1- Calibration of Pressure Gauge Using Dead Weight Tester

Procedure:

1- Fill the interior of the apparatus with oil, and free it from air bubbles.

2- Fit the tested gauge in position.

3- Level the apparatus in a horizontal position.

4- Table the reading of the tested gauge before putting the piston in place. This is the zero reading of the gauge.

5- Close the valve of the tested gauge and put the piston in place. Put a load on the piston and use the handle to reach the equilibrium position, Stake reading of gauge at equilibrium position.

6- Repeat, with increasing the load, use handle to retain equilibrium position.

7- Continue till you reach the maximum reading on the gauge then reduce the load gradually and take readings in the unloading process.

8- Plot a curve between the actual pressure and the indicated pressure.

The actual pressure = (Load)/(area of piston)
Indicated pressure = reading on the gauge.

Observations:

Load (Kg_f)	**Indicated pressure (Kg_f/cm^2)**	
	During Loading	**During Unloading**
Zero		

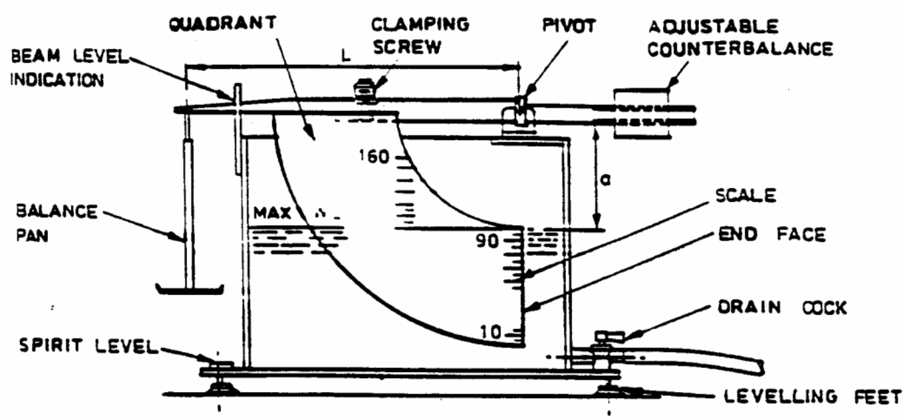
Results:

Actual Pressure	**Indicated pressure (Kg_f/cm^2)**		
(Kg_f/cm^2)	**Loading**	**Unloading**	**Average**
Zero			

2- Determination of the Centre of Pressure of a Plane Surface Immersed In Water Using Hydrostatic Pressure Apparatus

Objective of Experiment:

To determine the position of the centre of pressure of a plane surface immersed in water and to compare the experimental position with the theoretical position.



Experiment Setup:

Hydraulics Bench, Hydrostatic Pressure Apparatus.

Summary of Theory:

Any flat surface immersed in a liquid either partially or totally submerged is exposed to a force (F) which is exerted by the liquid on this surface. This force equals the pressure at the centroid multiplied by the area of the submerged surface.

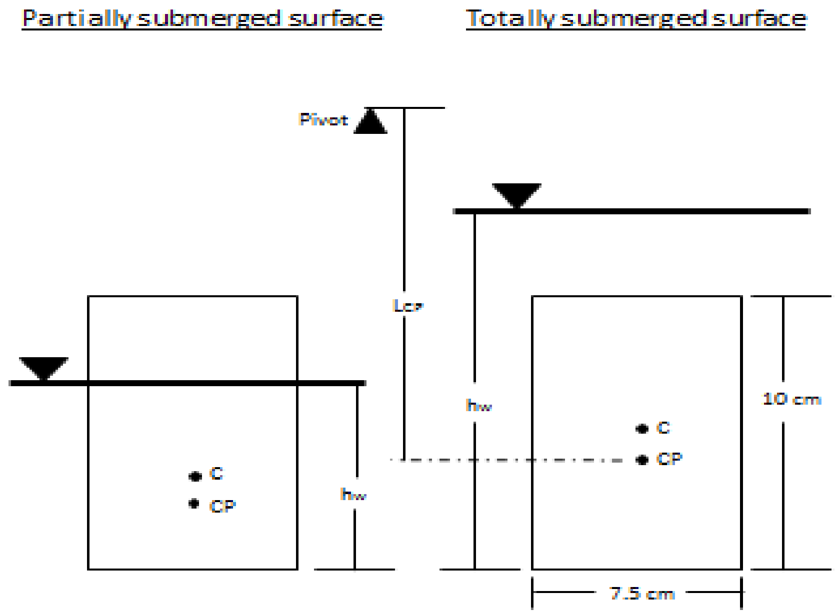
Procedure:

1. Level the tank using the adjustable feet and spirit level.
2. Move the counterbalance mass until the balance arm is horizontal.
3. Close the drain cock and admit water until the level reaches the bottom edge of the quadrant.
4. Place a mass on the balance pan then add water slowly into the tank until the balance arm is horizontal.
5. Repeat the above for each increment of mass until the water level reaches the maximum reading on the scale.

Readings to be taken:

Reading Number	Mass on Balance, M (gm)	Water level, h_{Water} (mm)
1		
2		
3		
4		
5		

+Results and Calculations:



$A = h_w * 7.5\ cm^2$

$h_C = \frac{h_w}{2}$

$L_{CP\ th} = 20 - \frac{h_w}{2} + CCP$

$A = 10 * 7.5\ cm^2$

$h_C = h_w - 5$

$L_{CP\ th} = 20 - 5 + CCP$

$$m * g * 27.5 = F_R * L_{CP\ Exp}$$

Determination of the position of the center of pressure Lcp_{exp} experimentally:

$$F_R = \gamma_w * h_c * A$$

Where,

γ_L = Specific weight of liquid.

h_c = Vertical distance from the liquid surface to the centroid of the submerged area.

A = Area of the submerged surface (A = b x d).

Taking moments about the pivot:

$Mg * L = F_R * Lcp_{exp}$

Where,

Lcp_{exp} = Actual vertical distance from the pivot to point C (center of pressure).

L = Perpendicular distance between the pivot and the point of action of the weights.

Calculations Table

Mg (N)	**L (m)**	**γ_L (N/m^3)**	**h_c (m)**	**A (m^2)**	**F_R (N)**	Lcp_{exp}

Determination of the position of the centre of pressure Lcp_{th} theoretically:

For totally submerged surface:

$$A = 10 * 7.5\ cm^2$$

$$h_C = h_w - 5$$

$$L_{CP\ th} = 20 - 5 + CCP$$

For partially submerged surface:

$$A = h_w * 7.5\ cm^2$$

$$h_C = \frac{h_w}{2}$$

$$L_{CP\ th} = 20 - \frac{h_w}{2} + CCP$$

$$CCP = \frac{I_{xx,c}}{A * y_c}$$

Where;

y_c = Vertical distance from the pivot to point G (centroid).

$I_{xx,c}$ = Second moment of area about horizontal axis passing through point "c" and parallel to the liquid surface.

b = Width of submerged surface.

d = Length of submerged surface.

Calculations Table

H_c (m)	h_O (m)	Y_c (m)	A (m^2)	$I_{xx,c}$	*CCP*	Lcp_{th}

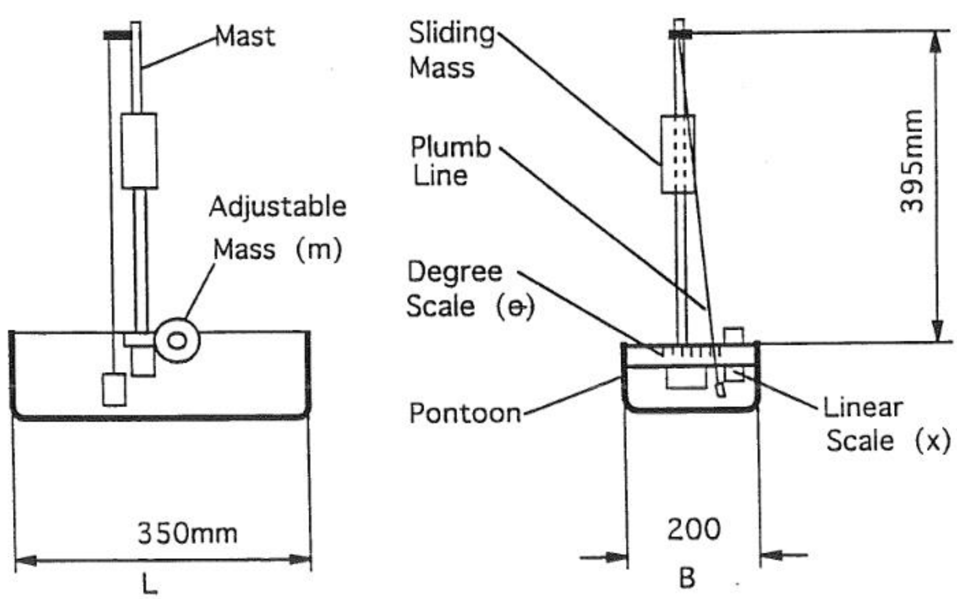
3- Stability of a floating body

Objectives of the Experiment:

Determination of the metacentric height.

Experimental Procedures:

1. Weight the adjustable mass (m).
2. Assemble the pantoon completely and weight it.
3. Position the sliding mass along the mast such that the centre of gravity occurs at the top of the pantoon
4. Determine the position of the centre of gravity.
5. Float the pantoon ensuring that the adjustable mass is in its centre position.
6. Move adjustable mass to the right in 10mm increments (distance x) to the end of the scale noting the angular displacement (θ)
7. Repeat the movement of adjustable mass to the left
8. Change the position of the sliding mass and repeat.



Observations:

Ajustable mass (m) = 304 g

Total mass (M) = 1478g

First position of the sliding mass:

Position of G from the pantoon (y) =

Distance (x) to the right	Angle (θ)	Distance (x) to the left	Angle (θ)

Second position of the sliding mass :

Position of G from the pantoon (y) =

Distance (x) to the right	Angle (θ)	Distance (x) to the left	Angle (θ)

Calculations:

$$\mathrm{GM_{ex}} = \frac{mx}{M \tan\theta}$$

$$\mathrm{BM} = \frac{\mathrm{I}}{\mathrm{V_{imm}}}, I = \frac{LB^3}{12}, V_{imm} = \frac{M}{\rho_L}$$

$$GM_{th} = BM - BG$$

$$BG = y - \frac{l_{imm}}{2}$$

4- Secondary Losses in Bends and Fittings

Objectives of the Experiment:

The objectives of the experiment are to demonstrate the secondary losses associated with flow through bends and fittings.

Experimental Procedures:

1. Close the regulation valve and start the centrifugal pump.
2. Open the valve partially.
3. Wait for steady flow (Peizometers readings = constant).

Read the differential readings of the Peizometers connected to the mitre, the elbow, the short bend, the enlargement and the contraction.

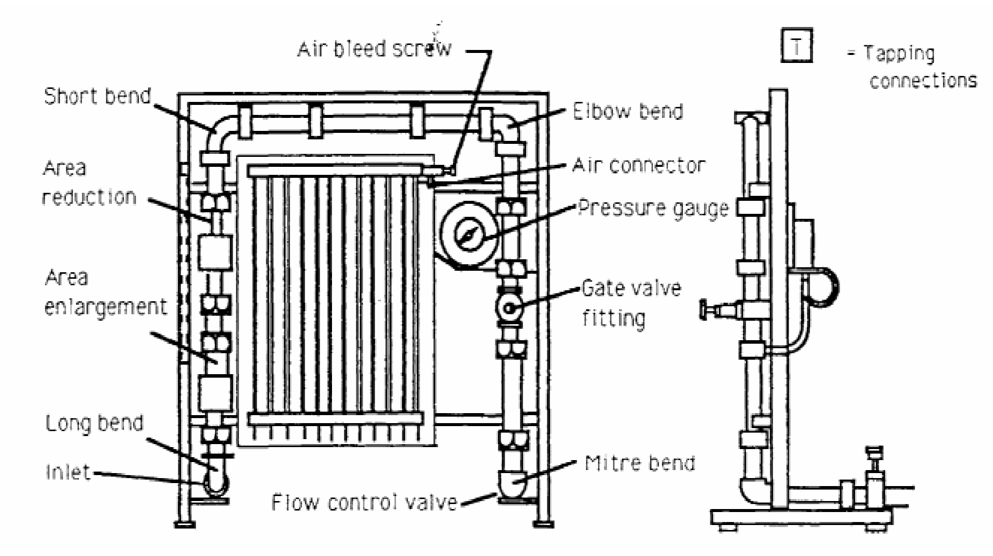
4. Read the initial volume in the collection tank V_1
5. Observe the time (t) to increase the collected volume to V_2
6. Increase the valve opening
7. Repeat the experiment two times.
8. After recording all the required readings, close the valve gradually then stop the centrifugal pump.

Note:

Pipe area: 301.7 mm^2

Enlargement pipe diameter: 26.2 mm

Contraction pipe diameter: 19.48 mm



Observations:

No	1				2			
	Δh (cm)	V_1 (lit.)	V_2 (lit.)	t (Sec.)	Δh (cm)	V_1 (lit.)	V_2 (lit.)	t (Sec.)
Mitre								
Elbow								
Short bend								
Enlargement								
contraction								

Calculations:

$$Q_{act} = \frac{V_2 - V_1}{t}$$

$$\Delta h = K\frac{v^2}{2g} \qquad \text{(Mitre, Elbow \& Short bend)}$$

$$\Delta h = K\frac{v_2^2}{2g} \qquad \text{(Contraction)}$$

$$\Delta h = K\frac{(v_1 - v_2)^2}{2g} - \frac{v_1^2 - v_2^2}{2g} \qquad \text{(Enlargement)}$$

Where:

v_1: *Upstream velocity*

v_2: *Downstream velocity*

Results:

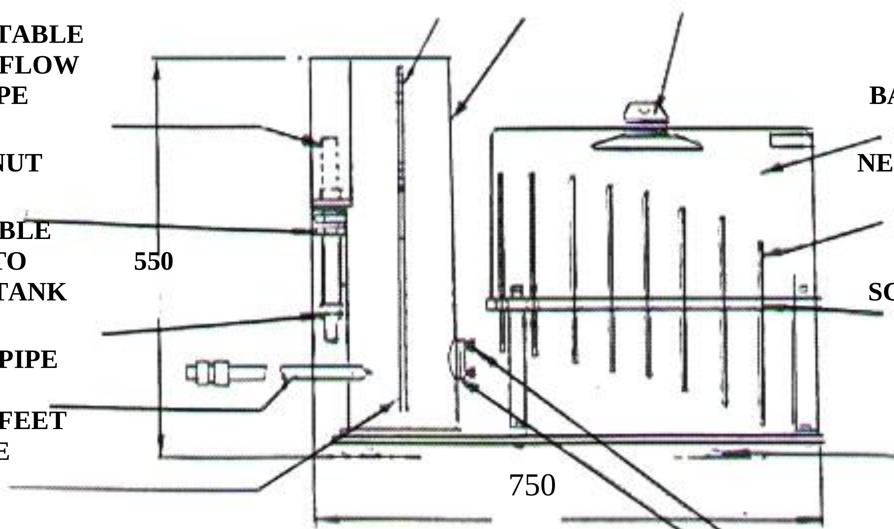
K	1	2	Average
Mitre			
Elbow			
Short bend			
Enlargement			
Contraction			

5- Calibration of Orifice Meter

Object of Experiment:

To find experimentally the coefficient of velocity, the coefficient of discharge and the coefficient of contraction for a small orifice for the flow under constant head tank.

Equipment setup:



Summary of Theory:

$$x = vt$$

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

$$v_{act} = \frac{x}{\sqrt{2y/g}}$$

$$v_{th} = \sqrt{2gh}$$

$$C_v = \frac{v_{act}}{v_{th}} = \frac{x}{\sqrt{4yh}} = \frac{x}{2\sqrt{yh}}$$

NOTE: x is the horizontal distance measured from the plane of the Vena Contracta. y is the distance measured from the plane of the orifice.
Q_{act} = Volume (V)/Time (T)

$$Q_{th} = A\sqrt{2gh}$$

$$C_d = Q_{act} / Q_{th}$$

Where A is the orifice area
Orifice diameter = 6 mm

$$C_c = C_d / C_v$$

Experiment procedure:

1. Connect the apparatus to the bench ensuring that the overflow pipe hose drains into the sump tank. Level the apparatus by adjusting the feet, ensuring that the path of the jet coincides with the row of measuring needles. Place a sheet of paper on the backboard, raise the needles to clear the path of the water jet.

2. Raise the overflow pipe, open the flow control valve, admit water into the head tank. Adjust the valve until the water is just spilling into the overflow. Record the head h on the scale. Assess the position of the Vena Contracta visually and note the distance from the orifice.

3. Adjust each of the needles in turn to determine the jet path, marking the position of the tops of the needles on the sheet of paper on the backboard.

4. Measure the flow rate Q using the volumetric tank and stopwatch.

5. Repeat for different water levels h.

6. Calculate C_d, C_v and C_c at different tank heads

7. Plot C_d, C_v, and C_c against tank heads then find a specified values for each one of them from the graph.

Results and Calculations:

Reading No.	Head (h) mm	Height (y) mm	Distance (x) mm	Velocity coefficient Cv
1				
2				
3				
4				
5				
6				

Volume of water (V) lit	Time (T) sec	Flowrate (Q) lit / sec	Discharge coefficient C_d	Contraction coefficient C_c

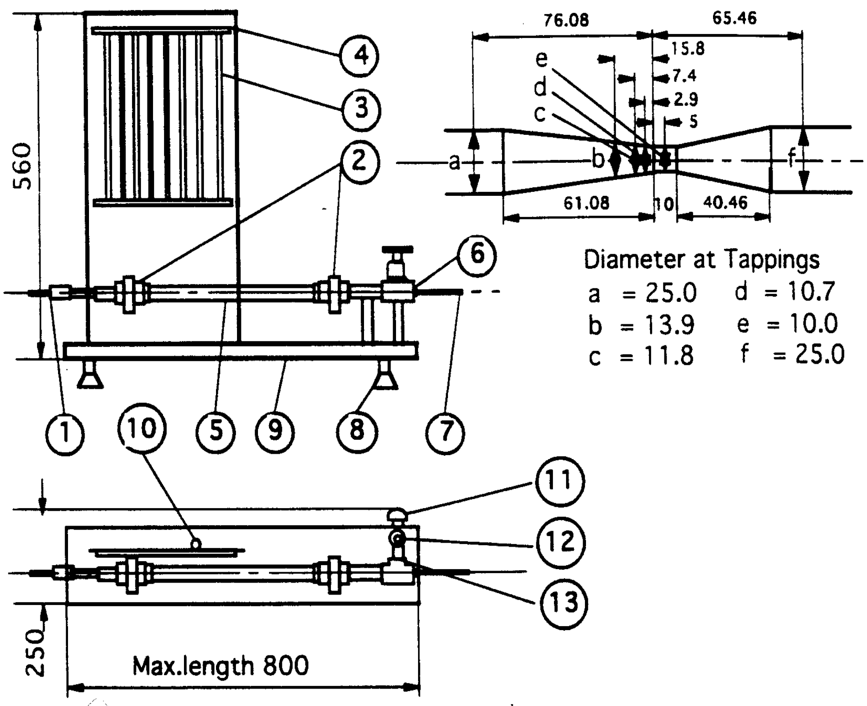
6- Bernoulli's Experiment and Calibration for Venturi-Meter

Objective of Experiment:

To investigate the validity of Bernoulli's Theorem as applied to the flow of water in a tapering circular duct.

Equipment Setup:

Hydraulics Bench, Bernoulli's Theorem Demonstration Apparatus, Stopwatch.



Summary of Theory:

Considering flow at two sections in a pipe, Bernoulli's equation may be written as:

$$\frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + Z_2$$

For this apparatus $Z_1 = Z_2$

Hence if Bernoulli's Theorem is obeyed

$H = \frac{V^2}{2g} + h$ is constant at all sections along the duct .

$$Q_{th} = \frac{A_1 A_5}{\sqrt{A_1^2 - A_5^2}} \sqrt{2g\, H_{1-5}}$$

A_1 : Inlet area, A_5 : Throat area

$$H_{1-5} = H_1 - H_5$$

$$Q_{act} = \frac{V_2 - V_1}{T}$$

$$C_{d(v)} = \frac{Q_{act}}{Q_{th}}$$

Theoretical head = $\frac{V^2}{2g} + \frac{P}{w}$

Actual head = Pitot tube head

Procedure:

1. Carefully fill the apparatus manometer tubes with water.
2. Discharge all pockets of air from the system.
3. Adjust the feed water and the flow control valve.
4. Take readings of volume and time to find the flow rate.
5. Take the manometer readings of the six tapping points.
6. Take the reading of the manometers at section 1&5 to calculate the discharge coefficient for five different flow rates.

Results and Calculations:

No.	V_1 (lit)	V_2 (lit)	T (s)	H_1 (m)	H_2 (m)	H_3 (m)	H_4 (m)	H_5 (m)	H_6 (m)
1									
2									
3									
4									
5									

No	Q_{act} (m^3/s)	Q_{th} (m^3/s)	C_d
1			
2			
3			
4			
5			