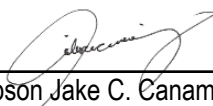


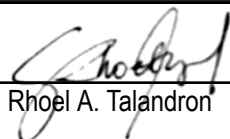
CHE 3214L Chemical Engineering Laboratory Investigations 1

Experiment Plan
(Form CHE 3214L-1)

Prepared and submitted by:


Gibson Jake C. Canama


Monica Claire L. Delco


Rhoel A. Talandron

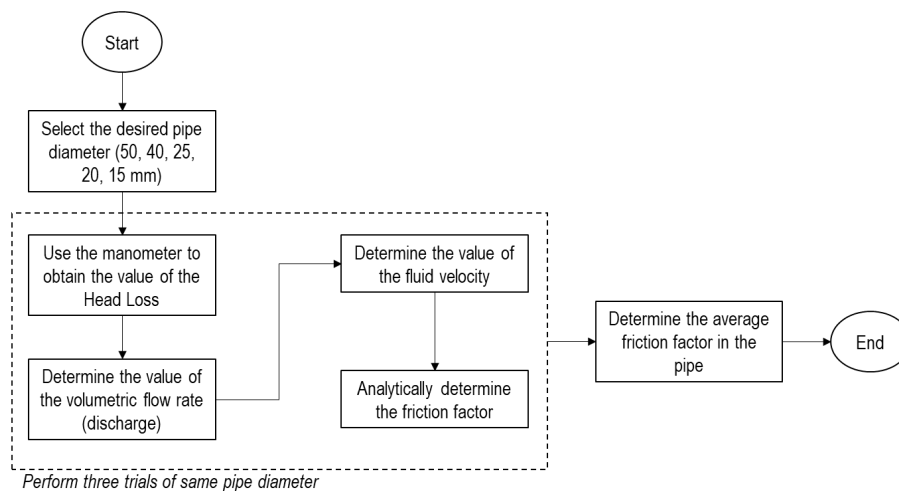
Experiment : **Fluid in Pipes 1: Friction in Pipes**

Objectives of the Experiment

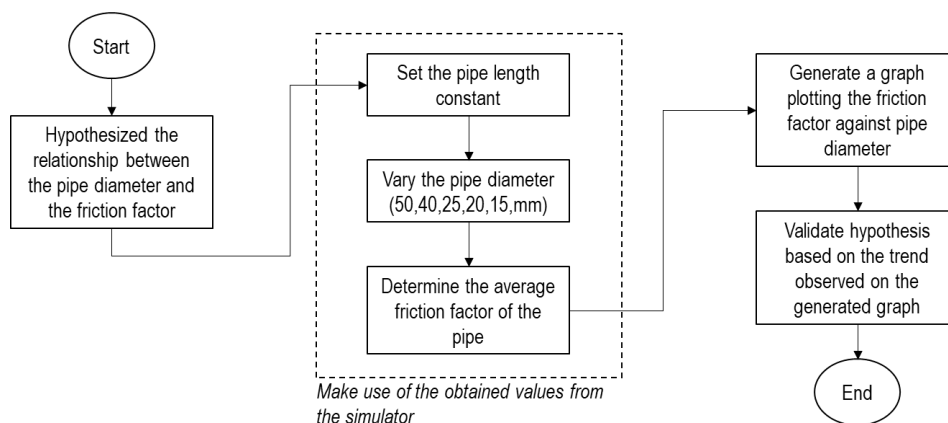
1. Determine the average friction factor in pipes of different diameter (50, 40, 25, 20, 15 mm)
2. Determine the effect of pipe diameter on the friction factor.
3. Compare the obtained experiment values to the calculated, simulator values.

Methodological Framework

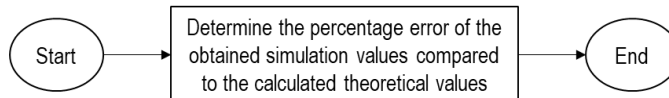
Objective 1: Determine the average friction factor in pipes of different diameter (50, 40, 25, 20, 15 mm)



Objective 2: Determine the effect of pipe diameter on the friction factor.



Objective 3: Compare the obtained experiment values to the calculated, simulator values.



Materials, Measuring Apparatus & Equipment

Material	Quantity
Water	-
Equipment	Specifications
Manometer	Differential
Pipes	15mm, 20mm, 25mm, 40mm, 50mm
Valves	Inlet
Stopwatch	Measures seconds
Collecting Tank	

Task Plan

Time	Task	Person Responsible
1:30-2:30	Pre-Laboratory Virtual Questioning	Canama
		Delco
		Talandron
2:30 – 2:45	Open Virtual Laboratory Link > Simulator Set-up	Canama Delco Talandron
	Selection of Pipe Diameter (50 mm)	
	Open Pipe Inlet Valve	
	Open Main Inlet Valve	(Note: Each member shall do the procedures)
	Changing of Manometer Knot (unique for each pipe diameter) from Isolate Position to Air-Vent Position	
	Change Knot to Reding Position and Open Pipe Exit Valve	

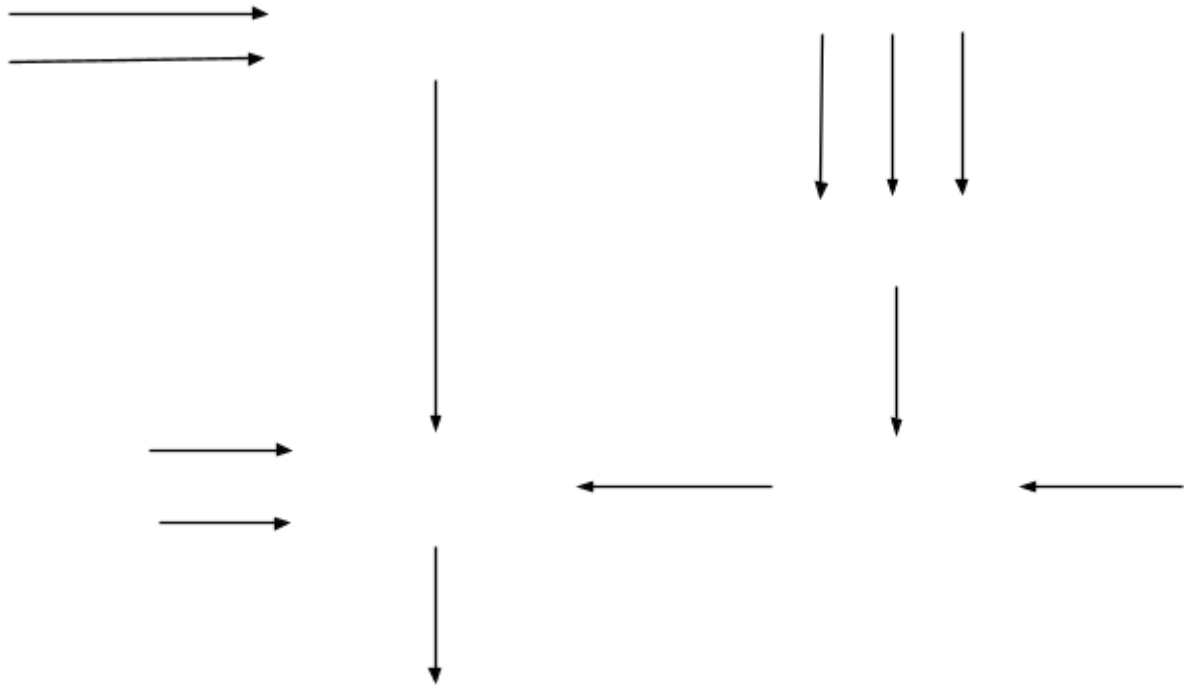
	Reading of Manometer and Calculating for the Pipe Head Loss	individually and simultaneously)
	Reading of Pipe Length, Tank Area, Water rises (height) in tank, and time taken	
	Calculate the Volume Flowrate	
	Calculate the fluid velocity in pipe	
	Calculation of Pipe Friction Factor	
	Resetting the Simulation Set-up for Next Pipe Diameter Trial	
2:45 – 3:00	Repetition of Procedures for 40 mm Pipe Diameter	Canama Delco Talandron (Note: Each member shall do the procedures individually and simultaneously)
3:00 – 3:15	Repetition of Procedures for 25 mm Pipe Diameter	Canama Delco Talandron (Note: Each member shall do the procedures individually and simultaneously)
3:15 – 3:30	Repetition of Procedures for 20 mm Pipe Diameter	Canama Delco Talandron (Note: Each member shall do the procedures individually and simultaneously)
3:30 – 3:45	Repetition of Procedures for 15 mm Pipe Diameter	Canama Delco Talandron (Note: Each member shall do the procedures individually and simultaneously)
3:45 – 4:15	Collection of Raw Data; Documentation Procedures; Analysis and Processing of Observed Mechanisms and Data Values from the Simulator	Canama Delco Talandron
4:25 – 4:30	Wrap-up of Discussions	

Information Flow Diagram

OBJECTIVE 1: Determine the Average Friction Factor in Pipes of Different Diameters

Assumptions:

- Pipe is cylindrical in form.
- Negligible Kinetic Energy, Potential Energy, Heat Transfer, and External Work
- Steady-State System
- Temperature of the system is at 25°C.



$$m_R$$

$$m_L$$

$$H_L = \frac{\Delta p}{\rho g} = (SG_m - SG_w)(m_L - m_R)$$

$$\phi_V = A \left(\frac{R}{t} \right)$$

$$v = \frac{4\phi_v}{\pi D^2}$$

$$f_D = \frac{2gH_L D}{Lv^2}$$

$$H_L$$

$$A$$

$$R$$

$$t$$

$$\phi_V$$

$$D$$

$$v$$

$$L$$

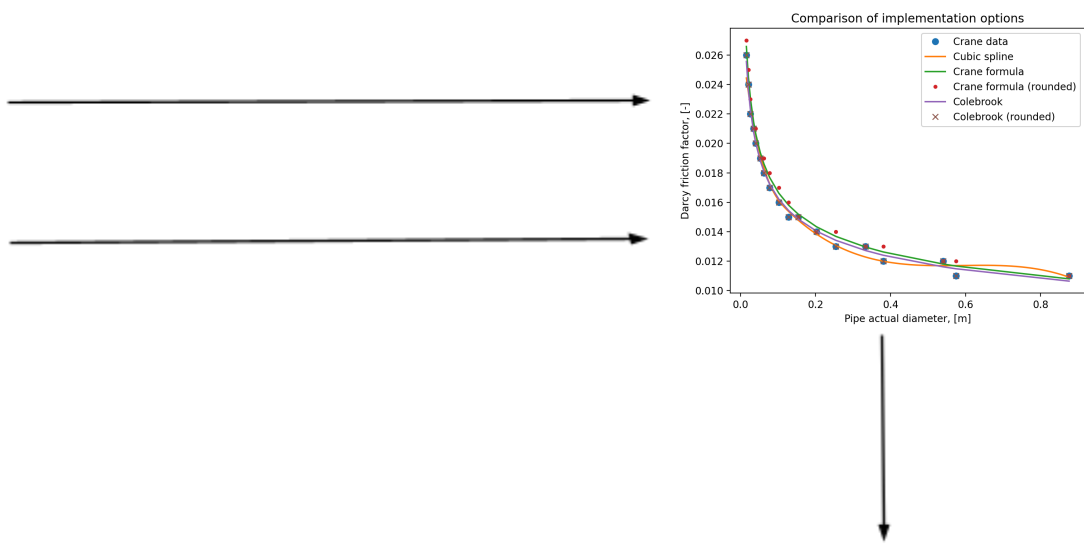
$$D$$

$$f_D$$

OBJECTIVE 2: Determine the Effect of Pipe Diameter on Friction Factor

Assumption:

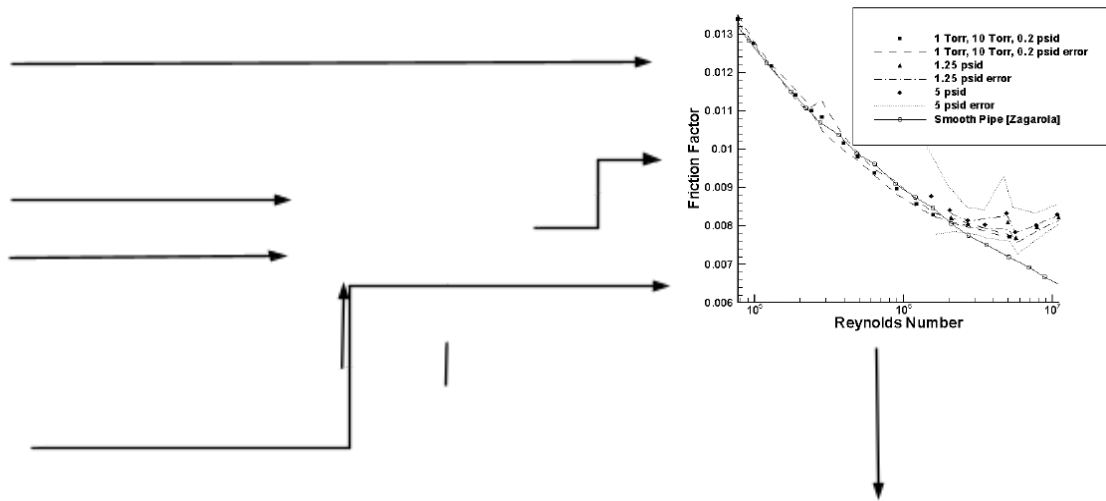
- Temperature of the system is at 25°C.



D

f_D

Relationship between Friction Factor and Pipe Diameter



D

L

ρ_w

μ_w

$$Re = \frac{\rho_w v L}{\mu_w}$$

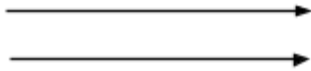
v

f_D

Relationship between Friction Factor and Reynold's Number at different Pipe Diameters

Re

OBJECTIVE 3: Compare the Obtained Experiment Values to the Calculated, Simulator Values



$$f_D$$

$$f_{D,expt}$$

$$\delta = \frac{|f_D - f_{D,expt}|}{f_D} \times 100\%$$

$$\delta$$

Legend:

$m_R = \text{Right Limb Reading (cm)}$

$m_L = \text{Left Limb Reading (cm)}$

$H_L = \text{Head Loss (cm)}$

$g = \text{Acceleration due to Gravity} \left(\frac{\text{cm}}{\text{s}^2} \right) = 981 \frac{\text{cm}}{\text{s}^2}$

$A = \text{Tank Area (cm}^2) = 3500 \text{ cm}^2$

$R = \text{Water rise in tank (cm)}$

$t = \text{Time (s)}$

$\phi_v = \text{Volumetric Flowrate} \left(\frac{\text{cm}^3}{\text{s}} \right)$

$D = \text{Pipe Diameter (cm)}$

$L = \text{Pipe Length (cm)}$

$v = \text{Velocity} \left(\frac{\text{cm}}{\text{s}} \right)$

$SG_m = \text{Specific Gravity of Mercury} = 13.6$

$SG_w = \text{Specific Gravity of Water} = 1.0$

$\varepsilon = \text{Relative Roughness (cm)} = 0.004572 \text{ cm [commercial steel]}$

$f_D = \text{Darcy – Weisbach Friction Factor}$

$SR = \text{Surface Roughness}$

$\rho_w = \text{Density of Water (g/cm}^3\text{)} = 1 \frac{\text{g}}{\text{cm}^3}$

$\mu_w = \text{Viscosity of Water} \left(\frac{\text{g}}{\text{s.cm}} \right) = 8.9 \times 10^{-3} \frac{\text{g}}{\text{s.cm}}$

$Re = \text{Reynold's Number}$

$f_{D, \text{expt}} = \text{Experimental Darcy – Weisbach Friction Factor from Simulator}$

$\delta = \text{Relative Error (\%)}$

Raw Data Sheets

CANAMA: Raw Data and Documentation

Table 1.1. Raw Data Set for Experiment Procedures at 50 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	42	30	55	65	10	3500	13
2	300	40	32	55	65	10	3500	24
3	300	39.5	32.5	55	65	10	3500	27
Average	300	40.5	31.5	55	65	10	3500	21.33

Table 1.2. Raw Data Set for Experiment Procedures at 40 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	40.5	28	55	65	10	3500	16
2	300	37	31.5	55	65	10	3500	42
3	300	38	30.5	55	65	10	3500	33.5
Average	300	38.5	30	55	65	10	3500	30.5

Table 1.3. Raw Data Set for Experiment Procedures at 25 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	32.5	25.75	55	65	10	3500	31.25
2	300	35	23.25	55	65	10	3500	22
3	300	34.5	23.75	55	65	10	3500	24.5
Average	300	34	24.25	55	65	10	3500	25.92

Table 1.4. Raw Data Set for Experiment Procedures at 20 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	31	22.5	55	65	10	3500	47.5
2	300	31	22.5	55	65	10	3500	47.5

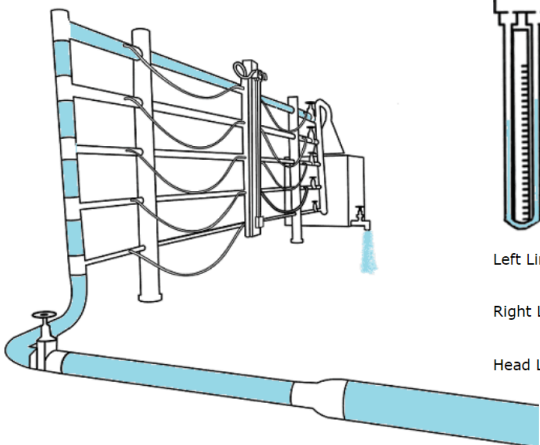
3	300	29.5	24	55	65	10	3500	61
Average	300	30.5	23	55	65	10	3500	52

Table 1.5. Raw Data Set for Experiment Procedures at 15 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	30	20.5	55	65	10	3500	59
2	300	30.5	20	55	65	10	3500	55
3	300	28	22.5	55	65	10	3500	72
Average	300	29.5	21	55	65	10	3500	62

FRICTION IN PIPES

STEP 5 Note down the manometer reading.



TRIAL : 2

Left Limb Reading (LL) = 32cm

Right Limb Reading (RL) = 40cm

Head Loss (H) = CHECK

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50mm										
Trial	Person	L (cm)	m_R (cm)	m_L (cm)	Initial Height	Final Height	R (cm)	A (cm ²)	t (s)	
1		300	42	30	55	65	10	3500	13	Head Loss
2		300	40	32	55	65	10	3500	24	VFL
3		300	39.5	32.5	55	65	10	3500	27	Velocity
Average		300	40.5	31.5	55	65	10	3500	18.5	Friction Factor
40mm										
Trial	Person	L (cm)	m_R (cm)	m_L (cm)	Initial Height	Final Height	R (cm)	A (cm ²)	t (s)	
1										
2										
3										
Average		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	
25mm										
Trial	Person	L (cm)	m_R (cm)	m_L (cm)	Initial Height	Final Height	R (cm)	A (cm ²)	t (s)	
1	Gibson									
2	Monica									
3	Rhoel									
Average										

DELCO: Raw Data and Documentation

Table 2.1. Raw Data Set for Experiment Procedures at 50 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	40	32	55	65	10	3500	24
2	300	39.5	32.5	55	65	10	3500	27
3	300	39.5	32.5	55	65	10	3500	27
Average	300	39.66666667	32.33333333	55	65	10	3500	26

Table 2.2. Raw Data Set for Experiment Procedures at 40 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	40	28.5	55	65	10	3500	19
2	300	38.5	30	55	65	10	3500	30
3	300	37	31.5	55	65	10	3500	42
Average	300	38.5	30	55	65	10	3500	30.33333333

Table 2.3. Raw Data Set for Experiment Procedures at 25 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	34.5	23.75	55	65	10	3500	24.5
2	300	33	25.25	55	65	10	3500	30.2
3	300	32.1	26.25	55	65	10	3500	35
Average	300	33.2	25.08333333	55	65	10	3500	29.9

Table 2.4. Raw Data Set for Experiment Procedures at 20 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	29	24.5	55	65	10	3500	69
2	300	29	24.5	55	65	10	3500	69
3	300	31.5	22	55	65	10	3500	46
Average	300	29.83333333	23.66666667	55	65	10	3500	61.33333333

Table 2.5. Raw Data Set for Experiment Procedures at 15 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	27.5	23	55	65	10	3500	75
2	300	28.5	22	55	65	10	3500	69
3	300	28.5	22	55	65	10	3500	69
Average	300	28.16666667	22.33333333	55	65	10	3500	71

50mm								
Trial/Person	L (cm)	m_R (cm)	m_L (cm)	Initial Height	Final Height	R (cm)	A (cm ²)	t (s)
1	300	40	32	55	65	10	3500	24
2	300	39.5	32.5	55	65	10	3500	27
3	300	39.5	32.5	55	65	10	3500	27
Average	300	39.66666667	32.33333333	55	65	10	3500	26

40mm								
Trial/Person	L (cm)	m_R (cm)	m_L (cm)	Initial Height	Final Height	R (cm)	A (cm ²)	t (s)
1	300	40	28.5	55	65	10	3500	19
2	300	38.5	30	55	65	10	3500	30
3	300	37	31.5	55	65	10	3500	42
Average	300	38.5	30	55	65	10	3500	30.33333333

25mm								
Trial/Person	L (cm)	m_R (cm)	m_L (cm)	Initial Height	Final Height	R (cm)	A (cm ²)	t (s)
1	300	34.5	23.75	55	65	10	3500	24.5

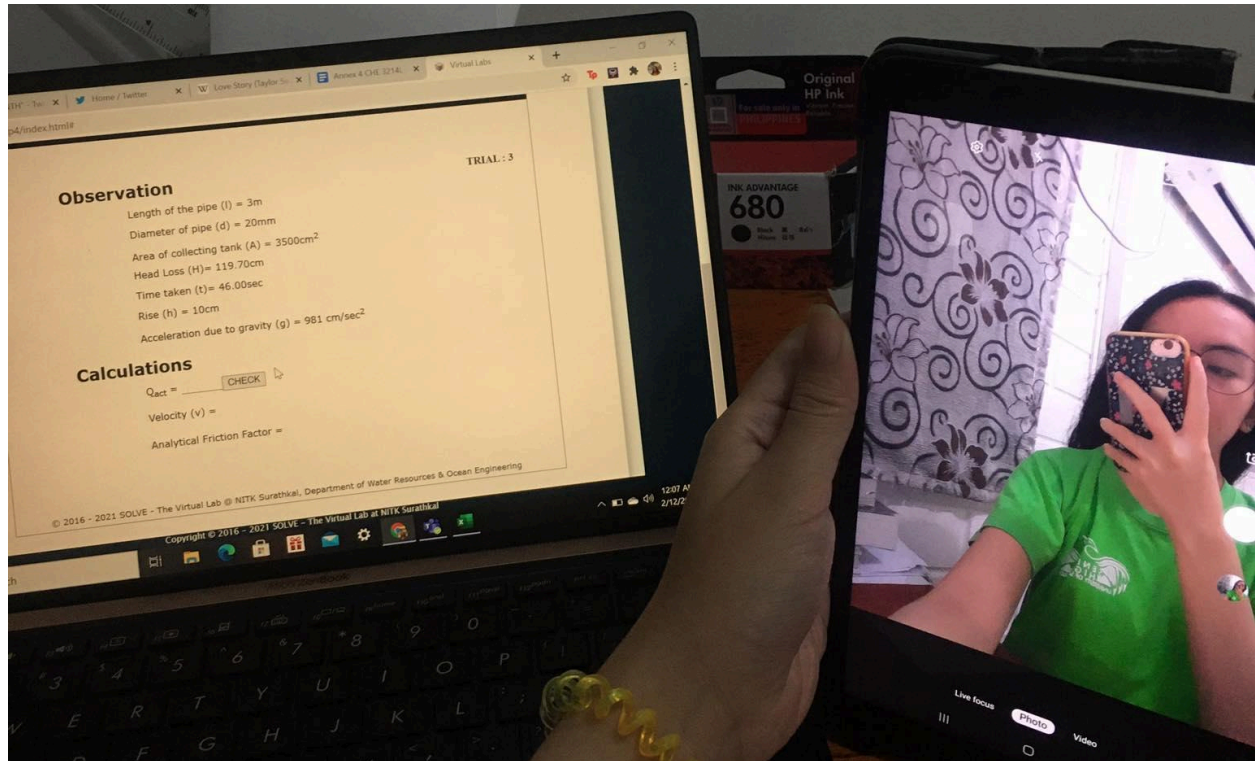
Gibson Raw Data **Monica Raw Data** Rhoel Raw Data (+) : 4

1	300	34.5	23.75	55	65	10	3500	24.5
2	300	33	25.25	55	65	10	3500	30.2
3	300	32.1	26.25	55	65	10	3500	35
Average	300	33.2	25.08333333	55	65	10	3500	29.9

20mm								
Trial/Person	L (cm)	m_R (cm)	m_L (cm)	Initial Height	Final Height	R (cm)	A (cm ²)	t (s)
1	300	29	24.5	55	65	10	3500	69
2	300	29	24.5	55	65	10	3500	69
3	300	31.5	22	55	65	10	3500	46
Average	300	29.83333333	23.66666667	55	65	10	3500	61.33333333

15mm								
Trial/Person	L (cm)	m_R (cm)	m_L (cm)	Initial Height	Final Height	R (cm)	A (cm ²)	t (s)
1	300	27.5	23	55	65	10	3500	75
2	300	28.5	22	55	65	10	3500	69
3	300	28.5	22	55	65	10	3500	69
Average	300	28.16666667	22.33333333	55	65	10	3500	71

Gibson Raw Data **Monica Raw Data** Rhoel Raw Data (+) : 4



TALANDRON: Raw Data and Documentation

Table 3.1. Raw Data Set for Experiment Procedures at 50 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	41.5	30.5	55	65	10	3500	15
2	300	39.5	32.5	55	65	10	3500	27
3	300	40	32	55	65	10	3500	24
Average	300	40.33333 3	31.666667	55	65	10	3500	22

Table 3.2. Raw Data Set for Experiment Procedures at 40 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	38.5	30	55	65	10	3500	30
2	300	39.5	29	55	65	10	3500	23
3	300	38.5	30	55	65	10	3500	30
Average	300	35.5	29.666667	55	65	10	3500	27.66666 7

Table 3.3. Raw Data Set for Experiment Procedures at 25 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
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1	300	34	24.25	55	65	10	3500	25.5
2	300	34.5	23.75	55	65	10	3500	24.5
3	300	33.5	24.75	55	65	10	3500	26.3
Average	300	34	24.25	55	65	10	3500	25.43333

Table 3.4. Raw Data Set for Experiment Procedures at 20 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	32.5	21	55	65	10	3500	43.5
2	300	31	22.5	55	65	10	3500	47.5
3	300	32.5	21	55	65	10	3500	43.5
Average	300	32	21.5	55	65	10	3500	44.83333

Table 3.5. Raw Data Set for Experiment Procedures at 15 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	28.5	22	55	65	10	3500	69
2	300	30.5	20	55	65	10	3500	55
3	300	29.5	21	55	65	10	3500	63
Average	300	29.5	21	55	65	10	3500	62.33333

The screenshot displays three tables of raw data for experiments at different pipe diameters. The tables are as follows:

Table 3.2: Raw Data Set for Experiment Procedures at 40 mm Pipe Diameter

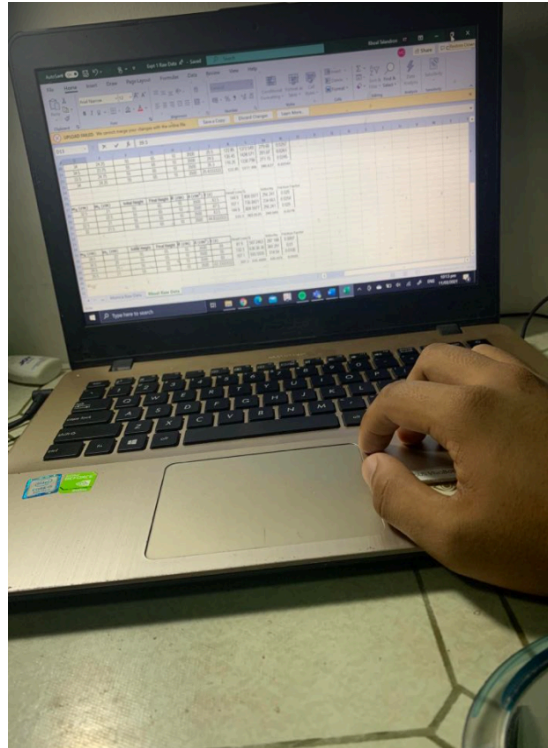
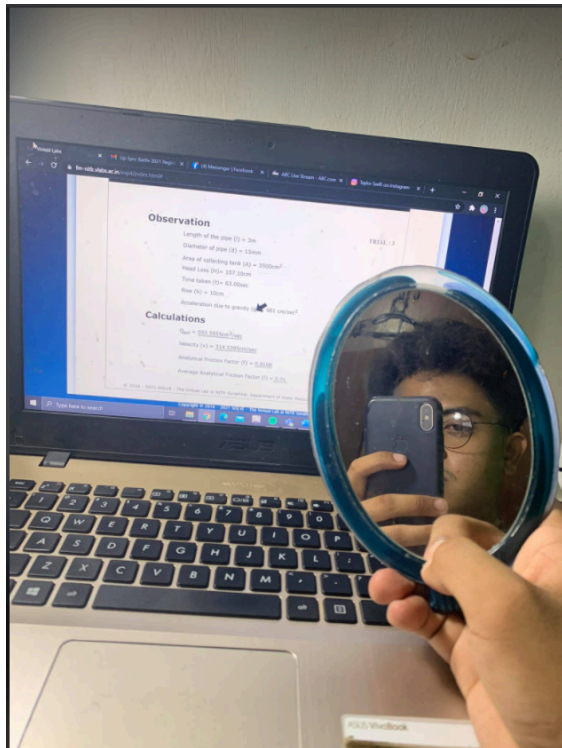
Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	38.5	30	55	65	10	3500	30
2	300	39.5	29	55	65	10	3500	23
3	300	38.5	30	55	65	10	3500	30
Average	300	35.5	29.66667	55	65	10	3500	27.66667

Table 3.3: Raw Data Set for Experiment Procedures at 25 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	34	24.25	55	65	10	3500	25.5
2	300	34.5	23.75	55	65	10	3500	24.5
3	300	33.5	24.75	55	65	10	3500	26.3
Average	300	34	24.25	55	65	10	3500	25.43333

Table 3.4: Raw Data Set for Experiment Procedures at 20 mm Pipe Diameter

Trial	L (cm)	m_R (cm)	m_L (cm)	R_0 (cm)	R_1 (cm)	R (cm)	A (cm ²)	t (s)
1	300	32	21.5	55	65	10	3500	44.83333



TEAM MEETING DOCUMENTATION

