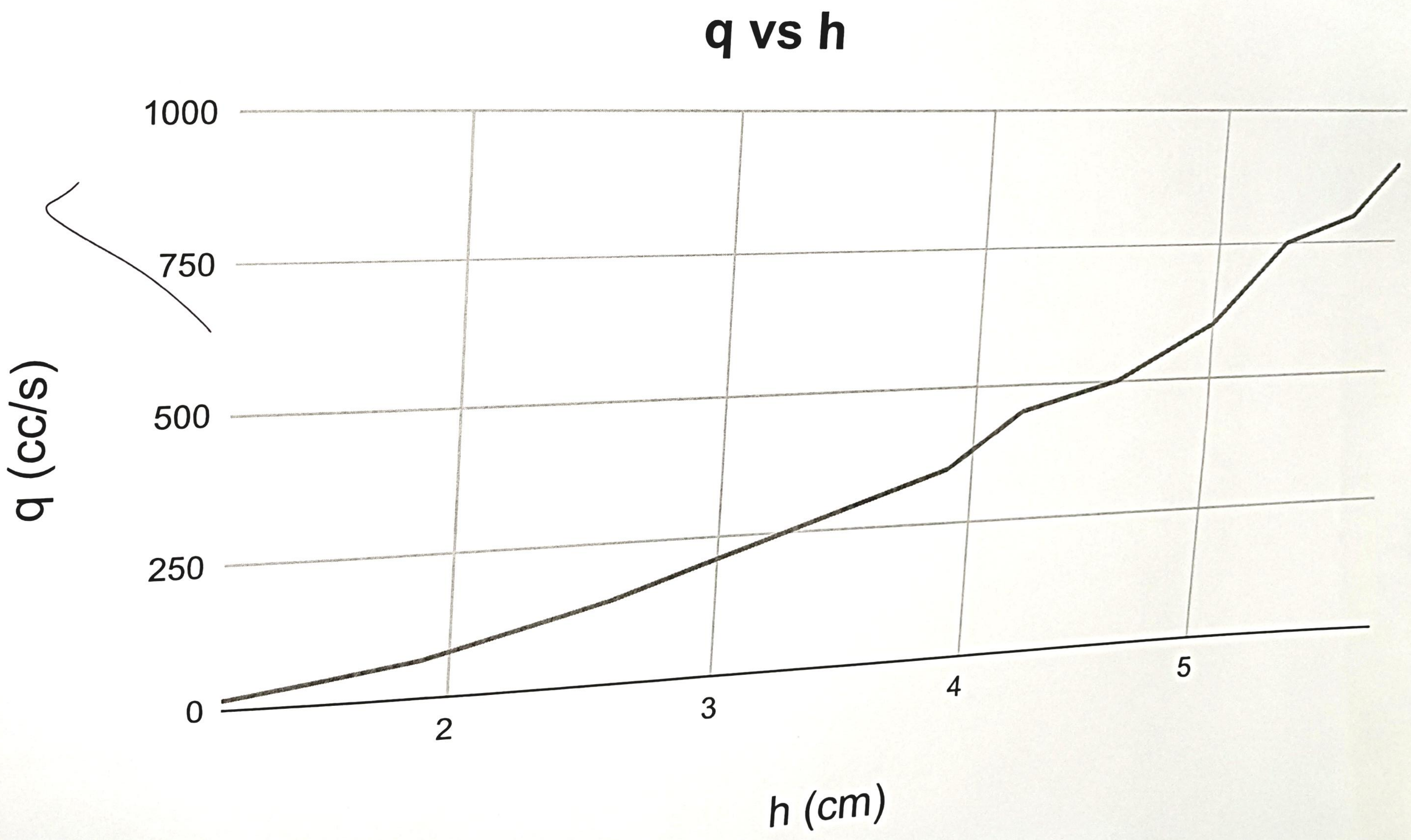
$= 23.6 \left(0.512\right)^{0.996} (3.9)^{2.47}$ ~~cc/s~~

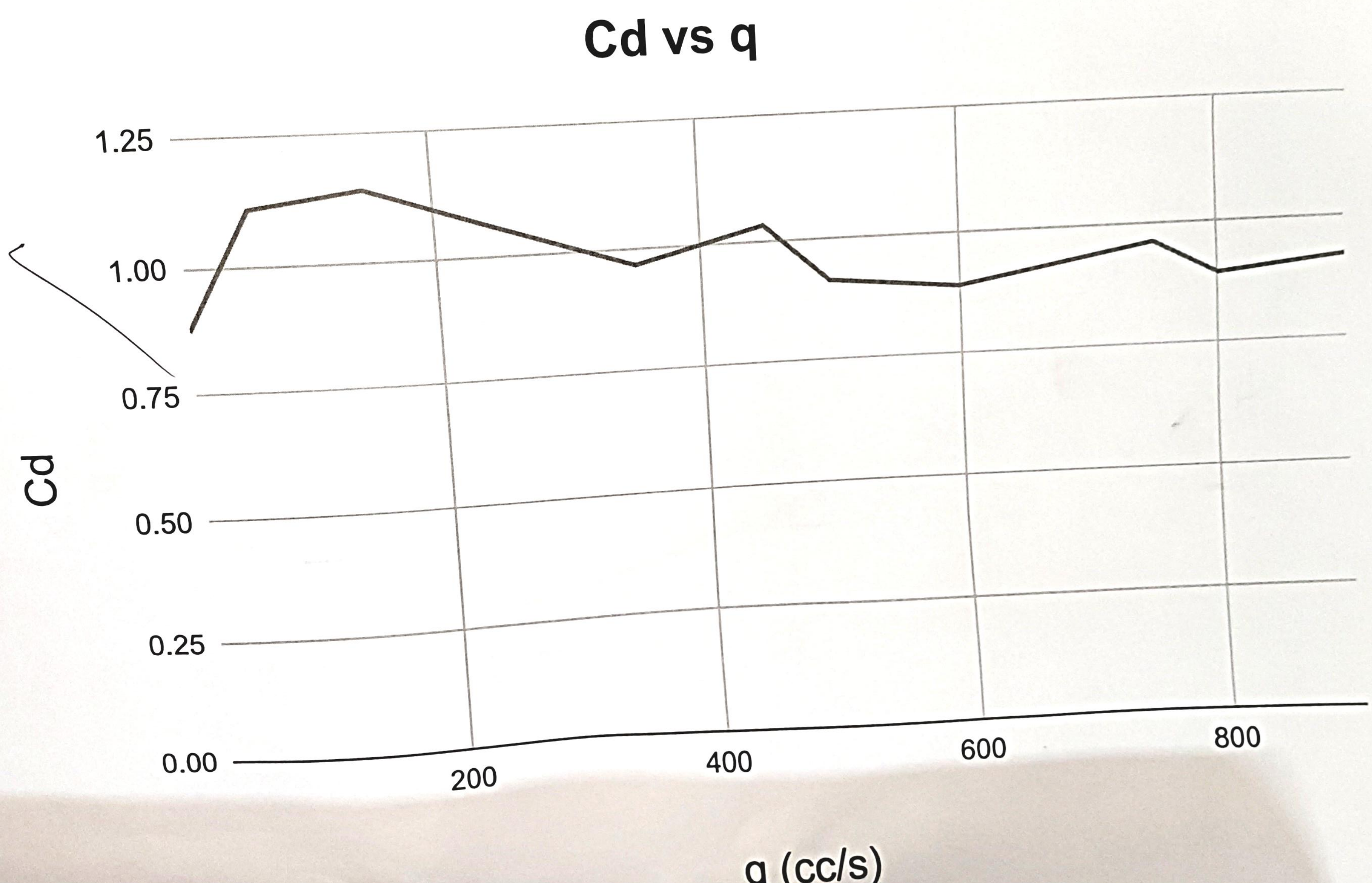
$= 348.68 cc/s$

$q_{ac} = \frac{8}{15} \times C_d \times \sqrt{2g} \tan(\theta/2)\, h^{5/2}$

$350 = \frac{8}{15} \times C_d \times \sqrt{2 \times 981} \tan \theta/2 \, (3.9)^{5/2}$

$C_d = 0.96$


q vs h
1000
750
500
250
0
2
3
4
5
q (cc/s)
h (cm)


Cd vs q
Cd
1.25
1.00
0.75
0.50
0.25
0.00
200
400
600
800
q (cc/s)

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→ Discussion

(i) Some water gets collected on the triangular notch which might gives the wrong flow rate of water.

(ii) During the first 3 trial the % Variation become low & steady, the suddenly increases for last run so we can say that at some optimum flow rate, % variation is low beyond this flow rate is random.

(iii) Their is a bend in the scale that measures the height of water which gives an error.

(iv) Random error of stopwatch is also counted.

9.5/10

Shivam G
14/2/23

→ Precautions :-

(i) Don't start the pump if supply is less than 300V.

(ii) Don't forget to give electric earth & neutral wire connection correctly, frequently least once in three month grease visual

P.R.E.